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Towards Reaching Sustainable Urban Development in the Kathmandu Valley of Nepal: An Economic Analysis of Solid Waste Management, Recycling, and the Health Impacts of Air Pollution.

Menuka Karki

Menuka Karki
Candidate

Economics
Department

This dissertation is approved, and it is acceptable in quality and form for publication:

Approved by the Dissertation Committee:

Alok K. Bohara, Co-Chairperson

Jennifer A. Thacher, Co-Chairperson

Richard Santos, Member

Keshav Bhattarai, Member

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MENUKA KARKI

BCIS, Bachelor of Computer Information System, Apex College, Pokhara University, 2004

M.A., Applied Economics, University of New Mexico, 2010

DISSERTATION

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DEDICATION

To my mom, the source of my strength

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ABSTRACT

The Kathmandu Valley is a rapidly growing and densely populated largest urban area, which includes the capital city, in Nepal, and it faces the challenge of protecting environment and safeguarding public health. This dissertation spans over three separate papers and addresses the two environmental issues of the Kathmandu valley i.e., management of solid waste and outdoor air pollution. Solid waste management related two papers talk about people's preference and willingness to pay for improvement in the solid

waste management service, and the determinants of people's recycling behavior. Outdoor air pollution paper estimates health impact of exposure to outdoor air pollution. All the papers use primary data from a household survey conducted in 2012.

Chapter 2 estimates the Kathmandu Valley residents' preferred changes to the existing household solid waste management using a choice experiment survey. Included waste management attributes are waste collection time, community waste management program, waste segregation types, frequency of waste collection and the monthly user fee. According to the results, sub-urban and core-urban residents have distinctively different preference for their most preferred attribute and willingness to segregate waste. For example, people in the core urban area are willing to pay the most (i.e., 404 Rupees per month per household) for having a community waste management program and people in the sub-urban area are willing to pay the most for (480 Rupees per month per household) for scheduled waste collection. Sub-urban area residents are willing to segregate two type of waste, but core urban residents are not willing to segregate any. An average Kathmandu Valley resident prefers having a waste management program and scheduled and frequent waste collection service in his/her community.. Kathmandu Valley residents, however, are willing to accept less frequent collection given the waste is collected in a scheduled time frame, which is an important policy implication for municipalities to optimally allocate their resources. People value walking shorter distances to dispose of their household waste. Based on the findings of this chapter, each municipality should create a unique set of waste management services that address the preferences of that municipality's residents, which will help municipalities to optimally allocate resources. Improvement in existing household solid waste management is important to protect the environment, the quality of the groundwater (source of the valley's drinking water), and reduce public health problems. Improved waste management also helps to maintain the aesthetic beauty of the city and overall, contributes to securing sustainable urban development. Previous studies on solid waste management in the Kathmandu Valley focus at solid waste management at the aggregate level by analyzing Kathmandu valley's municipal waste management. About 70 percent of the total municipal waste, however, comes from household. In such scenario, this chapter contributes to provide important policy recommendations to improve

Kathmandu Valley's solid waste management service from the perspective of household's preference towards it.

Chapter 3 analyzes the impact of exposure to outdoor air pollution on Kathmandu valley residents' health, more specifically on the probability of experiencing nausea, dust allergies, and respiratory illness. This chapter focuses on outdoor air pollution resulting from anthropogenic activities such as vehicle and industrial emissions, biomass and fossil fuel combustion, and biogas emissions from waste dumping sites. In comparison to all other source of pollutants, traffic emission has the strongest effect on these three measures of health as roads are the closest source of pollution. An average Kathmandu valley resident lives 28 meters away from the road. Our results show that people who live between 10 to 30 meters from the road are significantly more likely to experience nausea, dust allergies, and respiratory diseases. Adults less than 36 years old are less susceptible to such pollution exposure in comparison to older adults. People with higher education are more mobile, which keeps them more exposed to outdoor air pollution and are more likely to experience such health problems. Based on time activity pattern (measured through occupation) unskilled day laborers, who spend majority of their working hours in close proximity to road, are the most susceptible population to outdoor air pollution in comparison to housewives and people with indoor working environments. An average Kathmandu Valley resident is 16 percent less likely to experience nausea, dust allergies, and respiratory illness if he/she lives 100 meter further from a road from his/her current location. Based on the accumulated opportunity cost and medical cost, an average Kathmandu valley resident saves total of 389.17 Nepalese Rupees by living 100 meter farther from road. This chapter approaches to analyze impact of air pollution in a different way. Usually previous studies collect data on air pollutant level and related its effect on public health. This study, however, measures exposure to public health based on proximity to the sources of pollution. This study also extends on existing work by identifying the variation (heterogeneity) in exposure to outdoor pollution among communities using the multi-level modeling technique.

Chapter 4 identifies the factors determining household's informal recycling behavior in the Kathmandu valley in Nepal. The informal recycling, the only recycling method practiced in the Kathmandu Valley, is represented by households selling the recyclable waste to the scrapdealers. According to the results, people who generate more waste are also more likely to recycle. People who use vegetable garden and practice composting are significantly more likely to recycle. For example, people who compost are 11.8 to 12.8 percent more likely to recycle in comparison to those who do not. Based on this finding, municipalities can promote household recycling as a complementary offer with the existing offer of the subsidized composting bins. Also, urban gardening can be an important policy implication to promote recycling. Due to having a flat fee for waste collection in the Kathmandu Valley, increase or decrease in fee does not have any impact on recycling. The existing institutional regulation to avoid haphazard waste disposal not only helps to avoid haphazard waste disposal but also increases recycling by 7.8 to 9.5 percent. This study provides important findings that helps to increase recycling and achieve sustainable waste management. Overall, the policy recommendations from three papers compliment to improve solid waste management, reduce air pollution and promote recycling together.

Table of Contents

List of Figures

List of Tables

List of Acronyms

ACF	Auto-Correlation Function
ADB	Asian Development Bank
AIC	Akaike Information Criterion
ASC	Alternative Specific Constant
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CE	Choice Experiment
CMU	Community Mobilization Unit
COPD	Chronic Obstructive Pulmonary Disease
CRC	Community Recycling Centers
CVM	Contingent Valuation Method
DIC	Deviance Information Criteria
EPA	Environmental Protection Agency
ESPS	Environment Sector Program Support
ESS	Effective Sample Size
IIA	Independence from Irrelevant Alternatives
IR	Institutional regulation
JICA	Japan International Corporation Agency
KOICA	Korean International Cooperation Agency
LISA	Local Indicators of Spatial Association
MCMC	Markov-Chain Monte Carlo
MCSE	Monte Carlo standard error
MDI	Diphenyl-methane di-isocyanate
MMMC	Multiple Membership Multiple Classification
MWTP	Marginal Willingness to pay
NAR	Nausea, Dust Allergy and Respiratory
NIMBY	Not in My Backyard

OIRB	Office of Internal Review Board
PACF	Partial Auto-Correlation Function
PM	Particulate Matter
PPS	Probability Proportional to Size
RUM	Random Utility Maximization
RUT	Random Utility Theory
SLL	Simulated Log-Likelihood
TPB	Theory of Planned Behavior
UNM	University of New Mexico
VOC	volatile organic compounds
VPC	Variance Partition Coefficient
WEPCO	Women's Environment Preservation Committee
WHO	World Health Organization
WTP	Willingness to Pay

Chapter 1: Introduction

1.1 Environmental issues in the Kathmandu Valley

This dissertation addresses two important environmental issues i.e., solid waste management and outdoor air pollution of an urban area in the context of a developing country. According to the World Bank report (2012), global urban solid waste generation has been increasing exponentially and hence it is a challenge to manage solid waste. For example, the global urban waste generation in 2002 was 0.64 kilogram per person per day (with 2.9 billion urban residents) which increased to 1.2 kilogram per person per day in 2012 (3 billion urban residents) and in 2025 it is predicted to reach 1.42 per person per day (with 4.3 billion urban residents) (Hoornweg and Bhada-Tata, 2012). Similarly, outdoor air pollution is another challenge to secure public health in an urban area. According to the World Health Organization report (WHO, 2002), globally outdoor air pollution contributes to 0.6 to 1.4 percent of disease incidents in developing regions.

The Kathmandu Valley is a rapidly growing and densely populated area that includes the capital city (i.e., Kathmandu Metropolitan City) of Nepal[1]. Around 1.6 million people live in a 50.8 square kilometer area in the Kathmandu Valley, i.e. 10 percent of the country's total population lives on 0.5 percent of the country's total land[2] (Central Bureau of Statistics, 2002). Like most urban areas in a developing country, the Kathmandu Valley faces the challenge of developing sustainably. Kathmandu Valley faces the most pressing environmental challenges of managing solid waste, air pollution, and water pollution (Shah and Nagpal, 1997). We need to address these environmental issues to protect exhaustible natural resources (such as underground drinking water[3]), safeguard the public's health, and help achieve sustainable urban development.

This dissertation addresses two important issues of sustainable urban development in the Kathmandu valley, which are solid waste management and outdoor air pollution.

[1] A map of Kathmandu valley and Nepal is presented in figure 1.1.
[2] Rapid population growth due to migration (from other districts of the country) has also aggravated the waste management problem.
[3] Water pollution, however is not discussed in this dissertation.

One of the chapters (chapter 4) discusses about the determinants of people's recycling behavior, which is a branch of solid waste management itself. These two environmental issues of the Kathmandu valley are interconnected. For example, solid waste management practice is not only a problem in itself; it creates air pollution[4] due to biogas emission from the biodegradable waste at temporary and illegal dumping sites. Open air burning of plastics and paper waste is another source of outdoor air pollution. In this study, I start with solid waste management and link solid waste management practice's impact on outdoor air pollution and public health. This dissertation uses the primary data from a household survey conducted in urban area[5] of all five municipalities of Kathmandu Valley in 2012.

My motivation for choosing this dissertation topic is the existing emerging issue of solid waste management and its interrelationship with water and air pollution in the Kathmandu Valley. These two issues are closely interconnected and hence the policies to improve one issue complements the other as well. I aim to provide insights and policy recommendations for achieving a sustainable urban development of the Kathmandu Valley. The findings of this study can be relevant to urban areas in other developing countries as well.

1.2 Solid Waste Management

The management of waste in the Kathmandu Valley is an increasingly alarming issue. There are problems in each of the four stages of the waste management process (i.e., collection, handling, storing, and disposal). Based on the urgency of improvement, in this dissertation I focus on collection and processing only[6]. The existing problems of solid waste management are: haphazard waste disposal, poor waste collection service[7], low waste segregation and waste minimization, and inefficient waste collection process.

[4] Solid waste management also pollutes underground drinking water. However, this dissertation does not talk about water pollution and focuses on the outdoor air pollution only.
[5] The Kathmandu Valley also includes some villages but those are not included in the sample since this study addresses the environmental issues in the urban area only.
[6] About waste disposal, Kathmandu valley municipalities have adopted an open-air landfilling as the only solid waste disposal option. Developed countries use incineration as another method of final disposal; other methods of minimizing waste are recycling and recovery, composting, waste to energy conversion, and other methods.
[7] Poor waste collection service also includes no collection for some areas such as parts of Thimi municipality as evidenced in the descriptive statistics of the primary data used in this dissertation.

Despite public and private involvement in the waste collection process and the fact that the municipalities spend more than 50 percent of their total solid waste management budget on waste collection, the waste is neither collected completely nor on time. Uncollected waste litters the streets; and people haphazardly dispose of household waste in open spaces and riverbanks, and burn plastic and paper in open air. In the Kathmandu Valley, waste segregation and waste reduction is minimal because recycling is only practiced informally. Some people make a living by picking recyclable waste from dumping sites often in unsafe ways. Due to minimal waste segregation at the source of generation i.e., at household level, the total volume of municipal waste exceeds the predicted volume and the landfill capacity reaches its maximum before its estimated life. In the process of finding alternative landfill sites, municipalities always face public protest because people have a “not in my backyard” (NIMBY) perspective towards waste. In such scenario, finding the determinants of recycling household waste is a much needed topic of research as it helps to identify the tools of waste minimization. Therefore, I discuss about people’s recycling behavior in chapter 4. Improvement in current waste management practice not only keeps the city clean, but also helps to protect the quality of underground drinking water and prevents bio-gas emissions from the waste dumping sites. Therefore, proper solid waste management can reduce water and air pollution. According to the Environment Department of Kathmandu municipality, the per capita waste generation of the Kathmandu Valley in 2003 was 0.42 kg/day (KMC, Environment Department 2003).

Previous literature on solid waste management in the Kathmandu valley focuses on municipal waste management (Pokhrel and Viraraghavan, 2005; Dangi et al., 2011). About 70 percent of the total municipal waste, however, is produced by households. In such scenario, there is a research gap on the role of households on municipal waste management practice. Therefore, in chapter 2, I address the household waste management that influences municipal waste management practice. In addition, I estimate people’s preference of different attributes of household waste management and their willingness to pay for improvement in the existing waste management using the primary data from a household survey conducted in 2012 in the Kathmandu Valley in Nepal.

The Kathmandu Valley has five municipalities: Kathmandu, Lalitpur, Kirtipur, Bhaktpur, and Thimi, and each of these municipalities manage the solid waste differently[8]. For instance, Kathmandu municipality outsources waste collection to private organizations, and Lalitpur and Bhaktpur municipalities manage the waste themselves. Each of these municipalities also has customized waste reduction strategies. Household composting, however, is a homogeneous waste reduction strategy adopted by all municipalities.

1.2.1 Background of Solid Waste Management

Pokhrel and Viraraghavan (2005) discuss the history of solid waste management practices in the Kathmandu Valley since the 1950s. In the 1950s, the municipalities employed road sweepers for street waste collection, and the collected waste was dumped in the Bishnumati and Bagmati rivers. Both rivers are holy rivers for Hindus and Buddhists, and it flows through the Kathmandu Valley. In 1981, the Nepalese government handed over solid waste management responsibilities to the Solid Waste Management and Resource Mobilization Center (SWMRMC), which was funded by the German Technical Cooperation. After its establishment, the SWMRMC started promoting recycling and composting, and in 1986 built a sanitary landfill at Gokarna, near Tribhuvan International Airport in the Kathmandu municipality. Because of political intervention (change in government system with constitution) in 1990, the SWMRMC was discontinued and solid waste management responsibilities was handed over to individual municipalities. Between 1990 and 1993, many alternative landfills were used. In 1994, a new landfill site with an estimated lifespan of 50 years was developed in Ookharpauwa (27 km far from the Kathmandu Valley); it is being used till date.

Alam et al. (2008) conducted a study of Kathmandu's municipal waste management mechanisms, including processes like waste generation, storage, collection, and transportation and its relationship with population growth. The authors found that waste generation was directly proportional to the exponentially increasing population for several

[8] Existing solid waste management practices in each of these municipalities is included in the appendix A. The information in the appendix is based on a personal interview with the in-charge of the Environment Department of Kathmandu Metropolitan City, and with the in-charge of the solid waste management department of the other municipalities.

years between 1986 and 2003. Similarly, Dangi et al. (2011) found a strong positive linear relationship between population size and annual waste generation over different years during the 1976-2007 periods. Dangi et al. (2011) analyzed waste generation patterns and waste composition of 336 residences and a selection of non-residences (i.e. restaurants, hotels, schools, and streets) in Kathmandu Metropolitan City in 2007. Their findings suggest that waste generation is positively related to income; however, consumption patterns differed with income levels as did the amount and composition of waste. The relationship between waste generation and income had a U-shaped curve relationship, implying that waste generation decreased for high-, middle- and lower middle-income households in a decreasing order respectively, and it increased for low-income households. Such relationship is represented by the Environmental Kuznets Curve.

In a case study of the recycling behavior in 23 developing countries, Troschinetz and Mihelcic (2009) find that people's socio-economic status does not hinder them from recycling and land availability encourages people to recycle more.

In the Kathmandu Valley, between 1976 and 2003 the proportion of plastic waste increased compared with previous years (Mishra and Kayastha, 1998). Dangi et al. (2011) and Pokhrel and Viraraghavan (2005) found that about 70 percent of the total municipal waste was organic. Therefore, the authors recommended implementing waste segregation at source and continue traditional waste picking for livelihood to help divert waste from the landfills. Thapa (1998) recommended collection of a monthly user fee to support the municipalities' budget for waste management, involving the private sector in waste management, increasing people's environmental awareness, and enforcing stringent environmental policies to achieve sustainable solid waste management. Some details of the existing provisions of the solid waste management in the Kathmandu Valley is given in appendix A.

1.3 Outdoor air pollution

Outdoor air pollution is another challenge of an urban area. According to a World Health Organization (WHO) report, 1.4 billion urban residents worldwide breathe air with pollutant levels above the WHO's air guideline values (WRI, 1998). The health effects of the outdoor air pollution range from minor irritation of the eyes and the upper respiratory system to chronic respiratory diseases, heart diseases, and even death (American Lung Association, 2001). There are numerous studies that confirm the existence of adverse health effects from air pollution. According to WHO report, Based on the length of exposure, outdoor air pollution also causes premature mortality and reduces the life expectancy (WRI, 1998).

According to the Environment Sector Program Support (ESPS) monitoring stations analysis, the Kathmandu Valley has high levels of particulate matter, nitrogen dioxide, and sulfur dioxide (MOPE, 2004). In between 1993 to 2001, Kathmandu Valley's PM_{10} increased by more than four times, and traffic emission accounts for 42 percent of the total PM_{10} emission. The effect of outdoor air pollution is usually examined by measuring pollutants' level in the air and its effect on people's health. Unlike most of the previous studies, this dissertation analyzes the health impact of outdoor air pollution in the Kathmandu Valley by looking at people's exposure to air pollution based on their proximity to source of pollution. The factors that influence exposure to ambient air pollution include regional-scale polluted air masses, proximity to local ambient sources, and time-activity patterns (American Lung Association, 2001). In this dissertation, the source of outdoor air pollution we look at are traffic emission, biogas emission from waste dumping sites, emission from industries, and other surrounding environment. In addition, I identify variance at the community level and identify if the neighborhood has some impact on effect of air pollution. The findings from this (included in chapter 3) provides important policy implications.

1.4 Contributions of this Dissertation

In the Kathmandu Valley, municipalities strive to achieve a sustainable solid waste management by implementing different strategies. For example, some municipalities encourage people to stop haphazard waste disposal methods and to implement composting techniques at the household level. Some municipalities attempt to increase awareness so as to prevent haphazard waste disposal, and some municipalities enforce ordinances to stop haphazard waste disposal by charging penalties to people who are involved in such activities.

Solid waste management is a non-market good, quasi-public in nature, and cannot be traded in the market. Kathmandu Valley residents receive direct and indirect use value from improvements in the existing solid waste management. For example, direct use value comes from the proper management of their household waste; and indirect use value arises from a cleaner environment as a result of improvement in the existing solid waste management. To achieve sustainable solid waste management, we need to identify how people value improvements to the existing solid waste management and how much they are willing to pay for it. Chapter 2 of this dissertation will help to identify a sustainable waste management system based on people's preferences. It will also help to fill some research gaps in this field as this will be the first choice experiment study on solid waste management in Nepal. Also, this will be the first study that has included community involvement in solid waste management system. The identified spatial heterogeneity for waste management attribute preferences will provide feedback for the local authority to create waste management strategies.

The third chapter uses a unique approach to identify the effect of outdoor air pollution on health by observing people's exposure to air pollution. The majority of the previous studies look at pollution levels and relate its effect on health; I look at the level of exposure to such pollution through proximity to source of pollution, time activity patterns, and surrounding environment. This chapter provides insight about how to reduce exposure to outdoor air pollution. I also identify the interconnection between solid waste management practice and outdoor air pollution. For example, air pollution due to bio-gas emission from waste dumping sites negatively impacts people's health. The third chapter also extends the existing studies by identifying the variation (heterogeneity) in exposure to outdoor pollution among communities using the multi-level modeling and spatial neighborhood effects.

In chapter 4, I present a theoretical model that replicates existing recycling behavior in the Kathmandu Valley. Recycling happens informally and people collect and sell recyclable waste to the scrap dealers. Such practice is used as a proxy for recycling. The model incorporates the price received for sold recyclable waste. However, due to lack of data of price for sold recyclable waste, I cannot fully exploit the model. The findings of the chapter, however, will provide strong policy implications for promoting recycling as people can complement recycling with other complimentary behavior they are already practicing. For example, according to the results people who compost and use vegetable garden are also more likely to recycle. Overall, I identify policy implications that directly complement achieving all three objective of sustainable urban development (discussed in this dissertation) i.e., solid waste management, air pollution and recycling.

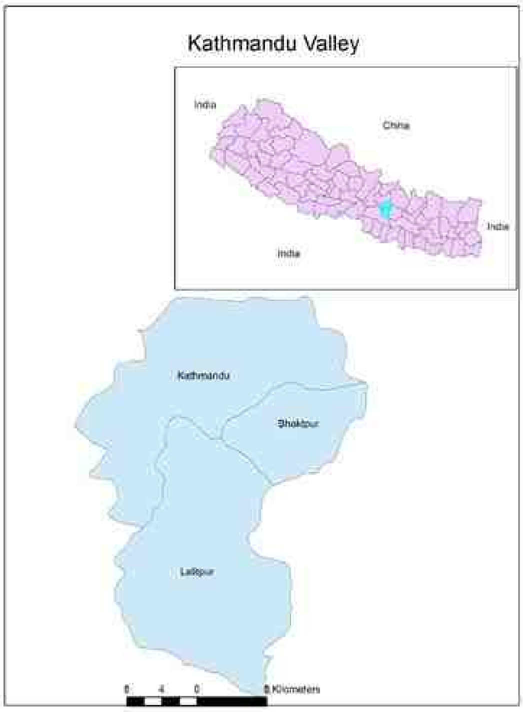

Figure 1.1: Map of the Kathmandu Valley

Chapter 2: Using a Choice Experiment to Estimate People's Willingness to Pay for Improved Solid Waste Management Service in the Kathmandu Valley of Nepal.

2.1 Introduction

Household solid waste management is a big challenge for rapidly growing and economically developing cities like the Kathmandu Valley of of Nepal. Current solid waste management practices need improvement as it pollutes the air, water, and soil, and have an adverse impact on public health. For example, haphazard waste disposal is a significant challenge as people dump waste in public places such as bus-stops, parks, and streets, due to irregular collection or no collection. Such practice decreases the aesthetic value of the city and it has a direct impact[9] on residents of the Kathmandu Valley. Similarly, waste dumping on the riverbank contaminates the soil and groundwater, which has caused flooding in the past by obstructing the natural river flow with waste. Haphazardly disposed biodegradable waste also emits methane gas[10].

According to the Solid Waste Management Act of Nepal, 2011, municipalities are responsible for all three processes of waste management, i.e., collection, processing, and disposal of solid waste[11]. The Solid Waste Management Act, 2011 also emphasizes on promoting waste segregation at the household level; however recycling has only been practiced informally. A sustainable solid waste management should be environmentally friendly, economically sound, and socially acceptable (Garrod and Willis, 1998). About 70 percent of the total municipal waste in the Kathmandu Valley is produced by households (Pokhrel and Viraraghavan, 2005; Alam et al., 2008). Therefore, it is important to identify the household representative's preference for solid waste management characteristics and people's waste management behavior to implement a sustainable solid waste management

[9] Direct impact includes effect on public health; and non-health related effect such as reduced visual attractiveness of the community or any outdoor setting. Indirect impact includes effect on economic productivity of land; impact of change in ecosystem on recreational use such as hunting, fishing, nature observation, and damage to materials and structures (Freeman III, 2003).

[10] Methane gas accounts for about 50 percent of the gases emitted, which is an active greenhouse gas that accounts for approximately 3 to 4 percent of the annual global greenhouse gas emissions (Ayalon et al., 2001; Monni et al., 2006). Air pollution from dumping sites and its impact on public health is discussed in detail in chapter 3.

[11] Other types of waste such as hazardous, medical, chemical and industrial waste should be managed by the individual or organizations that have generated the waste.

service. Therefore, the present study uses a household choice experiment survey conducted in 2012 to analyze the Kathmandu Valley residents' preference regarding waste collection and processing due to the urgency of improvement on these processes[12], and also estimate the Kathmandu Valley residents' willingness to pay (WTP) for improvement in the existing waste management service. .

The existing literature on solid waste management in the Kathmandu Valley focuses on waste generation pattern and waste management practices at the aggregate level. For example, Dangi et al (2011) estimates municipal waste generation and waste composition based on waste generation data from household and business houses. There is a data gap in estimating household level preference for solid waste management. This study will contribute to fill that gap to some extent. To my knowledge, this is the first study that uses households choice experiment survey on solid waste management in the Kathmandu Valley and across Nepal. Also, this will be the first study that has included community involvement in solid waste management system. Community involvement has been studied for forest management user groups in Nepal and is found to be a successful tool for forest management. This study will provide important policy recommendations regarding improvement in solid waste management service, promotion of waste segregation and recycling, and a feasible monthly user fee for waste management service.

The remainder of the paper is organized as follows. The second section details the literature review; the third section defines the choice experiment and an experimental design to prepare choice sets. The fourth section provides the theoretical background of the random utility model; the fifth section discusses about the econometric models used and the method to get welfare estimates. The sixth section explains data and its descriptive statistics; the seventh section interprets the results; and the eighth section presents the discussion and conclusion of the results. Lastly, in the ninth section, I provide the policy recommendations for improvement in waste management based on the findings of this study.

[12] The waste disposal process, more specifically the impact of final waste disposal at the landfill site is not included in this study. We assume that Kathmandu Valley residents are not affected by, and hence indifferent towards the disamenities produced by a landfill located at 27 kilometers away from the Valley.

2.2 Literature Review

Previous studies on municipal and household waste management focus on people's preferences, attitudes, and WTP for the attributes of the solid waste management processes. This study examines people's waste management preference using the attributes like waste collection time, waste segregation, community waste management program, frequency of waste collection and monthly user fee. I chose these attributes based on previous literature, and through debriefing and focus-group discussion with Kathmandu valley residents. In the previous studies, the most common attributes of waste collection and processing are: collection frequency, type (such as door-to-door and collection point), time (such as, scheduled or unscheduled), and types of materials collected. Other important (preferred) attributes of a waste management service are: sanitation methods during waste collection such as covered waste trucks (Das et al., 2008; Othman, 2002), clean food-waste collection (Ku et al., 2009), and noise reduction measures while picking up waste (Jin et al., 2006).

Based on the findings of this study, an average Kathmandu Valley household significantly prefers higher frequency of waste collection and is willing to pay positive amount for an increase in the frequency. As evidenced in previous studies and this study, the marginal utility of waste collection frequency, however, starts diminishing at some threshold level of pickups, which differs among studies and study areas (Das et al., 2008; Othman, 2002; Jin et al., 2006; Karousakis and Birol, 2008). For example, residents of India were willing to pay 9.6 rupees per month for collecting waste twice a day in 2007 (Das et al., 2008). Macao residents had a positive but insignificant preference for irregularly collecting waste more than once a day (Jin et al., 2006). On the other hand, in 2007, weekly collection of recyclable waste was sufficient for Korean residents (Ku et al., 2009). In this study, I estimate people's preference for waste collection frequency by giving choice of 5 levels of frequency in a range of once a week to daily collection.

Waste collection time is another important attribute of solid waste management. Having a scheduled collection can make the waste collection process more cost efficient. For example, Johansson (2006), in a simulated waste collection system that trades-off between collection cost and hauling cost, found that when the waste containers are closer to each other, the collection cost increases and hauling cost decreases. The author concluded that dynamic scheduling and routing policies[13] helps to reduce the operating cost of collection by reducing the collection and hauling distancesin comparison to that of the fixed route and collection frequency. In this study, I estimate people's preference for scheduled and unscheduled waste collection in comparison to no collection service.

Waste segregation and recycling at the household level (i.e., at the source of its generation) reduces the amount of waste dumped at the landfill site. Factors that impact people's waste processing behaviors are: people's attitude and preference towards waste segregation (Zhang et al., 2012; Czajkowski, Kądziela, & Hanley, 2014), people's preference and attitude towards curbside recycling and large-scale recycling (Huhtala, 1999; Karousakis and Birol, 2008; Caplam, 2002), and economic incentives (Keramitsoglou & Tsagarakis, 2013; Yau, 2010; Vicente & Reis, 2007). Other factors that affect people's waste processing behavior are people's demographic characteristics such as age, family size, house ownership, and access to facilities such as recyclable waste drop-off sites (Margai, 1997; Bartelings and Sterner, 1999; Van Houtven & Morris, 1999). Young individuals with a medium income and environmentally aware people are willing to segregate more waste (Afroz et al., 2011). People with individual commitment and intrinsic satisfaction are also likely to recycle more (Aini et al., 2002). An effective incentive for promoting curbside recycling is the implementation of deposit-refund schemes[14] (Karousakis and Birol, 2008).

As evidenced in the previous literature, some people like segregating waste and some do not. For example, Macao residents prefer waste segregation and recycling and were willing to pay $0.80 per person per month for it (Jin et al., 2006). People in Shanghai, China, however segregated much less waste despite being aware of the environmental benefit of segregation[15]. However, about 62 percent of the people were willing to pay for improvements in the waste segregation (Zhang et al., 2012). Similarly, Sakata (2007) found that in Kagoshima, Japan, people's marginal WTP for categories of waste segregation

[13] Dynamic scheduling and routing has lower operating cost, shorter collection and hauling distance and reduced labor hours. Please refer to Johansson (2006) for details of dynamic scheduling and routing system.

[14] Schemes in which people pay extra money while buying the product packed on recyclable waste and receive refund on return of those recyclable waste packets.

[15] In an attempt to understand such behavior, another study mentions that people's high environmental awareness does not necessarily translate into actions (De Feo and Gisi, 2010).

decreased by $1.77 per month because of the high handling costs. According to the author, some of the factors that limit segregation were: confusing waste classification, low neighborhood participation, and lack of motivation due to the inexistence of provisions for keeping waste segregated during pickup (Zhang et al., 2012).

The Kathmandu valley residents practice informal recycling by selling the recyclable waste to scrapdealers. Therefore, in this study, people's recycling behavior is indirectly captured by asking households about their preference for waste segregation. This study estimates household's willingness to segregate waste by comparing people's preference of segregate two or three types of waste in comparison to no segregation. Waste segregation is presented in the choice experiment with three levels: no segregation, two types of segregation (i.e, recyclable and non-recyclable waste), and three types of waste (biodegrabale, recyclable and other waste).

Unlike previous studies on solid waste management, I use community waste management program as one of the attributes of solid waste management. Regarding the management strategies of common property resources, Bradshaw (2003) suggests empowering communities by reaching a power balance through effective leadership and partnerships with the government to construct a community's capacity building process. According to Adhikari et al. (2004), in a community forest user's group in Nepal, rich households with more livestocks benefitted more from fodder and other resources from forest. Therefore, the authors caution to take into account of the heterogeneity among households to provide equitable access and use of such common resources. Agrawal and Ostrom (2001) outline four types of property rights that are most relevant for the use of common-pool resource: withdrawal, management, exclusion and alienation. The authors explain the success of transfer of national property right and decentralization of forest management to the community user's group in India and Nepal.

This study uses community waste management program as an unique attribute of the solid waste management in comparison to previous studies. This program involves community members working together to avoid haphazard waste disposal, provide public awareness, and keep the community clean in partnership with the municipality. In developing countries, community involvement is used in the management of common property resources and it has been an important tool in achieving sustainable development.

2.2.1 Spatial Heterogeneity

In this study, people's preference and WTP for the non-market good i.e., solid waste management program is heterogeneous. Taking into account such variation (or heterogeneity) using the mixed logit model allows us to estimate the unobserved preference heterogeneity. Another source of such heterogeneity is the observed effect of spatial components associated with the non-market good. In this study, it is measured through the distance-decay effect, according to which the WTP for a non-market good (or an attribute of the good) decreases as the distance between the household and the location of the good increases. According to Schaafsma et al. (2013), when the distance from an individual's household to a water recreational site (as well as to other recreational sites i.e., substitute sites) increases, people's WTP for certain attributes decreases; and the site user's WTP declines more slowly than that of non-users. Bateman et al. (2006), in a case study to estimate the WTP for improved urban river water quality in central England, found a highly significant distance-decay effect for the Euclidean distances from the respondent's house to the Tame River. Because of the distance-decay effect, 50% of the water-users live near the river and almost zero percent at a distance of 9 km from their house. Also, the distance-decay effect remains significant for current non-users as better site quality may induce non-users to become users. In addition, the distance-decay effect also impacts the recycling rate. This means that the shorter the distance to the recycling center, the higher the recycling rate for glass, batteries, and newspaper (Bartelings and Sterner, 1999). In waste collection processes, the distance to waste collection containers is important.

2.3 Choice Experiment

Valuing a non-market good is a challenging task because, unlike a market good, people's preferences for a non-market good and its costs and benefits cannot be inferred from the purchase and sale of that good[16]. Two methods have been used in the

[16] The instrumental value of a good is derived from two assumptions of neoclassical economics: a) the good increases the well-being of an individual, and b) he/she is able to judge how well-off they are at a given situation. Therefore, the economic valuation is measured based on people's preference for an alternative among given scenarios (Freeman III, 2003).

environmental valuation of a non-market good: revealed preference method and stated preference method. Revealed preference methods estimate people's preference for a non-market good by observing their actions (or possibility of action) involving that good, similar to what is done in the travel cost method and hedonic pricing technique. Stated preference method estimates people's preference for a non-market good by asking people about their preference among alternative choices. Stated preference methods include: Contingent Valuation Method (CVM), and Conjoint Analysis techniques like contingent ranking, contingent rating, and choice experiment (CE). In the conjoint analysis, respondents are provided with choice alternatives, which are constructed by the attributes or characteristics of the non-market good. Among the conjoint analysis techniques, choice experiment requires respondents to choose their most preferred alternative, while contingent ranking and rating requires respondents to rank and rate the alternatives, respectively. In this study, we use the choice experiment, which is one of the stated preference methods to value a non-market good.

The choice experiment method is an application of the characteristics theory of value. The utility is derived from the characteristics of the goods rather than the goods per se (Lancaster, 1966). The choice experiment, also called attribute-based discrete choice experiment, constructs a hypothetical market to value the non-market good. In this method, people are asked to choose their preferred alternative from a given sets, called a choice set, of alternatives. The choice experiment belongs to the classes of stated preference methods that are consistent with the Random Utility Theory (RUT)[17]. The choice experiment is regarded more powerful than contingent valuation method (CVM) because it can measure people's preference for multiple attributes through one choice set, which requires multiple close-ended CVM questions[18]. The choice experiment can also measure people's preference and marginal willingness-to-pay (MWTP) for an individual attribute of the non-market good.

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[17] In general, any preference elicitation method that provides information about preference ordering for all or subset of choice options should be consistent with Random Utility Theory (RUT) (see, Luce and Suppes, 1965).

[18] In CVM, the close-ended format was introduced by Bishop and Heberlein (1979). Open-ended questions directly report people's willingness-to-pay. However, a close-ended format has to obtain the willingness-to-pay values from a respondent's responses i.e., yes/no to the offered bid value in the choice alternative. Therefore, the close-ended format requires statistical specification to estimate people's willingness-to-pay (Hanemann and Kanninen, 1996)

2.3.1 Attributes of the Choice Experiment

The solid waste management attributes used in the choice experiment survey is determined based on focused group discussions, debriefings, personal interviews and a pilot survey. Each individual has 12 observations (4 choice sets*3 alternatives) and the sample size is multiplied by 12. After dropping the missing variables, 13527 observations is used to estimate the basic models. Table 2.1 presents the distribution of the sample by municipalities; Kathmandu and Kirtipur municipality have the highest and lowest sample in the survey i.e., 45 percent and 10.47 percent, respectively. Table 2.2.1 represents a list of attributes that are used to experimentally design the choice set. I use five attributes: waste collection time, community waste management program, waste segregation types, waste collection frequency and monthly user fee. Table 2.2.2 represents an example of the choice set. In this study, each individual is given 4 choice sets and each choice set has 3 alternatives, one of which represents the status-quo levels. Here, I provide the definitions of these solid waste management attributes. The attributes are:

1) Waste collection time: Waste collection time represent the waste collection service based on time allotted for collection that municipalities provide to collect household solid waste. Some examples are door-to-door collection, temporary dumping on the street and collection through running trucks at the center of the community. Municipalities are phasing out temporary dumping on the street because it produces disamenities such as odor, disease transmission and reduction in aesthetic value of the city; such problems are more severe during irregular collection. Based on focus-group discussant's comments, the door-to-door waste collection service is an only preferred waste collection type in the Kathmandu valley. Therefore, in the choice experiment I use door-to-door waste collection with three levels—scheduled, unscheduled and no collection. No collection is a level in the status-quo alternative only.

2) Community waste management program: Community waste management program involves community members to volunteer for three specific tasks i.e., monitoring of haphazard waste disposal, enforcement of proper waste disposal by penalizing haphazard waste disposal behavior, and promoting the environmental awareness in partnership with the respective municipality.

3) Waste segregation types: Households are supposed to segregate their household waste before giving it for waste collection. In the choice experiment, waste segregation is offered with three levels- no segregation, two types of segregation i.e., biodegradable and non-biodegradable, and three types of segregation i.e., biodegradable, recyclable and other types of waste.

4) Waste collection frequency: The waste collection frequency is measured as waste pickups per week. The levels of frequency are once a week, twice a week, three times a week, and seven times a week.

5) Monthly user fee: The municipalities in Kathmandu Valley are not self-sustained, except for Bhaktpur municipality. Therefore, solid waste management act, 2011 explicitly mention that municipalities are allowed (and should) to collect monthly waste collection fee.

An example of a choice experiment question to value people's preference for solid waste management service in the Kathmandu Valley is presented below.

Which solid waste management service packet do you choose from the following?

Note to enumerator: Please show the following tables to respondent while asking to choose solid waste management service packet.

Now, you will be given three solid waste management service packets including the existing one. Each of the service packets includes five attributes described earlier. The three solid waste management service packets are: solid waste management service packet A, B, and Status quo, C. Among these three service packets, please choose the service packet you like the most. If you are happy with the current waste management service, you can choose the last option C 'status quo'. If none of the option exactly matches your expectation, please choose the one that you dislike the least. While making your choice, please consider your current income and expenditure because the fee mentioned on your chosen packet may need to be paid in real life.

1	**Solid waste management service packet, A**	**Solid waste management service packet, B**	**Status Quo, C**
Waste collection time	Door to door waste collection service, without schedule	Door to door waste collection service, without schedule	Status quo
Community waste management program	Yes- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	No- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	Status quo
Waste collection frequency	Daily i.e. 7 times a week	Once a week	Status quo
Waste segregation types	No segregation	3 types: biodegradable, recyclable and other waste	Status quo
Additional monthly user fee	100 rupees per month	20 rupees per month	Status quo

1. A. which one of the services do you choose among given three service packets? (Single answer)
    - Waste management service packet, A
    - Waste management service packet, B
    - Status Quo, C

2.3.2 Experimental Design of the Choice Set

I obtained optimal choice set using the *%choiceff* macro[19] in SAS, which is based on D-efficiency, to pick the design, and chose the saturated design of 12 choice sets. The 12 choice sets are divided into three versions of questionnaire, each version including 4 choice sets. Each choice set includes three alternatives including the status-quo alternative. An example of a choice set is given in Table 2.2.2 Status-quo alternative, also called opt-out situation, represents the existing level of attributes, and including the status-quo alternative enhances the efficiency of the experimental choice set design (Louviere et al, 2000).

2.4 Theoretical Framework: Random Utility Model

The environmental valuation of a non-market good using the choice experiment method is based on an explicit utility theory[20] (Louviere, 2001). Much of the environmental valuation is based on Random Utility Maximization (RUM). According to RUM, utility received from choosing an alternative j for an individual i consists of two components: deterministic, which in principle is an observable component, and a stochastic component, which is random and unobservable. Therefore, the utility is given as,

$$U_{ij} = V\left(Z_{ij}, X_i\right) + \varepsilon_{ij} \qquad (1)$$

Where $V\left(Z_{ij}, X_i\right)$ is a deterministic portion and ε_{ij} is a random term with zero mean, where Z_{ij} represents the attributes of the alternative j for an individual i, and X_i represents an individual's socio-economic characteristics. Attributes Z_{ij} may be viewed differently by different individuals, and vary over alternatives with different levels of the attribute, whereas X_i remains constant over alternatives for an individual. An individual i chooses

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[19] %ChoicEff Macro is used to find efficient experimental designs for choice experiments, in which variances of the parameter estimates are minimized with a vector of assumed parameters. The macro considers swapping out every design alternatives and replace with each candidate alternative, which increases efficiency. And this process of evaluating and swapping continues until efficiency stabilizes (Kuhfeld, 2005).

[20] Utility is a latent construct that exists in the mind of the consumer, and cannot be observed by the researcher directly. When we use preference elicitation methods, like CE, the researcher can understand and explain a significant portion of the utility and the remaining portion of the utility always remains unexplained (Louviere, 2001). Therefore, a utility function consists of two parts: deterministic, which in principle is an observable portion, and stochastic, which is a random and unobservable portion.

an alternative j over alternative k if and only if the utility received from alternative j is greater than that of alternative k, i.e., $U_{ij} > U_{ik}$.

The probability that an individual i chooses alternative j over alternative k is given by,

$$Prob(j|J) = Prob\{V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}, for\ all\ j \in J\} \quad (2)$$

where J represents a complete choice set including all the available alternatives in each choice set (in the present study $J = 3$ including the status-quo alternative). In order to estimate equation (2), we have to assume the distribution of error terms[21]. The RUM assumes that errors are independently and identically distributed (IID) following a type I extreme value distribution.

2.5 Econometric Model

2.5.1 Conditional Logit Model:

In Conditional logit model, the expected utility for a chosen alternative is a function of the attributes of alternatives rather than the characteristics of individuals. The error terms have type I extreme value Gumbel-distribution, and they are assumed to be independently and identically distributed (McFadden, 1974), which implies that the probability of an individual i choosing an alternative j is given by:

$$P_i(j) = \frac{exp^{\mu v_{ij}}}{\sum_{j=1}^{J} exp^{\mu v_{ij}}} \quad (3)$$

[21] According to Louviere (2001), in order to calculate choice probabilities, we have to make assumptions about the distribution of the random component, ε_{in}. Typical assumptions are that the random components are: a) independently and identically distributed Gumbel random variables, which leads to binary or multinomial logit model, or b) not independent nor identically distributed normal random, which leads to reasonably complex binary or multinomial probit models. It is difficult to distinguish between Gumbel and normal distribution models because many observations at the far tail are required for such distinction. Therefore, both distribution models are derived from the same assumption about dependence, variance and covariance of random components. Choice of Gumbel or normal distribution of the random variable depends on logic and computational preference. For example, Normal distribution may be preferred as a limiting distribution and Gumbel might be preferred on computational or tractability grounds. Those who prefer maximum likelihood support a wide array of assumption about random component as well as distribution of parameters. Those who favor Bayesian estimation method prefer normal because Markov Chain Monte Carlo (MCMC) methods can be used to reduce problem to simulating from Gumbel distribution.

where μ is the scale parameter. In the conditional logit model, we have three assumptions: a) μ is equal to 1, which implies constant error variance (homoscedastic) model, b) Independence from Irrelevant Alternatives (IIA) property holds for the model, which means that the ratio of probabilities of choosing any two alternatives is independent of presence or absence of other alternatives in the choice set, and 3) respondents have homogenous preference.

The deterministic indirect utility v_{ij} can be represented as

$$v_{ij} = \beta_k z_{ijk} + \delta_n X_{in} + \varepsilon_{ij} \tag{4}$$

where z_{ijk} is kth attribute of an alternative j for an individual i, β_k represents a vector of coefficients for kth attribute, X_{in} represents nth socio-economic characteristics of an individual i, and δ_n represents a vector of coefficients for an individual's socio-economics characteristics. The probability of an individual choosing an alternative j is

$$P_{ij} = \prod_{j=1}^{J} P_i(j)^{y_{ij}} \tag{5}$$

where $y_{ij} = 1$ if respondent i chooses an alternative j, and 0 otherwise. The log-likelihood function for choices made by N individuals (i.e., total number of respondents) is given as,

$$\ln L = \sum_{i=1}^{N} \sum_{j=1}^{J} y_{ij} \cdot \ln P_i(j) \tag{6}$$

2.5.2 Mixed Logit Model

Mixed logit model relaxes three assumptions of the conditional logit model and allows for random taste variation among individuals, unrestricted substitution pattern due to relaxing the IIA property, and correlation in unobserved factors over time (Train, 2009). In the mixed logit model, an additional stochastic element, η_{ij} will take into account of heterogeneity and autocorrelation across alternatives (Hensher et al., 2007), where ε_{ij} is independently and identically distributed with type 1 extreme value. The utility in mixed logit model is given as,

$$U_{ij} = V(Z_{ij}, X_i;\ \beta_i) + \eta_{ij} + \varepsilon_{ij} \tag{7}$$

The Mixed logit probabilities are the integrals of the standard logit probabilities over a density of parameters, β_i which are distributed with density$f(\beta|\theta)$. The θ refers collectively to the parameters of this distribution such as mean and variance of β[22]. The choice probability of choosing alternative j in the mixed logit model is given as,

$$P_{ij} = \int L_{ij}(\beta) f(\beta) d\beta \tag{8}$$

where

$$L_{ij}(\beta) = \frac{e^{V_{ij}(\beta)}}{\sum_{k=1}^{J} e^{V_{ik}(\beta)}} \tag{9}$$

The probabilities are approximated through simulation for any given value of θ. The process is a) first, a values of β is drawn from $f(\beta|\theta)$, and label it β^r with r = 1 referring to the first draw; b) then, logit formula $L_{ij}(\beta^r)$ is calculated with this draw; c) previous two steps are repeated many times and average result is estimated. This average is the simulated probability given in equation (10)

$$\widehat{P}_{ij} = \frac{1}{R}\sum_{r=1}^{R} L_{ij}(\beta^r) \tag{10}$$

where R represents the total number of draws, and $\widehat{P}_{ij}$ is an unbiased estimator of P_{ij} by construction. The probability of an individual i choosing alternative j is given as,

$$P_{ij} = \prod_{k=1}^{J} \widehat{P}_{ij}^{\ y_{ij}} \tag{11}$$

The log-likelihood function of the simulated probability is given as,

$$SLL = \sum_{n=1}^{N} \sum_{k=1}^{J} y_{ij} ln\widehat{P}_{ij} \tag{12}$$

[22] If we denote the parameters that define the density of β as θ, then the density is denoted as $f(\beta|\theta)$. The mixed logit probabilities do not depend on the value of β. The mixed logit probabilities are,$P_{ni} = \int L_{ni}(\beta)\ f(\beta|\theta)d\beta$, which are functions of θ. Therefore, the researcher is interested in estimating the parameters of $f(\beta)$, i.e., b and W.

where, $y_{ij} = 1$ if an individual i chooses alternative j and 0 otherwise. The maximum simulated likelihood estimator is the value of θ that maximizes simulated log-likelihood. This estimator maintains independence over decision makers of the simulated probabilities that enter simulated log-likelihood.

There are some debates about the efficiency of the mixed logit model and the number of iterations required to reaches convergence of estimates. Chang and Lusk (2011) conducted a qualitative experiment about the accuracy and software choice while using mixed logit model. The authors used 500 halton draws and found that small sample size (n=200) will have considerable variability across 500 Monte Carlo iterations in all three econometric software package i.e., SAS, NNLOGIT and STATA. With bigger sample size (n=1000), results are consistently similar in all three packages[23]

2.5.3 Welfare Measure

WTP is the maximum amount of money a person is willing to pay in exchange for the improvement in a non-market good (for example, improvement in solid waste management in the present study). WTP is the amount of income that compensates for an increase in quality of the non-market good. Indirect utility is a function of price (p), quality of the non-market good such as status-quo quality (q) and improved quality (q^*), and income (y). Then, the WTP is the amount willing to pay for the change in indirect utility with increase in quality of the non-market good,

$$WTP = V(p, q^*, y) - V(p, q, y) \tag{13}$$

where $q^* \geq q$ and increase in q is desirable i.e, $\frac{\partial V}{\partial q} > 0$.

The total derivative of the indirect utility (V_{ij}) with respect to change in level k of attribute z, i.e., Z_k and price (P) is given by $dV_{ij} = \beta_K dZ_k + \beta_P dP$. Setting the total derivative

[23] In this study, I used *mixlogit* command, which is an add-in module to estimate mixed logit model in STATA developed by Arne Risa Hole (http://www.shef.ac.uk/economics/people/hole/stata.html). In this study, I estimated mixed logit model with different draw and iteration ranging from 50 Halton draws (default draw) to 50000 draw with 1000 iterations. According to the AIC values, model with 35000 draw and 1000 iterations is the best model. Table B5 presents different log-likelihood values at different iterations for all three groups of sample- pooled, core-urban municipalities and sub-urban municipalities.

equal to zero[24] and solving for dP/dZ_k gives change in price (for example, monthly fee in the present study) that keeps utility unchanged for given a change in an attribute Z_k. Therefore, the MWTP for an increase in the quality of an attribute $Z_k$is given as:

$$\frac{\partial P}{\partial Z_k} = MWTP_k = -\frac{\beta_K}{\beta_P} \quad (14)$$

Identifying the distribution of WTP is important for estimating the confidence interval of the MWTP. Two methods of estimating confidence interval is discussed in the present study: the delta method and the Krinsky-Robb method.

The conditional logit model estimates the model using the maximum likelihood, and hence the coefficients in the model are asymptotically normally distributed. The WTP is the ratio of the coefficients of attribute and price. For the distribution of WTP, the ratio of two normally distributed variables is normal if the coefficient of the denominator variable (i.e., price) is negligible.

Delta method assumes that the distribution of the WTP value is normally distributed, and the variance of WTP is given by taking first-order Taylor expansion around the mean values of the variables and calculating the variance of this expression (Greene, 2003). Therefore, the variance of WTP is given as,

$$var\left(W\hat{T}P_k\right) = (W\hat{T}P_{\beta_k})^2 var\left(\hat{\beta}_k\right) + (W\hat{T}P_{\beta_P})^2 var\left(\hat{\beta}_P\right) + 2W\hat{T}P_{\beta_k} \cdot W\hat{T}P_{\beta_P} cov\left(\hat{\beta}_k, \hat{\beta}_P\right) \quad (15)$$

where $W\hat{T}P_{\beta_k}$and $W\hat{T}P_{\beta_P}$ are partial derivate of WTP_k with respect to β_k and β_P, respectively. The confidence interval using delta method is given as,

$$W\hat{T}P_k \pm z_{\alpha/2}\sqrt{var\left(W\hat{T}P_k\right)} \quad (16)$$

where $z_{\alpha/2}$ is the inverse of the cumulative normal distribution and the confidence level is is $100(1-\alpha)\%$. If the distribution of WTP is not normal, as assumed in the Delta method,

[24] At the highest point of total utility (i.e., peak of the total utility curve where utility is highest), the partial derivate of utility with respect to change in attribute and price is zero.

the confidence interval using Delta method may be inaccurate since it will not reflect the skewness of the distribution of WTP.

In that situation, we may use Krinsky-Robb method, which estimates confidence interval in a non-parametric method using simulation and hence does not assume any distribution for the confidence interval of the WTP estimates. In Krinsky-Robb method, we take large number of draws from a multivariate normal distribution with means and covariance given by estimated coefficients. Then, R simulated values of WTP are calculated and those values are used to calculate the percentile of the simulated distribution reflecting the desired level of confidence interval.

2.5.4 Coefficient Distribution in the Mixed Logit Model

In discrete choice experiment method, the distribution of the WTP for a non-priced attribute is the ratio of the attribute coefficient to the price coefficient. When the price coefficient is kept fixed across the population, the distribution of the WTP for a non-priced attribute remains the same as that of its coefficient. The reasons for keeping the price coefficient fixed are: 1) fixed price coefficient will reduce the instability of the mixed logit model that would occur when all coefficients are allowed to vary (Ruud, 1996); 2) If the distribution of the price coefficient is allowed to vary, the distribution of the WTP is the ratio of the two distributions that is difficult to evaluate; and 3) the choice of distribution for the price coefficient is problematic. The price coefficient is necessarily negative, and hence a normal distribution is inappropriate. The lognormal distribution assures that the price coefficient is negative, but it can give implausibly high WTP values for prices close to zero (Revelt and Train, 2000).

According to Rudd (1996), when all variables are allowed to vary in the mixed logit model, the identification is empirically difficult[25]. Choosing the price coefficient to be fixed avoids such instability and allows easy derivation of the distribution of the willingness to pay. Revelt and Train (1998) estimated the household's preference for

[25] For example, if the stochastic portion of utility is dominated by the random parameters such that the iid extreme-value term has little influence, then the scaling of utility by the variance of the extreme-value term becomes unstable and an additional scaling is needed. At an extreme, where the extreme-value term has no influence (i.e., zero variance), the simulated probability becomes an accept/reject simulator, and a scaling of the remaining utility (that is, utility without the extreme-value term) is required (Rudd, 1996).

appliance efficiency level by keeping the price coefficient fixed and allowing non-price coefficients (to vary) to be independently normally distributed. Revelt and Train (2000) kept fixed price coefficients and used normal and log-normal distribution for the same non-price attribute in different models interchangeably. The authors used a log-normal distribution for attributes that have negative coefficient for all respondents. A log-normal distribution can be problematic as its parameters can be difficult to estimate and they have an unbounded upper support (limit).

2.6 Data and Descriptive Statistics

The present study uses the primary data from a household survey conducted in Kathmandu Valley in 2012. In preparation for conducting the household survey, I interviewed municipality personnel who informed about the respective municipality's existing provisions about of solid waste management. Prior to conducting the final survey, I also conducted debriefing with volunteer respondents, focus-group discussions with household representatives, and a pilot survey with randomly sampled households. Such activities help to review and finalize the survey questionnaire. For example, the focus-group discussions and personal interviews help to identify the most important characteristics of the solid waste management service in Kathmandu Valley. Some of the waste management attributes such as waste collection type and community waste management program were included based on local residents' feedback in focus-group discussions. I also received some important insights about the importance/necessity of improving the existing solid waste management attributes in debriefings with volunteer respondents. The step-by-step phases of the survey administration process are presented in appendix C - table C1. The detail explanation of survey administration, survey protocol and sampling design is included in appendix C.

The survey was conducted to 1155 households, which represents 96 percent response rate with the given target sample of 1200, in all five municipalities of Kathmandu Valley. The number of households in each municipality is selected using the Probability Proportional to Size (PPS) technique. Wards[26] in each municipality are randomly selected

[26] Ward is the smallest administrative unit in Nepal and each municipalities in Kathmandu Valley have different number of wards.

and 20 households are identified from each selected wards using the right-hand rule[27]. Then, the enumerator interviewed household representative of 18 years or older. The sample size of 1200 households produces $\pm 2.8\%$ sampling error margin at a 95 percent confidence interval at the overall sample level (Cochran, 2007). A list of randomly sampled wards in each municipality is listed in Table B1 (in appendix B). A detailed step-by-step process of survey administration is given in Table B2.

According to Table 2.2.3, 23.7 percent of the respondents chose status-quo alternative and the remaining choose either alternative A or B, which represent alternatives with proposed improvement in the solid waste management service. The total sample of five municipalities is represented in the pooled model. The pooled sample is divided into two groups, i.e., core-urban and sub-urban, based on municipality's location and the status-quo monthly fee that an average representative resident paid in the municipality. The core-urban represents sample from Kathmandu, Lalitpur and Kirtipur, and sub-urban represents sample from remaining two municipalities i.e., Bhaktpur and Thimi. Municipalities included in core-urban are situated at the core city of Kathmandu Valley on the east whereas municipalities included in sub-urban are located at the sub-urban area on the west. On average, the core-urban sample representatives (i.e., residents of Kathmandu, Lalitpur and Kirtipur municipality) pay positive amount of fee for solid waste management service, whereas about 87 percent of the sub-urban representatives do not pay any monthly fee. According to Table 2.3.1, 46.7 percent of core-urban households do not pay any monthly fee, whereas 87.9 percent of sub-urban households do not pay any monthly fee. Another distinct feature that distinguish core-urban and sub-urban is the occupation of residents, population and major occupant of the area. The core urban area, represented by core-urban, has a lot of business houses, school and college, few industries and highly populated residential area. The sub-urban area is located at the outskirt of the valley and the

[27] The starting points for the "Right-Hand-Rule" are recognizable locations such as schools, crossroads, *chautaras*, bazaars etc. At first, interviewers start to walk towards any direction randomly from a starting point counting number of households at the same time. If it is less than 20, an interviewer will select the first 10 households on the right hand side of his/her route. If it is 20 to 29 households, an interviewer will select the first household and then select each 3rd household on the right hand side of the interviewer route until he/she covered 10 households. If it is 30 or more than 30 households, an interviewer will select the first household and then select each 4th household on the right hand side of the interviewer route until he/she covers 10 households.

population is much less; it has a lot of farmlands and many people are smallholder farmers, mainly farming food and cash crops.

Table 2.3.1 represents socio-economic characteristics of the. On average 60 percentage of respondents have education above SLC (tenth grade in Nepalese schooling system), among which core-urban's sample has 63 percent and sub-urban's sample has 52 percent. On average 60 percent respondents own house; about 83 percent of sub-urban's respondents and 54 percent of core-urban's respondents are house owners. About 44 percent of sub-urban respondents and 34 percent of core-urban respondents are business-holders. The proportion of male and female is about equal in the pooled sample. I use distance as a spatial variable, which represents the walking distance in minutes from respondent's household to the waste collection point. On average people walk 1.12 minutes to dispose their household waste. People with door-to-door waste collection service are assumed to have 0 distance to the waste collection point. The survey was conducted with adults only; a representative respondent is 36 years. The income distribution of respondents in two groups of municipalities is distinctively different; the average household monthly income of core-urban respondents is 37,042 rupees whereas sub-urban respondents' average income is 23,145 rupees[28].

Table 2.3.2 presents the distribution of those respondents' individual characteristics who choose status-quo versus non status-quo alternative. In comparison to average respondents in the pooled sample (presented in Table 2.3.1), people who choose status-quo alternative are older and richer. As represented in Table 2.3.2, about 54 percent people who chose status-quo alternative have above SLC (i.e. 10th grade) education, and 63 percent people who chose non status-quo alternative have above SLC (i.e. 10th grade) education. People who chose non status-quo alternative have bigger population of more educated, younger and those living farther from the waste disposal site in comparison to those who choose status-quo alternative. People who choose status-quo live closer to the waste collection point, within less than a minute of walking distance (i.e., 0.69 minutes). People who choose non status-quo live farther, on average in 1.25 minute walking distance from the waste disposal site. Among people who chose status-quo, 63 percent are house owners,

[28] The exchange rate of one US dollar = 98 Nepalese rupees (Source: The central Bank of Nepal, 2012).

54 percent have education above SLC, and 54 percent do not pay any monthly fee. People who choose non status-quo have small percentage of house owners and business holders in comparison to those who choose status-quo. Among people who choose status-quo, about 42 percent, higher than average respondents, are business-holders. The proportion of male and female is equal.

Table 2.4 presents the descriptive statistics of the existing provisions (i.e., status-quo levels of the choice sets) of the solid waste management service available in pooled sample and two groups of municipalities as given below.

A) Waste collection time: Waste collection time attribute has three attributes: scheduled, unscheduled and no collection. About 12 percent of the respondents have no collection, among which about 28 percent are sub-urban respondents and 7.8 percent are core-urban respondents. About 60 percent of the respondents have unscheduled door-to-door waste collection service. The proportion of scheduled collection is higher in sub-urban municipalities in comparison to that in core-urban municipalities. About 33 percent of core-urban respondents and 25 percent of sub-urban respondents have scheduled collection.

B) Community waste management program: About 25 percent households have community waste management program. Based on the debriefing and pilot survey, community waste management program is one of the most preferred and important attributes of solid waste management service.

C) Waste segregation types: There are three waste segregation types i.e., biodegradable, recyclable and other types of waste. About 59 percent of the respondents do not segregate waste. About 34 percent of sub-urban respondents and 24 percent of core-urban respondents segregate 2 types of waste. Three types of segregation is lower in both group municipalities; about 13 percent of the core-urban and 15 percent of the sub-urban respondents segregate three types of waste.

D) Waste collection frequency: Waste collection frequency choices range from once a week to daily collection. On average, the waste is picked up 4 times per week in pooled sample; core-urban respondents have 3.3 times waste collection per week and sub-urban respondents have 6.8 times waste collection per week.

E) Monthly user fee: An average Kathmandu Valley resident pays 56 rupees per month per household for the waste collection service. Core-urban respondents pay about 71 rupees per month whereas sub-urban respondents pay 8 rupees per month. Such higher difference in monthly fee between two groups is due to the fact that about 83 percent of sub-urban respondents do not pay any monthly fee for waste collection service.

2.7 Results

All the results are represented for pooled sample as well as core-urban and sub-urban sample. The pooled model represents all the sample, and core-urban and sub-urban represents the core urban area and sub-urban area, respectively. Table 2.5 represents the results obtained using the conditional logit model, an important method for confirming the model specification. The dependent variable is people's choice among three alternatives provided in the choice experiment. The independent variables are the attributes of the respective choice alternative, other socio-economics variables, and the provisions of solid waste management service in the community. The levels of the attributes are represented as the categorical variables, keeping one of those levels as the reference category. I do not include an Alternative Specific Constant (ASC)[29] as the status-quo alternative is not necessarily a worst-case scenario and the status-quo levels of the attributes are heterogeneously distributed among households. Therefore, the ASC in this study captures the heterogeneous distribution of attributes rather than people's preference for the constant status-quo level as usually seen.

According to Table 2.5, respondents derive utility from most of the attributes except for monthly fee and three types of waste segregation. People prefer scheduled and unscheduled collection service in comparison to no collection. People find disutility in segregating 3 types of waste in comparison to no segregation; however, people prefer to

[29] ASC would be equal 1 if status-quo alternative is chosen and 0 otherwise. Usually the status-quo alternative is constant over the sample and it represents the least improved alternative with lowest level of attributes. . For example, a public good (for example, attributes of a lake) can have a constant level of the status-quo alternative among the entire sample. In this study, because of heterogeneous distribution of attributes at the status-quo level, the ASC does not compare people's preference for change in solid waste management service in comparison to the existing service represented by status-quo levels, and it is the reason ASC is not included.

segregate two types of waste in comparison to none. People always prefer more frequent waste collection and having a community waste management program. If we compare two groups of municipalities, preferences for most of the attributes are similar except for waste segregation. Respondents in sub-urban area (sub-urban respondents) prefer to segregate 2 types of waste whereas core-urban respondents do not prefer to segregate any waste.

In Table 2.6, I interact some of the waste management attribute levels with an individual's characteristics such as age and education, and spatial characteristics such as distance from respondent's house to the waste collection point. The sign and significance of the variables remains the same in the base and interaction model. According to Table 2.6, older individuals do not prefer community waste management program. This estimate is also established by the fact that older individuals choose status-quo alternative as presented in Table 2.3.2. When the distance from an individual's house to the waste collection point is 1 and half minute, with increasing distance people prefer more frequent collection. However, when distance is more than 5.35 minutes (as represented by average value of the 'distance square' variable), people prefer less frequent collection. People's preference and WTP for frequency is further discussed later in this section. When the distance from an individual's household to the waste collection point increases, people prefer scheduled collection in comparison to unscheduled and no collection. With increasing distance from their household to the waste collection point, people are willing to accept less frequent collection give the waste is collected in a pre-informed schedule i.e., they have scheduled collection service. Such estimates signify that people are willing to trade-off scheduled collection with frequency of collection. As a policy implication, municipalities can optimize the waste management budget by increasing scheduled collection and decreasing the frequency of waste pickup. Based on Likelihood Ratio Test, interaction terms are found to have significant impact[30].

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[30] The Log-likelihood ratio test between pooled model of Base model (from Table 2.5) and pooled model from interaction model (from Table 2.6):

$$LR = -2\left(\ln\hat{L}_R - \ln\hat{L}_U\right) = -2\left((-4131.2) - (-4077.7)\right) = -2(-53.5) = 107$$

Chi-square computed for 7 degree of freedom and 5% significance level = 14.067. Greene (2003)

Having robustness estimates in base and interaction model, the conditional logit model confirms the model specification. Conditional logit model assumes that the independence from irrelevant alternatives (IIA) property holds for the model, which means people's choice probability for an alternative is independent of the availability of other choice alternatives that are not chosen. To test for IIA property I used Hausman test, which compares full model with all the alternatives and restricted model with one of the alternatives dropped. Given in Table 2.7, the IIA property does not hold according to the chi-square statistics of the Hausman test. . When one of the alternatives is dropped, the chi-square values are higher than that of the chi-square for 7 degree of freedom at 5% significance level. Therefore, Hausman test for IIA property proves that the data violates the IIA assumption. Conditional logit model assumes that IIA property holds and it is not an appropriate method for the given data. The conditional logit model assumes all the individuals have homogeneous preference, which is not a realistic assumption. As an alternative, I use mixed logit model, which relaxes all three assumption of the conditional logit model. According to Table 2.8, the sign and significance of the estimated attributes and other interaction variables in the mixed logit model are consistent with the estimates of the conditional logit model. The estimates of the mixed logit model are robust with conditional logit model's result.

Table 2.8 represents the coefficients of the mixed logit base model. In mixed logit model, all the attributes except monthly fee is allowed to vary randomly. The distribution of the monthly fee is kept fixed. According to Table 2.8, the standard deviations of all the random parameters are significant except unscheduled collection. It means that all the attributes except unscheduled waste collection are heterogeneously distributed among respondents. According to the sign and significance of the coefficients, core-urban respondents significantly dislike three types of waste segregation but it did not have significant impact of sub-urban respondents' choice. Sub-urban respondents rather significantly prefer segregating two types of waste. Therefore, the spatial heterogeneity between two groups of municipalities exists for their preference to segregate the waste.

Table 2.9 represents the mixed logit model that includes interaction variables along with the variables in the base model. Interaction variables with the distance (walking distance from household to the waste disposal site) allow us to estimate the distance-decay effect. According to the distance-decay effect, when the distance to the non-market good increases people's WTP for that good decreases. Both in the conditional and mixed logit model distances are interacted with two solid waste management attributes – waste collection frequency and scheduled collection type. Four variables are generated by interacting distance with frequency, scheduled collection, and both frequency and scheduled collection together. Those variables are: *freq_distance, freq_distancesq, distance_sch, and dist_sch_freq*. An average representative household is located at 1 and half minute walking distance from the waste collection point. According to the significantly positive *distance_freq* variable, when the walking distance to waste collection point increases (i.e., farther than 1 and half minute) people prefer more frequent collection service. The *freq_distancesq* variable is significantly negative, which means when the waste collection point is farther or equal to 6 minutes of walking distance (mean value of *distance square* variable), people dislike frequent waste collection service. Variable *distance_sch* is positively significant, which means when the distance to waste collection point increases, people prefer scheduled collection. The variable *dist_sch_freq* is significantly negative, which means when the scheduled collection is available, with increasing distance people prefer less frequent collection. This variable provides an important characteristic of individuals that they are willing to trade-of scheduled collection and frequency. This finding provides a significant input for policy implication for municipalities to optimize the use of resource by considering people's trade of between scheduled collection and frequency.

The dummy variables for community waste management program and scheduled collection service are interacted with age variable, and those interaction variables are *comm_age* and *scheduled_age.* For the pooled sample both of those variables are significantly negative, which represent that on average older people do not prefer scheduled collection and community waste management program. The effect of both of those variables are different in core urban and sub-urban areas represented by core-urban and sub-urban, respectively. For example, older people in core-urban municipalities significantly dislike scheduled collection and community waste management program, whereas older people in sub-urban have insignificant effect of those variables. The other interaction variable, between community waste management program and above SLC (10^{th} grade in Nepali education system) education level is *comm_aboveSLC* and its effect is significantly positive for core-urban and insignificant for pooled sample and sub-urban sample. In core urban area, represented by core-urban sample, respondents with above SLC education prefer community waste management program and it represents that more educated people have public awareness and knowledge towards the benefit of community involvement for better waste management service.

In addition to the spatial heterogeneity identified from distance-decay effect, I used log-likelihood ratio test between pooled sample and core-urban and sub-urban samples. Log-likelihood ratio test compares the log-likelihood of the unrestricted (i.e., pooled) and restricted (i.e., two disaggregated) models respectively. As given in Table 2.10, when I keep the monthly fee variable's distribution fixed, the log likelihood ratio test accept the null hypothesis and we do not have significant difference between pooled sample and two group samples. The spatial heterogeneity is explained with distance variables only but the segregation of core urban and sub-urban area does not seem to be significantly heterogeneous. On the other hand, the mixed logit model with all the variables including monthly fee randomly distributed rejects the log-likelihood ratio test. This model further proves the spatial heterogeneity exists in monthly fee in the data. According to Table 2.10-B, the chi-square value of the log-likelihood ratio test rejects the null hypothesis and confirms that the pooled model and two dis-aggregated models (i.e., core-urban and sub-urban) are significantly different[31].

The coefficients of logit model cannot be interpreted as that of linear regression model because of the logistic distribution. Therefore, I interpreted the sign and significance of those variables in earlier part. Now, people's preference for solid waste management attributes is estimated through their MWTP for the attributes. Table 2.11 presents the MWTP for solid waste management attributes using conditional logit model and the Delta

[31] The Log-likelihood ratio test between pooled model and two dis-aggregated model is:

$$LR = -2\left(\ln\hat{L}_R - \ln\hat{L}_U\right) = -2\left((-3567.913) - (-2792.207 - 761.706)\right) = -2(-3567.913 + 3553.913) = 28$$

Greene (2003)

method is used for the distribution of the confidence interval. The MWTP values are higher than expected and the diagnostics test for conditional logit model proved that the data fits better for mixed logit model than conditional logit model. Therefore, we give more importance to the MWTP values obtained using the mixed logit model. According to Table 2.11, in the pooled sample the MWTP for scheduled collection is the highest i.e., 1275.327 Nepalese Rupees. The MWTP between two groups of municipalities are distinctly different. For example, core-urban respondents are willing to pay the most i.e., 810.27 Nepalese Rupees for the community waste management program. Sub-urban respondents are willing to pay the most i.e., 803.20 Nepalese Rupees for scheduled collection. Both group's respondents dislike segregation of three types of waste. The MWTP for frequency has a big difference between two group's respondents. The MWTP for frequency for core-urban and sub-urban are 147.13 Nepalese Rupees and 50.70 Nepalese Rupees, respectively. Core-urban respondents have higher MWTP for waste collection frequency and community waste management program in comparison to that of sub-urban respondents. Sub-urban respondent's MWTP is higher than core-urban for scheduled collection, unscheduled collection and segregation of two types of waste.

Next, I estimated the MWTP for the attributes for the mixed logit base model, and used both the Delta method and the Krinsky Robb method for the distribution of the confidence interval. Table 2.12 represents the MWTP values for the attributes using the mixed logit base model. For the Delta and Krinsky Robb method, only the confidence interval values are different and the MWTP value remains the same. In Table 2.11 and 2.12, *ll* and *ul* represents the lower level and the upper level values of the confidence interval. Unlike the MWTP for conditional logit model, for the pooled sample, people have the highest MWTP i.e., 401.22 Nepalese Rupees for the community waste management program instead of scheduled collection. Two group's respondents have distinctly different preference. For example, core-urban respondent have the highest MWTP i.e., 404.93 Nepalese Rupees for the community waste management program and sub-urban residents have the highest MWTP i.e., 480.70 Nepalese Rupees for the scheduled collection. Similarly, core-urban respondents are willing to pay more than sub-urban respondents for community waste management program and waste collection frequency. Sub-urban respondents are willing to pay more than core-urban respondent for scheduled collection, unscheduled collection and segregation of two types of waste.

Based on the MWTP values, we can distinguish the specific preference and nature of two group's respondents. First, sub-urban give more preference for waste collection service, either scheduled or unscheduled in comparison to having no collection, the reference category. Sub-urban includes two municipalities - Bhaktpur and Thimi, and these two municipalities have the best and the worst scenario for waste collection service. Bhaktpur's respondents have the experience of regular collection and most of Thimi's respondents have no waste collection service. Therefore, the sub-urban's respondents value having regular collection (either scheduled or unscheduled) because either they have experienced its importance or it is their necessity. Second, sub-urban have much higher MWTP for segregation than core-urban i.e., 108.21 Nepalese Rupees versus 26.70 Nepalese Rupees. This means that sub-urban residents are willing to spend time for waste segregation and want to contribute on the waste reduction that goes to landfill site. It may also represent distinctively different opportunity cost of time. Based on their monthly income, a proxy for opportunity cost of time, core-urban respondents have much higher opportunity cost than sub-urban respondents as their monthly income are 37,042 and 23,145 Nepalese Rupees, respectively. The MWTP for waste collection frequency is slightly higher for core-urban respondents than sub-urban respondents as the MWTP values are 82.65 and 69.81 Nepalese Rupees, respectively. In Table 2.12, I compare the two methods of defining MWTP's distribution for confidence interval i.e., Delta and Krinsky Robb method. Those two methods hold different assumptions for estimating confidence interval. Delta method assumes normal distribution, and hence mean and median MWTP values are same. Krinsky Robb method does not have any distributional assumptions and the confidence interval of MWTP values are obtained using simulation. Therefore, Krinsky Robb method has different values for mean and median MWTP. In Delta method, the MWTP for segregation of two and three types of waste is not significantly different from zero for the pooled sample. When we relax any distributional assumption for MWTP in Krinsky Robb method, we find that residents of Kathmandu valley on average and respondents of sub-urban municipalities have significantly positive WTP for two types of segregation.

Waste collection frequency is one of the significantly preferred attribute and its MWTP is significantly different from 0. Kathmandu valley residents prefer more frequent collection. The MWTP for frequency, however, starts decreasing at some threshold value. According to Figure 2.1, the threshold value of waste collection frequency is about 9 times per week (more specifically, 8.61 times per week). When the waste collection frequency is 8.61 times per week, its MWTP becomes zero and the total utility curve reaches maximum[32]. As presented in figure 2.2, the downward sloping MWTP curve for frequency represents that people have diminishing marginal utility for having each additional pick-up service in a week. Their total utility is increasing at the decreasing rate. People have positive MWTP for frequency up to 8.61 times per week; any frequency beyond that provides disutility and the MWTP curve extends to fourth quadrant of the Cartesian plane. Based on the status-quo level of attributes, the highest status-quo frequency of waste collection is 21 times i.e., 3 times per week in Bhaktpur municipality. Therefore, the comparison of the MWTP and total utility is focused within the frequency of 21. Higher than 21 pick-ups per week is not feasible and practical.

People's WTP for transferring between two non-status quo alternatives (i.e., alternative A and B) is given in Table 2.14.1, 2.14.2 and 2.14.3. The negative sign on the WTP values represents that alternative B is better than alternative A, and the value only (by ignoring the sign) would mean people's WTP for transferring from alternative B to A. According to Table 2.14.2, the lowest and the highest WTP for transferring from alternative B and A are 11.33 and 1084.82 Nepalese rupees, respectively. Both the highest and lowest WTP values come from the version 2 of the choice sets. The lowest WTP is for transferring from waste management service with unscheduled daily collection without community waste management program and three types of waste segregation to waste management service with weekly scheduled collection with community waste management program and two types of waste segregation. The highest WTP is for transferring from waste management service with weekly (once in a week) collection without community waste

[32] The non-linear MWTP value for frequency is calculated by using the coefficients of a non-linear frequency model presented in Table 2.13, and in figure 2.1 and 2.2. With the given equation here, I am explaining the utility model, MWTP derivation and total utility derivation for the non-linear frequency model.

$U = \beta_1 Freq + \beta_2 Freq^2 + \beta_3 Freq^3 + \beta_P Price + \beta_X X$; MWTP $= \frac{\partial U}{\partial freq} / \frac{\partial U}{\partial P}$; $\frac{\partial U}{\partial freq} = \beta_1 + 2\beta_2 Freq + 3\beta_3 Freq^2$; $\frac{\partial U}{\partial P} = \beta_P$; Total Utility for frequency $= U = \beta_1 Freq + \beta_2 Freq^2 + \beta_3 Freq^3$

management program and three types of waste segregation to waste management service with daily collection with community waste management program and no segregation. That means people highly value frequent collection, community waste management program, and prefer not to segregate waste. The values in Table 2.14.1 to 2.14.3 present compensating surplus for trade-off between different levels of the attributes.

2.8 Discussion and Conclusion

The current solid waste management service in the Kathmandu Valley needs improvement to reach a sustainable state. Currently, some places have irregular or no waste collection service. Available service can be designed better that caters to people's need, are more efficient and effective, and reduce waste generation through recycling and reuse. I estimate people's preference and MWTP for improvement in current solid waste management using data from a primary household survey conducted in 2012. I used a choice experiment to estimate people's MWTP for attributes of solid waste management service. The attributes are decided based on feedbacks received from meetings with municipality officials, debriefing with volunteer respondents, and focus-group discussions with household representatives of all five municipalities. I use five attributes of the solid waste management service, including the monthly user fee.

The initial model specification is identified using the conditional logit model. Conditional logit model, however, has three strong assumptions: a) error terms are identically and independently distributed, b) households have homogenous preference, and c) people's choice alternative does not change irrespective of the availability of more alternatives and this assumption is called Independence from irrelevant alternatives (IIA) property. The Hausman test proves that IIA property does not hold in the given data. Hence, conditional logit model is inappropriate method for the given data. Taking that into account, I used mixed logit model that relaxes all three assumptions of the conditional logit model. The sign and significance of the variables coefficients in the mixed logit model is consistently similar with that of the conditional logit model. Based on the location of households and their pattern of monthly user fee payment, the total sample of the Kathmandu Valley is divided into two groups: core-urban and sub-urban. Core-urban represents core urban area where majority of households pay monthly user fee. Sub-urban represents the sub-urban area and majority of respondent do not pay any monthly user fee.

This study identifies that an average resident of the Kathmandu Valley is not willing to segregate waste. However, residents of sub-urban area in particular are willing to segregate two types of waste. As a policy implication of this finding, municipalities have to promote segregation of waste by provide incentive for doing so or by increasing the public awareness of positive impact of waste reduction.

In developing countries, community involvement is used in the management of common property resources and it has been an important tool in achieving sustainable development. Hoever, the community involvement has not been discussed in waste management related studies. In this study, community waste management program is an unique attribute for a study related to solid waste management. According to the results, the Kathmandu Valley residents always preferred having a community waste management program and its MWTP is significantly different from zero. Based on this findings and some examples of successful community forest management programs in Nepal, community waste management program can be another innovative option to keep community clean. The community waste management program provides an option for community members to volunteer for keep community clean by monitoring haphazard waste disposal behaviors and promoting public awaness, in partnership with municipalities. Community waste management program also creates a sense of ownership for community members. Therefore, community waste management program can help us to achieve sustainable improvement in solid waste management service.

I also found distance-decay effect on people’s preference for solid waste management attributes. People are willing to trade-off between frequency of waste collection and scheduled collection. With an increasing distance from respondent’s house to the waste collection point, people are willing to accept less frequent collection given they have scheduled collection available. People’s willingness to trade-off between frequency and scheduled feature of collection can be used to create an important policy. Municipalities can reduce the waste collection cost by reducing collection frequency and emphasizing on providing scheduled and regular collection.

One of the challenges of current solid waste management service in the Kathmandu Valley is the budget constraint of the municipalities. To overcome the budget constraint, solid waste management act, 2011 explicitly states that municipalities are allowed to collect monthly user fee providing waste collection. To identify a feasible monthly user fee per household, I have estimated people's MWTP for different attributes of solid waste management. Based on the MWTP estimates, Sub-urban respondent are willing to pay the most for scheduled collection. Core-urban respondents are willing to pay the most for community waste management program. Therefore, each municipality has to create a customized waste management service to cater to those municipality resident's needs.

I also estimated the consumer surplus for transferring from one scenarios to another scenario of waste management service. The highest WTP for such transfer is 1084.82 Nepalese rupees. The alternative that people are willing to pay the most have no waste segregation, daily waste pickup and have a community waste management program; the collection type, however, is unscheduled.

2.9 Policy Recommendations

In the Millennium Development Goal progress report prepared by Nepal Planning Commission and United Nations Country Team of Nepal (2013), sanitation has been identified as one of seven major development goals; and the goal is to decrease the total population of those living without sanitation by half by 2015. However, sanitation refers to the basic necessities like access to toilet, sewerage and drinking water; but not the solid waste management service. Interim constitution of Nepal, 2007 has identified the access to drinking water as a fundamental right, and has targeted to achieve universal access to water and sanitation by 2017. In Kathmandu valley, household waste is dumped in river bank and the leachate from biodegradable waste is sucked into the underground drinking waste source. Therefore, the improvement in waste disposal practices will secure the quality of the underground drinking water as well. The policy recommendations on improved solid waste management service can help to achieve the goal of having universal access to water and sanitation.

Some of the policy recommendations based on our main findings are: 1) promoting decentralized authority and local leadership to address spatial heterogeneity among residents of the Kathmandu Valley as identified by core-urban and 2 in this study; 2) defining municipalities as the smallest unit of planning and ensuring that financial support is locally managed; 3) keeping into account of trade-off between waste collection frequency and scheduled collection while creating a solid waste management plan; and 4) identifying an incentive for promoting waste segregation and recycling. The main findings from this study can pinpoint on people's preference on specific attributes of solid waste management in each municipalities so that municipalities can optimally allocate their resources that caters to people's need and sanitation preference.

Asian Development Bank (ADB) (2013) provides policy recommendations about improvement in existing solid waste management system based on the quantity and composition of waste generation; and emphasis in using 3R (reduce, reuse and recycle) policy. ADB report addresses the fact that waste segregation at source will help to reduce waste and hence the waste disposal cost. However, their policy recommendation does not address people's preference on waste segregation. Therefore, ADB's policy recommendation is based on top-down approach as they suggest municipalities to involve community participation through information, education and communication campaign based on their findings. However, in our policy recommendation, we encourage municipalities to use bottom-up approach by providing the policy recommendation based on people's preference towards the existing solid waste management practices. Cost recovery is another important policy recommendation. In our study, we estimate representative household's average and marginal willingness to pay for the waste management service and the specific attributes, respectively. Based on those WTP estimates, increases in monthly user fee are recommended. The Cost recovery through this process is expected to be more feasible as the increase in monthly fee is derived from people's response in a choice experiment.

Tables and Figures:

Table 2.1 Distribution of Sample Used for Estimation by Municipalities

Municipality	**Percent**
Kathmandu	45.97
Lalitpur	20.67
Kirtipur	10.47
Bhaktpur	12.33
Thimi	10.56
Total Number of observations	**13,527**

Table 2.2.1 Attribute with Levels Used in the Choice Set Design

Attributes	**Levels**
Waste collection type	Scheduled door to door waste collection service Unscheduled door to door waste collection service
Is Community waste management Program available?	Yes and No
Waste collection frequency per week	1 time, 2 times, 3 times, and 7 times a week
Waste segregation type	0 types (No segregation) 2 types (Biodegradable and non-biodegradable) 3 types (Biodegradable, recyclable and other)
Additional Monthly user fee	5 Rupees, 10 rupees, 20 rupees, 40 rupees, 50 rupees, and 100 rupees

Table 2.2.2 An Example of a Choice Set

	Alternative A	Alternative B	Status Quo
Waste collection type	Door to door waste collection service, without schedule	Door to door waste collection service, without schedule	Status quo
Community waste management program available	Yes	No	Status quo
Waste collection frequency	Daily i.e., 7 times a week	Once a week	Status quo
Waste segregation types	No segregation	3 types: biodegradable, recyclable and other waste	Status quo
Additional monthly user fee	100 rupees per month	20 rupees per month	0

Community waste management program includes 3 important features: 1) Public awareness program about proper waste management and disposal, 2) waste collection, and 3) monitoring haphazard waste disposal and taking action against it.

Table 2.2.3 Distribution of Sample by Choice of Alternatives

	Pooled	Core-urban	Sub-urban
Chosen Alternative	**Percent**	**Percent**	**Percent**
A	44.67	45.93	40.41
B	31.65	32.96	27.23
Status-quo	23.69	21.11	32.36
observations (n)	**13,527**	**10,431**	**3,096**

Table 2.3.1 Distribution of Sample by Solid Waste Management Attributes and Individual Characteristics

	Pooled		Core-urban		Sub-urban	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Zero Status-quo Fee (in percent)	56.22	49.61	46.75	49.90	87.98	32.52
Education above SLC(i.e., 10th Grade) (in percent)	60.89	48.80	63.32	48.20	52.71	49.93
Own house (in percent)	60.78	48.83	54.06	49.84	83.33	37.27
Business holders (in percent)	36.87	48.25	34.81	47.64	43.80	49.62
Female (in percent)	52.68	49.93	53.25	49.90	50.78	50.00
Distance	1.12	2.20	1.04	2.07	1.39	2.58
Distance square	6.09	33.85	5.35	33.55	8.55	34.73
Age	36.01	13.43	36.57	13.42	34.13	13.29
Average Household Monthly Income (in Rupees)	33,853.09	156,832.40	37,042.15	178,320.40	23,145.67	16,420.52
No of observations	13491		10395		3096	

Table 2.3.2 Distribution of Solid Waste Management Attributes by Status-quo Vs Non Status-quo Choices

	Choose status-quo alternative		Chose non status-quo alternative	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Zero Status-quo Fee (in percent)	54.58	49.79	56.64	49.56
Education above SLC (i.e., 10th grade)(in percent)	54.03	49.85	63.03	48.27
Own house (in percent)	63.2	48.23	60.17	48.96
Business holders (in percent)	42.7	49.47	34.93	47.68
Female (in percent)	50.94	50	53.27	49.90
Distance	0.69	1.46	1.25	2.37
Distance square	2.6	10.21	7.15	38.22
Age	38.43	14.08	35.31	13.15
Average Household Monthly Income (in Rupees)	46,792.42	306,247.10	30030.37	54458.68
Monthly user fee	84.12	95.58	82.05	93.68
No of observations	3204		10323	

Table 2.4 Descriptive Statistics of the Status-quo Level Attributes for All Municipalities and Two Groups of Municipalities

Variable	Description	All Municipalities		Core-urban		Sub-urban	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Waste Segregation Types	**Types of waste segregation at household level**						
segregateZero	Zero (Yes =1, otherwise=0)	0.591	0.492	0.619	0.486	0.5	0.5
segregate2	2: Biodegradable and non-biodegradable waste (Yes=1, otherwise=0)	0.269	0.443	0.247	0.432	0.341	0.474
segregate3	3: Biodegradable, Recyclable and other waste (yes=1, otherwise=0)	0.14	0.347	0.134	0.341	0.159	0.366
Waste Collection Types	**Types of waste collection (pick-up) service**						
collNone	No collection (Yes=1, otherwise=0)	0.125	0.33	0.078	0.268	0.283	0.451
scheduled	Scheduled collection (Yes=1, otherwise=0)	0.271	0.445	0.252	0.434	0.337	0.473
unscheduled	Unscheduled collection (Yes=1, otherwise=0)	0.604	0.489	0.671	0.47	0.38	0.486
communityorg	Has Community Waste Management Program in the community (yes=1, otherwise=0)	0.255	0.436	0.236	0.425	0.318	0.466
freq	Frequency of waste collection per week	4.164	3.768	3.378	2.074	6.81	6.203
monthlyFee	Monthly user fee per household per month in Nepalese rupees	56.883	88.413	71.452	94.721	7.798	28.335
No. of observations			4509		3477		1032

Maximum frequency: pooled= 21, core-urban=14 , sub-urban=21;
Maximum Monthly Fee: pooled=600, core-urban=600, sub-urban= 200; Monthly Fee is divided by 100 while running estimations

Table 2.5 Conditional logit Base model

	Pooled		Core-urban		Sub-urban	
Dependent Variable: Choice						
Monthly Fee/100	-0.0955*	(-1.65)	-0.118*	(-1.79)	-0.226*	(-1.71)
Community waste management program	0.925***	(27.42)	0.958***	(24.69)	0.813***	(11.42)
Collection type: (Reference: No collection)						
scheduled	1.218***	(7.29)	0.847***	(4.02)	1.817***	(6.46)
unscheduled	0.763***	(4.59)	0.363*	(1.73)	1.461***	(5.24)
Segregation type: (Reference: No segregation)						
segregate2	0.0912**	(2.07)	0.0722	(1.42)	0.201**	(2.2)
segregate3	-0.0713	(-1.53)	-0.0532	(-1.03)	-0.11	(-1.09)
Waste collection frequency per week	0.149***	(21.21)	0.173***	(19.1)	0.115***	(11.16)
no. of observations	13527		10431		3096	
Log Likelihood	-4131.2		-3204		-913	
chi-squared	1289.3		1004.2		320.2	
AIC	8276.5		6422		1839	

* p<0.1 ** p<0.05 *** p<0.01
t statistics in parentheses

Pooled includes all 5 municipalities; Core-urban= Kathmandu, Lalitpur and Kirtipur; and Sub-urban= Bhaktpur and Thimi

Table 2.6 Conditional Logit Interaction Model with Non-linearity and Spatial Heterogeneity

	Pooled		Core-urban		Sub-urban	
Dependent Variable: Choice						
Monthly Fee/100	-0.102*	(-1.73)	-0.112*	(-1.67)	-0.251*	(-1.82)
Community waste management program	1.265***	(10.56)	1.318***	(9.67)	1.128***	(4.21)
Collection type: (Reference: No collection)						
scheduled	1.165***	(5.75)	1.058***	(4.42)	1.136***	(2.83)
unscheduled	0.591***	(3.44)	0.299	(1.42)	1.174***	(3.73)
Segregation type: (Reference: No segregation)						
segregate2	0.106**	(2.37)	0.0771	(1.49)	0.255***	(2.73)
segregate3	-0.0465	(-0.99)	-0.0395	(-0.76)	-0.0644	(-0.61)
waste collection frequency per week	0.137***	(17.40)	0.161***	(15.30)	0.107***	(9.29)
communityorg*age	-0.0125***	(-4.86)	-0.0137***	(-4.73)	-0.00933	(-1.55)
frequency*distance	0.0405***	(5.30)	0.0326***	(3.65)	0.0498***	(3.17)
Frequency*distance^2	-0.00124***	(-3.05)	-0.000795	(-1.18)	-0.00224*	(-1.92)
distance*scheduled	0.207***	(4.58)	0.207***	(3.43)	0.173**	(2.37)
Distance*scheduled*frequency	-0.0386***	(-4.10)	-0.0335***	(-2.89)	-0.0397**	(-2.45)
Communityorg*aboveSLC	0.154**	(2.16)	0.203**	(2.50)	-0.0302	(-0.19)
Scheduled*age	-0.00459	(-1.62)	-0.00927***	(-2.86)	0.0117*	(1.89)
N	13491		10395		3096	
log_likelihood	-4077.7		-3156.1		-902.3	
chi-squared	1318.6		1027.2		347.0	
AIC	8183.4		6340.1		1832.5	

* p<0.1 ** p<0.05 *** p<0.01

t statistics in parentheses

Table 2.7 Test of Independence of Irrelevant Alternatives

Alternative Dropped	Chi square	Degree of Freedom	Probability
A	53.95	7	0.00
B	135.92	7	0.00

H_0: IIA property holds. H_0 is rejected if one of the alternatives is dropped; Above Chi-square values are used for conditional logit estimates in pooled model; Chi square computed for 7 degree of freedom and 5% significance level = 14.067

Table 2.8 Coefficients of Mixed logit Base model

	Pooled		Core-urban		Sub-urban	
Dependent Variable: Choice						
monthlyFee1	-0.581***	(-4.30)	-0.583***	(-3.80)	-0.618**	(-2.14)
communityorg	2.331***	(13.79)	2.360***	(12.11)	2.261***	(6.51)
scheduled	2.293***	(6.04)	1.724***	(3.81)	2.972***	(4.51)
unscheduled	1.328***	(3.63)	0.670	(1.53)	2.345***	(3.71)
segregate2	0.252**	(2.04)	0.156	(1.11)	0.669**	(2.44)
segregate3	-0.411***	(-3.25)	-0.463***	(-3.27)	-0.204	(-0.73)
freq	0.469***	(13.54)	0.482***	(12.05)	0.432***	(6.15)
Standard Deviation of the Random Parameters						
communityorg	3.094***	(13.88)	3.197***	(12.48)	2.675***	(5.90)
scheduled	2.205***	(7.57)	2.290***	(8.16)	1.806***	(4.00)
unscheduled	0.211	(0.08)	-0.155	(-0.06)	-0.446	(-0.38)
segregate2	2.037***	(9.29)	2.067***	(8.29)	2.012***	(4.29)
segregate3	2.483***	(11.55)	2.413***	(9.99)	2.627***	(5.54)
freq	0.548***	(12.75)	0.551***	(10.95)	0.534***	(6.41)
N	13527		10431		3096	
log_likelihood	-3618.6		-2833.4		-778.2	
chi-squared	1025.3		741.1		268.5	
AIC	7263.2		5692.9		1582.5	

* p<0.1 ** p<0.05 *** p<0.01
t statistics in parentheses

Halton draws= 35000, iterations=100, All the attributes except the monthly fee are randomly distributed with normal distribution; Core-urban includes Kathmandu, Lalitpur and Kirtipur; Sub-urban includes Bhaktpur and Thimi.

Table 2.9 Mixed Logit Interaction Model with Nonlinearity and Spatial heterogeneity

	Pooled		Core-urban		Sub-urban	
Dependent Variable: Choice						
monthlyFee1	-0.602***	(-4.42)	-0.603***	(0.156)	-0.642**	(-2.23)
communityorg	3.336***	(7.18)	3.455***	(0.537)	2.882***	(3.07)
scheduled	2.637***	(5.39)	2.555***	(0.599)	1.927**	(2.28)
unscheduled	1.175***	(3.29)	0.630	(0.452)	2.105***	(3.39)
segregate2	0.269**	(2.16)	0.167	(0.141)	0.705***	(2.59)
segregate3	-0.364***	(-2.86)	-0.422***	(0.143)	-0.162	(-0.58)
freq	0.437***	(11.88)	0.451***	(0.0426)	0.385***	(5.36)
comm_age	-0.0350***	(-3.68)	-0.0399***	(0.0109)	-0.0175	(-0.88)
freq_distance	0.0758***	(3.45)	0.0800***	(0.0263)	0.0848*	(1.93)
freq_distancesq	-0.00319**	(-2.35)	-0.00280*	(0.00166)	-0.00514*	(-1.71)
distance_sch	0.423***	(4.56)	0.490***	(0.115)	0.308*	(1.92)
dist_sch_freq	-0.0588***	(-3.03)	-0.0701***	(0.0240)	-0.0404	(-1.19)
comm_aboveSLC	0.355	(1.36)	0.510*	(0.301)	-0.170	(-0.32)
scheduled_age	-0.0196**	(-2.32)	-0.0297***	(0.00976)	0.0180	(1.05)
Standard Deviation of the Random Parameters						
communityorg	3.044***	(13.81)	3.141***	(0.253)	2.574***	(5.90)
scheduled	2.111***	(8.22)	2.193***	(0.359)	1.669***	(3.62)
unscheduled	0.404	(0.40)	0.416	(1.589)	-0.393	(-0.31)
segregate2	2.073***	(9.44)	2.107***	(0.250)	1.979***	(4.33)
segregate3	2.513***	(11.59)	2.441***	(0.244)	2.672***	(5.69)
freq	0.548***	(12.79)	0.557***	(0.0508)	0.517***	(6.43)
N	13527		10431		3096	
log_likelihood	-3592.3		-2806.7		-773.8	
chi-squared	996.7		724.0		256.8	
AIC	7224.6		5653.5		1587.7	

* p<0.1 ** p<0.05 *** p<0.01
t statistics in parentheses

Halton draws= 35000, iterations=100, All the attributes except the monthly fee are randomly distributed; Core-urban includes Kathmandu, Lalitpur and Kirtipur; Sub-urban includes Bhaktpur and Thimi.

Table 2.10 Log-Likelihood Ratio Test between Pooled and Spatially Segregated Models with Fixed Monthly Fee

Model	Obs	Log Likelihood(null)	Log Likelihood(model)	Degree of Freedom	AIC	BIC
Pooled	13527	-4131.24	-3617.21	13	7260.428	7358.09
Core-urban	10431	-3203.99	-2832.5	13	5690.995	5785.278
Sub-urban	3096	-912.498	-778.969	13	1583.938	1662.43
	Log-likelihood Ratio Formula		**Calculated Chi2(14)**	**Tabulated Chi2(14)**		
	-2(lnL^_R-lnL^_U)		11.5	22.36		

Chi-Square values are at 5% significance level; Log Likelihood Value are obtained using Mixed logit model with all the variables randomly distributed except the monthly fee. 1000 Halton draw and 100 iterations; Basic model for Pooled and two-disaggregated models based on location is used.

Table 2.10_B Log-Likelihood Ratio Test between Pooled and Spatially Segregated Models with Randomly Distributed Monthly Fee

Model	Obs	Log Likelihood(null)	Log Likelihood(model)	Degree of Freedom	AIC	BIC
Pooled	13527	-4131.242	-3567.913	14	7163.826	7269
Core-urban	10431	-3203.985	-2792.207	14	5612.415	5713.95
Sub-urban	3096	-912.4984	-761.7063	14	1551.413	1635.943
	Log-likelihood Ratio Formula		**Calculated Chi2(14)**	**Tabulated Chi2(14)**		
	-2(lnL^_R-lnL^_U)		28	23.685		

Chi-Square values are at 5% significance level; Log Likelihood Value are obtained using Mixed logit model with all the variables randomly distributed **including the monthly fee.** 1000 Halton draw and 100 iterations; Basic model for Pooled and two-disaggregated models based on location is used.

Table 2.11 Marginal Willingness to Pay(in Nepalese Rupees per Month per Household) for Conditional Logit Base Model using Delta Method

	Pooled			Core-urban			Sub-urban		
		95% CI			95% CI			95% CI	
	MWTP	ll	ul	WTP	ll	ul	WTP	ll	ul
communityorg	968.648	-175.982	2113.278	810.270	-73.503	1694.042	359.269	-61.758	780.296
scheduled	1275.327	-218.483	2769.137	716.268	-102.251	1534.788	803.206	-86.869	1693.282
unscheduled	799.176	-154.387	1752.740	307.167	-146.668	761.002	645.782	-69.772	1361.336
segregate2	95.486	-40.695	231.667	61.043	-39.113	161.199	88.869	-37.464	215.202
segregate3	-74.648	-215.323	66.027	-45.045	-151.327	61.237	-49.473	-158.138	59.193
freq	155.635	-29.821	341.092	146.133	-14.050	306.316	50.701	-10.896	112.299

MWTP = Marginal Willingness to pay, CI= Confidence Interval

Table 2.12 Marginal Willingness to Pay(in Nepalese Rupees per Month per Household) for Mixed Logit Base Model using Delta and Krinsky Robb Method

	Delta Method								
	Pooled			**Core-urban**			**Sub-urban**		
	wtp	**ll**	**ul**	**wtp**	**ll**	**ul**	**wtp**	**ll**	**ul**
communityorg	401.227	222.667	579.787	404.943	201.769	608.116	365.690	30.633	700.747
scheduled	394.711	191.980	597.442	295.732	93.803	497.661	480.703	34.944	926.463
unscheduled	228.563	81.144	375.983	115.043	-37.423	267.508	379.321	27.205	731.437
segregate2	43.438	-1.464	88.341	26.705	-21.338	74.749	108.217	-22.443	238.877
segregate3	-70.780	-126.787	-14.773	-79.461	-145.745	-13.176	-33.016	-127.495	61.463
freq	80.730	43.462	117.998	82.657	39.879	125.435	69.818	1.997	137.639
	Krinsky Robb method								
	wtp	**ll**	**ul**	**wtp**	**ll**	**ul**	**wtp**	**ll**	**ul**
communityorg	401.227	275.488	727.218	404.943	267.220	821.125	365.690	158.929	1853.912
scheduled	394.711	240.793	732.064	295.732	136.534	643.809	480.703	186.554	2348.210
unscheduled	228.563	104.529	450.115	115.043	-35.728	325.365	379.321	129.425	1788.243
segregate2	43.438	1.785	104.911	26.705	-22.858	90.438	108.217	1.866	598.049
segregate3	-70.780	-159.124	-25.474	-79.461	-197.739	-28.074	-33.016	-278.489	101.814
freq	80.730	54.465	148.329	82.657	53.623	169.911	69.818	27.674	370.280
	Krinsky Robb method								
	Mean	**Median**		**Mean**	**Median**		**Mean**	**Median**	
communityorg	401.227	401.315		404.943	405.022		365.690	358.959	
scheduled	394.711	394.471		295.732	295.690		480.703	471.281	
unscheduled	228.563	228.049		115.043	115.008		379.321	371.321	
segregate2	43.438	43.249		26.705	26.578		108.217	105.129	
segregate3	-70.780	-70.849		-79.461	-79.538		-33.016	-31.601	
freq	80.730	80.684		82.657	82.598		69.818	68.281	

Halton draws= 35000, iterations=100, All the attributes except the monthly fee are randomly distributed; Core-urban includes Kathmandu, Lalitpur and Kirtipur; Sub-urban includes Bhaktpur and Thimi. The amounts are in Nepalese rupees per month. $1= $98 Nepalese Rupees. Source: Central Bank of Nepal, June 2012. MWTP are obtained using coefficient estimates in Table 2.8.

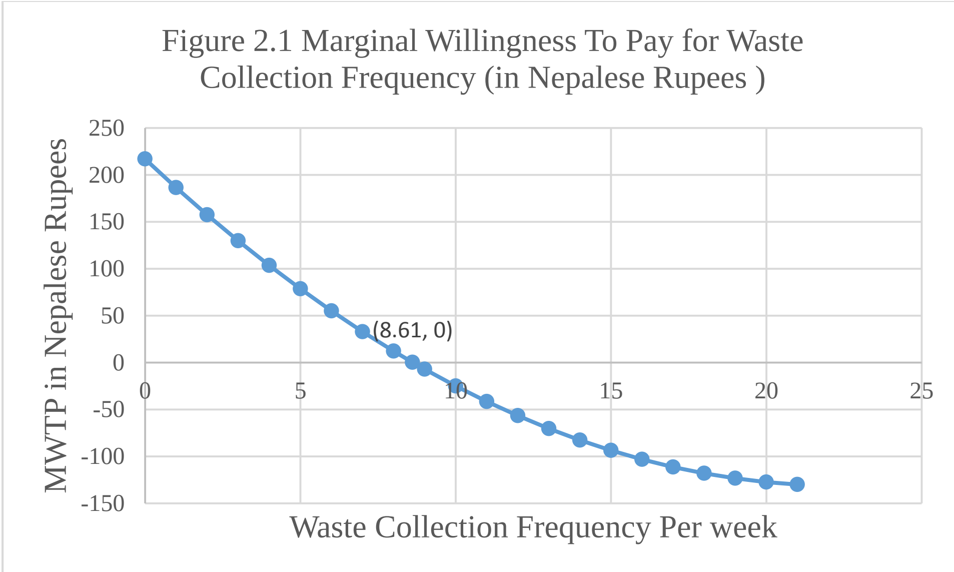

Figure 2.1 Marginal Willingness To Pay for Waste Collection Frequency (in Nepalese Rupees)
MWTP in Nepalese Rupees
250
200
150
100
50
0
-50
-100
-150
0
5
10
15
20
25
(8.61, 0)
Waste Collection Frequency Per week

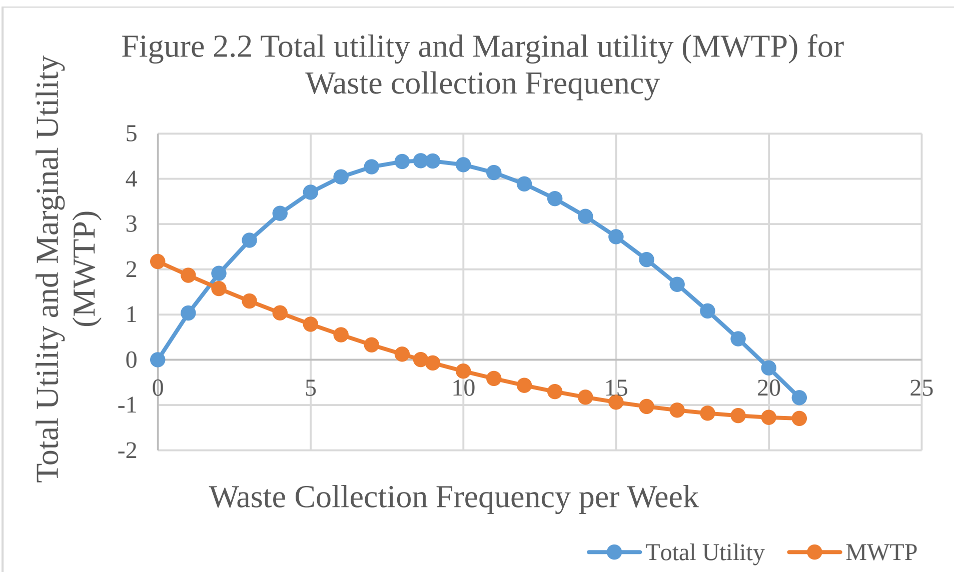

Figure 2.2 Total utility and Marginal utility (MWTP) for Waste collection Frequency
Total Utility and Marginal Utility (MWTP)
5
4
3
2
1
0
-1
-2
0
5
10
15
20
25
Waste Collection Frequency per Week
Total Utility
MWTP

Table 2.13. Basic Mixed Logit Model for the Pooled Sample using Non-linear Frequency

Dependent Variable: Choice		
Mean		
monthlyFee1	-0.511***	(-3.75)
communityorg	2.469***	(14.05)
scheduled	1.015***	(8.06)
segregate2	0.261**	(2.11)
segregate3	-0.467***	(-3.50)
freq	1.109***	(8.94)
freq_sq	-0.0797***	(-4.21)
freq_cube	0.00119	(1.58)
Standard Deviation of the Random Parameter		
communityorg	3.124***	(13.61)
scheduled	2.242***	(11.27)
segregate2	1.950***	(8.73)
segregate3	2.654***	(11.72)
freq	-0.532***	(-11.85)
freq_sq	0.00231	(0.62)
freq_cube	0.00357***	(6.38)
N	13527	
log_likelihood	-3581.6	
chi-squared	1019.6	
AIC	7193.3	

* p<0.1 ** p<0.05 *** p<0.01

t statistics in parentheses; estimates for non-linear frequency variable is used to obtain Total utility and Marginal WTP graph for frequency, as given in graph 1 and 2; iterations= 1000

Table 2.14.1 WTP for Transferring from Scenario A to B, using Mixed Logit Model with Fixed Distribution for Monthly Fee in Version 1

Choice Set	Attributes	Level of Attributes		WTP for transferring from A to B
		Alternative A	Alternative B	WTP
1	Collection type	Unscheduled	Scheduled	
	Community Waste Management Program available?	Yes	No	
	Waste Collection Frequency per week	7	3	
	Waste Segregation Types	0	2	-481.13
	Monthly Fee	20	40	
2	Collection type	Scheduled	Scheduled	
	Community Waste Management Program available?	No	Yes	
	Waste Collection Frequency per week	7	3	
	Waste Segregation Types	0	3	150.31
	Monthly Fee	5	10	
3	Collection type	Scheduled	Unscheduled	
	Community Waste Management Program available?	No	Yes	
	Waste Collection Frequency per week	7	1	
	Waste Segregation Types	0	2	-241.24
	Monthly Fee	50	5	
4	Collection type	Scheduled	Scheduled	
	Community Waste Management Program available?	No	Yes	
	Waste Collection Frequency per week	7	3	
	Waste Segregation Types	3	0	236.81
	Monthly Fee	40	10	

Table 2.14.2 WTP for Transferring from Scenario A to B, using Mixed Logit Model with Fixed Distribution for the Monthly Fee in Version 2

Choice Set	Attributes	Level of Attributes		WTP for transferring from A to B
		Alternative A	Alternative B	WTP
1	Collection type	Unscheduled	Unscheduled	
	Community Waste Management Program available?	Yes	No	
	Waste Collection Frequency per week	7	1	
	Waste Segregation Types	0	3	-1084.82
	Monthly Fee	100	20	
2	Collection type	Scheduled	Unscheduled	
	Community Waste Management Program available?	No	Yes	
	Waste Collection Frequency per week	3	1	
	Waste Segregation Types	2	3	-111.39
	Monthly Fee	20	50	
3	Collection type	Scheduled	Unscheduled	
	Community Waste Management Program available?	Yes	No	
	Waste Collection Frequency per week	7	3	
	Waste Segregation Types	2	0	-997.33
	Monthly Fee	10	40	
4	Collection type	Scheduled	Unscheduled	
	Community Waste Management Program available?	Yes	No	
	Waste Collection Frequency per week	1	7	
	Waste Segregation Types	2	3	-134.44
	Monthly Fee	50	10	

Table 2.14.3 WTP for Transferring from Scenario A to B, using Mixed Logit Model with Fixed Distribution for the Monthly Fee in Version 3

Choice Set	Attributes	Level of Attributes		WTP for transferring from A to B
		Alternative A	Alternative B	WTP
1	Collection type	Unscheduled	Scheduled	
	Community Waste Management Program available?	No	Yes	
	Waste Collection Frequency per week	1	3	
	Waste Segregation Types	2	3	609.59
	Monthly Fee	100	5	
2	Collection type	Unscheduled	Scheduled	
	Community Waste Management Program available?	Yes	No	
	Waste Collection Frequency per week	7	1	
	Waste Segregation Types	2	3	-687.00
	Monthly Fee	40	100	
3	Collection type	Scheduled	Unscheduled	
	Community Waste Management Program available?	Yes	No	
	Waste Collection Frequency per week	1	3	
	Waste Segregation Types	0	2	-294.16
	Monthly Fee	40	50	
4	Collection type	Unscheduled	Unscheduled	
	Community Waste Management Program available?	No	Yes	
	Waste Collection Frequency per week	1	3	730.67
	Waste Segregation Types	0	3	
	Monthly Fee	10	100	

Chapter 3: Geo-Spatial Analysis of the Effect of Outdoor Air Pollution on People's Health in the Kathmandu Valley in Nepal.

3.1 Introduction

In the previous chapter, I estimated people's willingness to pay for improvements in the existing waste management service using a household choice experiment survey. One of the motivations for improving the waste management service is to safeguard public health. This chapter connects with the previous chapter by addressing the public health problem people face due to air pollution from existing solid waste management practices and other sources of air pollution in the Kathmandu Valley. This paper estimates the effect of outdoor air pollution on public health and calculates the health benefit of reducing one's exposure to the air pollution. Some of the sources of such pollution are traffic emission, industries, and temporary and permanent waste dumping sites. With the estimation of the public health impact through one of the means of environmental externality i.e., outdoor air pollution, this chapter addresses the environmental issues of the Kathmandu Valley and provides policy implication for sustainable urban development.

According to a World Health Organization (WHO) report, 1.4 billion urban residents worldwide breathe air with pollutant levels above the WHO's air guideline values (WRI, 1998). The trans-boundary movement of emissions causes public health problems locally as well as globally. In addition to the public health problems, air pollution alters global climate; global warming causes natural disaster such as glacier melting, flooding and avalanche. Some of the most discussed and riskiest outdoor air pollutants include different levels of particulate matter (for example, $PM_{2.5}$, PM_{10}[33] etc.), ozone, nitrogen dioxide, black carbon, sulfur dioxide, benzene, and many more. There are two types of emission sources: point source and area source[34]. In this study, emissions come from area source such as motor vehicle emission, waste dumping sites, and small industries.

[33] PM_{10} stands for Particulate Matter of less than 10 millionths of a meter i.e., 10 micrometers or 10 um in diameter. General population is exposed to total suspended particles available in dust. Particulate air matter of less than 10 microns in diameter, such as 2.5 microns in diameter, impose bigger threat on public health as it can penetrate into lungs.

[34] Point source refers to large single facilities that are required to report emissions. Area source refers to smaller facilities and sources of pollution that release lesser quantity of pollutants.

According to the Environment Sector Program Support (ESPS) monitoring stations' analysis, the Kathmandu Valley has high levels of particulate matter, nitrogen dioxide, and sulfur dioxide (MOPE, 2004). It is found that the PM_{10} value is high in the dry winter season and lower in the rainy season[35]. In 2003, the PM_{10} ranged from 30 to 295 micrograms per cubic meter in central areas and 23 to 130 microgram per cubic meter in the outskirts of the Kathmandu Valley (MOPE, 2004). WHO guidelines values for PM_{10} are 50 microgram per cubic meter for 24-hours mean. However, WHO also says that low level of PM_{10} can also cause health problems and low level of PM_{10} neither is a safe limit for the concentration of PM_{10}

The health effects of the outdoor air pollution range from minor irritation of the eyes and the upper respiratory system to chronic respiratory diseases, heart diseases, and even death (American Lung Association, 2001). There are numerous studies that confirm the existence of adverse health effects from air pollution. Based on the length of exposure, outdoor air pollution also causes premature mortality and reduces the life expectancy. Children and people with pre-existing health conditions are more vulnerable to such effects[36].

This study will focus on outdoor air pollution due to anthropogenic activities such as vehicle and industrial emissions, biomass and fossil fuel combustion, and biogas emissions from waste dumping sites[37]. I estimate the effect of personal air pollution exposure on the health of urban area residents in the Kathmandu Valley[38]. The factors that influence exposure to ambient air pollution include regional-scale polluted air masses, proximity to local ambient sources, and time-activity patterns (American Lung Association, 2001). The time-activity pattern represents the total time spent indoors and outdoors, transportation modes used, and other activities. The other factors that can

[35] This paper uses primary data from the survey conducted in June to August (of 2012) and we asked individuals about their health problem during past one month. Therefore, this paper represents the effect of air pollution in the Kathmandu Valley during summer or rainy season.

[36] Because of the lack of data, we use a simplified model and assume that people do not have pre-existing conditions. All the respondents are at least 18 years old. This study estimates the static effect of outdoor air pollution on health as we do not account for length of stay in their current residence.

[37] Biogas emission from landfill site is another important factor to contribute on outdoor air pollution. However, our study area does not include the landfill site. The landfill site is situated 27 kilometers away from the landfill site and hence our study does not include people's health related data from neighboring communities of the landfill site.

[38] Small portion of Kathmandu Valley is spread across villages as well. The sample of this study includes only the urban area of the Kathmandu Valley.

influence such exposure are the pollution and pollutant types, its concentration in the air, the length of exposure, each individual's susceptibility, and source of pollutant's geographic characteristics such as latitude and topography. We identify individuals' time-activity patterns based on their occupation, which identifies one's exposure to pollution, and look at its effect on their health. For example, unskilled day laborers mostly work outdoors, close to traffic congested areas such as bus parks and bus stops, and at the roadside. Alternatively, women who are not working outside of the homes are less exposed to traffic emissions.

The effect of outdoor air pollution is usually examined by measuring pollutants' level in the air and its effect on people's health. Many of those studies use pollutant level data received from meteorological stations and estimate the marginal effect of those pollutant factors on people's respiratory health. For example, epidemiological studies use dose-response function by estimating the expected health effect per unit of a given pollutant and adjusting it for required reduction in pollution level to reach safe level and population at health risk. The approach used in this paper is different; we examine people's personal exposure to pollutants based on the proximity to the source of pollution such as traffic emission, industries, and waste dumping sites, and relate it with people's health. .

This study extends the existing studies by identifying the variation (heterogeneity) in exposure to outdoor pollution among communities. Hence, this study accounts for communities' geographic characteristics, proximity to the source of pollutants, and people's individual characteristics. I found that exposure to traffic emissions has the strongest impact on people's health. More specifically we look at the probability of adverse health conditions such as nausea, dust allergy, asthma, and other respiratory infections; and relate occurrences of such health conditions with distance to the emissions sources. The emission from brick factories is another concern, and hence we estimate the effect of proximity to brick factories on people's health. The brick factories are selectively located in the outskirts of the city, where the population is thinner and farm land and forest density is higher. Therefore, we did not find any significant effect of those brick factories on public health. We find the positive effect of having open space and forest in the surrounding environment, and try to identify if such factors can offset part of the existing emissions.

3.2 Literature Review

Outdoor air pollutants are high in concentration in industrial and traffic congested areas and its adverse effect on people's health is widely accepted in epidemiological and other field. For example, a higher ozone concentration (i.e., 10 parts per billion) significantly increases the risk of death from respiratory diseases (Jerrett, et al., 2009). People exposed to 6.2 parts per billion nitrogen dioxide per year are 1.29 times more risky to produce asthma that those who are not (Jerrett et al., 2008). Higher concentrations of nitrogen dioxide are likely to cause asthma and bronchitis among children, and chronic phlegm among adults (Jerrett et al., 2008; Kim et al., 2004; Sunyer et al., 2006; McConnell, et al., 2010). According to Gül et al. (2011), Student living in industrial region with high concentrations of both nitrogen dioxide and ozone are 1.49 times likely to produce chronic pulmonary disease, 1.81 times likely to cough in mornings, and 1.57 times likely to suffer from tightness of the chest. When nitrogen dioxide concentration increases by 10 microgram per cubic meter, school children's wheezing increases by 1.16 times (Pikhart et al., 2000). Wheezing is also calused by higher concentration of acid in the air (Peters et al., 1999).

In this study, we analyze the health effect of different sources of emission in urban areas and explore the policy implications of different air pollution abatement methods. The sources of emission are categorized into three types: 1) urban traffic represented by the road, bus stops and intersections, 2) Industries represented by brick factories and other industries, 3) waste dumping sites, and 4) surrounding environment represented by open space, river, and forest and farm land. We use the distance from respondent's house to these sources of emission as the independent variables to measure its effect on people's health.

3.2.1 Health Effects from Exposure to Traffic Emission

In addition to the respiratory health problems, exposure to traffic emission causes heart (cardiac) disease. For example, in the Netherlands, living 50 to 100 meters from freeways is positively associated with cardiopulmonary mortality (Hoek et al., 2002). Tonne et al. (2007) found a 5% increase in acute myocardial infraction with people living within 100 meters of major roadways in Massachusetts. Traffic density plays stronger role in such effect than the ambient air pollution. Brugge et al. (2007) found epidemiologic evidence that people living within 200 meters from highways experience high risk of suffering from asthma and reduced lung function, with stronger effect on children. In the distance between 30 to 90 meters downwind of the highways, particulate matter are larger than 10 nm, and people who live within 90 meter of roadways are exposed to such particles that others are not (Zhang et al., 2004).

Schikowski et al. (2005) examined the effect of long-term exposure to air pollution on respiratory symptoms, more specifically the chronic obstructive pulmonary disease (COPD) in 55-year-old women. According to the results, women living less than 100 meters from busy roads have significantly decreased lung function and COPD was 1.79 times more likely in comparison to those who live farther away. Living within 20 meters of a main road increases the risk of regular phlegm by 15 percent and wheezing with breathing problem by 34 percent in non-smokers in Switzerland (Bayer-Oglesby et al., 2006). Barros et al. (2013) in a study in Portugal found that emission of Nitrogen dioxide and Benzene is significantly less at 100 meters far from road in comparison to the roadside locations. Other factors that changes the concentration of these pollutants are wind direction, population dispersion, season, traffic pattern, number of vehicles on the road, topography and other environmental conditions.

3.2.2 Health Effects from Exposure to Waste Dumping Sites

The open-air burning of plastics is a common practice among households in the Kathmandu Valley, which could have adverse effects on people's respiratory health. The chemical used to make rigid polyurethane foam is called diphenyl-methane di-isocyanate (MDI) Employees working on polyurethane foam manufacturing factories develop hypersensitivity to MDI and suffer from many respiratory illnesses such as bronchitis, asthma, and allergy. In addition, MDI also damages the respiratory tract (Carino, et al., 1997).

Some major contaminants that are found at dumping sites and landfills are: leachate, potentially carcinogenic methane gas, and airborne bacteria and fungi. These contaminants can affect soil, water, and air, and pose health hazard to people residing in close proximity to those dumping sites and landfills. The nitrogen in methane can rapidly replace oxygen in the lungs and blood streams. A methane and hydrogen sulfide concentration of 5 ppm causes respiratory illnesses such as bronchitis and asthma, and a 500 ppm concentration causes loss of consciousness and greater than 700 ppm concentration can be fatal. Similarly, exposure to hydrogen sulfide for a long period of time causes chronic headaches, memory problems, and decreased motor function. People living close to dumping sites and landfills (where biodegradable waste is heavily decomposed) are infected by mold species and volatile organic compounds[39] (VOC) that cause skin, eye, and respiratory tract irritation. Schrapp and Al-Mutairi (2010) in a study in Kuwait indicated that landfills produce a high amount of airborne dust, bacteria, and fungi within the breathing zone of residences near the landfill sites. In contrast to above mentioned studies, Durmusoglua et al. (2010) in a study in Turkey found that the BTEX emission (which includes benzene, toluene, ethyl benzene and xylene) in the landfill site does not pose a health threat to people working at landfill sites. The study found cancer risk from BTEX emission is 6.75E−05, which is less than acceptable risk level of 1.0E−04. We assume the health effect of temporary dumping sites close to residential areas is similar to landfill sites, probably in smaller scale.

3.2.3 A Tool to Reduce the Effect of Air Pollution: Urban Foresting

Urban foresting is found to be an effective way of removing large number of airborne particles and hence improving the air quality. Trees and plants act as biological filters. Plants remove gaseous air pollutant by absorbing it through leaves, and diffusing those particles into intercellular spaces. Therefore, vegetation is a temporary retention site for many atmospheric particles (Beckett, Freer-Smith and Taylor, 1998). Urban trees and shrubs reduce air pollutants such as ozone, PM_{10}, nitrogen dioxide, sulfer dioxide and carbon monoxide (Nowak et al., 2006; Bealey, et al., 2007). Nowak et al. (2006) recommend growing low-VOC-emitting plants rather than high-VOC-emiting plants, as it contributes to the formation of ozone instead. Some pollutants are also removed by plant

[39] Volatile organic Compounds are emitted from the incomplete combustion of fuels or evaporation of fuels, lubricants or solvents, and incomplete burning of biomass. In the presence of sunlight, VOC will cause photochemical smog (World Resources Institute (WRI), 1998).

surface; plants in roofs and walls also help to remove the particulates of air pollutants (Currie and Bass, 2008).

3.2.4 Multilevel Modeling and Spatial Analysis in Health Related Studies

Multilevel modeling has been used to capture household- and neighborhood-level effects on people's health and mortality. Wu et al. (2012) analyzed spatial distribution of syphilis in China and the effect of individual, neighborhood, and district-level factors on its distribution. The authors analyzed spatial clustering of syphilis cases using Moran's I-statistic and local indicators of spatial association (LISA) and estimated optimal generalized equations. The study found substantial clustering of primary and secondary syphilis cases at the neighborhood-level. The results also showed that men, young people, and migrant workers are more likely to get syphilis.

Chen et al. (2007) found that the effect of PM_{10} on respiratory emergency admission varies across different geographic regions in Brisbane, Australia: an increase of 10 μg/m^3 of PM_{10} increases respiratory emergency admissions by 4 percent. Air pollutant such as $PM_{2.5}$ and Black Carbon's concentration is observed spatially heterogeneous in three sites of Detroit, USA, and elevated Black Carbon concentration found outdoor at homes near roadways (Vette et al., 2013).

3.3 Research Hypothesis

The closer one lives from the emission sources, the more exposed one is to the ambient air pollution and the more likely he/she is affected by such outdoor air pollution.

3.4 Theoretical Model

The theoretical model in this study presents a simplified version of the general health production function proposed by Freeman (1993) and also use the household production function derived by Becker (1965). According to the households production function derived by Becker (1965), people use time and market goods to produce a commodity (z) that enters their utility function. Health is an example of such commodity, and it can be either a consumption or an investment[40] commodity in maximizing people's utility. In this study, health is taken as a consumption commodity, which directly enters their utility preference function (Grossman, 1972).

Following Freeman (1993), Dasgupta (2001), Murty et al. (2003), and Gupta (2006), we use a health production function that explains the economic benefit of reduced morbidity with a reduced exposure to air pollution. Using the household health production function and demand functions derived from utility maximization problem, demand for mitigating activities is derived based on Freeman (2003).

An individual's utility function is given as,

$$U = U(X, L, H) \quad (1)$$

Where X represents aggregate consumption of market goods, L represents leisure time, H represents an individual's health status as a binary variable which equals 1 if an individual experience nausea, dust allergy and respiratory health problems, and 0 otherwise. An individual derives utility from an increase in the consumption of X and L, and disutility if $H = 1$ i.e. from sickness.

An individual's health status (a consumption commodity) is modeled as a function of the level of the ambient air pollution (Q), one's mitigating activities (M) such as health preventive care, visiting a doctor, undertaking laboratory tests; and his/her socio-economic characteristics (Z). The household health production function is given by,

$$H = H(Q, M; Z) \quad (2)$$

An individual maximizes his/her utility subject to the budget constraint given in (3),

$$Y = I + w * (T - L - H) = X + P_M M \quad (3)$$

Where I is the non-labor income; w is the wage rate with working time given as the remaining time from total time (T) after deducting leisure time (L) and time lost due to

[40] Health as an investment commodity determines the total amount of time and market good that creates the commodity. For example, sick days reduce time for health activities. At the same time it reduces earnings and reduce amount of non-market good.

sickness (H); P_M represents the price of mitigating activities; and Y represent the total income as a sum of labor and non-labor income.

After setting the utility maximization problem with respect to X, L, and M, the first order condition yields a demand function for M (mitigating activities), as given below. Here, Q is an exogenous variable in demand function for M in equation (4).

$$M^* = M(I, w, P_M, Q; Z) \tag{4}$$

Therefore, the optimal health status is represented as,

$$H^* = H(I, w, P_M, Q; Z) \tag{5}$$

The marginal willingness to pay (MWTP) for reduction in exposure to air pollution is obtained by totally differentiating the health production function given in equation (5) and we obtain equation (6). A detailed explanation of the derivation of the MWTP is given in appendix E.

$$MWTP(W_c) = \left(w \frac{\partial H}{\partial Q}\right) + \left(P_M \frac{\partial M^*}{\partial Q}\right) - \left(\frac{\partial U/\partial H}{\lambda} \frac{\partial H}{\partial Q}\right) \tag{6}$$

The marginal willingness to pay (MWTP) for reduction in air pollution is the sum of the opportunity cost of work days lost due to sickness, the cost of mitigating activities, and the monetary equivalent of the disutility from illness. To compute $\frac{\partial H}{\partial Q}$ we need to estimate a dose-response function, a reduced form relationship between illness and ambient pollution, keeping all other variables that affects the health constant. The last term in equation (6) represents the disutility from illness, which has been ignored in this study due to the complexity of estimating it and lack of data. Therefore, the monetary benefit from a reduction in air pollution are generally captured by the first two terms of the equation, as given in equation (6’).

$$MWTP(W_c) = \left(w \frac{\partial H}{\partial Q}\right) + \left(P_M \frac{\partial M^*}{\partial Q}\right) \tag{6'}$$

3.5 Why Do We Need to Use Multi-level Model?

In the multilevel research, the data structure in the population is hierarchical, and the sample data are viewed as a multistage sample from this hierarchical population. Multilevel modeling recognizes the existence of such data hierarchy and allows for residual components at each level in the hierarchy.

Analyzing variables with multilevel nature of data in a single level and not using a multi-level model leads to two distinct problems. 1) Statistical: Aggregating multi-level data into one single level, ignoring the multi-level nature of data, causes loss of information and statistical analysis power. Alternatively, if the data are disaggregated, data from a small number of super-units are blown up into many more values for a much larger number of sub-units. The statistical test treat those disaggregated data as independent observations from a much larger sample of sub-unit and researchers come up with many significant results that are totally spurious. An appropriate sample size is the number of higher-level unit variables such as the number of communities in this study. 2) Conceptual: the researcher may obtain results at one level and formulate the conclusion of those results at another level. For example, ecological fallacy is the situation when you interpret aggregate data at the individual level. Similarly, Simpson's paradox is experienced when we analyze the grouped data and interpret the results with the assumption that the data comes from a homogenous population (Hox, 2002).

Different levels specified in a multi-level model represent a unique feature of the data in statistical analysis. Multi-level model concerns the relationship between variables that are measured at a number of different hierarchical levels. It is important to determine if the group level variable can explain the relationship among individual-level variables. If it does, it shows the statistical interaction of explanatory variables from different levels. Some of the reasons for using multilevel model are: a) correct inferences – traditional multiple regression treats units of analysis as independent observations. One consequence of failing to recognize hierarchical data structure is that the standard errors of regression coefficients will be underestimated, leading to overstatement of statistical significance, b) substantive interest in group effect can be — it serves to answer the key research question concerning the extent of grouping in individual outcome, c) can estimate group effects along with effect of group-level predictors, and d) inference to a population of group can be estimated (Browne et al., 2001).

The interaction between the characteristics of people living within a community and the community itself are bi-directional. Both determine and influence the development of the other. In this study, 928 households are nested within 205 communities. Such data structure represents a hierarchical system of individuals and communities, which should be modeled through multi-level modeling. In a multilevel model, individuals (the household representatives in the sample) and communities represent levels 1 and 2, respectively.

Three important reasons for using multi-level modeling are: 1) to take into account of how the macro context affects the impact of a covariate at the micro level; 2) to correct for biases in parameters resulting from clustering and its standard errors; 3) to correct standard errors and thus correct confidence intervals and significance tests. When the clustering structure in the data is ignored and the independence assumption is violated, the traditional binary models tend to underestimate the standard errors (Guo and Zhao, 2000).

3.6 Data and Descriptive Statistics

In this paper, the dependent variable is a binary variable representing people's health status, where 1 represents respondent or any member of his/her family experienced nausea, dust allergy and respiratory health problems within last 30 days of the interview date, and 0 otherwise. For brevity, I refer to these sicknesses as NAR sickness throughout this paper.

We estimate the spatial effect of community's outdoor air pollution on the incidence of NAR sickness among Kathmandu Valley residents. The households are nested within a community and hence we look at the spatial effect of living in the same community. To take into account the community-level effect, we use a multi-level model. The community and individual characteristics are obtained from a household survey conducted in the Kathmandu Valley in 2012. To take into account the spatial effect of the communities, the sampled households are geo-referenced using their address and landmarks in Google Earth with geographic coordinates. Households in the same community (block) are assigned the same coordinates and are coded with the same community id. Therefore, 928 households are nested within 205 communities. Communities are composed of 1 to 20 households with a mean of 4.5 households. Distance variables are calculated using google earth and ArcGIS software. We include distance from a community to the nearest source of emission as well as the surrounding environment. Some examples of distance variables used are distance to source of traffic emission (such as road, bus intersections, and bust stops), nearest temporary and permanent waste dumping sites, and other environmental attributes (such as open spaces, rivers and farmland). According to the descriptive statistics presented in Table 3.1, about 26 percent of the survey respondents experienced NAR sickness within last 30 days of the interview date.[41] In other words, among 929 total sample, one or more household members of 244 respondents experienced NAR sickness and 685 respondents did not experience such sickness, nor did any of their family members. On average, households are within 28 meters away from a road, 657 meters away from a waste dumping site, 201 meters away from bushes and forest, and 577 meters away from a river. On average, household are 254 meters away from bus-stops and intersections, 145 meters away from open space, and 120 meters away from farm areas. Brick factories are the farthest i.e, 4885 meters from households. Road is the closest source of pollutants among all other distance variables included in this study. Hence, I expect traffic emission to have the strongest impact on people's health in the Kathmandu Valley.

The survey is conducted with adult household representative. The average age of the respondents is 36 years, and the average education level is 9th grade. The proportion of male and female respondents is about equal. About 4 percent of the respondents are unskilled day-laborers who work outside home and are assumed to be the most vulnerable to air pollution due to their work environment. About 24 percent are housewife and the remaining (i.e., 72 percent) are employed in indoor jobs. Average household income is 34,868 Nepalese rupees[42].

[41] The survey was conducted in June - August, 2012.
[42] The exchange rate of $1 = 98 Rupees, June 2012. Source: The central bank of Nepal.

3.7 Methodology

The dependent variable is a binary variable representing people's health status, where 1 represents that respondent or any member of his/her family experienced NAR sickness within last 30 days of the interview date, and 0 otherwise.

The dependent variable follows a binomial distribution, with parameters $denomb_{ij}$ that represents the number of trials each binomial is based on, and π_{ij} that represents the probability of people experiencing sickness.

$NARsickness_{ij} \sim Binomial(denomb_{ij}, \pi_{ij})$, given $denomb_{ij} = 1$.

To begin with we run a standard logistic regression, which ignores the dependence among individuals (household representatives) based on their shared location (for example, a number of households sharing the same community, as in this study) and proximity in space. The standard logistic regression model is given as,

$$logit(\pi_{ij}) = \beta_0 cons + \beta_1 X_{ij} \quad (7)$$

$$var(NARsickness_{ij} | \pi_{ij}) = \pi_{ij}(1 - \pi_{ij})/denomb_{ij}$$

In the next model, we account for the multi-level nature of data where households are nested within communities. I start with a null model, given in equation (8) that does not include any predictor variables. The null model estimates Kathmandu Valley resident's average respiratory health status. With the null model, we can focus on communities' characteristics that influence on people's health. The null model also maintains the unexplained variability in people's health status for the purpose of partitioning the study area into geographic membership and spatial components. The two-level households-within-communities random intercept null model is given as,

$$logit(\pi_{ij}) = \beta_0 + u_j \quad (8)$$

$$u_j \sim N(0, \sigma_u^2)$$

$NARsickness_{ij}$ is the binary response variable representing whether an individual household representative i $(i = 1, \dots \dots, 928)$ in community $j (j = 1, \dots ., 205)$ experienced the sickness related to NAR (i.e., nausea, dust allergy and respiratory illness). β_0 represents the intercept that measures the log-odds of experiencing with such health problems in an average community. u_j is a community level random effect, which is assumed to be normally distributed with mean 0 and a constant variance, σ_u^2. In binary response model (in contrast to the continuous response models), we do not make the intercept random at level 1 as the model does not include individual-level residual error[43].This specification allows households from the same community to be more similar than those from different communities, and have similar impact of outdoor pollution in a given community residents' health. We may see clusters of households based on a similar reflection of the community-level factors such as distance to pollutants.

The likelihood of observed data in the discrete response multilevel models does not have closed form solutions[44]. Therefore, such models are estimated using quasi-likelihood and Markov-Chain Monte Carlo (MCMC) methods. MCMC is a simulation approach, in which after assigning starting values from quasi-likelihood estimates and prior distributions for the model parameters, a Markov chain is used to sequentially sample a subset of parameters from their conditional posterior distributions given current values of the other parameters. The Markov chain converges into a stationary distribution after the initial burn-in periods. Then, we run the chain for a further monitoring period, and the process yields the estimates such as mean and standard errors of the sampled parameters and 95% Bayesian credible interval (2.5th and 97.5th quantiles of those chains). In the present study, multi-level modeling estimates are obtained using the 'runmlwin' command in stata that runs Mlwin software and provides output in Stata[45]. The Mlwin software uses a combination of two methods of MCMC estimation: Gibbs sampling and Metropolis Hasting (Browne, 2012).

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[43] In case of binary response variable, the ICC and VPC does not have a single value because the variance at level 1 is a function of the mean. Therefore, as a solution, we can formulate the model in terms of latent response variable which underlies the observed binary response. Now the ICC and VPC, in terms of the underlying latent response, are calculated as $\sigma_u^2 / (\sigma_u^2 + \frac{\pi^2}{3})$

[44] The response/dependent variable in this study is in discrete format as it is a binary variable representing people's respiratory health status.

[45] Hence, this method uses best features of both software. Mlwin software have multi-level modeling features that also allows to use spatial multiple membership models. Stata has a lot of features that can generate tables and figures.

Next model adds some predictor variables to equation (8). The predictor variables are distance to the source of outdoor air pollution and individual characteristics such as gender, age, education, and occupation. The random-intercept model with predictor variables is given in equation (9).

$$logit(\pi_{ij}) = \beta_0 + \beta_1 X_{ij} + \beta_2 Z_{ij} + u_j \tag{9}$$

$$u_j \sim N(0, \sigma_u^2)$$

In the multi-level model, random-slope model introduces a random coefficient to estimate the heterogeneity across communities based on the given predictor variable, in addition to the random intercept. The random slope model is given as,

$$logit(\pi_{ij}) = \beta_0 + \beta_1 X_{ij} + \beta_2 Z_{ij} + u_{0k} + u_{1k} \tag{10}$$

$$\begin{pmatrix} u_{0k} \\ u_{1k} \end{pmatrix} \sim N\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix}\right\}$$

In the random part model, the between community variance is a function of variable X.

$$var(u_{0j} + u_{1j} X_{ij}) = \sigma_{u0}^2 + 2\,\sigma_{u01} X_{ij} + \sigma_{u1}^2 X_{ij}^2$$

The diagnostic of how well data fits for the given model is identified based on Bayesian deviance information criteria (DIC).[46]

As an extension to the standard multilevel model, we are using a multiple membership model. The above model can be re-written in the classification notation and presented as a Multiple Membership Multiple Classification (MMMC) Model. In addition to allowing for multilevel modeling, we include the spatial relationship among communities. We create a spatial patches of communities. For each community j, a spatial patch consists of community j and its nearest 10 neighboring communitiesas given in equation (11).

$$logit(\pi_{ij}) = \beta_0 + \beta_1 X_{ij} + Z_{ij}^{(2)} u_{hh(i)}^{(2)} + \sum_{j \in community(i)} W_{i,j}^{(3)} Z_{ij}^{(3)} u_{community(j)}^{(3)} \tag{11}$$

[46] Formula for DIC, $D = -2\sum_i [y_i \log(p_i) + (1 - y_i)\log(1 - p_i)]$, where $p_i$is the predicted value for observation i. p_i is calculated using the inverse distribution function that corresponds to the link function. Therefore, we will need to calculate anti-logit for each fitted value as described above for average individual.

where $u_{hh(i)}^{(2)} \sim N(0, \sum_{u(2)})$ $\qquad u_{community(j)}^{(3)} \sim N(0, \sum_{u(3)})$

Here, β_0 represents the random intercept, β_1 represents a vector of fixed effect parameters, $u_{hh(i)}^{(2)}$ and $u_{community(j)}^{(3)}$ represent vectors of residuals for random effects for classifications 2 (households) and 3 (communities), respectively. e_i is a scalar that indicates the lowest level unit residuals. X_i, $Z_i^{(2)}$ and $Z_i^{(3)}$ are vectors of fixed effects, household-level and community-level explanatory variables, respectively. $W_{i,j}^{(3)}$ is a weight scalar for a household in a community. For prior distribution, we use multivariate normal prior for fixed effect parameters. The multilevel model is estimated using the simulation-based Markov Chain Monte Carlo (MCMC) method[47]. In the multilevel model, we use 'place' perspective that uses geographic information to form groups. For example, a community represents a group of households based on those house's geographic location and boundary.

The spatial multiple-membership model uniquely identifies each observation according to its proximity to all other observations. Here we are talking about each community's closest 10 neighborhoods.

3.8 Results

In the first part of my analysis I use a standard logit model to identify the effect of exposure to ambient air pollution and its effect on people's health. According to Table 3.2, distance from the respondent's house to a road, a waste dumping sites, and a river has a consistently significant effect on the community residents' health. Living closer to a road and a waste dumping site increases the probability of getting sick with NAR sickness. Alternatively, living far away from these sites reduces that probability[48].

On the other hand, living closer to a river reduces one's probability of experiencing NAR sickness. It is a strong example of a built environment that directly helps people improve their health. The positive effect of close proximity to river on people's health

[47] Details of MCMC method is included in Appendix F.
[48] Table 3.3 provides magnitude of these probabilities and it will be discussed in the next paragraph.

represents the positive effect of water, open space and greenery in and around the river[49]. According to the United Stated Environmental Protection Agency (EPA), people receive social and health benefit by living closer to riparian areas, nature, parks, and walking and biking trails. Health benefits occur from both increased physical activity and reduced mental stress. Healthy watersheds that maintain riparian corridor are expected to be more resilient to the anticipated effects of climate change. For example, Jackson (2003) recommends to include greenery in urban design of the communities to improve people's health and living environment. A significant number of previous studies found that plants (and hence urban foresting) help to absorb some of the air pollutants (Beckett, Freer-Smith and Taylor, 1998; Nowak et al., 2006; Bealey, et al., 2007; Currie and Bass, 2008).

Living closer to a forest (including continuous canopy and small bushes) and an open space, however, has positive but insignificant effect on people's health. Similarly, the distance to brick factories has positive but insignificant effect on people's health. The brick factories are selectively located in the outskirts of the city, where the population density is lower and farm land and forest density is higher. Therefore, the positive effect of plants and negative effect of factory's emission may offset each other, and hence I did not find any significant effect of those brick factories on public health. Respondents' age has a non-linear effect t on their probability of experiencing NAR illness. Age has positive and age square has negative effect on health which indicates that adults up to 36 years old are less susceptible to outdoor air pollution in comparison to older adults.

Table 3.3 presents the average marginal effect[50] results of the standard logit model presented in Table 3.2. When the distance from one's community (or one's house as houses are closely clustered in a community) to a road increases by 100 meters, the probability of experiencing NAR sickness decreases by 15.9 percent to 17.57 percent through model 1 to 4. When one lives 1 kilometer further from a waste dumping site in comparison to his/her current location, his/her probability of experiencing NAR sickness decreases by 16.2

[49] In this study, I limit the health effect based on outdoor air pollution and look at the probability of experiencing nausea, dust allergy and respiratory sickness. Therefore, we may not observe negative effect of water pollution in the river. Bacteria in water supplies can pose a potential health risk (Dlugolecki, L., 2012).

[50] In the average marginal effect, the term 'average' is defined as having the mean value for the other independent variables in the model while looking at the effect of a given explanatory variable on the dependent variable (Cameron and Trivedi, 2005).

percent to 21 percent. The positive effect of living close to river increases by 19.7 percent to 22.2 percent for each 1 kilometer closer to the river from one's current location. Surprisingly, living close to brick factory is good for one's health as living one kilometer closer to the brick factory decreases one's probability of experiencing NAR sickness by 1.3 to 1.5 percent. The brick factories are located at the outskirt of the city and hence the effect might be more of open space and reduced traffic emission than that of factory's emission. An adult of up to age 36 is .25 percent to .3 percent less likely to experience NAR sickness with each additional year of aging. People with one more year of education are 1.0 to 1.2 percent more likely to experience NAR sickness. Education may not directly impact one's health but rather their work nature may do so. People with higher education may involve in work that keeps them more mobile and more exposed to outdoor air pollution. While comparing people's susceptibility to outdoor air pollution based on their occupation, day laborers are the most susceptible in comparison to housewives and other employed people. Housewives are 13.9 percent to 14.4 percent less likely to experience NAR sickness in comparison to that of day laborers. People with other employment (with mostly indoor work) are 14.7 percent to 15.2 percent less likely to experience NAR sickness than that of day laborers.

Next, I use a two-level random-intercept model and estimate it with the Markov Chain Monte Carlo (MCMC)[51] method. The estimated model is presented in equation (8) in the methodology section. In the MCMC method, the fixed-effect parameter estimates represent the means and standard error of the parameter's posterior distribution. The MCMC method uses a simulation approach and does not assume that the parameters follow an asymptotic normal sampling distribution. Table 3.4 presents the results for 3 models of standard logit model as well as two-level random intercept models using MCMC method. Models 1 and 2 include a random-intercept only, and a random-intercept with distance variables, respectively. Models 3 include a random-intercept term, respondents' individual characteristics and the distance variables. The distance variables represent distance from

[51] Second-order Quasi-likelihood (PQL2) method does not report log-likelihood or deviance statistics as the model is fitted by quasi-likelihood method rather than by maximum likelihood. As Quasi-likelihood estimates are known to be biased, we refit the model by MCMC. PQL2 method's estimates also provide starting value for MCMC estimation. We used the 'runmlwin' command that uses Mlwin software for multi-level modeling and reports output in Stata; we fitted a binomial logit response model.

one's community (and hence proxy for one's house as houses are closely clustered in a community) to the nearest source of pollutants.

In Table 3.4, the first model is intercept-only model, which predicts the probability of experiencing NAR sickness. In Model 1, the maximum likelihood estimate from the standard logit model is $\exp(-1.032) = 0.3562$, which is the ratio of respondents who experienced NAR sickness (i.e., 26 percent of the sample) to those who did not i.e. the ratio of 244 and 685, respectively. In comparison, the same ratio is estimated to be $\exp(-1.121) = 0.3259$ from the multilevel model using MCMC method. Therefore, when we did not take into account of the clustering within a community, standard logit model overestimated the ratio by 3.03 percent. In the MCMC method, the random effect parameter represents the estimated variances of the random intercept and it represents a unique effect for each community in addition to the fixed intercept of -1.121, which is the average for all communities. In the random-intercept model, the variance of constant at community level is significant, which indicates that community characteristics are causing heterogeneous effects on people experiencing NAR sickness. In model 1 of the MCMC method, about 25 percent of respondents and their family members experienced NAR sickness in an average community (P (β_0) =0.246). The coefficient of the random intercept (β_0) represents the log-odds of getting sick with NAR illness in an average community[52]. The expected correlation in the propensity of getting sick between two respondents in the same community, called intro-community correlation, is 13.6 percent (in Table 3.4 model 1, VPC = 0.136). [53] In other words, 13.6 percent of the variance in the likelihood of experiencing NAR sickness can be attributed to differences within a community.

In Table 3.4 model 2 using multilevel MCMC method, when the distance variables are included, the heterogeneity within a community and its effect on people's respiratory health is captured by the distance variables and the variance of the random intercept (i.e., constant) remains significant. . Increasing the distance from the respondent's house to a road and a waste dumping site both decreases the likelihood of people experiencing NAR

[52] The corresponding odds and probability of experiencing respiratory health problems are derived as $\exp(\beta_0)$ and $\exp(\beta_0)/\{1+\exp(\beta_0)\}$, respectively.

[53] In the constant-only model, ICC=VPC. The ICC and Variance partition Coefficient (VPC) for the binary discrete response model is given by $\frac{\sigma^2}{\sigma^2+\pi^2/3}$.

sickness. More specifically, when the distance between the respondents' houses and the road is greater than 30 meters, people are less likely to experience NAR sickness. However, when a respondent lives in between 10 meter to 30 meters away from the road, they are significantly more likely to get sick with NAR illness (mean values of distance and distance square to road are 30 and 10 meters, respectively). Living closer to river decreases the likelihood of experiencing NAR sickness. The effect of river, however, is not significant while not controlling for people's demographic characteristics, as presented in model 2 (Table 3.4).

In model 3, the relationship between proximity to river and probability of experiencing NAR sickness is significantly positive. That means, when the distance from a road to respondent's house increases (or proximity to road decreases), his/her probability of getting sick also decreases. The results of Model 3 and 4, which control for the respondent's gender, age, education, and occupation, are consistent with the results of model 1 and 2. The proximity to waste dumping site and the likelihood of experiencing NAR sickness is significantly positive. That means when the proximity to waste dumping site decreases, the probability of getting sick also decreases and vice versa. This result is consistently significant in model 1 through model 3 in both the standard logit and multilevel model.

Table 3.4 compares results obtained using standard logit model and the multi-level model. In all three models, the estimates of some of the variables is underestimated by the standard logit model. For example, estimate of standard logit model for distance to a road, a brick factory, and other demographic characteristics are underestimated in comparison to that of multi-level model. However, the estimates for distance to waste dumping site and river are mixed between model 2 and 3. For example, the standard logit estimates are underestimated in model 2 and overestimated in model 3 in comparison to multilevel model's estimates. The estimated variance of the random effect at the community level is consistently similar in model 1 through 3 in Table 3.4.

Age has a non-linear significant effect on people's health as the coefficients of age and age squared are negative and positive, respectively. People who are 18 to 36 years old are less likely to experience NAR illness with an additional year of age. However, people older than 36 are more likely to experience NAR sickness with an additional year of age. People with higher education, with one more year of education, are more likely to experience such health problems. More educated people could be associated with work that keeps them more mobile and are more exposed to traffic emission. Here, we are assuming that people are not experiencing pre-existing respiratory health problems and individuals are equally sensitive and aware of information relating to NAR sickness. While comparing the likelihood of having these health problems among people with different occupations, unskilled day laborers are the most susceptible population to NAR sickness due to the direct exposure to traffic emission due to their work location mostly outdoor and highly traffic congested area. Housewives and people with other employment that involves mostly indoor work are less likely to experience those health problems in comparison to that of day laborers.

As shown in Table 3.4, when I account for neighborhood effect accounting for the 10 nearest neighborhood for a given community, the variance of the random is not significant. The sign and significance of the other variables remains the same.

3.9 Health Benefit Due to Reduction in Ambient Air Pollution

With the impact of anthropogenic pollutants on environment, people experience sickness, which in general obstructs their daily activities and, in extreme cases, reduces their life expectancy. Such incidents create opportunity cost of missing work-days due to sickness and increases medical cost. I estimate the health benefit one can receive by improving ambient level of air pollution. The health benefits from the reduction in pollution levels is derived in two steps: first, estimate the economic value of changes in health status or health risk, and second, combine such value with an independently derived predictions of health changes or health risk as a function of environmental changes (Freeman, 2003). For example to measure the economic value of air quality improvement in reducing risk of premature mortality, people measure the value of the risk reduction derived from the studies of wage rate and combine that with epidemiological study about relationship between air pollution and mortality rates. The economic valuation of the change in health status is obtained by monetizing the reduction in the number of sick days (as the would-be opportunity cost). Another component of such economic valuation is obtained from avoided medical costs from improved health. Later, I use similar concept as dose-response function to derive the health benefit estimation of reducing exposure to ambient air pollution based on proximity to source of pollutants such as traffic emission, industries' emission and other surrounding environmental externalities. Equation (7) represents the MWTP that estimates the health benefit of reducing ambient air pollution.

Usually the health benefit of reducing air pollution is measured with broad estimate of reducing air pollutant such as Particulate Matter, Lead, Ozone and other pollutants to a standard safe level determined by World Health organization (WHO). For example, Ostro (1996) explains three factors to be considered for estimating health impact associated with air pollution. Those factors are dose-response relationships, the susceptible population impacted, and the change in air pollution under consideration. Ostro (1996), in a study in Santiago city (a valley) in Chile with stable atmospheric condition and wind velocity, found a high level of PM10 concentration. The city's unique topography and climate is one of the strong determinants, and winter months have the highest PM10 concentration.

For health benefit estimation, I monetize the opportunity cost through wage lost due to the number of sick days. This simplified model does not make distinction between two consecutive sick days and total of two sick days in an interval of time. It also ignores the types of symptoms and the severity of the illness. The estimated health impact using dose-response function is represented as,

$$\sum \Delta H_{ij} = b_i(\Delta A_j)(Pop_{ij}) \tag{12}$$

where $\Delta H_{ij} =$ change in population risk of health effect i in region j, b_i= slope from dose-response curve for health effect i indicating the expected health effects per unit of PM10, ΔA_j= reduction in PM10 in region j to reach the safe standard level, Pop_{ij}= population at risk of health effect i in region j. In this study, b_i represents the average marginal health effect with reduction in exposure to pollutants by living farther from the source of pollutant such as road, waste dumping sites and other surrounding environment.

According to Table 3.6, $b_i = 0.16$ percent i.e., marginal effect[54] of staying 1 meter far from road for an average Kathmandu Valley resident (from the current location) is 0.16 percent. In other words, the marginal effect of living 100 meter far from road from an average resident's current location reduces the probability suffering from nausea, dust allergy and respiratory illness by 16 percent. Exposure to road has the strongest effect on people's health. Therefore, I measure the health benefit estimation to traffic emission only. An average Kathmandu valley resident's probability of getting sick is reduced by 1.62 percent if he/she lives 100 meter far from the current location. The effect of proximity to river is positive. For example, an average Kathmandu Valley resident increase the probability of getting sick by 1.5 percent by staying 100 meters far from river. Individuals up to certain age, increasing age make them more resistant to exposure to air pollution. An individual's probability of getting sick with nausea, dust allergy and respiratory disease decreases by 0.25 percent for each additional year of his/her life. More educated people, however, are more susceptible to air pollution as they might be more exposed to pollution due to their job nature and travel schedules. Having one additional year of schooling increases the probability of getting sick with these diseases by 1.2 percent. An individuals' occupation also has a significant effect on their personal exposure to air pollution and it directly affects their health. Occupation represents an individual's time activity patterns, which significantly determines one's exposure to pollution. For example, in comparison to the daily laborer, housewife and other indoor employment holders are better off in term of their exposure to pollution. Being a housewife, the probability of suffering from nausea, dust allergy and respiratory illness decreases by 13.9 percent. Indoor employment holders are 14.7 percent less likely to get sick with nausea, dust allergy and respiratory disease in comparison to daily laborers.

About 26 percent residents suffer from nausea, dust allergy and respiratory illness. The health benefit estimation of reducing ambient air pollution is measured through the opportunity cost of missing work-days due to sickness and the medical cost incurred. According to Table 3.7, average missing days due to the sickness of these disease is 1.52

[54] Computing the marginal effect of the logistic regression: The probability of the logistic distribution is given by, $prob(Y = 1|\boldsymbol{x}) = \frac{e^{x'\beta}}{1+e^{x'\beta}} = \Lambda(\boldsymbol{x}'\beta)$. The marginal effect is given as, $\frac{\partial E[y|x]}{\partial x} = \left\{\frac{d\Lambda(x'\beta)}{d(x'\beta)}\right\} \beta = \left[\frac{e^{x'\beta}}{(1+e^{x'\beta})^2}\right]\beta = \Lambda(\boldsymbol{x}'\beta)[1 - \Lambda(\boldsymbol{x}'\beta)]\beta$

days in a month. Reducing the exposure to traffic emission also reduces the opportunity cost of 0.24 missing workdays (16 percent of 1.52 days, based on the marginal effect of traffic emission on health). According to Table 3.8, reducing the exposure to traffic emission saves the opportunity cost of 281.27 Nepalese Rupees for avoiding the missing sick days. In addition to that, an individual saves 107.89 Nepalese Rupees in medical cost. An average Kathmandu valley resident saves total of 389.17 Nepalese Rupees by living 100 meter far from road.

3.10 Discussion and Conclusion

This study analyzes the effect of people's exposure to outdoor air pollution on experiencing NAR sickness. About 26 percent of the total sample experiences NAR sickness in the Kathmandu Valley. The exposure to such pollution is measured through people's time activity patterns, proximity to the source of pollutants, and individuals' susceptibility based on their demographic characteristics. The sources of pollutants are traffic emissions, biogas emissions from waste dumping sites, and emissions from industries. Respondents living between 10 to 30 meters away from the road are significantly more likely to get sick with NAR sickness. When the same person lives 100 meter far from road from his/her current location, he is 16 percent less likely to experience NAR sickness. In comparison to all other sources of pollutants, traffic emission has the strongest effect on people's health as road is the closest source of pollutant to an average respondent in the Kathmandu Valley. I also look at the positive effect of greenery, plants, farm land, rivers, and open space, and its positive effect on health. Brick factories are another concern in the Kathmandu Valley, thus we include data on a limited number of brick factories (n=75 brick factories). This study takes a different approach in the examination of the relationship between outdoor air pollution and negative health effects by looking at the exposure level rather than the concentration of pollutants. I also allow for community-level heterogeneity by using a multi-level model. With a significantly positive random intercept term, I found that community characteristics are causing heterogeneous effects on people's respiratory health.

People who are 18 to 36 years old are less susceptible to such pollution exposure than older people. Higher educated people are associated with jobs that keep them more mobile and hence are more exposed to outdoor air pollution, and are more likely to experience such health problems. Unskilled day laborers are the most vulnerable population to nausea, dust allergy and respiratory sickness due to the direct exposure to traffic emission during their work hours. Housewives and people with indoor working environment are less likely to experience those health problems in comparison to that of daily labors.

I estimated the health benefit of reducing exposure to air pollution in terms of avoiding the opportunity cost of missing workdays and avoiding medical cost. The estimation uses a similar method as that of the dose-response function. Exposure to road has the strongest effect on people's health and I measure the health benefit due to a reduction in the exposure to traffic emission only. An average respondent misses 1.52 working days due to this sickness. Reducing the exposure to traffic emission also reduces the opportunity cost of 0.24 missing workdays in a month (16 percent of 1.52 days, based on the marginal effect of traffic emission on health). Similarly, the medical cost is decreased by 16 percent as well. Reducing the exposure to traffic emission saves an average of 281.27 Nepalese Rupees for avoiding the missing sick days 107.89 Nepalese Rupees in medical cost. Therefore, an average Kathmandu valley resident saves total of 389.17 Nepalese Rupees by living 100 meter far from road.

3.11 Policy Recommendation

An average individual in the Kathmandu Valley lives 28 meters away from the road. I examine people's exposure to air pollution and its effect on their health. According to the results, exposure to the traffic emissions has the strongest effect on people's health. I measure people's exposure to traffic emission based on the distance from their house to the nearest road. My approach to measuring the effect to ambient air pollution on people's health is unique as I look at the health effect based on proximity to the source of pollutants. Usually the studies use pollutant's level and relate it to people's health data. This study has been simplified by holding different assumptions. For example, I assume that people are not experiencing pre-existing respiratory health problems and individuals are equally sensitive and aware of information relating to NAR sickness. As a policy recommendation based on the findings, transportation authority can impose stronger regulation to reduce vehicle emission and can strongly enforce emission testing on two-wheel as well as four-wheel vehicles. Having a better solid waste management also helps to reduce impact of biogas emission from waste dumping sites on public health. Promoting urban foresting (for example, roof gardening) and planting trees on the road sides are also highly recommended.

Table 3.1 Descriptive Statistics of Variables of Interest

Variable	Variable Definition	Mean	Std. Dev.	Min	Max
NAR_sickness	1 if anyone in the household suffered from Nausea, respiratory disease and/or dust allergy in last 30 days of the interview date, 0 otherwise	0.26	0.44	0.00	1.00
dist_road	distance from respondent's community to the road in meters	28.22	90.52	0.14	1228.36
dist_waste	Distance from respondent's community to the waste dumping site in meters	657.24	421.13	26.09	2090.89
dist_fores	Distance from respondent's community to the forest in meters	201.36	153.84	0.00	1235.46
dist_river	Distance from respondent's community to the river in meters	577.54	407.87	22.06	2093.56
dis_bus_in	Distance from respondent's community to the busstops and intersections in meters	254.48	313.11	2.32	2278.95
dist_open	Distance from respondent's community to an open space in meters	145.22	143.19	0.00	1239.65
dist_farm	Distance from respondent's community to the farmland in meters	120.98	191.35	0.00	1259.67
dist_brick	Distance from respondent's community to the brick factories in meters	4885.20	2683.12	487.49	11073.51
q48age	Age of respondent	36.04	13.56	18.00	86.00
Education	education in number of years	8.78	4.09	0.00	14.00
female	1 if female, 0 otherwise	0.51	0.50	0.00	1.00
dailylabor	1 if unskilled Day labor, 0 otherwise	0.04	0.20	0.00	1.00
housewife	1 if housewife, 0 otherwise	0.24	0.43	0.00	1.00
Indoor_emp	1 if other employment than above 2, 0 otherwise	0.72	0.45	0.00	1.00
income	Household's monthly income	34868.75	171466.50	1000.00	5000000.00
Number of households	928.00				
Number of communities	205.00				

Table 3.2 Standard Logit Model for Different Distance Variables

	Model 1		Model 2		Model 3		Model 4		Model 5	
Dependent Variable: NAR Sickness										
dist_road_km	-8.870***	(-2.69)	-9.652***	(-2.81)	-9.822***	(-2.83)	-9.957***	(-2.82)	-10.03***	(-2.81)
dist_road_km^2	6.832**	(2.08)	7.377**	(2.23)	10.06**	(2.40)	10.55**	(2.35)	10.78**	(2.28)
dist_waste_km	-3.175**	(-2.48)	-3.648***	(-2.74)	-3.885***	(-2.85)	-3.914***	(-2.84)	-3.951***	(-2.80)
dist_waste_km^2	1.830**	(2.49)	2.017***	(2.68)	2.178***	(2.81)	2.220***	(2.82)	2.241***	(2.77)
dist_forest_km	0.387	(0.23)	0.891	(0.52)	0.588	(0.33)	1.153	(0.61)	1.150	(0.61)
dist_forest_km^2	0.242	(0.09)	-0.202	(-0.07)	0.355	(0.12)	-0.375	(-0.12)	-0.387	(-0.13)
dist_river_km	2.471**	(1.97)	2.880**	(2.16)	3.119**	(2.27)	3.293**	(2.31)	3.320**	(2.26)
dist_river_km^2	-1.479**	(-2.02)	-1.634**	(-2.14)	-1.782**	(-2.25)	-1.900**	(-2.28)	-1.908**	(-2.23)
dist_brick_km			0.140	(0.99)	0.123	(0.86)	0.140	(0.96)	0.136	(0.92)
dist_brick_km^2			-0.00714	(-0.49)	-0.00517	(-0.35)	-0.00593	(-0.39)	-0.00573	(-0.37)
dist_openSpace_km					1.549	(0.89)	1.580	(0.91)	1.633	(0.92)
dist_openSpace_km^2					-4.099	(-1.08)	-4.200	(-1.11)	-4.419	(-1.09)
dist_farm_km							-0.879	(-0.63)	-0.819	(-0.57)
dist_farm_km^2							0.661	(0.34)	0.606	(0.31)
dist_busStation_int_km									0.0938	(0.13)
dist_busStation_int_km^2									-0.0296	(-0.08)
age	-0.0569*	(-1.93)	-0.0608**	(-2.05)	-0.0591**	(-1.99)	-0.0582*	(-1.96)	-0.0580*	(-1.95)
age^2	0.000616*	(1.78)	0.000635*	(1.83)	0.000616*	(1.77)	0.000615*	(1.76)	0.000613*	(1.75)
Edu (in number of years)	0.0647***	(2.84)	0.0578**	(2.52)	0.0579**	(2.52)	0.0576**	(2.50)	0.0575**	(2.49)
female	0.0290	(0.16)	0.0245	(0.14)	0.0318	(0.18)	0.0256	(0.14)	0.0263	(0.14)
Reference Occupation: Daily Labor										
housewife	-0.751*	(-1.88)	-0.778*	(-1.94)	-0.765*	(-1.90)	-0.757*	(-1.88)	-0.757*	(-1.87)
other_emp	-0.789**	(-2.18)	-0.826**	(-2.26)	-0.818**	(-2.23)	-0.802**	(-2.18)	-0.801**	(-2.17)
_cons	0.588	(0.78)	0.311	(0.40)	0.232	(0.29)	0.0883	(0.11)	0.0752	(0.09)
N	929		929		929		929		929	
log_likelihood	-515.2		-512.6		-511.9		-511.5		-511.5	
chi-squared	39.40		44.62		46.05		46.90		46.93	
AIC	1060.4		1059.2		1061.8		1064.9		1068.9	

* p<0.1 ** p<0.05 *** p<0.01

t-statistics in parentheses

Table 3.3 Average Marginal Effects of the Logit Model for Distance Variables

VARIABLES	Model 1		Model 2		Model 3		Model 4		Model 5	
dist_road_km	-1.590***	(0.587)	-1.719***	(0.608)	-1.725***	(0.613)	-1.744***	(0.622)	-1.757***	(0.628)
dist_waste_km	-0.162*	(0.0875)	-0.203**	(0.0911)	-0.210**	(0.0925)	-0.205**	(0.0933)	-0.207**	(0.0943)
dist_forest_km	0.0904	(0.134)	0.149	(0.136)	0.135	(0.138)	0.184	(0.148)	0.182	(0.149)
dist_river_km	0.155	(0.0961)	0.197*	(0.102)	0.211**	(0.103)	0.219**	(0.105)	0.222**	(0.108)
dist_brick_km			0.0130**	(0.0060)	0.0133**	(0.00608)	0.0150**	(0.00640)	0.0148**	(0.00667)
dist_open_km					0.0744	(0.162)	0.0748	(0.163)	0.0733	(0.165)
dist_farm_km							-0.133	(0.180)	-0.124	(0.188)
dist_bus_km									0.0145	(0.101)
age	-0.00259*	(0.00152)	-0.00305**	(0.00152)	-0.00299**	(0.00152)	-0.00283*	(0.00153)	-0.00282*	(0.00153)
edu	0.0120***	(0.00419)	0.0107**	(0.00420)	0.0107**	(0.00420)	0.0106**	(0.00420)	0.0106**	(0.00421)
Female	0.00538	(0.0335)	0.00452	(0.0334)	0.00586	(0.0334)	0.00472	(0.0334)	0.00485	(0.0335)
Reference Occupation: Day Laborer										
housewife	-0.139*	(0.0736)	-0.144*	(0.0736)	-0.141*	(0.0738)	-0.139*	(0.0738)	-0.139*	(0.0740)
other_emp	-0.147**	(0.0668)	-0.152**	(0.0669)	-0.151**	(0.0669)	-0.148**	(0.0671)	-0.147**	(0.0673)
Observations	929		929		929		929		929	

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 3.4 Standard Logit Model and the Two-level Random-intercept Model using MCMC method

	Logit		ML MCMC		Logit		ML MCMC		Logit		ML MCMC	
	Model 1				Model 2				Model 3			
Dependent Variable: NAR Sickness												
constant	-1.032***	(-13.85)	-1.121***	(-10.73)	-0.632**	(-1.99)	-0.772*	(-1.82)	0.311	(0.40)	0.33	(0.36)
dist_road_km					-9.085***	(-2.79)	-9.867**	(-2.39)	-9.652***	(-2.81)	-10.67**	(-2.42)
dist_road_km^2					6.207*	(1.92)	6.4	(1.60)	7.377**	(2.23)	8.019*	(1.85)
dist_waste_km					-3.072**	(-2.42)	-2.413*	(-1.74)	-3.648***	(-2.74)	-4.068**	(-2.52)
dist_waste_km^2					1.808**	(2.49)	1.403*	(1.69)	2.017***	(2.68)	2.194**	(2.40)
dist_forest_km					-0.00448	(-0.00)	-0.213	(-0.11)	0.891	(0.52)	0.814	(0.36)
dist_forest_km^2					1.206	(0.45)	1.705	(0.51)	-0.202	(-0.07)	0.00552	(0.00)
dist_river_km					2.258*	(1.81)	1.907	(1.52)	2.880**	(2.16)	3.573**	(2.17)
dist_river_km^2					-1.392*	(-1.90)	-1.209	(-1.62)	-1.634**	(-2.14)	-2.030**	(-2.14)
dist_brick_km									0.14	(0.99)	0.185	(1.16)
dist_brick_km^2									-0.00714	(-0.49)	-0.0108	(-0.65)
age									-0.0608**	(-2.05)	-0.0710**	(-2.14)
age^2									0.000635*	(1.83)	0.000738*	(1.90)
Edu (in number of years)									0.0578**	(2.52)	0.0606**	(2.38)
female									0.0245	(0.14)	0.0415	(0.21)
Reference Occupation: Daily Labor												
housewife									-0.778*	(-1.94)	-0.781*	(-1.70)
other_emp									-0.826**	(-2.26)	-0.915**	(-2.14)
Random Effect parameter												
var(constant)			0.519**	(2.08)			0.484**	(2.03)			0.532**	(2.02)
Odd(β0)			0.326									
P(β0)			0.246									
VPC (Intra-community correlation)			0.136				0.13				0.139	
N	929		929		929		929		929		929	
Bayesian DIC			1051.89				1054.2					
log_likelihood	-534.9				-525.4				-512.6			
chi-squared	5.46E-12				18.98				44.62			

AIC	1071.9	1068.9	1059.2	1046.48

* p<0.1 ** p<0.05 *** p<0.01; t-statistics in parentheses

Table 3.5 A Spatial Multiple Membership Model and Multi-level Random- Effect Model of Effect on Respiratory and Related Disease

		Dependent Variable: NAR Sickness	
		Multi-level Random Effect	
dist_road_km		-9.751**	(-2.39)
dist_road_km^2		7.383*	(1.84)
dist_waste_km		-3.070**	(-2.15)
dist_waste_km^2		1.720**	(2.02)
dist_forest_km		0.468	(0.22)
dist_forest_km^2		0.165	(0.05)
dist_river_km		2.524*	(1.69)
dist_river_km^2		-1.507*	(-1.68)
age		-0.0604**	(-2.11)
age^2		0.000634*	(1.88)
Edu (in no of years)		0.0651***	(2.61)
female		0.0415	(0.21)
Reference Occupation: Daily Labor			
housewife		-0.753*	(-1.80)
other_emp		-0.854**	(-2.26)
constant		0.620	(0.78)
Random Effect Parameter			
Level 2: Community	var(constant)	2.973	(0.48)
Level 3: Spatial Neighborhood	var(constant)	0.388	(1.34)
N		928	
Bayesian DIC		1050.74	

* p<0.1 ** p<0.05 *** p<0.01

t-statistics in parentheses; MCMC= Markov-chain Monte Carlo, burn-in period of 1000 iterations and monitoring period of 50,000 iterations and 10 thinning periods

Table 3.6 Average Marginal Effect of Experiencing Nausea, Dust Allergy and Respiratory Diseases

Dependent Variable: Experiencing NAR Sickness (Yes = 1/0)

VARIABLES	dy/dx Pr(NAR Sickness)	
dist_road	-0.00159***	(0.000549)
dist_waste	-0.000162*	(8.37e-05)
dist_fores	9.04e-05	(0.000140)
dist_river	0.000155*	(8.96e-05)
age	-0.00259*	(0.00153)
edu	0.0120***	(0.00409)
female	0.00538	(0.0336)
Reference: Day laborer		
housewife	-0.139*	(0.0736)
other_emp	-0.147**	(0.0668)
Observations	929	

Dependent variable =1 if an individual experiences nausea, dust allergy and respiratory health problems (i.e., NAR Sickness), 0 otherwise; Distance variables are in meters.

Table 3.7 Descriptive Statistics of Variables for Estimating Health Benefit from Improved Environment

Variable Name	Variable Description	Mean	Std. Dev.	Min	Max
dist_road	Distance from respondent's house to Road in Meters	28.22	90.52	0.14	1228.36
dist_waste	Distance from respondent's house to Waste dumping sites in Meters	657.24	421.13	26.09	2090.89
NAR_days	Number of Missing days due to nausea, dust allergy and Respiratory disease	1.52	4.98	0	60
income	Household's monthly income in Nepalese Rupees	34,868.89	171,374.10	1,000.00	5,000,000.00
NAR_medCost (n=281)	Monthly Medical cost for nausea, dust allergy and respiratory disease	678.58	3,488.47	0	55,000.00
N		929			

$1= 98 Nepalese Rupees(Central Bank of Nepal, June 2012)

Table 3.8 Estimating Health Benefit by Reducing Exposure to the Traffic Emission, Staying 100 meter Far from Road (in Nepalese Rupees)

	Values, Calculation	**Final estimates**
Marginal Effect of staying 1 meter far from road	0.16%	
Marginal Effect of staying 100 meter far from road	15.90%	
Average missing work days due to sickness with COPD disease (per month)	1.52 days	
Reduction in missing days by living 100 meter far from road	0.159*1.52	0.24 days
Opportunity cost per missing work day i.e., daily income (in Nepalese Rupees)	34,868.89/30	1162.30 Rupees
Health benefit of avoiding missing work days	0.242*1162.29	281.27 Rupees
Average Medical cost per month for Nausea, dust allergy and respiratory Illness	678.58	
Saved medical cost	.159*678.58	107.89 Rupees
Total Health Benefit = Opportunity cost + Medical cost (in Nepalese Rupees)	281.27+107.89	389.17

The above calculations are based on estimated health impact using dose-response function (Ostro, 1996), and it is explained below.

$\sum \Delta H_{ij} = b_i(\Delta A_j)(Pop_{ij})$; where $\Delta H_{ij} =$ change in population risk of health effect i in region j, b_i= slope from dose-response curve for health effect i indicating the expected health effects per unit of PM10, ΔA_j= reduction in PM10 in region j to reach the safe standard level, Pop_{ij}= population at risk of health effect i in region j.

Chapter 4: Analyzing the Relationship between Total Waste Generation and Recycling, and Identifying the Determinants of People's Recycling Behavior.

4.1 Introduction

The Kathmandu Valley faces the challenge of managing household waste in a sustainable way. Waste reduction efforts are practiced minimally, and waste recycling is practiced informally. Some people and households collect recyclable waste (such as paper, glasses, and plastic bottles) and sell it to scrap dealers as part of their livelihood. Because of minimum waste reduction, the majority of the total waste is dumped at the Ookharpauwa landfill site, 27 kilometers away from the Kathmandu Valley. In the past, landfill sites reached their maximum capacity before their estimated life, and municipalities faced the challenge of finding an alternative site. The waste is dumped in open air at the landfill site and it poses a threat to public health in neighboring communities. Therefore, people always tend to avoid locations near landfill sites to reside and oppose building new landfill sites in close proximity to their house. In this chapter, I aim to provide policy recommendations for promoting waste reduction through recycling and hence alleviate the issue of short-life landfill sites.

I analyze the relationship between the total waste generation and people's recycling behavior, and identify the determinants of people's recycling behavior. The key explanatory variables that determine people's recycling behavior are the existing recycling provisions, social capital, and people's attitude towards waste segregation and other complementary behavior.

This study uses a different approach in formulating the theoretical model based on the conventional waste disposal pricing system used in the Kathmandu Valley (with flat fee for waste collection irrespective of weight or volume of the waste). The majority of studies use unit-based pricing methods, in which the price of waste collection depends on the weight or volume of the waste and the unit-based pricing promotes recycling as it gives people the price-incentive to reduce their waste. The municipalities in the Kathmandu Valley use a fixed monthly waste collection fee and we do not expect to have price incentive on recycling behavior. Household sell recyclable waste to the scrap dealers and I incorporate it in the modeling, which is unique to this study. The price received from the recyclable waste can be an important incentive to promote recycling. However, I lack the information on the price received for recyclable waste. The contribution of this dissertation is in building a theoretical model that replicates unique features of Kathmandu valley's informal recycling market, and provide relevant policy recommendations.

In the Kathmandu Valley, the majority of the waste (i.e., about 65 percent) is biodegradable waste. I find that people who compost are also more likely to recycle in comparison to those who do not. Therefore, composting behavior works as a complementary behavior to recycling. Municipalities may promote recycling by bundling its offers along with the existing offer of providing composting bins at a subsidized price. Information regarding recycling method and social capital through sanitation related organizational membership also increases recycling. Institutional regulation not only avoid the haphazard waste disposal but also increase recycling. People's caste membership also seem to influence their recycling behavior as those who faced past social discrimination are less likely to recycle in comparison to other caste groups.

4.2 Literature Review

Two approaches have been used to build the theoretical model regarding people's recycling behavior: a) The time allocation model based on Becker's household production function and Lancaster's consumer theory (Becker, 1965; Lancaster 1966), and b) solid waste generation demand proposed by Pollak and Wachter (1975), who allowed time to be an input for household production and an entity, in itself, to produce utility for an individual.

The majority of studies have shown the inter-dependence between total waste generation and recycling. Recycling effort has been measured as: a) the quantity of recycled waste, and b) a binary variable representing whether people recycle or not. People's recycling effort is modeled as endogenous as well as exogenous variable. For example, Hong (1999) and Hong and Adams (1999) analyzed people's recycling effort with the total waste generation as an endogenous variable. On the other hand, Callan and Thomas (2006) represented that the demand for recycling is determined within the model of the demand for waste disposal. The authors found that the change in the waste collection fee does not have a significant impact on the combination of illegal disposal and source-reduction activities.

Exogenous policy instruments have been found to be significant determinants of people's recycling behavior. Some of those variables that determine a household's waste disposal service demand are: mandatory recycling, deposit-refund scheme, waste collection fee, waste collection frequency, distance from one's house to the waste disposal site, and household income (Wertz, 1976; Kinnaman and Fullerton, 2000). Waste collection fee works as an exogenous variable inasmuch households recycle more waste when the waste collection fee per unit weight or volume of the disposed waste increases (Jenkins, 1993; Morris and Holthausen, 1994). This relationship between waste collection fee and recycling effort represents the impact of price incentive of unit-based pricing structure on people's recycling behavior. Sidique et al. (2010) found that having a mandatory recycling policy and increasing public awareness through recycling education are effective tools then lead to an increase in recycling. The authors also found that the curbside recycling and drop-off centers complement each other and together they increase recycling. On the other hand, curbside recycling and deposit refund scheme are substitute programs as communities with deposit-refund scheme are 18 percent less likely to implement curbside recycling (Kinnaman and Fullerton, 2000).

Studies have identified that unit-based pricing[55] is a significant incentive for people to increase their recycling effort. However, the demand for waste collection service is not reduced significantly (Hong et al., 1993). Hong (1999) found that as the household's recycling rate increases, the total waste generation increases since the household reduces its source-reduction effort. On the other hand, the quantity of recyclables increases as the total waste generation increases (Hong, 1999). Sidique et al. (2010) also finds that variable pricing[56] of waste disposal increases the rate of recycling. Similarly, Kinnaman and

[55] In the unit-based pricing, the household solid waste collection fee is based on number of bags of waste or volume of the waste disposed. In this pricing system, people have a price incentive to recycle their household waste so as to reduce the unit or volume of the total waste disposed. In this system, people also tend to reduce total waste generation through source-reduction effort.

[56] In the Variable pricing system, waste collection fee varies over the volume of waste as well as among different blocks/communities.

Fullerton (2000) found that with every $10 increase in tipping fee[57] the likelihood of implementing curbside recycling increases by 7.8 percent.

In our context, the waste collection fee is not based on weight or units like in the unit-based pricing. Kathmandu Valley residents pay a fixed waste collection fee based on conventional waste disposal method[58] and they also sell their recyclable waste to the scrap dealers. The few studies that have discussed such scenario have found that such fee structure does not give any incentive to recycling (Morris and Holthausen, 1994; Hong, 1993). However, if households sell the recyclable waste, an increase in such price encourages households to recycle more (Morris and Holthausen, 1994). Among the debate of finding the pricing structure that gives the highest incentives for recycling, Kinnaman and Fullerton (1995) favor a deposit-refund system that allows taxing illicit burning and dumping as well.

Bigger family size and higher income has significant positive effects on total waste generation (Hong, 1999). An increase in education level has a significant positive effect on recycling, whereas increase in opportunity cost of time, represented by income, has a significantly negative effect on people's recycling behavior (Hong, 1999). In the unit-based pricing system, an increase in waste collection fee positively affects recycling and does not have any effect on total waste generation (Hong, 1999).

Another way to analyze people's recycling behavior is by using theory of planned behavior (TPB) and identity theory. Self-identify dimension can be addition to the theory of planned behavior to identify one's repeated behavior such as recycling. For example, attitude is a variable of classic TPB (Mannetti et al., 2004). Hornik et al. (1995) group consumer recycling behavior into four theoretical groups – intrinsic and extrinsic incentive, and internal and external facilitator[59]. Knowledge and commitment of recycling is the internal facilitator, the strongest determinant of recycling behavior. The authors identify

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[57] Tipping fee is also based on volume of waste disposed and hence the effect can be interpreted similar to that of unit-based pricing.

[58] In conventional waste disposal method, waste collection fee is fixed, irrespective of the unit or volume of waste. The fixed waste collection fee varies over communities.

[59] Intrinsic incentives include locus of control, personal satisfaction in avoiding waste and practicing recycling; extrinsic incentives are monetary rewards for practicing recycling, social influence and commitment to recycling; internal facilitators are the cognitive variables that enable an individual to recycle, knowledge and awareness of recycling; external facilitator are time, money and effort required for recycling and these factors can act as barriers as well.

the frequency of collection as the external facilitator that significantly determines recycling behavior. The other factors than can sustain recycling are perceived satisfaction, commitment and locus of control. Schultz et al, (1995) found that environmental concern relates to recycling when recycling requires high degree of effort. Situational variables such as public commitment, normative influence, goal setting, removing barriers, providing rewards, and feedback significantly increase recycling behavior.

4.3 Research Question: The objective of this study is to identify the determinants of people's recycling behavior.

4.3.1 Hypothesis

1) Recycling provision: Given there are recycling provisions available from municipalities, households are encouraged to recycle more waste. Recycling provisions are represented by institutional regulations, waste collection frequency and distance from one's household to the waste collection point. I expect that people with better recycling provisions are more likely to recycle.
2) Social capital: Having an environmental awareness through community organizations and building social capital will induce people to recycle more waste due to positive peer pressure. I expect that people with such social capital are more likely to recycle in comparison to those without social capital and knowledge of recycling.
3) Attitude: People with a positive attitude towards the process of recycling (for example, waste segregation) are expected to recycle more. Similarly, people with positive environmental attitude are expected to recycle more.
4) Substitute or complement behavior: In household production function, time spent for waste management related activities includes both recycling and composting. Composting can be a substitute or complement behavior to recycling behavior (Sidique et al., 2010).

4.4 Theoretical Model

The theoretical model of this paper is based on household production function framework introduced by Becker (1965) and revised by Pollak and Wachter (1975). This model also follows Hong (1999) and Morris and Holthausen (1994). According to Becker's household production function, an individual combines the market goods and time to produce a commodity. An individual maximizes his/her utility with the commodity produced; time and market goods are only the inputs into the production of the commodities (Becker, 1965). Pollak and Wachter (1975) revise the household production function where time is not only an input for commodity production but also a direct source of utility

According to the household production function, an individual household uses market good and time to produce household commodities and also allocate time for recycling waste, which is the byproduct of the household production process. Household's utility function is represented as,

$$U = U(X, T_c, T_s), \;\; U_X > 0, U_{T_c} > 0, U_{T_s} < 0 \tag{1}$$

Where X is the composite market good, T_c is the time spent for producing household commodity and T_s is the time spent recycling waste.

The budget constraint is given as,

$$X - pr + K = wT_w + N \tag{2}$$

In equation (2), the price of composite market good is normalized to 1, p is the per-unit price of the recyclable waste household receives from selling it, r is the quantity of recyclable waste sold, K represents a fixed fee for solid waste collection service using a conventional disposal method[60]. On the right-hand side of the budget constraint, the total income represents labor income for working T_w working hours with wage w; and the non-labor income, N.

Time constraint is represented as,

$$T = T_C + T_S + T_w \tag{3}$$

[60] The Kathmandu valley uses a conventional disposal method where solid waste management fee is a flat fee that varies among communities and the fee does not depend on the unit or volume of waste unlike in unit-based pricing.

Following Becker's Household production function, the total time is allocated for producing household commodities, managing household waste through segregation and recycling, and working. Households generate solid waste, which is the by-product of household production. The technology of total waste generation and the household production is given as,

$$g = \theta X; \qquad 0 < \theta < 1 \tag{4}$$

Where g represents the total waste generation and θ is the waste transformation coefficient. The magnitude of θ depends on producer's packaging and household's source reduction effort. We do not have any control over firm's packaging effort and we focus on household's source-reduction effort and its impact.

The technology of household recycling is given as,

$$r = R(g, T_s);\ R_g > 0, R_{T_s} > 0 \tag{5}$$

Where r is the quantity of recyclables. Given an effort for household recycling, the quantity of recyclables increases as the total waste generation increases. Given a stock of total solid waste, quantity of recyclables increases as the effort of recycling increases.

Combining all constraint, we get the total budget constraint,

$$M = wT + N = X - pr + K + wT_c + wT_S \tag{6}$$

Where M is the full income. The household maximizes the utility, given the constraints, with respect to X, T_c and T_s. The corresponding lagrangian is given as,

$$L = U(X, T_c, T_s) + \lambda(M - X + pr - K - wT_c - wT_S) \tag{7}$$

After solving the utility maximization problem given above, we derive the optimal solutions for demand functions T_s as given below.

$$T_s^* = T_s(N, K, p, w, \theta)$$

Based on the above solutions, the total waste generation and recyclable supply are derived from constraint (4) and (5). Optimal demand for waste collection service and recycling service is given as,

$$r^* = R(N, K, p, w, \theta, g) \tag{8}$$

$$g^* = R(N, K, p, w, \theta) \tag{9}$$

4.5 Empirical Model

To represent the relationship between recycling and total waste generation, we use a system of structural equations given in equation (8) and (9). Based on the theoretical model outlined above, people's recycling behavior depends on exogenous variables such as non-labor income and fixed monthly waste collection fee. The total waste generation is an endogenous variable that determines people's recycling effort and behavior. The dependent variable is a dummy variable which equals 1 if household sells recyclable waste to the scrap dealer and 0 otherwise. As the recycling is practices informally, household selling the recyclable waste is taken as a proxy to their recycling behavior. The price received from selling the recyclable waste encourages people to recycle more and we expect a positive sign for this variable. Unlike the unit-based pricing system, increase in monthly fixed fee for waste collection may not induce people to recycle more as the price does not depend on the weight or volume of the waste. I expect that monthly fee may not have any significant impact on people's recycling behavior. Instead of wage we use monthly income to represent the effect of labor income on people's recycling behavior. The income represents opportunity cost of time and hence higher income people are expected to recycle less. The reaction function of recyclable supply derived from (5) also includes household's characteristics A, and the recyclable supply function is given as,

$$r^* = R(N, K, p, w, \theta, g; A) \tag{8'}$$

We represent the simultaneous equation model where household's recycling effort and behavior depends on the total waste generation and the total waste generation depends on income and family size, fixed waste collection fee. The total waste generation is represented in log-linear form.

$$r = \alpha_0 + \alpha_1 lng + \alpha_2 p + \alpha_3 Rec_{provision} + \alpha_4 soc_{capital} + \alpha_5 attitude + \alpha_6 A + \varepsilon \quad (9)$$

$$lng = \beta_0 + \beta_1 lnIncome + \beta_2 Family_{size} + \ \beta_2 Fee + v \tag{10}$$

Where lng represents log of total waste generation, p is the price received from selling recyclable waste. Factors that encourage recycling is: $Rec\_provision$ that represents recycling provision variables such as waste collection frequency, institutional regulation and distance from one's household to the waste collection point. Social capital represented by $soc\_capital$ is a variable that creates public awareness regarding recycling such as recycling information, participation and membership to sanitation related organization. Another important variable that impact people's recycling behavior is people's attitude towards recycling and waste segregation. I expect α_1, $\alpha_3$and α_4 are positively related to people's recycling behavior. As the dependent variable is a binary variable, I use Probit model to estimate effect of different variables on people's recycling behavior. I check for endogeneity and found that the total waste generation does not endogenously determine recycling. Hence the simultaneous equation model is not used.

4.6 Data and Descriptive Statistics

This study uses the primary data from a household survey conducted in 2012. In the Kathmandu Valley, recycling is practiced informally. Household's recycling behavior is the dependent variable and it is represented using a dummy variable which is equal to 1 if household sells recyclable waste to the scrap dealer and 0 otherwise[61]. According to Table 4.1, about 51 percent households recycle waste and sell it to the scrap dealer. The average household representative is 35 years old with an income of 34,127 Nepalese Rupees per month. Average households generate 5.8 kilogram total waste per week. Regarding institutional regulation, about 48 percent households have municipality's notice boards that impose institutional regulation regarding haphazard waste disposal. About 29 percent respondents have participated and been a member of the sanitation related organizations and 26 percent of households have a community waste management program. Those variables represent social capital in result estimation. About 33 percent households have a vegetable garden ("kitchen garden") and 12 percent of households practice composting. On average, people need to walk 1.12 minutes to dispose their waste from their household to the waste collection point. Waste is collected 4.12 times per week

[61] To be more specific, recycle =1 if household sold recyclable waste in past six months of the interview date (i.e., June 2012) and, 0 otherwise.104

and household pay 56.39 Nepalese rupees per month for the waste collection service. About 61 percent respondents have completed 10^{th} grade. Majority of the respondents (i.e, 50 percent of respondents) are Newar and 34 percent respondents are Brahman and Chhetris.

4.7 Results

According to Table 4.2, when the total waste generation increases people tend to increase recycling as given by a significant positive association of variable *log(totalWaste)* with recycling. This result is consistent with Hong (1999). Table 4.2 also suggests the existence of a causal relationship of household's recycling behavior with four key variables of interest: recycling provision, social capital, complement behavior, and attitude. Table 4.2 includes the results for three models. Model 1 includes a waste generation variable and two key explanatory variables; model 2 includes all the key explanatory variables but excludes demographic variables; and the model 3 includes all relevant variables.

The effect of recycling provision on people's recycling behavior is estimated using three variables - Institutional regulation (*IR*), distance to waste disposal site (*distance*) and frequency of waste collection (*frequency*). Variables that represent social capital are membership participation with sanitation and environment related organization (*participation_membership*), and access to recycling information (*recycling_inf*). Variables representing complimentary behavior to recycling are – using a vegetable garden or a kitchen garden (*kitchenGarden*), and practicing composting (*compost*).

Having a better recycling provisions usually encourage people to recycle more. For example, institutional regulations are enforced to avoid haphazard waste disposal and people tend to sell the recyclable waste. As shown in Table 4.2, the institutional regulation has a consistently positive effect on recycling through model 1 to 3. Having to walk long distance from one's house to the waste disposal site discourage people to recycle as the long distance may create inconvenience as well as increase the opportunity cost of walking time. Frequency of collection, however, does not have any effect on household's recycling behavior.

Institutional regulation enforces people to avoid haphazard waste disposal and people tend to sell more recyclable waste. Recycling seems to be an alternative method of managing waste which would otherwise be disposed haphazardly. Therefore, the institutional regulation has a positive effect on recycling. Having to walk longer distances from one's house to the waste disposal site discourages recycling as the long distance may inconvenience people as well as increase the opportunity cost of walking time. Frequency of collection, however, does not have any effect on household's recycling behavior. The waste collection service does not collect recyclable waste separately; selling the recyclable waste to scrap dealers are people's personal decision and hence waste collection frequency does not influence their recycling behavior.

Social capital of having membership to sanitation related organization has consistently significant positive effect on recycling through model 1 to 3. The knowledge of recycling, however has significantly positive effect on recycling in model 1 and 2; and positive but insignificant effect after accounting for people's demographic characteristics in model 3. People who compost are significantly more likely to recycle as well. Similarly, people with a kitchen garden are more likely to recycle than those without it. Having a negative attitude towards recycling related activity such as waste segregation negatively affects people's recycling behavior. People with above SLC education (i.e., above 10th grade) are more likely to recycle as they could have a higher understanding of the environmental benefits of recycling. Monthly fee for waste collection does not have any effect on recycling behavior. The fixed monthly fee does not provide price incentive for recycling unlike the unit-based pricing. Respondent's age do not have any effect on household's recycling behavior. Household income has a significantly positive relationship with household's recycling behavior, but the magnitude is small. When one's income increases they are more likely to recycle waste. Brahman Chhetri, Newar and Janajati are more likely to recycle waste in comparison to the caste group who faced discrimination in the past (i.e., Madheshi, Dalit and other caste groups).

Table 4.3 presents the marginal effect of the probit model for household's recycling behavior, with 1 representing households sell recyclable waste and 0 otherwise. When the total waste generation increases by 1 kilogram per households, those households are likely to increase recycling by 8 to 9.8 percent. When I include other demographic variables in model 2 and 3, the effect of waste generation remains consistently significant. Having an institution regulation that controls haphazard waste disposal increases the probability of household recycling by 7.8 to 9.5 percent. People dislike walking long distance to dispose their household waste and it has negative effect on their recycling behavior. When an individual walks 1 minute more to dispose household waste, his/her probability of recycling decrease by 1.3 to 1.7 percent. As given in model 1 and 2 of Table 4.3, if respondent or anyone in the family is a member of a sanitation related organization, they are 5.7 to 10.9 percent significantly more likely to recycle. If a household compost biodegradable household waste, their probability of recycling is 11.8 to 12.5 percent more than those who do not compost. Hence, composting is a complimentary behavior to recycling in this study. People who use kitchen garden are 4.8 to 4.9 percent more likely to recycle in comparison to those who do not have kitchen garden. Having a negative attitude towards waste segregation reduces recycling. For example, people who dislike waste segregation are 5.2 to 5.8 percent less likely to recycle in comparison to those who like segregating waste. Educated people also recycle more waste, which signifies the positive effect of knowledge and environmental awareness that induce them to recycle more. In comparison to people with below 10th grade education, people with above 10th grade education are 11.1 percent more likely to recycle. People's caste has a significant impact on their recycling behavior. In comparison to Madheshi, Dalit and other cate groups, Brahman Chhetris are 11.3 percent more likely to recycle, Newars are 14.6 percent more likely to recycle and Janajati are 17.7 percent more likely to recycle.

According to the Wald test conducted in Table 4.4, there is no endogeneity in the model and hence the IV-Probit model is not required. However, I ran the IV-Probit model, with *total_waste* as the endogeneous variables, and income household size and monthly waste collection fee as the instrument variables to test for the Wald test of exogeneity.

4.8 Discussion and Conclusion

Waste reduction at the source of generation is a sustainable way of managing the Kathmandu Valley's household waste. The standard three methods of minimizing waste are: reduce, reuse and recycle. In the Kathmandu valley, people practice informal recycling by selling the recyclable waste to the scrap dealers. Some households also reuse some of the recyclable waste such as plastic bottles and bins. Some households, however, burn paper and plastic in their back yard which emits carcinogenic gas and pose threat to public health. Recycling is a safe way to minimize waste and it will increase the life of landfill sites. In the past, many landfill sites filled up much earlier than its estimated life and finding an alternative landfill site has been a challenge to municipalities as people have 'Not in My Backyard (NIMBY)' attitude. In this study, I use people's behavior of selling the recyclable waste as a proxy of recycling behavior and identify its causal relationship with recycling provisions, social capital, composting behavior, people's attitude towards waste segregation, and other demographic characteristics.

Previous studies have found inter-dependence between total waste generation and recycling. People's recycling effort is modeled as endogenous as well as exogenous variable. I accounted for such possible interrelationship in my theoretical model; total waste generation is assumed to endogenously determine people's recycling behavior. The Wald test of exogeneity, however, proved that the model did not have endogeneity effect (and the results are estimated using Probit model, rather than IV-Probit model). The relationship between total waste generation and recycling is significantly positive. People who generate more waste are more likely to recycle; this result is consistent with the findings of Hong (1999). Hong (1999) also found that when household's recycling rate increases, total waste generation increases as the households reduce their waste reduction effort at the source.

This study directly addresses the real problem of waste minimization in the Kathmandu Valley by representing the conventional disposal method (existing pricing system in the valley) in theory and estimation. The findings of this study are different from previous studies that use unit-based pricing system. The majority of the existing literature identifies unit-based pricing as an important incentive to promote recycling (Jenkins, 1993; Morris and Holthausen, 1994). This study, however, did not find any significant effect of pricing as the waste collection fee is not based on unit, weight or volume. Based on my findings, the important determinants of household's recycling behavior are people's knowledge of recycling, positive peer pressure through social capital, institutional regulation, their complementary behaviors, and attitude towards waste segregation. My findings are rather more similar to that of theory of planned behavior even though I do not apply this theory in building the model of the paper.

The theoretical model in this study incorporates the monetary benefits received from selling the recyclable waste. I expect to find an important policy implication i.e., the price received on sold recyclable waste can be a significant price incentive to promote recycling. However, the limitation comes with the lack of data of price received on sold recyclable waste. In future, I aim to use secondary data or a proxy to represent this price, and provide the policy implication of promoting recycling.

4.9 Policy Recommendation

As a policy implication based on my findings, municipalities can implement and enforce institutional regulations that will not only avoid haphazard waste disposal but also increase recycling. Local authorities can take an initiative to establish sanitation and environment related organizations at community level and involve more people in such organizations. People who compost their household waste are significantly more likely to recycle. Municipalities are promoting household composting by providing composting bins at the subsidized price. As a policy implication, municipalities can promote recycling along with composting to the same individuals who have already been practicing composting. Municipalities can also promote recycling to new households by providing a complementary offer with the subsidized composting bins and equipment. Increasing public awareness regarding recycling method can also boost recycling as recycling information has significantly positive relation with recycling behavior.

Table 4.1 Descriptive Statistics of the Variables of Interest

Variable	Definition	Mean	Std. Dev.	Min	Max
recycle	Dummy for household's recycling behavior - 1 if household recycles, 0 otherwise.	0.51	0.50	0	1
totalwaste	Total waste generation per household per week in Kilogram.	5.80	4.14	1	50
Institutional Regulation	Institutional regulation - 1 if community has notice board about the rules of haphazard waste disposal, 0 otherwise.	0.48	0.50	0	1
distance	Walking distance in minutes from respondent's house to the waste collection point.	1.12	2.21	0	30
frequency	Frequency of waste collection per week.	4.12	3.70	0	21
Participation_membership	1 if respondent or any other family member has participated in and is a member of environment and sanitation related organization, 0 otherwise.	0.29	0.45	0	1
recycling_inf	1 if respondent has access to information regarding recycling method, 0 otherwise.	0.87	0.34	0	1
compost	1 if household practice composting, 0 otherwise	0.12	0.33	0	1
kitchenGarden	1 if respondent owns a vegetable garden at their residence, 0 otherwise	0.33	0.47	0	1
notlikeSeg	1 if respondent do not like to segregate waste, 0 otherwise	0.38	0.49	0	1
aboveSLC	Dummy for respondent's education level, 1 if education above 10th grade, 0 otherwise	0.61	0.49	0	1
monthlyfee	Monthly Fee for solid waste collection service; fixed for units and varies over communities	56.39	88.61	0	600
age	Age of the respondent	35.97	13.41	18	86
income	Household's monthly income in Nepalese Rupees	34,127.76	157,646.70	1,000.00	5,000,000.0
Familysize	Family size	4.73	2.15	0	21
Caste					
Janajati	Janajati	0.10	0.31	0	1
Brahman Chhetri	Brahman and Chhetri	0.34	0.47	0	1
Newar	Newar	0.50	0.50	0	1
MD_DT_other	Madheshi, Dalit and Other	0.05	0.22	0	1
N		1113.00			

We use a proxy variable for representing household's recycling behavior. If household sold recyclable waste within past six months o the interview date, recycle=1, 0 otherwise.

Table 4.2: Probit Model for Household's Recycling Behavior

		Model 1		Model 2		Model 3	
	Dependent variable: recycle						
	Log(totalwaste)	0.256***	(3.73)	0.262***	(3.71)	0.220***	(2.89)
Recycling Provision	Institutional Regulation	0.226***	(2.76)	0.253***	(3.04)	0.213**	(2.48)
	distance	-0.0453**	(-2.46)	-0.0447**	(-2.42)	-0.0389**	(-2.03)
	frequency	-0.0111	(-1.06)	-0.00672	(-0.64)	-0.00549	(-0.48)
Social Capital	participation_membership	0.287***	(3.17)	0.268***	(2.94)	0.157[a]	(1.64)
	recycling_inf	0.337***	(2.79)	0.284**	(2.25)	0.188	(1.48)
Attitude Complement	compost			0.332***	(2.82)	0.321***	(2.59)
	kitchenGarden			0.127[a]	(1.64)	0.134*	(1.65)
	notlikeSeg			-0.156**	(-2.02)	-0.142*	(-1.81)
	aboveSLC					0.303***	(2.99)
	Monthlyfee/100					-0.00528	(-0.10)
	age					0.00219	(0.14)
	Age^2					-0.00011	(-0.61)
	income/10000					0.0598*	(1.65)
	(income/10000)^2					-0.00205	(-1.26)
	Reference Caste: Janajati						
	Brahman Chhetri					-0.174	(-1.21)
	Newar					-0.0858	(-0.58)
	Madheshi, Dalit and Other					-0.482**	(-2.13)
	_cons	-0.771***	(-4.54)	-0.781***	(-4.47)	-0.712**	(-2.03)
	N	1113		1113		1113	
	log_likelihood	-740.9		-732.3		-715.2	
	chi-squared	67.17		90.31		128.2	
	AIC	1495.8		1484.6		1468.3	

* p<0.1 ** p<0.05 *** p<0.01

t statistics in parentheses; a= significance at 10.1 %

Table 4.3: Marginal Effect of the Probit Model for Household's Recycling Behavior

	Dependent variable: recycle	Model 1		Model 2		Model 3	
	Log(totalwaste)	0.0976***	(3.788)	0.0988***	(3.761)	0.0810***	(2.908)
Recycling Provision	Institutional Regulation	0.0864***	(2.790)	0.0952***	(3.076)	0.0784**	(2.495)
	distance	-0.0173**	(-2.474)	-0.0169**	(-2.436)	-0.0143**	(-2.041)
	frequency	-0.00424	(-1.066)	-0.00253	(-0.641)	-0.00202	(-0.484)
Social Capital	participation_membership	0.109***	(3.218)	0.101***	(2.973)	0.0577[a]	(1.643)
	recycling_inf	0.129***	(2.817)	0.107**	(2.268)	0.0692	(1.484)
Complement behavior	compost			0.125***	(2.837)	0.118***	(2.603)
	kitchenGarden			0.0480*	(1.651)	0.0494*	(1.652)
Attitude	notlikeSeg			-0.0588**	(-2.031)	-0.0522*	(-1.819)
	aboveSLC					0.111***	(3.017)
	Monthlyfee/100					-0.00194	(-0.0978)
	age					-0.00209	(-1.427)
	Income/10000					0.0178[a]	(1.640)
	Reference Caste: Janajati						
	Brahman Chhetri					-0.0638	(-1.216)
	Newar					-0.0315	(-0.576)
	Madheshi, Dalit and Other					-0.177**	(-2.139)
	Observations	1,113		1,113		1,113	

* p<0.1 ** p<0.05 *** p<0.01; t-statistics in parenthesis; a= significance at 10.1 %

Table 4.4: IV-Probit Model for Household's recycling Behavior

	Model 1		Model 2		Model 3	
Dependent variable: Recycle						
Log(totalwaste)	0.519***	(2.91)	0.482***	(2.66)	0.674**	(1.97)
Institutional Regulation	0.177**	(2.15)	0.211**	(2.51)	0.151	(1.56)
distance	-0.0444**	(-2.46)	-0.0442**	(-2.42)	-0.0457**	(-2.37)
frequency	-0.0113	(-1.08)	-0.00716	(-0.68)	-0.00889	(-0.78)
participation_membership	0.274***	(2.99)	0.258***	(2.79)	0.143	(1.45)
recycling_inf	0.317***	(2.67)	0.270**	(2.18)	0.184	(1.50)
kitchenGarden			0.106	(1.35)	0.118	(1.42)
compost			0.353***	(3.04)	0.371***	(2.99)
notlikeSeg			-0.154**	(-1.99)	-0.134*	(-1.68)
aboveSLC					0.259**	(2.32)
Monthlyfee/100					-0.0463	(-0.77)
age					-0.00812	(-0.47)
Age^2					0.000000355	(0.00)
Income/10000					0.006295	(0.12)
(income/10000)^2					-7.22e-12	(-0.57)
Reference Caste: Janajati						
Brahman Chhetri					-0.196	(-1.39)
Newar					-0.0961	(-0.65)
Madheshi, Dalit and Others					-0.502**	(-2.34)
_cons	-1.146***	(-3.87)	-1.092***	(-3.62)	-1.477***	(-3.50)
athrho	-0.162	(-1.56)	-0.134	(-1.29)	-0.244	(-1.26)
lnsigma	-0.690***	(-22.93)	-0.693***	(-23.13)	-0.712***	(-23.86)
N	1113		1113		1113	
log_likelihood	-1550.6		-1539.1		-1501.3	
chi-squared	59.32		81.09		142.7	
AIC	3137.1		3126.2		3080.6	
Wald test of Exogeneity (/athrho = 0)						
athrho	-0.162	(-1.56)	-0.134	(-1.29)	-0.244	(-1.26)
chi2(1)		2.45		1.65		1.6

* p<0.1 ** p<0.05 *** p<0.01

t statistics in parentheses; ln_totalwaste is the endogenous variable; Family size, income and waste collection fee are the instrument variables.

Chapter 5: Concluding Remarks

5.1 Dissertation Summaries

This dissertation has three separate studies, each of which addresses environmental issues of the Kathmandu Valley. More specifically, I discuss about solid waste management and air pollution; recycling is also discussion, which is a branch of the solid waste management itself. The issues are interlinked and hence the provided policy recommendations are complimentary to improve solid waste management, reduce air pollution and promote recycling together.

Chapter 2 addresses an emerging issue and a less researched topic i.e., solid waste management system. Previous studies look at the waste management problem at a macro scale and focus on municipal waste management. The majority of the municipal waste generation, however, comes from households. Therefore, I look at individual household's waste management choices using a choice experiment survey. The attributes of the choice experiment is identified using focus group discussions, debriefings, personal interviews, and a pilot survey. I segregated the sample conducted in all five municipalities into two groups – core urban and sub-urban residents. The spatial heterogeneity exists for preference for waste segregation; core urban residents do not like to segregate any waste and sub-urban residents are willing to segregate two types of waste. This result may represents difference in people's opportunity cost of time and occupation. Also, people's highly preferred attribute in core urban and sub-urban area is distinctively different. Core urban residents are willing to pay the most (i.e., 404 Rupees) for community waste management program and sub-urban residents are willing to pay the most (i.e., 480 Rupees) for scheduled collection. As a policy implication of this finding, the local authorities can decentralize the waste management and involve community in waste management program. The Kathmandu valley residents are willing to trade off frequency with scheduled collection. Therefore, municipalities can increase scheduled collection and reduce the collection frequency. Majority of the residents dislike higher fee and like higher collection frequency. Due to heterogeneously distributed status-quo level attributes, the Alternative

Specific Constant does not necessarily compare one's preference for change from worst (or lowest constant level) to best (better) solid waste management service. Therefore, I do not include alternative specific constant.

Outdoor air pollution is another important issue of the valley, which I have included in chapter 3. My research approach in this topic is different from previous studies in this field in Nepal. Previous studies used pollutant level data and analyzed its health effect. I look at people's exposure to pollution based on one's proximity to source of pollution, time activity patterns and surrounding environment, and analyze its effect on their health, more specifically on the probability of experiencing dust allergy, nausea and respiratory sickness. The sources of pollution used are traffic emission, bio-gas emission from waste dumping sites, and industrial emission from brick factory and other industries. Road is the closest source of pollution and its effect is the strongest in people's health. Based on the findings, living farther from road and waste dumping site is better for people's health. Living closer to a river, however, is better for health as it may represent benefit of aquatic resource, and greenery and open space around the river. In addition, I estimate the monetary health benefit of reducing exposure to traffic emission. An average Kathmandu valley resident saves 389 rupees per month by living 100 meters far from a road from his/her current residence. Age and occupation has significant health effect. For example, day laborers, who mostly work outdoor and in close proximity to road, are the most susceptible to air pollution in comparison to housewives and other employed workers. Adults of up to 36 years are less susceptible in comparison to older adults. As a policy implication of this study, municipality can strongly enforce emission testing on vehicles that will reduce the traffic emission. Also, promoting urban foresting can be an important positive change to reduce the effect of air pollution.

In chapter 4, I analyze the determinants of people's recycling behavior and relate it with waste generation pattern. I present a theoretical model that replicates unique pricing system of the Kathmandu Valley, which is a flat fee (that varies over communities) irrespective of weight or volume. The model also incorporates the price received from sold recyclable waste; its effect, however, cannot be estimated due to the lack of price data. People collect and sell their household recyclable waste to the scrap dealers and it is used as a proxy for recycling in this chapter. Unlike many other studies, total waste generation is not endogenously related to recycling; the recycling, however, significantly increases with increase in total waste generation. Unlike unit-based pricing, in which recyclable waste is collected based on its volume or weight, the waste collection fee does not have any effect on recycling. People's recycling behavior is positively influenced by institutional regulations of proper waste disposal method, complementary behavior such as composting and using vegetable gardening, and social capital of sanitation related organization. Based on the finding, the policy implication would be to promote recycling along with an ongoing household composting promotion. Urban gardening is another important way to promote recycling.

In overall, the findings of all three chapters lead to similar policy implications which can complement each other. For example, urban foresting and gardening will promote recycling and also helps to reduce the negative effect of outdoor air pollution. Community involvement and institutional regulation helps to manage solid waste properly, avoid haphazard waste disposal and boost recycling. Based on the spatial preference heterogeneity for waste segregation in core urban and sub-urban area, municipality may implement different strategies to promote recycling in those areas.

5.2 Future Research

In future, I plan to extend some of the existing studies, which have some limitations at present. For example, the theoretical model in chapter 4 can provide an important policy implication when I collect primary or secondary data of the price of sold recyclable waste in households. I expect to find that such price will give households an incentive to increase recycling similar to that of unit-based pricing system. Unit-based pricing system gives incentive to reduce waste during waste generation as well. Following are some of the future studies I aim to carry in collaboration with my dissertation advisors.

1) Estimating bivariate Probit model for recycling and composting behavior. Both recycling and composting variables are binary. Add composting related variables. Joint modeling of two behavior (composting and recycling)

2) Collect emission data from Kathmandu valley's meteorological stations and interpolate the emission data. Also, run health estimate with emission data and source of pollutant as in chapter 3 in dissertation.

3) Collect water quality data from municipality for wards. And then use the waste quality perception data from our survey. The study will look at water quality-perception versus reality.

Appendix A: Details of the Current Solid Waste Management Service in the Kathmandu Valley

The Kathmandu Valley is made up of three districts: Kathmandu, Lalitpur and Bhaktpur. These three districts consist of five municipalities: Kathmandu and Kirtipur municipalities in Kathmandu district; Lalitpur municipality in Lalitpur district; and Bhaktpur and Thimi municipalities in Bhaktpur district. The following information is based on personal interviews with the then solid waste management department personnel in all three municipalities of the Kathmandu Valley.

a) Kathmandu Municipality: In June 2012, I conducted a personal interview with the Kathmandu municipality's solid waste management officer Ram Krishna Karki and community mobilization unit officer Raja Ram Shrestha (at the Environment Department of the Kathmandu municipality). The municipality of Kathmandu has 35 wards[62] and each ward has about 20 employees devoted to waste management.

The Kathmandu municipality privatized the waste collection service in 2001 and it lasted until 2003 when the municipality's employees opposed the privatization. During the privatization of the waste collection service, for the first three months the private waste collectors offered waste management membership that offers regular waste collection with certain monthly fee to the residents of 1, 2, and 24 ward and transported collected waste to the transfer station in Teku.

Kathmandu municipality did not and still does not collect waste at the household level. However, the sweepers clean and collect the street waste, which is picked up by small collection trucks and transported to the waste transfer station at Teku. The street waste is generated by business firms, produce street markets, and other stores. After the reversal of the privatization, household waste is now picked up by small and large-scale waste collection contractors. In 2012, 36 contractors were involved in the door-to-door waste collection service. Each small-scale waste collector picked up the waste from 50 to 60 households, and dumped the waste at transfer stations. The large-scale contractors collected waste from 500 to 600

[62] Ward is the smallest administrative unit in Nepal.

households and transferred it to the landfill site, using rented trucks from the municipality (at a rate of 2000 rupees per truck per day).

Kathmandu municipality has two departments for waste management related work i.e., solid waste management unit and the community mobilization unit. The Community Mobilization Unit (CMU) is a specific branch in the Environment Department of Kathmandu municipality that has the responsibility of raising public awareness. CMU promotes awareness about waste reduction at the source by providing composting equipment at a subsidized rate. For example, in 2002, CMU started providing composting bins, and other necessary equipment like nets and spoons at a subsidized price of 1500 rupees per bin (the non-subsidized price was around 1800 rupees). Those composting bins have 100 liter capacity, and a bin is filled up in about 3 months at the rate of 1 kg of biodegradable waste per day. In between 2002 and 2012, about 6000 composting bins were sold. The Japan International Corporation Agency (JICA) provided 500 composting bins to ward number 21 at a rate of 500 rupees per bin. CMU is also operating community recycling centers (CRC) in coordination with local community organizations.

CMU is involved in public announcement campaigns to promote proper waste disposal rules through TV, radio, flyers, and loud speakers. For example, municipality promotes waste management rules in its own radio channel called Metro FM and broadcast a daily TV program called 'Hamro Kathmandu' in Nepal Television. In addition, CMU conducted a week long Special Sanitation Program in April 4-7, 2012 to create public awareness about proper waste disposal methods. Kathmandu municipality plans to conduct different programs in ward number 21 to represent this community as an exemplary model of a solid waste management; ward number 21 has a recycling plant that buys plastic bags and sells fabric-made bags.

b) Thimi Municipality: Thimi is one of two municipalities in Bhaktpur district. It is 11.47 square kilometer in area and is divided into 17 wards. The municipality collects waste from public places such as bus parks and streets. About 17 sweepers clean roads and streets in the community. Private organizations collect household waste using door-to-door collection. Those private organizations are of four types: community based organizations, female group, mother's group, and community improvement committee. Currently, 19 community based organizations are operating and each group has 20 to 25 women. Such community organizations (specifically women's group) are also involved in development related community works such as women's rights, child development, and skill development programs. The municipality itself and some of the community organizations occasionally collect haphazardly disposed waste.

Thimi municipality previously ran a composting plant, and promotes household composting. However, the plant stopped operating due to some technical problems and low demand. Currently, the municipality is operating a biogas plant. For managing plastic waste, the municipality distributes needles to households to store plastic. The municipality raises public awareness through community programs, exhibition, mass communication, and local newspaper. It also broadcasts a radio program called 'Madhyapur Thimi, our property' which is aired every Thursday 7 pm to 8 pm. The municipality provides training to community organization volunteers and operates some public awareness program within schools. The municipality spends 3.6 million out of 160 million municipal budget on waste management. Municipality has a strategy of 'no container at all' as they find that regular management of container is not effective.

c) Lalitpur Municipality: Lalitpur municipality collects household waste from core urban area and private contractors collect waste from the sub-urban area. Currently, 14 private organizations (contractors) are involved in waste collection in sub-urban area. There are 73 routes for street sweeping and waste collection. Previously, there were 32 waste collection points where households would dump waste on the street and the municipality would pick it up from there later. Due to many disamenities associated with such collection points, the municipality got rid of them.

Some organizations have studied the waste management system in Lalitpur municipality and provided some policy recommendations. For example, Japan International Corporation Agency (JICA) has prepared a 10-year action plan for 2005 to 2015, and is policy recommendations are: 1) improvement of collection and transportation; 2) promotion of waste minimization; 3) improvement of final disposal system; and 4) promotion of public participation and behavior change. In 2009, Korean International Cooperation Agency (KOICA) prepared a report and identified the three most important factors of improvement: 1) waste sanitation; 2) urban traffic; and 3) waste management. The municipality does not charge any fee for waste collection. Private organizations, however, charge 100 to 300 rupees per month for waste collection service.

The municipality operates 2 composting plants. For example, Nepse Mac is operating a three-ton-capacity composting plant and Women's Environment Preservation Committee (WEPCO) is operating a 1one-ton-capacity capacity composting plant. WEPCO works on producing biogas and other environmental activities too. Lalitpur municipality spends 60 million on waste management, which is 50 percent of the total municipal budget.

Appendix B: Details of Choice Experiment

Table B1. list of selected clusters

District	Municipality	Sample cluster/wards	Sample size per ward	Sample Size
Bhaktpur	Bhaktpur	11, 7, 1, 4, 2, 15,14	20	140
	Thimi	4,3,9,12,7,14	20	120
Kathmandu	Kathmandu	1,2,3,4,6,7,8,9,10,12,13,14,15,16,17,19 ,23,24,26,27,28,29,30,31,32,33,34,35	20	560
	Kritipur	12,1,16,9,13,17	20	120
Lalitpur	Lalitpur	15,7,12,5,13,18,19,21,17,14,10,11,19	20	260
			Total Sample size	**1,200**

Table B2. Sample Design step-by-step process

Steps	Description
1	5 municipalities of Kathmandu valley are considered the strata of the sample.
2	Each Municipality is a strata based on stratified sampling principle.
3	Sample size for each strata is selected using the probability proportional to size (PPS) sampling principle.
4	Wards from each strata are randomly selected (using random sampling).
5	From the selected wards, household is identified using Right-Hand-Rule technique.
6	18 or older household representative is interviewed

Table B3. The factors suggested by survey respondents that are required to improve the existing solid waste management system

Factors suggested for improving the existing solid waste management service.	frequency
Regular waste collection	23
Public awareness program	22
Haphazard waste disposal	15
Municipality should be active	13
Waste collection bin	11
Self-active, waste segregation (self)	10
Waste management policy	7
Scheduled pickup	6
Waste management process should be good	3
Fee(high/less/free)	2
Waste collection point	2
Pollution	1

Source: Pretest 1 of solid waste management survey, 2012

Table B4. Log-likelihood values for different Halton draws in Mixed logit model

	Log-likelihood values		
Halton Draws	**Pooled**	**Core-urban**	**Sub-urban**
500	-3571.8	-2794.4	-764
1000	-3567.9	-2792.2	-761.7
5000	-3566.9	-2794.3	-764.6
6000	-3567.2		-764.4
10000	-3567.7	-2794	-763.4
12000	-3566.7	-2794.3	-763.7
13000	-3567.6	-2793.8	-764.1
14000	-3566.6	-2793.3	-763.6
15000	-3566.7	-2793.8	-763.7
16000	-3567.2	-2793.9	-764.3
17000	-3567.1	-2793.8	-764.1
18000	-3567	-2793.2	-763.7
20000	-3566.6	-2793.1	-763.9
25000	-3567.2	-2793.8	-763.9
30000	-3566.6	-2793.8	-763.9
35000	-3567.2	-2793.8	-764.0
40000	-3566.4	-2794.0	-764.0
50000	-3567.4	-2793.9	-763.8

Appendix C: Details of Survey Administration process and sampling design

Survey Administration

Before conducting the survey, I received approval of conducting survey that involves people i.e., human subject research under the expedited review category from University of New Mexico's Office of Internal Review Board (OIRB). We asked people about their socioeconomics characteristics and we received verbal consent for them for asking such questions. During the survey preparation, Kathmandu Valley's municipality officials gave me important information regarding existing provisions of the solid waste management services in different municipalities. Therefore, I thank all five municipalities' officials for helping me to review survey questionnaire with the given information. I also thank the survey field supervisor, Ram Pokharel, and all the enumerators and data entry operators for helping me to successfully complete the household survey. The household survey is financially supported by Nepal study Center's research assistantship savings, University of New Mexico (UNM) — Office of Graduate Studies' the Graduate Student Supplement Award, and University of New Mexico — Department of Economics' Stuart award.

In preparation for conducting the household survey, we conducted other tasks such as personal interviews with municipality personnel, debriefs with volunteer respondents, focus-group discussions with household representatives, and a household pilot survey. These activities helped review and finalize the survey questionnaire. The focus-group discussions and personal interviews helped identify the most important characteristics of the solid waste management system in Kathmandu Valley. Some of the waste management attributes (community waste management program and collection type) were changed based on the feedback obtained from local residents. In the debriefing, the importance for improving those attributes were discussed with volunteer respondents. The step-by-step phases of the survey administration process are presented in Table C1

Survey Protocol

The survey protocol included: Expert interview, Focus-group discussion, debriefing, first pilot survey, debriefing, second pilot survey, and the final survey.

To identify the existing provision on solid waste management in the Kathmandu Valley, municipality personnel, ward office personnel and other experts were interviewed. Such personal interview gave some insight about the existing service and the government provisions on solid waste management. After each of the steps on survey protocol, questions were reviewed and modified.

Then, two focus-group discussions were conducted. Both of the focus-group discussions had 9 to 10 participants, who represented three municipalities in equal proportion and included equal proportion of male and female participants. As a principal investigator, I led the focus-group discussion in roundtable discussion format. Focus-group discussion started with introduction of the survey and self- introduction of participants. The main objective of the focus-group discussion was to answer specific questions regarding choice experiment and existing provisions of solid waste management. For example, majority of the discussions were focused on finding important attributes of waste management system. During the discussion, each participant was encouraged to comment on the raised issue/topic. I took some precaution to avoid the discussion off-topic and lead the discussion to identify important attributes of solid waste management service.

Then, debriefing was conducted in one-to-one interview with household respondents. During debriefing, I asked other important questions that can lead to identify the most important attributes of solid waste management. The initial phase of debriefing was conducted with 3 to 4 Kathmandu University's students. The questionnaire was modified according to the findings on expert interview, focus-group discussions and debriefings.

Then, the first pretest survey was conducted in 50 randomly sampled households in five municipalities of the Kathmandu Valley; 5 wards were randomly sampled, one from each municipality, and 10 respondents were interviewed from each sample wards. First pretest survey was conducted with 10 enumerators and 3 field supervisors; in addition to the field supervisors, I supervised the interview process.

With the first pilot survey, I estimated some preliminary results. According to the preliminary estimates, more than 40% of the respondents were choosing status-quo alternative. It was identified that some of the attributes presented in the choice experiment were not much different than existing service. Therefore, we (the dissertation committee and I) decided to identify more important attributes for solid waste management by conducting another pilot survey.

Before second pilot survey, final phase of debriefing was conducted with about 20 household respondents. The debriefing was formatted as an informal talk that included all the questions as well as the additional questions relating to people's preference on having an ideal solid waste management. At the initial phase of debriefing, we found that community waste management program is an important attribute of solid waste management service. On remaining debriefings, the respondents highly preferred community waste management program; it was the most important attribute among all the other attributes. After repeatedly asking similar questions to people at different locations, we finalized the choice experiment attributes.

Then, we conducted second pilot survey in 50 households, in the same logistics of first pilot survey. The second pilot survey was conducted in 5 randomly sampled wards, one from each municipality, and 10 respondents were interviewed from each ward. The preliminary result analysis of the second pilot survey did not have any major issue, which confirmed to questionnaire quality and choice experiment attributes.

Then finally, we conducted final survey. During the final survey, I ensured that the survey rules were strictly adhered. For example, some of the rules that applied to enumerators are: be respectful and neutral to all the respondents, do not influence respondents on their response, do not show any kind of verbal and non-verbal signs towards their response, and most importantly read the questions just the way it is and listen carefully.

At many instances, I had to listen to instinct and had to make quick decision to make the whole process better. To conduct the survey, we need team spirit. Therefore, being a good program coordinator is the role of principal investigator during the final survey. I made sure that enumerators and field supervisors were incentivized monetarily and morally to complete the process successfully.

Table C1. Survey administration process, step-by step tabulation

Date	Event	Purpose	Location	People involved
06/2012	Meeting with municipality personnel	To collect information about the existing waste management service available in municipality, their work strategies and their future plans.	Municipality offices	Municipality's waste management section officers, myself and field manager.
	Focus-group discussion with Kathmandu, Lalitpur and Kirtipur municipality residents	To test how significant are the attributes of waste management system discussed in the questionnaire.	Kathmandu university	Municipality residents, field managers and myself
	Focus-group discussion with Bhaktpur and Thimi municipality residents		Kathmandu University	Municipality residents, field managers and myself
	Debriefing			
28-Jun	Pretest 1			
July 3 to July 6	Debriefing for pretest 2	Finalizing on the attribute and the questions	Kathmandu, Lalitpur, Bhaktpur, Thimi	Individual household at their house. I interviewed them as done in pretesting, but also asked some of the questions out of the questionnaire.
8-Jul	Pretest 2			
July 14 to July 31	Final survey			

The following picture is a glimpse of the focus group discussion with the residents of the Kathmandu Valley in Nepal Study Center's branch office in the Kathmandu University.

Sampling design:

The household survey on solid waste management service in Kathmandu valley was conducted in 5 municipalities of Kathmandu Valley using random sampling technique. The 5 municipalities are considered the strata of the sample. The sample size for each of the given five municipalities is selected using the Probability Proportional to Size (PPS) sampling technique. Then, wards are selected by using random sampling technique. From each of the selected wards, twenty households are selected for survey. During the survey administration, the households are chosen by using the right-hand rule. During the survey, enumerators interview the household representative of age 18 years or older. Table A6 presents the sample design process that includes six steps. The actual breakdown of the sample by each municipality (i.e., stratum) is given in Table A6.

The sample size of 1,200 respondents is spread across 3 districts and five municipalities. This sample size produces results with +/- 2.8 percent of the error margin at a 95 percent confidence level at the overall sample level (Cochran, 2007). The formula to calculate the error margin at 95% confidence level is given as:

$$\text{Error margin} = 1.96 \sqrt{\frac{PQ}{n}} \sqrt{\frac{N-n}{N-1}}$$

Where N is population size, n is sample size, P is probability of selection and Q is probability of no selection and 1.96 is the critical value at 5% significance level. Table C2 provides values of each components of the Error margin.

Table C2. Sample Distribution and Margin of Sampling Error

District	Municipality	Total No. of wards	Population Size	Population (%)	Sample size (in number of households)
Bhaktpur	Bhaktpur	17	72,543	7.3	140
	Thimi	17	47,751	4.8	120
Kathmandu	Kathmandu	35	671,846	67.5	560
	Kirtipur	19	40,835	4.1	120
Lalitpur	Lalitpur	22	162,991	16.4	260
Total		**110**	**995,966**	**100**	**1,200**

Calculation of Margin of sampling Error:

	Probability of selection (P)	Probability of no selection (Q)	Population size in number of households(N)	sample size in number of households(n)	Error margin[63] (%)
	0.36	0.64	337,298	1200	2.7%

63 $\sqrt{\frac{PQ}{n}} = 0.0138$; $\sqrt{\frac{N-n}{N-1}} = 0.9982$; $\text{Error Margin} = 1.96 * \sqrt{\frac{PQ}{n}} \sqrt{\frac{N-n}{N-1}} = 1.96 * 0.0138 * 0.9982 = 0.027 * 100 = 2.7\%$

Appendix D: Step-by-step explanation of estimating log-likelihood in mixed logit model

1. Given utility $U_{ni} = \beta'_n x_{ni} + \varepsilon_{ni}$, where β_n are distributed with density $f(\beta|\theta)$, where θ refers collectively to the parameters of this distribution (such as mean and variance of β). The functional form of $f(\beta|\theta)$ is provided to estimate the parameters θ. For example, in this study, all the attributes and interactions terms are randomly distributed and price is kept fixed. The choice probabilities are:

$$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta \quad (5)$$

Where

$$L_{ni}(\beta) = \frac{e^{V_{ni}(\beta)}}{\sum_{j=1}^{J} e^{V_{nj}(\beta)}} \quad (6)$$

2. The probabilities are approximated through simulation for any given value of θ: a) First, a values of β is drawn from f(β|θ), and label it β^r with r = 1 referring to the first draw; b) then, logit formula $L_{ni}(\beta^r)$ is calculated with this draw; c) step (a) and (b) is repeated many times and average result is estimated. This average is the simulated probability:

$$\hat{P}_{ni} = \frac{1}{R} \sum_{r=1}^{R} L_{ni}(\beta^r)$$

where R is the number of draws, $\hat{P}_{ni}$ is an unbiased estimator of P_{ni} by construction. Its variance decreases as R increases. $\hat{P}_{ni}$ is strictly positive so that $ln\hat{P}_{ni}$ is defined; $\hat{P}_{ni}$ sums to 1 over alternatives and is smooth (twice differentiable) in the parameters θ and variables x, which facilitates numerical search for the maximum likelihood function.

3. The simulated probabilities are inserted into the log-likelihood function to give a simulated log-likelihood:

$$SLL = \sum_{n=1}^{N} \sum_{i=1}^{J} d_{ni} ln\hat{P}_{ni}$$

Where, $d_{ni} = 1$ if an individual n chooses i and 0 otherwise. The maximum simulated likelihood estimator is the value of θ that maximizes Simulated Log-Likelihood (SLL). This estimator maintains independence over decision makers of the simulated probabilities that enter SLL.

Panel Data

In panel data, like in this study, each sampled decision maker uses repeated choices. Utility from alternative i in choice situation t by person n is

$U_{njt} = \beta_n x_{nit} + \varepsilon_{nit}$ where, ε_{nit} is independently and identically distributed extreme value over time, person and alternatives. Consider a sequence of alternative, one for each time period, $i = \{i_1 \ldots \ldots \ldots \ldots \ldots \ldots, i_T\}$. Conditional on β the probability that each person makes this sequence of choices is the product of logit formulas:

$$L_{ni}(\beta) = \prod_{t=1}^{T} \left[\frac{e^{\beta'_n x_{ni_t t}}}{\sum_j e^{\beta'_n x_{njt}}} \right] \qquad (6)$$

The ε_{nit}'s are independent over time.

In mixed logit with repeated choice per decision maker, the integrand involves a product of logit formulas, one for each time period, rather than just one logit formula. The probability is simulated similarly to the probability with one choice period. A draw of β is taken from its distribution. The logit formula is calculated for each period, and the product of these logits is taken. This process is repeated for many draws, and the results are averaged.

Stata Code and related calculations:

1) Figure 2.1, 2.1 and Table 2.12

```
mixlogit choice monthlyFee1, rand(communityorg scheduled segregate2 segregate3 freq freq_sq freq_cube) group(gid) id(qsn_no) nrep(1000) iterate(100) trace
estimates store table12_nonlinFreq_1000 /*Table 2.12*/
```

$$Total\ Utility = \beta_1 Freq + \beta_2 Freq^2 + \beta_3 Freq^3$$

$$\frac{\partial U}{\partial Freq} = \beta_1 + 2\beta_2 Freq + 3\beta_3 Freq^2$$

$$\frac{\partial U}{\partial Fee} = \beta_{fee}$$

$$MWTP = \frac{\frac{\partial U}{\partial Freq}}{\frac{\partial U}{\partial Fee}} = \frac{\beta_1 + 2\beta_2 Freq + 3\beta_3 Freq^2}{\beta_{fee}}$$

Appendix E: Details of the health benefit estimation, following Freeman (2003)

An individual's marginal willingness to pay (MWTP) for reduction in pollution is the largest sum of money one is willing to pay without reducing his/her utility. Reduction in pollution can benefit people with better health and many other factors such as aesthetic pleasure, tourism and other. However, I concentrate on health benefit only and estimate such benefit in currency. The MWTP for reduction in pollution is given as the product of reduction in sick time associated with reduction in pollution and the marginal cost of reducing sick time. The processes for calculating MWTP are:

a) Using the utility maximization problem, obtain the demand functions for mitigating activity given by equation (4), i.e., $M^* = M(\, I, w, P_M, Q)$. The optimal quantity of M is a function of income (I), prices (w and P_M), and pollution level (Q).

b) Then, I take the total derivative of the health production function, which is given as $H = H(Q, M)$. The total derivative is given as,

$$\frac{\partial H}{\partial Q} = \frac{\partial H}{\partial Q} + \frac{\partial H}{\partial M}\frac{\partial M^*}{\partial Q}$$

The above equation can also be written as,

$$\frac{\partial H}{\partial Q} = \frac{\partial H}{\partial Q} - \frac{\partial H}{\partial M}\frac{\partial M^*}{\partial Q}$$

c) Multiply the total derivate by the first-order conditions of utility maximization problem. The utility maximization problem is given as,

$$\mathcal{L} = U\big(X, L, H(M, Q)\big) + \lambda\{I + w[T - L - H(M, Q)] - X - P_M M\}$$

The first order conditions with respect to X, L and M are given as,

$$U_X = \lambda \qquad (a)$$

$$U_L = \lambda w \qquad (b)$$

$$\frac{\partial U}{\partial H} - \lambda w = \lambda \frac{P_M}{\partial H/\partial M} \; or \; -\frac{P_M}{\partial H/\partial M} = w - \frac{\partial U/\partial H}{\lambda} \qquad (c)$$

Multiplying the total derivative of health production function with the first order condition given in equation (c), we get

$$-P_M \frac{\partial H/\partial Q}{\partial H/\partial M} = \left[w - \frac{\partial U/\partial H}{\lambda}\right]\frac{\partial H}{\partial Q} - \left[w - \frac{\partial U/\partial H}{\lambda}\right]\frac{\partial H}{\partial M}\frac{\partial M^*}{\partial Q}$$

After arranging the above equation, we get

$$-P_M \frac{\partial M}{\partial Q} = \left[w - \frac{\partial U/\partial H}{\lambda}\right]\frac{\partial H}{\partial Q} - \left[w - \frac{\partial U/\partial H}{\lambda}\right]\frac{\partial H}{\partial M}\frac{\partial M^*}{\partial Q}$$

From the above equation, we derive the marginal willingness to pay for reduced pollution, W_c.

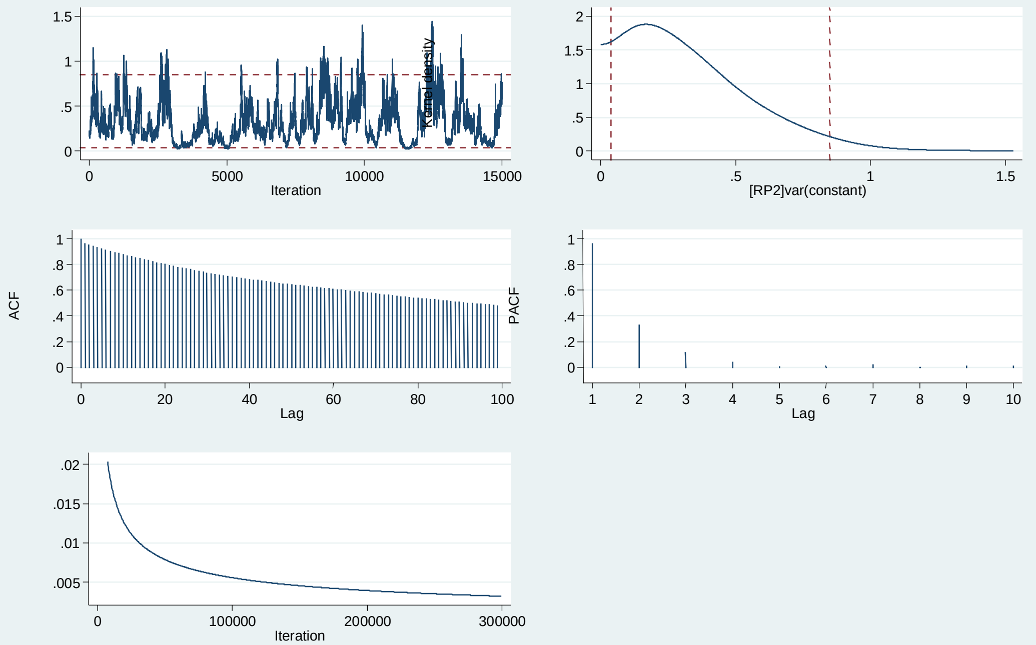
$$W_c = \left(w\frac{\partial H}{\partial Q}\right) + \left(P_M \frac{\partial M^*}{\partial Q}\right) - \left(\frac{\partial U/\partial H}{\lambda}\frac{\partial H}{\partial Q}\right)$$

Appendix F: Details of MCMC method

When the burning-in and monitoring periods are increased in the MCMC method, the between-community variance remains significant. In the first row of the right panel in Figure 1, the smoothed histogram shows the posterior distribution of the between-community variance to be positively skewed. The second row of the left panel shows the auto-correlation function (ACF) plot between the t and t-k iterations and the right panel shows partial auto-correlation function (PACF). The less correlation in the chain the better it is. The first order auto-correlation is about 0.9. Here the chain looks highly correlated and we may need to run the chain for longer. The single graph in the third row presents Monte Carlo standard error (MCSE), an indication of how much error is in the mean estimate due to the MCMC estimation method. As the number of iterations increases, the MCSE tends to 0.

The effective sample size (ESS) reported in the MCMC output represents an estimate of the equivalent number of independent iterations that the Markov chain represents. The ESS is usually less than the actual number of iterations because the chains are positively auto-correlated. For example, Table F1 has an ESS=397, meaning that the sample of 5000 values is equivalent to only 397 independent iterations. If the ESS for between-communities variance (σ_u^2) is 704, then its parameters are less auto-correlated than the intercept's parameter chain. The period when the chains are settling down is normally called the burn-in period and these iterations are omitted from the sample from which summaries are constructed.

Graph 1: Five-way diagnostic of between-community variance



Burn-n =1000, monitoring period= 15000 [Model 1]

Table F1. Two-level Variance Component Model using MCMC Method

Dependent Var: NAR Sickness	Mean	Std. Dev.	ESS	P	[95% Conf. Interval]	
constant	-1.333	0.098	397.000	0.000	-1.543	-1.150
Odds(β0)	0.264					
P(β0)	0.209					

Random-effects Parameters	Mean	Std. Dev.	ESS	[95% Conf. Interval]	
Level 2: communityid					
var(constant)	0.257	0.152	29.000	0.061	0.608

odds= exp(β0); P= exp(β0)/1+exp(β0)
ICC and Variance Partition Coefficient (VPC)= σ^2/(σ^2+π^2/3); , burn-in period = 1000, monitoring period = 50,000 iterations and thinnings = 10

Appendix G: Procedure of merging household survey data with geocoded data in preparation for chapter 3's data

Location: E:\Dissertation\Stata_files\Ch2_merging

1. File 'community_nonUnique_allMun.csv' includes non-unique community id for all the observations from all five municipalities. N= 1136; unique community, n= 251; includes longitude and latitude for all the observations. Do file: nonunique_communityID.do
2. File 'SWM_dataOriginal_wide.csv' is the original SWM data in wide version. N=4540 i.e 1135 observations*4 choice sets per individual.
3. Merge two files in step 1 and 2. Do file: swm_nonUniqueCommunityID_Merge.do
   Matched observations: 4540 i.e. 1135 observations* 4 observatons per individual. This merging includes all the sample in original SWM data.
4. File 'SWM_dataOriginal_wide_nonUniqueCommunityMerge.dta' is saved step 3 in do file. N= 4540, SWM data + community id + latitude and onlgitude data.
5. Now, mean value of the health and demographic variables is calculated using 'collapse' command. Do file: HealthDemographic_swm.do.
6. After Collapse, Unique community, n= 205 range of community id = 111 to 5145.

Creating Health and Demographic Variables

7. Count number of households in each communityid, for unique community.
   - sort communityid hh_no
   - egen tag= tag(hh_no communityid)
   - count if tag
   - egen no_of_hh= sum(tag), by(communityid)

   /*Number of Household in each community; each household has four observation but counted as 1 household*/
8. Number of Household Members in each community
   - sort communityid
   - egen hhmember = mean(Familysize), by(qsn_no)
   - gen hhmember2= hhmember*tag1
   - egen no_of_hhmember= sum(hhmember2), by(communityid
9. Number of People who had nausea or respiratory disease during last 30 days in each househols
   - gen nausea_RespDisease= 1 if (q405nausea==1| q406respiration==1) /*either one*/
   - replace nausea_RespDisease= 0 if (q405nausea==2 & q406respiration==2)

- gen noof_nauseaA= nausea_adult if (nausea_RespDisease==1 & nausea_adult!="NA")
- destring noof_nauseaA, gen(noof_nauseaAdult)
- replace noof_nauseaAdult= 0 if noof_nauseaAdult==.

- gen noof_nauseaC= nausea_child if (nausea_RespDisease==1 & nausea_child !="NA")
- destring noof_nauseaC, gen(noof_nauseaChild)
- replace noof_nauseaChild= 0 if noof_nauseaChild==.

- gen noof_respirationA= respiration_adult if (nausea_RespDisease==1 & respiration_adult !="NA")
- destring noof_respirationA, gen(noof_respirationAdult)
- replace noof_respirationAdult=0 if noof_respirationAdult==.

- gen noof_respirationC= respiration_child if (nausea_RespDisease==1 & respiration_child !="NA")
- destring noof_respirationC, gen(noof_respirationChild)
- replace noof_respirationChild=0 if noof_respirationChild==.

- gen noOf_nausea_RespDisease=(noof_nauseaAdult + noof_nauseaChild + noof_respirationAdult + noof_respirationChild)

10. Number of People who had nausea or respiratory disease during last 30 days, aggregated at community level, in each community
    - sort communityid
    - egen noOf_nausea_RespDisease1 = mean(noOf_nausea_RespDisease), by(qsn_no)
    - gen noOf_nausea_RespDisease2= noOf_nausea_RespDisease1*tag1
    - egen no_of_nausea_RespDisease= sum(noOf_nausea_RespDisease2), by(communityid)
11. Get the required variables, aggregated at community level, with unique community id
    - collapse center1 ward_no q59income q48age female q52edu no_of_nausea_RespDisease no_of_hh no_of_hhmember, by(communityid)
12. Merging Health and Demographic Variables with Georeferenced location data and Buffer distance variables data (with community as the centroid).

a) Save all the variables in step 7 to 11 is saved. File name: HealthDemographic_SWM Do file: HealthDemographic_swm.do
b) Save distance variable data and collapse it by communityid and save it as dta file, as given below
   - cap log close
   - insheet using "E:\Dissertation\Stata_files\Ch2_merging\Community_half_km_busparks_intersections_original.csv", clear
   - rename center center1
   - rename psu_code psu
   - collapse qsn_no center1 psu ward_no longitude1 latitude1 buff_dist bld_halfkm frm_halfkm opn_halfkm rd_halfkm, by(communityid)
   - sort communityid
   - save Community_half_km_busparks_intersections_original1, replace
c) Then, merge the file in step 12(b) with file from step 12 (a). Collapse the required variables by communityid again and save the file.
   - merge 1:m communityid using HealthDemographic_SWM
   - drop _merge
   - collapse center1 ward_no longitude1 latitude1 buff_dist bld_halfkm frm_halfkm opn_halfkm rd_halfkm no_of_hh no_of_hhmember no_of_nausea_RespDisease q59income q48age female q52edu, by(communityid)

   - save SWM_nonUniqueCommunity_busstopIntMerge, replace

13. Final Merged file is copied from Data editor and pasted in excel file and saved as : Demographic_pollutionSWMMerge.xls

<u>List of Do files and its purpose and its order</u>

1. Data File: community_nonUnique_allMun.csv;
   Do file: nonunique_communityID.do
   Purpose: Read csv file and save as dta file ; the File has GPS locations for all five municipalities.
   Saved file: community_nonUnique_allMun1

2. Data File: SWM_dataOriginal_wide.csv;
   Do file: swm_nonUniqueCommunityID_Merge.do
   Purpose: Read SWM data file in wide format and save as dta file;

Then, SWM data is merged with community data in step 1(community_nonUnique_allMun1.dta) so that SWM data can have community id.

Merged File: SWM_nonUniqueCommunityMerge.dta

3. Data File: SWM_nonUniqueCommunityMerge.dta;
   Do file: HealthDemographic_swm.do
   Purpose: create some health and demographic variables, collapse them by community id; and saved the file
   Saved file: HealthDemographic_SWM.dta

4. Data File: Community_half_km_busparks_intersections_original.csv; (File sent by Keshav sir with variables in half km buffer)
   Do file: swm_commID_busstopIntersection_3merged.do
   Purpose: read the file sent by Keshav sir and save as dta file (Community_half_km_busparks_intersections_original1.dta); merge 1:m by communityid with file in step 3 (ealthDemographic_SWM), and save the file.
   Saved file: SWM_nonUniqueCommunity_busstopIntMerge.dta
5. From step 5, go to data editor and copy and paste the collapse data, aggregated at community level and paste it in excel file.
   File name:
   E:\Dissertation\Stata_files\Ch2_merging\MergedFiles\Demographic_pollutionSWMMerge.xls
   Household Level
   1. Data File: SWM_nonUniqueCommunityMerge
      Do file: HealthDemo_HHlevel.do
      This file is same as HealthDemographic_swm.do but it gives data at the household level.
      Saved file: HealthDemographic_SWMHHlevel.dta
   2. Data File: SWM_nonUniqueCommunityMerge
      Do file: swm_commID_busstopIntersection_3mergeHHlevel.do
      Merge the file with HealthDemographic_SWMHHlevel.dta by qsn_no
      Saved file: SWM_nonUniqueCommunity_busstopIntMergeHHlevel.dta

Appendix H: Stata Codes

Stata Code for Chapter 2

```
/*No missing variables*/

/*Outliers in income is not deleted*/

cap log close

set memory 8m

use "F:\Dissertation\ch1_CE\CEdata_results\swm_dataoriginal_long_recoded.dta",
replace

gen monthlyFee1= monthlyFee/100

/*Attribute Categories*/

*Dummy for Collection types*

gen scheduled=1 if collectiontype==2

replace scheduled=0 if (collectiontype==1|collectiontype==0)

gen unscheduled=1 if collectiontype==1

replace unscheduled=0 if (collectiontype==2|collectiontype==0)

gen collNone=1 if collectiontype==0

replace collNone=0 if collectiontype!=0

*Dummy for segregate types*

gen segregateZero=1 if segregate==0

replace segregateZero=0 if (segregate==2|segregate==3)

gen segregate2=1 if segregate==2

replace segregate2=0 if (segregate==0|segregate==3)

gen segregate3=1 if segregate==3

replace segregate3=0 if (segregate==0|segregate==2)

gen aboveSLC=1 if (q52edu==10|q52edu==11|q52edu==12|q52edu==13|q52edu==14)

replace aboveSLC=0 if (q52edu<=9|q52edu==15|q52edu==16|q52edu==17)


*drop if q59income>=1500000

replace q59income=q58totalexp if (q59income==11|q59income==12) /*imputed missing
income variable with total expenditure*/

*drop if (q59income==11|q59income==12)

gen freq_sq=freq*freq

gen freq_cube=freq*freq*freq
```

gen lnmonthlyFee= log(monthlyFee+1.9)

gen distance_sq= q12distance*q12distance

gen distanceSq_freq= freq*distance_sq

gen income_s= q59income/1000

gen comm_inc= communityorg*income_s

gen seg2_inc = segregate2*income_s

gen freq_income=freq*q59income

gen distance_sch= q12distance*scheduled

gen distance_freq= q12distance*freq

gen dist_sch_freq = q12distance*scheduled*freq

gen comm_age = communityorg*q48age

gen comm_aboveSLC= communityorg*aboveSLC

gen scheduled_age = scheduled*q48age

gen SQfee0= 1 if q20monthlyfee==0

replace SQfee0= 0 if q20monthlyfee>0

gen fee_SQfee0 = monthlyFee1*SQfee0

gen fee_inc = monthlyFee1*q59income

gen female=1 if sex==2

replace female=0 if sex==1

gen female_freq= freq*female

gen medinc=1 if q59income==25000

replace medinc=0 if (q59income<25000|q59income>25000)

gen inc_fee= (monthlyFee)*medinc

Table 2.1

tab center

Table 2.2.3

tab q22abcd_choice1

Table 2.3.1

sum SQfee0 aboveSLC own_house occupBusiness female q12distance distance_sq q48age q59income monthlyFee

sum SQfee0 aboveSLC own_house occupBusiness female q12distance distance_sq q48age q59income monthlyFee if (center==1|center==2|center==3)

sum SQfee0 aboveSLC own_house occupBusiness female q12distance distance_sq q48age q59income monthlyFee if (center==4|center==5)

Table 2.3.2

sum SQfee0 aboveSLC own_house occupBusiness female q12distance distance_sq q48age q59income monthlyFee if q22abcd_choice1==3

sum SQfee0 aboveSLC own_house occupBusiness female q12distance distance_sq q48age q59income monthlyFee if (q22abcd_choice1==1|q22abcd_choice1==2)

Table 2.4

Sum segregateZero segregate2 segregate3 collNone scheduled unscheduled communityorg freq monthlyFee1 if q22abcd_choice1==3

Sum segregateZero segregate2 segregate3 collNone scheduled unscheduled communityorg freq monthlyFee1 if (q22abcd_choice1==3) & (center==1|center==2|center==3)

Sum segregateZero segregate2 segregate3 collNone scheduled unscheduled communityorg freq monthlyFee1 if (q22abcd_choice1==3) & (center==4|center==5)

Table 2.5

/*Base Conditional Logit Models*/

matrix start = 1, .2, .5, .7, .3, .4, .9

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, group(gid) vce(robust) from(start, copy) iterate(500000)

estimates store c_base_pool

keep if center==1|center==2|center==3

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, group(gid) vce(robust)

estimates store c_base_g1

keep if center==4|center==5

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, group(gid) vce(robust)

estimates store c_base_g2

esttab c_base_pool c_base_g1 c_base_g2 using base_clogit.csv, title("Table Mixlogit1NoASC: Conditional logit model ") wide mtitles ("model1") nogap star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC")replace

Table 2.6

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq comm_age distance_freq distanceSq_freq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, group(gid) vce(robust) iterate(500000)

estimates store cI_base_pool

keep if center==1|center==2|center==3

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq comm_age distance_freq distanceSq_freq distance_sch dist_sch_freq comm_aboveSLC scheduled_age,group(gid) vce(robust) iterate(500000)

keep if center==4|center==5

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq comm_age distance_freq distanceSq_freq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, group(gid) vce(robust) iterate(500000)

estimates store cI_g2_pool

Table 2.7

clogit choice monthlyFee1 communityorg scheduled segregate2 segregate3 freq freq_sq freq_cube, group(gid)

estimates store full

keep if (abcd_choice==2| abcd_choice==3)

clogit choice monthlyFee1 communityorg scheduled segregate2 segregate3 freq freq_sq freq_cube, group(gid)

estimates store restricted

hausman restricted full, alleqs constant

keep if (abcd_choice==1| abcd_choice==3)

clogit choice monthlyFee1 communityorg scheduled segregate2 segregate3 freq freq_sq freq_cube, group(gid)

estimates store restricted

hausman restricted full, alleqs constant

*H0: IIA assumption is valid; H1: IIA assumption is not valid and violated; If Chi square_conputed>= Chi square tabulated; Reject H0

Table 2.8

matrix start = (-.5899164, 2.346256, 2.429855, 1.476816, .2418837, -.4079825, .4662113, 3.101781, 2.000977, .9890733, 2.071365, 2.50393, .5442973)

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from (start, copy) trace

estimates store m_base_pool50000

keep if center==1| center==2|center==3
matrix start = (-.5832859, 2.360743, 1.726669, .672987, .1557661, -.4652428, .4828804, 3.205795, 2.268252, -.3837343, 2.078293, 2.413333, .5519725) /*Starting value of 5000 draw*/

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(35000) iterate(100) from(start, copy) trace estimates store m_base_g135000

keep if center==4|center==5

matrix start = (-.6192657, 2.266216, 2.936806, 2.308163, .666407, -.1918886, .434606, 2.676952, 1.875605, -.1489147, 2.017456, 2.642247, .53484) /*starting value of 12000 draw*/

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from(start, copy) trace

estimates store m_base_g250000

Table 2.9

mixlogit choice monthlyFee1 comm_age freq_distance freq_distancesq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from (start, copy) trace

matrix start = (-.5988137, -.0346174, .0765515, -.0032316, .4214627, -.0573903, .3516893, -.0209854, 3.3339, 2.804249, 1.300253, .2608698, -.369078, .4313529, 3.051335, 1.910029, .9989418, 2.087924, 2.529911, .5500834)

mixlogit choice monthlyFee1 comm_age freq_distance freq_distancesq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from (start, copy) trace

estimates store m_INT_pool50000

keep if center==1| center==2|center==3

mixlogit choice monthlyFee1 comm_age freq_distance freq_distancesq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) trace

matrix start = (-.6022226, -.0350316, .0757581, -.0031911, .4230734, -.0587671, .354528, -.0195678, 3.335581, 2.637475, 1.174987, .2691447, -.3637326, .4371079, 3.043939, 2.111148, .4039266, 2.073485, 2.513312, .5478986)

mixlogit choice monthlyFee1 comm_age freq_distance freq_distancesq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from (start, copy) trace

estimates store m_INT_pool50000

keep if center==4|center==5

mixlogit choice monthlyFee1 comm_age freq_distance freq_distancesq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(1000) iterate(100) trace

matrix start = (-.6336831, -.0191701, .0873434, -.0052655, .3112009, -.0388559, -.2489978, .0179863, 2.951062, 1.860826, 2.03209, .6796758, -.1392379, .378263, 2.577976, 1.490006, -.7855801, 1.981071, 2.657816, .5184348)

mixlogit choice monthlyFee1 comm_age freq_distance freq_distancesq distance_sch dist_sch_freq comm_aboveSLC scheduled_age, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from (start, copy) trace

estimates store m_INT_pool50000

Table 2.10

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(1000) iterate(1000) trace

estimates store m_base_pool1000

keep if center==1|center==2|center==3

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(1000) iterate(100) trace

estimates store m_base_g1500_100ite

keep if center==4|center==5

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(1000) iterate(100) trace

estimates store m_base_g25000

Likelihood Ratio Test

lrtest (m_base_pool1000)(m_base_g1500_100ite m_base_g25000), stats

Tabl 2.10_B

mixlogit choice, rand(monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(1000) iterate(1000) trace

estimates store m_base_pool1000

keep if center==1|center==2|center==3

mixlogit choice, rand(monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(1000) iterate(100) trace

estimates store m_base_g1500_100ite

keep if center==4|center==5

mixlogit choice, rand(monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(1000) iterate(100) trace estimates store m_base_g25000

Likelihood Ratio Test

lrtest (m_base_pool1000)(m_base_g1500_100ite m_base_g25000), stats

Table 2.11

matrix start = 1, .2, .5, .7, .3, .4, .9

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, group(gid) vce(robust) from(start, copy) iterate(500000)

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq

estimates store c_base_pool

keep if center==1|center==2|center==3

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, group(gid) vce(robust)

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq

estimates store c_base_g1

keep if center==4|center==5

clogit choice monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, group(gid) vce(robust)

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq

estimates store c_base_g2

esttab c_base_pool c_base_g1 c_base_g2 using base_clogit.csv, title("Table Mixlogit1NoASC: Conditional logit model ") wide mtitles ("model1") nogap star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC")replace

Table 2.12

matrix start = (-.5899164, 2.346256, 2.429855, 1.476816, .2418837, -.4079825, .4662113, 3.101781, 2.000977, .9890733, 2.071365, 2.50393, .5442973)

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from (start, copy) trace

estimates store m_base_pool50000

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, krinsky reps(100000)

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, krinsky reps(100000) level(0)

keep if center==1|center==2|center==3

matrix start = (-.5832859, 2.360743, 1.726669, .672987, .1557661, -.4652428, .4828804, 3.205795, 2.268252, -.3837343, 2.078293, 2.413333, .5519725) /*Starting value of 5000 draw*/

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(35000) iterate(100) from(start, copy) trace

estimates store m_base_g135000

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, krinsky reps(100000)

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, krinsky reps(100000) level(0)

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq

keep if center==4|center==5

matrix start = (-.6192657, 2.266216, 2.936806, 2.308163, .666407, -.1918886, .434606, 2.676952, 1.875605, -.1489147, 2.017456, 2.642247, .53484) /*starting value of 12000 draw*/

mixlogit choice monthlyFee1, rand(communityorg scheduled unscheduled segregate2 segregate3 freq) group(gid) id(qsn_no) nrep(50000) iterate(100) from(start, copy) trace

estimates store m_base_g250000

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, krinsky reps(100000)

wtp monthlyFee1 communityorg scheduled unscheduled segregate2 segregate3 freq, krinsky reps(100000) level(0)

Table 2.13

mixlogit choice monthlyFee1, rand(communityorg scheduled segregate2 segregate3 freq freq_sq freq_cube) group(gid) id(qsn_no) nrep(1000) iterate(100) trace

estimates store m_basenonlfreq_pool1000

***Table 2.14.1, 2.14.2, 2.14.3 ***

mixlogit choice monthlyFee1, rand(communityorg freq1 freq2 freq3 freq4to6 freq7 freqMorethan7 segregate2 segregate3 scheduled) group(gid) id(qsn_no) nrep(150) iterate(150) from(start, copy) trace

estimates store m_base_g2150

matrix start= -1.591274, 1.511683, 2.000464, -1.65398, 2.417627, 1.078771, .6643359, -.2560536, .9547164, 2.480287, 1.530022, .026475, 1.3133, 1.559242, 1.505828, 1.446895, 1.781149, 1.747416

```
mixlogit choice, rand(monthlyFee1 freq1to2 freq3 freq4to6 freq7orMore communityorg
segregate2 segregate3 scheduled) group(gid) id(qsn_no) nrep(100) iterate(100)
from(start, copy) trace

estimates store m_base_g2_100
```

Stata Code for Chapter 3

```
clear all

cap log close

*Matrix is 205*205*

*Use merged data with spatial matrix*

use
"F:\Dissertation\Stata_files\Ch2_merging\GIS_CommunityData\merge_indivCommData
_invdisNeighMatrix", clear

/**/

destring q59income, gen(income)

drop if (q59income==11|q59income==12)

replace q59income=2500 if (q59income==1)

replace q59income=7500 if (q59income==2)

replace q59income=15000 if (q59income==3)


rename q50totalsize Familysize

drop if sex=="NA"

destring sex, gen(sex1)

gen female=1 if sex1==2

replace female=0 if sex1==1

*Edu*

replace q52edu=0 if q52edu==16

replace q52edu=2 if q52edu==17

drop if q52edu==15

/*Labor: 1 if works 0 otherwise from Occupation*/

drop if q53occup=="NA"

destring q53occup, gen(occupation)

gen labor=1 if (occupation<=7| occupation ==11)

replace labor=0 if (occupation>=8 & occupation <=10)
```

```
/*Index of exposure to Public Health related exposure*/

/* q26program_participate= ever participated in environment protection program such as
poster presentation, community meeting, byanner presentation, road rally, road drama,
sanitation program etc? */

drop if q26program_participate=="NA"

destring q26program_participate, gen(program_participate)

drop if program_participate==3

/*q27org_involvement = you or any of your family members actively involved in solid
waste management and environment protection related organizations?*/

/*q301env_org = 30    Does your community have Sanitation and environment related
community organizations? */

gen envAware=1 if (program_participate==1|q27org_involvement==1| q301env_org==1)

replace envAware=0 if (program_participate==2 & q27org_involvement==2 &
q301env_org==2)

************************************************************

gen nausea_RespDisease= 1 if (q405nausea==1| q406respiration==1)   /*either one*/

replace nausea_RespDisease= 0 if (q405nausea==2 & q406respiration==2)

************************************

/*Number of sick people in the household, with Nausea and respiratory disease*/

gen noof_nauseaA= nausea_adult if (nausea_RespDisease==1 & nausea_adult!="NA")

destring noof_nauseaA, gen(noof_nauseaAdult)

replace noof_nauseaAdult= 0 if noof_nauseaAdult==.


gen noof_nauseaC= nausea_child if (nausea_RespDisease==1 & nausea_child !="NA")

destring noof_nauseaC, gen(noof_nauseaChild)

replace noof_nauseaChild= 0 if noof_nauseaChild==.

gen noof_respirationA= respiration_adult if (nausea_RespDisease==1 &
respiration_adult !="NA")

destring noof_respirationA, gen(noof_respirationAdult)

replace noof_respirationAdult=0 if noof_respirationAdult==.


gen noof_respirationC= respiration_child if (nausea_RespDisease==1 &
respiration_child !="NA")

destring noof_respirationC, gen(noof_respirationChild)
```

```
replace noof_respirationChild=0 if noof_respirationChild==.

gen noOf_nausea_RespDisease=(noof_nauseaAdult + noof_nauseaChild +
noof_respirationAdult + noof_respirationChild)


gen lnincome= log(q59income)

rename pop150m pop_150m

/*Distance variables*/

gen dist_road_km= dist_road/1000

gen dist_river_km= dist_river/1000

gen dist_busStation_int_km = dis_bus_in/1000

gen dist_waste_km = dist_waste/1000 /*istance in km now: converted m to km*/

gen dist_forest_km= dist_fores/1000 /*distance in km now: converted m to km*/

gen dist_open_km= dist_open/1000

gen dist_farm_km= dist_farm/1000

gen dist_brick_km= dist_brick/1000

gen dist2_road_km= dist_road_km^2

gen dist2_river_km= dist_river_km^2

gen dist2_busStation_int_km = dist_busStation_int_km^2

gen dist2_waste_km = dist_waste_km^2

gen dist2_forest_km= dist_forest_km^2

gen dist2_open_km= dist_open_km^2

gen dist2_farm_km= dist_farm_km^2

gen dist2_brick_km= dist_brick_km^2

/*Base occupation: Daily labor in comparison to 1) house-wife and 2) Other*/

gen dailylabor=1 if occupation==7

replace dailylabor=0 if occupation!=7

gen housewife=1 if occupation==9

replace housewife=0 if occupation!=9

gen other_emp=1 if (occupation==1
|occupation==2|occupation==3|occupation==4|occupation==5|occupation==6|occupation
==8|occupation==10|occupation==11)

replace other_emp=0 if (occupation==7|occupation==9)

**

gen age_sq= q48age^2
```

```
gen cons=1
gen denomb=1
/*gen weight1= 10/205
gen weight2= 10/205
gen weight3= 10/205
gen weight4= 10/205
gen weight5= 10/205
gen weight6= 10/205
gen weight7= 10/205
gen weight8= 10/205
gen weight9= 10/205
gen weight10= 10/205 */
save "F:\Dissertation\Stata_files\Ch2_merging\GIS_CommunityData\multilevelest_use_uniqueComm_matrixIndivComm1", replace
gen constant=1
/*Using MLwin*/
global MLwiN_path "C:\Program Files (x86)\MLwiN v2.30\i386\mlwin.exe" /* path for Mlwin in STATA: Multilevel modeling*/
sort communityid qsn_no /*qsn_no represents household*/
*AA1.
replace q401diarrohea=0 if q401diarrohea==2
destring q402jundice, gen(q402jundice1) force
replace q402jundice1=0 if (q402jundice1==2|q402jundice1==3)
destring q403typhoid, gen(q403typhoid1) force
replace q403typhoid1=0 if (q403typhoid1==2 |q403typhoid1==.)
destring q404allergy, gen(q404allergy1) force
replace q404allergy1=0 if (q404allergy1==2|q404allergy1==.)
replace q405nausea=0 if q405nausea==2
replace q406respiration=0 if q406respiration==2
gen Dtotal= q401diarrohea+ q402jundice1 + q403typhoid1 + q404allergy1 + q405nausea + q406respiration /*Sum of occurences of all disease */
gen Dtotal_NAR = (q404allergy1 + q405nausea + q406respiration) /*NAS= Nausea, Allergy, Respiratory*/
```

```
gen Nausea_Alleg_RespProp = Dtotal_NAR/Dtotal

replace q41scholl_leave=0 if q41scholl_leave==99

destring q41job_leave, gen(q41job_leave1) force

replace q41job_leave1=0 if (q41job_leave1==99|q41job_leave1==.)

destring q41simplework_leave, gen(q41simplework_leave1) force

replace q41simplework_leave1=0 if (q41simplework_leave1==99 |
q41simplework_leave1==.)

gen TotalDaysMissed= (q41scholl_leave + q41job_leave1 + q41simplework_leave1)

gen NAR_days= Nausea_Alleg_RespProp*TotalDaysMissed

destring q42bmedical_expenses, gen(q42bmedical_expenses1) force

replace q42bmedical_expenses1=0 if  q42bmedical_expenses1==.

gen NAR_medCost = Nausea_Alleg_RespProp*q42bmedical_expenses1

** New dependent Variable

gen nausea_RespAllegDisease= 1 if (q405nausea==1|
q406respiration==1|q404allergy1==1)   /*either one*/

replace nausea_RespAllegDisease= 0 if (q405nausea==0 & q406respiration==0 &
q404allergy1==0)
```

Table 3.1

```
*Descriptive Statistics*

sum nausea_RespDisease dist_road_km dist2_road_km  dist_waste_km dist2_waste_km
dist_forest_km dist2_forest_km dist_river_km dist2_river_km q48age
c.q48age#c.q48age q52edu female dailylabor housewife other_emp q59income
```

Table 3.2 and Table 3.3

```
/*Table 2: Logit Model for Different Distance Variables*/

logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km
dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km
c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km
q48age c.q48age#c.q48age q52edu female housewife other_emp

estimates store Statalogit_fullM1

margins, dydx(*) post

outreg2 using mfx_tabl2.doc

logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km
dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km
c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km
dist_brick_km c.dist_brick_km#c.dist_brick_km q48age c.q48age#c.q48age q52edu
female housewife other_emp

estimates store Statalogit_fullM2
```

```
margins, dydx(*) post

outreg2 using mfx_tabl2.doc

logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km dist_brick_km c.dist_brick_km#c.dist_brick_km dist_open_km c.dist_open_km#c.dist_open_km q48age c.q48age#c.q48age q52edu female housewife other_emp

estimates store Statalogit_fullM3

margins, dydx(*) post

outreg2 using mfx_tabl2.doc


logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km dist_brick_km c.dist_brick_km#c.dist_brick_km dist_open_km c.dist_open_km#c.dist_open_km dist_farm_km c.dist_farm_km#c.dist_farm_km q48age c.q48age#c.q48age q52edu female housewife other_emp

estimates store Statalogit_fullM4

margins, dydx(*) post

outreg2 using mfx_tabl2.doc


logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km dist_brick_km c.dist_brick_km#c.dist_brick_km dist_open_km c.dist_open_km#c.dist_open_km dist_farm_km c.dist_farm_km#c.dist_farm_km dist_busStation_int_km c.dist_busStation_int_km#c.dist_busStation_int_km q48age c.q48age#c.q48age q52edu female housewife other_emp

estimates store Statalogit_fullM5

margins, dydx(*) post

outreg2 using mfx_tabl2.doc

esttab Statalogit_fullM1 Statalogit_fullM2 Statalogit_fullM3 Statalogit_fullM4 Statalogit_fullM5 using Tabl2.csv, title("Table 2: Logit Model for Different Distance Variables") wide mtitles ("model1") nogap  star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC" "rho RHO" "sigma_u sigma_u")replace
```

Table 3.4

*/*Logit model 1 to 3*/*

```
logit nausea_RespAllegDisease
```

estimates store logit_fullM1

margins, dydx(*) post

outreg2 using mfx_tabl2_revised.doc

logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km

estimates store logit_fullM2

margins, dydx(*) post

outreg2 using mfx_tabl2_revised.doc

logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km dist_brick_km c.dist_brick_km#c.dist_brick_km q48age c.q48age#c.q48age q52edu female housewife other_emp

estimates store logit_fullM4

margins, dydx(*) post

outreg2 using mfx_tabl2_revised.doc

esttab logit_fullM1 logit_fullM2 logit_fullM4 using Tabl2_revised.csv, title("Table 2_revised: Logit Model for Different Distance Variables") wide mtitles ("model1") nogap star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC" "rho RHO" "sigma_u sigma_u")replace

Multilevel modeling: Two level random intercept model 1 to 3

Model 1- Constant Only Model

**get initial values for MCMC from PQL2-Quasi-likelihood method*

runmlwin nausea_RespAllegDisease constant, level2(communityid: constant) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(constant) pql2) nopause

MCMC method

runmlwin nausea_RespAllegDisease constant, level2(communityid: constant) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(constant)) mcmc(burnin(1000) chain(50000) thin(10)) initsprevious nopause nogroup

estimates store TableM1B

display exp([FP1]cons)

display exp([FP1]cons)/(1 + exp([FP1]cons)) /*Probability*/

display [RP2]var(constant)/([RP2]var(constant) + (_pi^2)/3) /*Variance Partition Coefficient*/

** Model 2: Constant + Distance Variable Model**

get initial values for MCMC from PQL2

runmlwin nausea_RespAllegDisease constant dist_road_km dist2_road_km dist_waste_km dist2_waste_km dist_forest_km dist2_forest_km dist_river_km dist2_river_km, level2(communityid: constant) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(constant) pql2)nopause

MCMC method

runmlwin nausea_RespAllegDisease constant dist_road_km dist2_road_km dist_waste_km dist2_waste_km dist_forest_km dist2_forest_km dist_river_km dist2_river_km, level2(communityid: constant) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(constant)) mcmc(burnin(1000) chain(50000) thin(10)) initsprevious nopause nogroup

estimates store TableM2B

Model 3: Constant + Distance var that include distance to brick factory + Control var Model

**get initial values for MCMC from PQL2*

runmlwin nausea_RespAllegDisease constant dist_road_km dist2_road_km dist_waste_km dist2_waste_km dist_forest_km dist2_forest_km dist_river_km dist2_river_km dist_brick_km dist2_brick_km q48age c.q48age#c.q48age q52edu female housewife other_emp, level2(communityid: constant) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(constant) pql2) nopause

MCMC

runmlwin nausea_RespAllegDisease constant dist_road_km dist2_road_km dist_waste_km dist2_waste_km dist_forest_km dist2_forest_km dist_river_km dist2_river_km dist_brick_km dist2_brick_km q48age c.q48age#c.q48age q52edu female housewife other_emp, level2(communityid: constant) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(constant)) mcmc(burnin(1000) chain(50000) thin(10)) initsprevious nopause nogroup

estimates store TableM3B2

esttab TableM1B TableM2B TableM3B2 using TablM1B.csv, title("Table logit: Fixed and Random- Effect Multileve mixed-effect model ") wide mtitles ("model1") nogap star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC" "rho RHO" "sigma_u sigma_u")replace

*** Table 3.5***

*10 nearest neighbors model

gen weigh10_1 = 10/205 // rows standardized

gen weigh10_2 = 10/205

gen weigh10_3 = 10/205

gen weigh10_4 = 10/205

gen weigh10_5 = 10/205

gen weigh10_6 = 10/205

gen weigh10_7 = 10/205

gen weigh10_8 = 10/205

gen weigh10_9 = 10/205

gen weigh10_10 = 10/205

*Spatial Multi level model where upper level community has spatial neighborhood list created according to the inverse of the distance

* starting values

sort neigh1 communityid qsn_no // First sort the data according to the level where the r.e. are present i.e., :cons)

quietly runmlwin nausea_RespAllegDisease cons dist_road_km dist2_road_km dist_waste_km dist2_waste_km dist_forest_km dist2_forest_km dist_river_km dist2_river_km q48age age_sq q52edu female housewife other_emp, level3(neigh1: cons) level2(communityid: cons) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(cons) pql2) nopause

*MCMC spatial error multiple membership model

runmlwin nausea_RespAllegDisease cons dist_road_km dist2_road_km dist_waste_km dist2_waste_km dist_forest_km dist2_forest_km dist_river_km dist2_river_km q48age age_sq q52edu female housewife other_emp, level3(neigh1: cons, mmids(neigh1-neigh10) mmweights(weigh10_1-weigh10_10)) level2(communityid: cons) level1(qsn_no:) discrete(distribution(binomial) link(logit) denominator(cons)) mcmc(burnin(1000) chain (50000) refresh(500) thin(10)) initsprevious nopause nogroup

estimates store R1B

Table F1: Five-way MCMC graphical diagnostic of coefficient of all the estimated variables

mcmcsum [RP2]var(cons), fiveway

mcmcsum, densities

mcmcsum [FP2]var(dist_road_km), fiveway

esttab R1B using TablM4.csv, title("Table logit: Fixed and Random- Effect Multileve mixed-effect model ") wide mtitles ("model1") nogap star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC" "rho RHO" "sigma_u sigma_u")replace

*** Table 3.6***

logit nausea_RespAllegDisease dist_road_km c.dist_road_km#c.dist_road_km dist_waste_km c.dist_waste_km#c.dist_waste_km dist_forest_km c.dist_forest_km#c.dist_forest_km dist_river_km c.dist_river_km#c.dist_river_km q48age c.q48age#c.q48age q52edu female housewife other_emp

estimates store Statalogit_fullM1

margins, dydx(*) post

```
outreg2 using mfx_tabl2.doc
```

```
*Table 3.7*
sum dist_road dist_waste NAR_days q59income NAR_medCost
```

```
* Stata Code for Chapter 4*
cap log close
use
"F:\Dissertation\Stata_files\Ch2_merging\IndivHHLevelData\3HHSWM_nonUniqueCo
mmunityMerge.dta", replace
destring q59income, gen(income)
drop if (q59income==11|q59income==12)
replace q59income=2500 if (q59income==1)
replace q59income=7500 if (q59income==2)
replace q59income=15000 if (q59income==3)
*drop if q50totalsize=="NA"
*encode q50totalsize, gen(Familysize)
rename q50totalsize Familysize
drop if sex=="NA"
destring sex, gen(sex1)
gen female=1 if sex1==2
replace female=0 if sex1==1
*Edu*
replace q52edu=0 if q52edu==16
replace q52edu=2 if q52edu==17
drop if q52edu==15
/*Labor: 1 if works 0 otherwise from Occupation*/
drop if q53occup=="NA"
destring q53occup, gen(occupation)
gen labor=1 if (occupation<=7| occupation ==11)
replace labor=0 if (occupation>=8 & occupation <=10)
```

```
/*Index of exposure to Public Health related exposure*/
```

```
/* q26program_participate= ever participated in environment protection program such as poster presentation, community meeting, byanner presentation, road rally, road drama, sanitation program etc? */

drop if q26program_participate=="NA"

destring q26program_participate, gen(program_participate)

drop if program_participate==3

/*q27org_involvement = you or any of your family members actively involved in solid waste management and environment protection related organizations?*/

/*q301env_org = 30    Does your community have Sanitation and environment related community organizations? */

gen envAware=1 if (program_participate==1|q27org_involvement==1| q301env_org==1)

replace envAware=0 if (program_participate==2 & q27org_involvement==2 & q301env_org==2)


************************************************************

/*Logit estimates*/

gen lnincome= log(q59income)

/*Base occupation: Daily labor in comparison to 1) house-wife and 2) Other*/

gen dailylabor=1 if occupation==7

replace dailylabor=0 if occupation!=7

gen housewife=1 if occupation==9

replace housewife=0 if occupation!=9

gen other_emp=1 if (occupation==1 |occupation==2|occupation==3|occupation==4|occupation==5|occupation==6|occupation==8|occupation==10|occupation==11)

replace other_emp=0 if (occupation==7|occupation==9)

gen age_sq= q48age^2

/*Garbage Collection and Recycling variables*/

gen Garbage_coll=1 if (q11collection_typerecoded==1|q11collection_typerecoded==2) /* Q11. 1= Household uses garbage collection service; 0= no garbage collection*/

replace Garbage_coll=0 if (q11collection_typerecoded==0)

gen recycle=1 if q18sellrecyclable==1 /*Q18. 1= household recycles, 0 = no recycling*/

replace recycle=0 if q18sellrecyclable==2

destring q87recyclesell, gen(q87recyclesell1) force

replace q87recyclesell1 =0 if q87recyclesell1==.

gen recycleQ8 =1 if q87recyclesell1==1
```

```
replace recycleQ8 =0 if q87recyclesell1==0
destring q89compost, gen(q89compost1) force
gen compostQ8 =1 if q89compost1==1
replace compostQ8 =0 if q89compost1==.

gen kitchenGarden= 1 if q47kitchen_garden==1
replace kitchenGarden= 0 if q47kitchen_garden==2
/*Institutional regulation Dummy*/
gen IR=1 if q31notice_board==1       /*Q31*/
replace IR=0 if (q31notice_board==2|q31notice_board==3)
gen participate_member=1 if (q27org_involvement==1|program_participate==1) /*Q26
and 27. actively Participate and member in env activities*/
replace participate_member=0 if (q27org_involvement==2 & program_participate==2)
gen social_cap=1 if q301env_org==1    /*Q30 part 1: have sanitation and env related
org*/
replace social_cap=0 if (q301env_org==2|q301env_org==3)

gen aboveSLC=1 if (q52edu==10|q52edu==11|q52edu==12|q52edu==13|q52edu==14)
/*Above tenth grade*/
replace aboveSLC=0 if (q52edu<=9|q52edu==15|q52edu==16|q52edu==17)

gen distance_sq= q12distance^2
gen lntotalexp = log(q58totalexp)
gen ln_totalwaste = log(q2totalwaste)
*gen percap_waste = q2totalwaste/Familysize
destring q4recyclablewaste, gen(q4recyclablewaste1) force
gen percap_recwaste = q4recyclablewaste1/Familysize
gen percap_totwaste = q2totalwaste/Familysize
gen ln_recwaste = log(q4recyclablewaste1)
destring q9ahouse_compounddumpplace, gen(space1) force
gen spaceTostore=1 if space1==1
replace spaceTostore=0 if space1==2
destring q331, gen(q331new) force
gen notlikeSeg=1 if (q331new==3|q331new==4|q331new==5|q331new==6)
```

```
replace notlikeSeg=0 if (q331new==1 |q331new==2| q331new==.)

gen female_aboveSLC =1 if (aboveSLC==1 & female==1)
replace female_aboveSLC =0 if (aboveSLC==0 | female==0)

gen monthlyfee1= q20monthlyfee/100
destring q55esidence, gen(residence) force
gen ownHouse=1 if residence==2
replace ownHouse=0 if residence==1|residence==.
gen income_sq= q59income^2
*Who manage household waste*
destring q46waste_collect, gen(q46waste_collect1) force
gen female_wasteResp=1 if q46waste_collect1==3
replace female_wasteResp=0 if (q46waste_collect1==.| q46waste_collect1==1|
q46waste_collect1==2|q46waste_collect1==4| q46waste_collect1==5)
*Caste Dummy*
gen Brahman=1 if (qbcaste==1 )
replace Brahman=0 if (qbcaste>=2 & qbcaste<=9)
gen Chhetri=1 if (qbcaste==2)
replace Chhetri=0 if (qbcaste==1 |qbcaste>=3 & qbcaste<=9)
gen BC=1 if (qbcaste==1|qbcaste==2)
replace BC=0 if (qbcaste>=3 & qbcaste<=8)
gen NW=1 if (qbcaste==3)
replace NW=0 if (qbcaste<=2 | qbcaste>=4 & qbcaste<=8)
gen JJ=1 if (qbcaste==4)
replace JJ=0 if (qbcaste<=3 | qbcaste>=5 & qbcaste<=8)
gen MD_DT_other=1 if (qbcaste>=5 & qbcaste<=8)
replace MD_DT_other=0 if (qbcaste<=4 )
*Awareness regarding recycling and composting*
destring q285recycling_method, gen(q285recycling_method1) force
gen recycling_inf=1 if q285recycling_method1==1
replace recycling_inf=0 if (q285recycling_method1==2 | q285recycling_method1==.)
gen income_1= q59income/10000
```

```
gen income_sq1= income_1^2
```

Table 4.1

```
sum recycle q2totalwaste IR q12distance q16frequency participate_member recycling_inf compost kitchenGarden notlikeSeg aboveSLC q20monthlyfee q48age q59income Familysize JJ BC NW MD_DT_other
```

Table 4.2

```
probit recycle ln_totalwaste IR q12distance q16frequency participate_member recycling_inf, vce(cluster communityid)

estimates store probM1

probit recycle ln_totalwaste IR q12distance q16frequency participate_member recycling_inf compostQ8 kitchenGarden notlikeSeg, vce(cluster communityid)

estimates store probM2

probit recycle ln_totalwaste IR q12distance q16frequency participate_member recycling_inf compostQ8 kitchenGarden notlikeSeg BC NW MD_DT_other aboveSLC monthlyfee1 income_1 c.income_1#c.income_1 q48age c.q48age#c.q48age, vce(cluster communityid)

estimates store probmFinal2

esttab probM1 probM2 probmFinal2 using model1to3_v2.csv, title("Table 2 Probit Model: Household's recycling Behavior ") wide mtitles ("model1") nogap star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC")replace
```

Table 4.3

```
probit recycle ln_totalwaste IR q12distance q16frequency participate_member recycling_inf, vce(cluster communityid)

estimates store probM1

margins, dydx(*) post

outreg2 using mFinal3.doc, ctitle(mfx) wide tstat

probit recycle ln_totalwaste IR q12distance q16frequency participate_member recycling_inf compostQ8 kitchenGarden notlikeSeg, vce(cluster communityid)

estimates store probM2

margins, dydx(*) post

outreg2 using mFinal3.doc, ctitle(mfx) wide tstat

probit recycle ln_totalwaste IR q12distance q16frequency participate_member recycling_inf compostQ8 kitchenGarden notlikeSeg BC NW MD_DT_other aboveSLC monthlyfee1 income_1 c.income_1#c.income_1 q48age c.q48age#c.q48age, vce(cluster communityid)

estimates store probmFinal2

margins, dydx(*) post
```

outreg2 using mFinal3.doc, ctitle(mfx) wide tstat

Table 4.4

ivprobit recycle IR q12distance q16frequency participate_member recycling_inf (ln_totalwaste= Familysize lnincome monthlyfee1), vce(cluster communityid) /*No Endogeneity */

estimates store ivprobM1

/*Recycling Provision + Social capital. Social capital: participate_member q14community_recoded*/

ivprobit recycle IR q12distance q16frequency participate_member recycling_inf kitchenGarden compostQ8 notlikeSeg (ln_totalwaste= Familysize lnincome monthlyfee1), vce(cluster communityid) /*No endogeneity*/

estimates store ivprobM2

/*Recycling Provision + Social capital + control variable*/

ivprobit recycle IR q12distance q16frequency participate_member recycling_inf kitchenGarden compostQ8 notlikeSeg aboveSLC monthlyfee1 q48age age_sq income_1 income_sq BC NW MD_DT_other (ln_totalwaste= Familysize lnincome monthlyfee1), vce(cluster communityid) /*No endogeneity*/

estimates store ivprobM3

esttab ivprobM1 ivprobM2 ivprobM3 using ivmodel1to3.csv, title("Table IV-Probit Model: Household's recycling Behavior with Total waste generation as the endogeneous variable ") wide mtitles ("model1") nogap star(* 0.1 ** 0.05 *** 0.01) scalars ("ll log_likelihood" "chi2 chi-squared" "aic AIC")replace

Appendix I: Survey Questionnaire in English

Qsn no. | | | | | **Version 2** **HH No. :** | | |

Knowledge, Attitude, behavior and Choice experiment survey on Solid waste Management in Kathmandu, Nepal.

Namaskar, I am …(Menuka Karki)… . , from the Nepal Study Center at the University of New Mexico, USA and Kathmandu University. We are conducting a survey with the residents of Kathmandu valley like you about your household solid waste management practice. In this survey, we ask your opinion about:

- the current waste collection and waste processing practices in your community;
- your opinion about the environmental issues and
- your perception of the health effect of existing solid waste management system

Your answer will be an important input for the policymakers in improving the existing solid waste management system. Participation is voluntary and if you do not want to take part in this research, you can quit this interview at any time you want. Your answers to these questions are completely confidential and your name will never be associated with your answers.

Thank you very much for your kind cooperation.

Center	Kathmandu	**1**	Lalitpur	**2**	Kirtipur	**3**	Bhaktpur	**4**	Thimi	**5**

I. Are you 18 years or older?? *(Ask if respondent looks very young)*

18 years or older	1 (start the survey)
Less than 18 years old	2 (ask for adult person in the house])

<u>Note to enumerators: Please write number in English</u>

PSU Code: HH No.:	Date of Interview: (day/month/year) eg. 14 July 2012
Respondent's Name:	Enumerator's name:
Phone Number:	Enumerator's code:
Address:	Signature:
Ward Number:	
Name of the place:	Supervisor's Name:
Community Name:	Supervisor's code:
Landmark:	Signature:
House number(very important):	

Interview start time:	Data entry operator's name:
Interview end time:	Signature:
Back Checked : 1 **Accompanied : 2** **Scrutinized : 3**	

Q A. Relationship of the respondent to the household head:

Household head / self+	1
Husband / wife	2
son / daughter	3
Grand Son / grand daughter	4
mother / father	5
brother / sister	6
Mother-in-law' / father-in-law	7
Brother-in-law' / sister-in-law	8
Son-in-law / daughter-in-law	9
Nephew / Niece	10
Other Relatives	11
Other	12

Q B. Caste

Brahman	1	Madheshi	5
Chhetri	2	Madheshi Dalit[64]	6
Newar	3	Pahadi Dalit[65]	7
Janajati[66]	4	Other, Please specify	8

Section 1: Solid waste management related existing behavior

1. In your opinion, how big of a problem, if at all, is the solid waste management system in your municipality?

Not a problem	Not a big problem	Somewhat problem	Big problem
1	2	3	4

[64] (10) Kuche, (11) Chyame, (12) Pode, (13) Chamar, (14) Dhobi, (15) Paswan (Dusadh), (16) Tatma, (17) Batar, (18) Khatbe, (19) Musahar, (20) Santhal, (21) Satar, and (22) Halkhor. Satar and Santhal is the same indigenous nationality but they are listed as *Dalit*s because they are treated as untouchables by some "high caste" people in some villages and towns in the eastern Terai region.

[65] (1) Lohar, (2) Sunar, (3) Kami, (4) Damai, (5) Kasai, (6) Sarki, (7) Badi, (8) Gaine, (9) Kusule,

[66] Magar,Tamang, Rai, Gurung, Limbu, Sherpa, Bhote, Walung, Buansi, Hyolmo, Gharti/Bhujel, Kumal, Sunuwar, Baramu, Pahari, Adivasi Janajati, Yakkha, Shantal, Jirel, Darai, Dura, Majhi, Dunuwar, Thami, Lepcha, Chepang, Bote, Raji, Hayu,Raute, Kasunda

Now, I would like to ask some question about your household waste management system.

Note to Enumerator: Solid waste is defined as unnecessary waste generated in each household such as kitchen waste, old newspapers, papers, empty glass, bottle, plastic, metal and empty cartoons. These waste can be categorized into three types: 1) biodegradable waste such as kitchen waste, 2) recyclable waste such as paper, glass, plastic, metal cans etc, and 3) other waste.

2. Usually, how much total waste do you produce from your household in a week?

   ……………………Kg

3. In your household, how much biodegradable waste do you generate in a week? …………………..Kg

4. In your household, how much recyclable waste do you generate in a week? …………………..Kg

5. Usually, how many household members stay home most of the time? …………………..member

6. Which of the following services are available in your community? Read aloud

Private door to door waste collection service	1
Municipality Door to door waste collection service	2
Municipality truck's waste collection service from center of the community	3
Roadside container	4
Designated waste collection point	5
Other, please specify	6
None	7

7. Do you have the following dumping site within walking distance from your household?

Door to door waste collection service's dumping site	1
River bank dumping site	2
Haphazard/illegal dumping site	3
Designated dumping site for municipality or private organization	4

8. How do you manage your household waste? Please specify mostly used methods. (Multiple answer, Read aloud)

Give to door to door waste collection service	1
Put in Municipality's truck	2
Put in roadside container	3
Dump in designated dumping site	4

Dump in haphazard/illegal dumping site	5
Dump in river bank	6
Sell the recyclable waste	7
Bury the biodegradable waste and produce fertilizer	8
Composting	9
Burn plastic, paper	10
Other method, please specify……………………………	11

9. A. Do you have space to store waste inside your house compound?

Yes	1	No	2

9. B. Does the waste collector collect waste that is stored inside your house compound?

Yes	1	No	2

10. Usually, where do you receive most important information about environmental sanitation?

School, campus, University	1
Radio	2
TV	3
Newspaper	4
Brochure, notice board	5
Family and friends	6
Municipality or ward office	7
Community and environmental organizations	8
Public awareness program	9
None	10
Other sources, please specify……………………….	11

Choice experiment

Note to enumerator: The following paragraph must be read to the respondents.

Now, I would like to talk about the improvement on solid waste management system in Kathmandu valley.

There are many recommendations to improve on existing solid waste management system in Kathmandu valley. Among these points, we have selected five important attributes. Those attributes are:

- Waste collection time
- Community Waste Management Committee
- Waste collection frequency in a week
- Waste segregation types
- Additional monthly user fee

In addition to your existing solid waste management system, two solid waste management service packet are created using the above five attributes. Among those service packets, you have to choose the one you like the most. Before that, I would like to briefly introduce you about each of these attributes.

1. Waste Collection time

While collecting waste from door to door, waste can be collected in two ways: 1) door to door waste collection, with schedule, and 2) Door to door waste collection, without schedule. With, unscheduled waste collection service, your household waste can be left uncollected because of time conflict or because of no information about waste pickup time. For schedules waste collection service, such difficulty does not occur.

11. What type of waste collection service is available in your community? Check all that apply.

Door to door waste collection service, without schedule	1
Door to door waste collection service, with schedule	2
Truck's collection service, without schedule	3
Truck's collection service, with schedule	4
Designated waste collection point, without schedule	5
Designated waste collection point, with schedule	6
None	7

12. How long does it take to walk from your house to waste disposable place?

………………………… minutes (please keep 0 for door to door waste collection service)

2. Community Waste Management Program

Your community members and waste collection service organization will create community waste management program. This program will conduct three important functions: 1) conduct public awareness program related to solid waste management system in community, 2) collect haphazardly disposed waste in community from time to time, and 3) monitor haphazardly waste disposal activities and take action to stop it. In this committee, community members will participate as volunteers and municipality will provide necessary assistance. To improve the existing solid waste management system, part of your monthly user fee will be spent for this program.

13. Had your community have a Community Waste Management Program, would you be willing to willing to volunteer for the program?

Yes	1	No	2

14. Does your community have a Community Waste Management Committee?

Yes	1	No	2

15. who collects your household waste?

Municipality	1
Private sector	2
None	3
Do not know	4

3. Waste collection frequency

Waste collection frequency per week is another important attribute.

16. In a week, how often does the waste collector collect your household waste?

………………….. times.

4. Waste segregation types

If you segregate your household waste before disposing it, it will reduce the pressure at landfill site. There are three ways to segregate your household waste: 1) No segregation, 2) two types of waste segregation: biodegradable and non-biodegradable, 3) three types of waste segregation: biodegradable, recyclable, and other.

17. How many types of waste do you segregate while disposing your household waste?

No segregation	1
2 types: Biodegradable and non-biodegradable waste	2
3 types: Biodegradable, recyclable and other	3

18. In past six months, did you sell recyclable household waste?

Yes	1	No	2

19. Usually, how often do you hear the recyclable waste scrap dealers hawking around your community?

Never heard	Once in a month	Once in a week	Once in a day	Many times in a day
1	2	3	4	5

5. Additional monthly user fee

You may need additional fund to improve the existing solid waste management system. Such fund can be generated from the monthly user fee from each household. Currently, you are paying waste management fee in either of two ways: 1) pay monthly user fee, or 2) pay tax to the municipality. To improve the existing solid waste management system, you may have to pay additional monthly user fee. The additional monthly user fee in your waste management service packet may need to be paid in real life. Therefore, please consider your income and expenditure while choosing your solid waste management service packet.

20. How much monthly fee do you pay for the waste collection service?
NRs..............................

21. How satisfied are you with the existing solid waste management service in your community?

Very dissatisfied	Somewhat dissatisfied	Neither satisfied, nor dissatisfied (Okey)	Somewhat satisfied	Very satisfied
1	2	3	4	5

<u>Which solid waste management service packet do you choose from the following?</u>

Note to enumerator: Please show the following tables to respondent while asking to choose solid waste management service packet.

Now, you will be given three solid waste management service packets including the existing one. Each of the service packets includes five attributes described earlier. The three solid waste management service packets are: solid waste management service packet A, B, and Status quo, C. Among these three service packets, please choose the service packet you like the most. If you are happy with the current waste management service, you can choose the last option C 'status quo'. If none of the option exactly matches your expectation, please choose the one that you dislike the least. While making your choice, please consider your current income and expenditure because the fee mentioned on your chosen packet may need to be paid in real life.

1	**Solid waste management service packet, A**	**Solid waste management service packet, B**	**Status Quo, C**
Waste collection time	Door to door waste collection service, without schedule	Door to door waste collection service, without schedule	Status quo
Community waste management program	Yes- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	No- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	Status quo
Waste collection frequency	Daily i.e. 7 times a week	Once a week	Status quo
Waste segregation types	No segregation	3 types: biodegradable, recyclable and other waste	Status quo
Additional monthly user fee	100 rupees per month	20 rupees per month	Status quo

22. A. which one of the services do you choose among given three service packets? (Single answer)

- Waste management service packet, A
- Waste management service packet, B
- Status Quo, C

22.1 Which attribute did you like in your recent choice of solid waste management service?

Waste collection time	1
Community waste management program	2
Waste collection frequency	3
Waste segregation types	4
Additional monthly user fee	5

23A. how certain are you with your recent choice?

Very uncertain	Somewhat uncertain	Neither certain nor uncertain (neutral)	Somewhat certain	Very certain
1	2	3	4	5

2	**Solid waste management service packet, A**	**Solid waste management service packet, B**	**Status Quo, C**
Waste collection time	Door to door waste collection service, with schedule	Door to door waste collection service, without schedule	Status quo
Community waste management program	No- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	Yes- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	Status quo
Waste collection frequency	3 times a week	Once a week	Status quo
Waste segregation types	2 types: biodegradable and non-biodegradable waste	3 types: biodegradable, recyclable and other waste	Status quo
Additional monthly user fee	20 rupees per month	50 rupees per month	Status quo

22 B. which one of the services do you choose among given three service packets? (Single answer)

- Waste management service packet, A
- Waste management service packet, B

- Status Quo, C

22.1 Which attribute did you like in your recent choice of solid waste management service packet?

Waste collection time	1
Community waste management program	2
Waste collection frequency	3
Waste segregation types	4
Additional monthly user fee	5

23B. how certain are you with your recent choice?

Very uncertain	Somewhat uncertain	Neither certain nor uncertain (neutral)	Somewhat certain	Very certain
1	2	3	4	5

3	**Solid waste management service packet, A**	**Solid waste management service packet, B**	**Status Quo, C**
Waste collection time	Door to door waste collection service, with schedule	Door to door waste collection service, without schedule	Status quo
Community waste management program	Yes- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	No- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	Status quo
Waste collection frequency	7 times a week	3 times a week	Status quo
Waste segregation types	2 types: biodegradable and non-biodegradable waste	No segregation	Status quo
Additional monthly user fee	10 rupees per month	40 rupees per month	Status quo

22 C. which one of the services do you choose among given three service packets? (Single answer)

- Waste management service packet, A
- Waste management service packet, B
- Status Quo, C

22.1 Which attribute did you like in your recent choice of solid waste management service packet?

Waste collection time	1
Community waste management program	2
Waste collection frequency	3
Waste segregation types	4
Additional monthly user fee	5

23C. how certain are you with your recent choice?

Very uncertain	Somewhat uncertain	Neither certain nor uncertain (neutral)	Somewhat certain	Very certain
1	2	3	4	5

4	**Solid waste management service packet, A**	**Solid waste management service packet, B**	**Status Quo, C**
Waste collection time	Door to door waste collection service, with schedule	Door to door waste collection service, without schedule	Status quo
Community waste management program	Yes- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	No- Public awareness program about waste management in community, waste collection, monitoring and taking action against haphazard waste disposal	Status quo
Waste collection frequency	Once a week	7 times a week	Status quo
Waste segregation types	2 types: biodegradable and non-biodegradable waste	3 types: biodegradable, recyclable and other waste	Status quo
Additional monthly user fee	50 rupees per month	10 rupees per month	Status quo

22 D. which one of the services do you choose among given three service packets? (Single answer)

- Waste management service packet, A
- Waste management service packet, B
- Status Quo, C

22.1 Which attribute did you like in your recent choice of solid waste management service packet?

Waste collection time	1
Community waste management program	2
Waste collection frequency	3
Waste segregation types	4
Additional monthly user fee	5

23D. how certain are you with your recent choice?

Very uncertain	Somewhat uncertain	Neither certain nor uncertain (neutral)	Somewhat certain	Very certain
1	2	3	4	5

23

24 On your choice, How important role did the following attributes play in choosing the service packets?

	Very less important	**Somewhat important**	**Okey**	**Very important**
How important was **Waste collection time** in your choice?	1	2	3	4
How important was **Community waste management program** in your choice?	1	2	3	4
How important was the **Waste collection frequenc**y in your choice?	1	2	3	4
How important was the **Waste segregation types** in your choice?	1	2	3	4
How important was the **Additional monthly user fee** in your choice?	1	2	3	4

25 (*Ask if they choose status quo, C*) why did you choose the status quo, C instead of other two choices?

Monthly user fee was too high	1
Do not believe on improved solid waste management service	2

Government's responsibility	3
Satisfied with status Quo	4
Other reason……………..	5

Environment related Knowledge and opinion

26 Have you ever participated in environment protection program such as poster presentation, community meeting, banner presentation, road rally, road drama, sanitation program etc?

Yes	1	No	2

27 Are you or any of your family members actively involved in solid waste management and environment protection related organizations?

Yes	1	No	2

28 Have you heard, read or seen public announcement about any of the following topic?

	Yes	No
Haphazard waste disposal is prohibited	1	2
Impact of haphazard waste disposal on public health and environment	1	2
Impact of plastic on public health and environment	1	2
Water treatment methods	1	2
Waste recycling, composting and its importance	1	2

29 Did you change your waste disposal method after you heard such public announcement?

Yes	1	No	2

30 Does your community have any of the following community organizations?

	Yes	No	Do not know
Sanitation and environment related	1	2	3
Sports, exercise and recreational clubs	1	2	3

31 Have you seen a notice board in your community that says “waste dumping is prohibited here, and if disobeyed, can be penalized certain charges”.

Yes	1	No	2

32 In your opinion, which of the following waste are recyclable wastes?

	Yes	No	Do not know
Newspaper	1	2	3
Plastic bottle	1	2	3
Food waste	1	2	3
Glass bottle	1	2	3

33 How do you agree with the following opinions? Please rank in the order of 1 to 5. 1 means “do not agree at all”, 5 mans “completely agree”, and 6 means “do not know”.

1.Waste segregation is very boring and irritable	1	2	3	4	5	6
2.Waste segregation take long time	1	2	3	4	5	6
3.I can benefit a lot by segregating my household waste	1	2	3	4	5	6
4. By disposing my household waste appropriately, I can help to keep my community clean.	1	2	3	4	5	6
5. My friend, family and neighbor think we should not dispose waste haphazardly.	1	2	3	4	5	6
6. I won’t stop disposing waste haphazardly until my neighbors do not stop it.	1	2	3	4	5	6
7. I am concerned about the disease spread by fly, insect, mouse and crows on waste dump	1	2	3	4	5	6
8. Waste segregation and recycling is my personal decision.	1	2	3	4	5	6
9. Municipality wants us not to dispose waste haphazardly.	1	2	3	4	5	6
10. It is my duty to keep my community clean.	1	2	3	4	5	6
11. If I was given a separate bin, I would segregate more waste.	1	2	3	4	5	6
12. If possible, I dispose my household waste properly.	1	2	3	4	5	6
13. I am concerned about the aesthetic impact of haphazard waste disposal in my community.	1	2	3	4	5	6

34 Do you know about municipality providing composting bin at subsidized rate to promote household composting?

Yes	1	No	2

35 Have you used any type of composting bin?

Yes	1 (go to Q 37)	No	2

36 If you are not using any type of composting bin, are you willing to buy a composting bin?

Yes	1 (go to Q 37)	No	2

37 Do you know that Ministry of Environment has operated community mobilization unit to promote environmental public awareness?

Yes	1	No	2

38 Have you ever watched Solid waste management related TV program "our Kathmandu"? or listened to solid waste management related program in Metro FM? (read aloud)

	Never watched/listened	Sometime watched/listened	Mostly watched/listened	Always watched/listened	Do not know about program
TV program "Hamro Kathmandu"	1	2	3	4	5
Metro FM's sanitation related program	1	2	3	4	5

39 Did you hear about and/or participated on special sanitation program?

	Heard	Participated
Yes	1	2
No	1	2

Your and your family's health

Now, I would like to ask you some health related questions. *(0 to 18 years is called child and above 18 years are called adult.)*

40 During the last 30 days, how many times did you and/or your family member get sick with the following disease?

	Got sick	Did not get sick	Number of Sick children	Number of sick adults
Diarrhea/ Dysentery	1	2		
Jundice	1	2		
Typhoid fever	1	2		
Dust allergy	1	2		
Nausea, itchy eyes, headache	1	2		
Respiratory infection	1	2		

41 A. Due to the above mentioned disease, how many days did you miss work or school in last 30 days?

	Days of school missed	Days of work missed	Days of personal work missed
Total days			
Not applicable	99	99	99

42 B. How much did you spend for the treatment of above mentioned disease?

……………….. Rupees.

42 What is the source of your drinking water?

Sources	
Municipality piped water	1
Purchased bottled water	2
Tanker or truck water	3
Well	4
Tube well	5
Spring water	6

Boring	7
Dug well	8

43 How do you like the color, smell and taste of your drinking water? (read aloud)

	Very bad	Bad	Okey	Good	Very good
Water taste	1	2	3	4	5
Water color	1	2	3	4	5
Water smell	1	2	3	4	5

44 How safe do you think is your drinking water?

Very dirty	Somewhat dirty	Okey	Clean	Very clean
1	2	3	4	5

45 Which of the following water treatment method do you use to treat your drinking water?

	Yes	No
Filter water	1	2
Boil water	1	2
use water purifying chemical	1	2
Use water purifying machine	1	2
Other…………	1	2
	1	2

Socio-economic and demographic information

46 In your household, which member of the household usually takes the responsibility of collecting, processing (if you do) and disposing the household waste?

Anyone in the household	1
Household head	2
Female other than household head	3

Male other than household head	4
Servant or maid	5

47 Do you have kitchen garden?

Yes	1	No	2

48 What is your completed age?........................years

49 What is your marital status?
Never married………1
Married……………...2
Divorced…………… 3
Separated……………4
Widow/widower…… 5
Live-in relationship……….6

50 Number of members in your household (currently living in the household)

Number of children	0-5 years	
	6-18 years	
Number of adults (Older than 18 years)		
Number of adult with earning		

51 Does your household own any of the following items? (index for wealth and income)

Item	**Yes**	**No**	**How many?**
Radio/Tape/CD player	1	2	
Bicycle	1	2	
Motorcycle/scooter	1	2	
Fans	1	2	
Television/deck	1	2	
Telephone set/cordless phone/mobile phone/pager	1	2	
Sewing machine	1	2	
Camera (still/movie)	1	2	
Motor car, etc	1	2	
Refrigerator or freezer	1	2	
Washing machine	1	2	
Computer/printer	1	2	

52 What is your educational qualification?

Less than SLC (keep number of completed years)	………………
SLC	10
11 class complete	11

12 class complete	12
BA complete	13
MA complete	14
Vocational training	15
Can't read and write	16
Can read and write	17

53 Describe your occupation based on the following major work divisions.

1. Education (school, institute, university, tuition center)
2. Government administration (administration, Beaurocratic, corporation, politics)
3. Health(Doctor, nurse, midwife, pharmacist, therapist)
4. Information technology
5. Business
6. Employment(salary)
7. Daily Labor
8. Unemployed (looking for job)
9. Housewife
10. Student
11. Others (Please specify)……

54 Does anyone in your family involved in health related occupation?

Yes	1	No	2

55 Do you own or rent your current residence?

Rent…………….1
Own…………….2

56 How long have you lived in Kathmandu?

A. Less than 5 years
B. 5 to 10 years (go to question 58)
C. 11 to 20 years (go to question 58)
D. More than 20 years (go to question 58)

57 If you have been migrated to Kathmandu within the past 5 years, what was the reason of migration?

A. Employment opportunity
B. Business opportunity
C. Education opportunity
D. Migrated from foreign country
E. Migrated from other district
F. Other reason, Please specify……….

58 What is the total monthly expenditure of your household?

Food expenditure only	……… rupees
Total expenditure	………..rupees

59 Range of household income (monthly in NRs)
Total income of household per year……………..

If you are not sure about the exact annual income please choose the range of income level from the following choices.

1. Less than 5,000
2. 5,001-10,000
3. 10,001-20,000
4. 20,001-30,000
5. 30,001-40,000
6. 40,001-50,000
7. 50,001-60,000
8. 60,001-70,000
9. 70,001-90,000
10. More than 100,000
11. Do not know
12. Refused

60 In your opinion, what are the three important things to improve existing solid waste management system?
1)
2)
3)

The End!

Appendix J: Survey Questionnaire in Nepali

Qsn no.					भर्सन २	HH No. :		

काठमाण्डौ उपत्यकाको फोहोर मैला व्यवस्थापन सम्वन्धी ज्ञान,सोचाइ तथा व्यवहारमा आधारित छनौट एक्स्पेरिमण्ट सर्वे ।

नमस्कार,मेरो नाम ....हो । म काठमाडौं युनिभरसींटी तथा युनीर्भसीटी अफ न्यु मेक्सिकोमा रहेको नेपाल स्टडी सेण्टरबाट आएको हु । हामी तपाई जस्तै काठमाण्डौ उपत्यकाका वासिन्दाहरुसग यहांको फोहोर मैला व्यवस्थापनको वारेमा केही प्रश्न सोधि तपाईको विचार तथा राय जान्न चाहन्छौ । हामीले जान्न खोजेका विषयहरु हुन् :

- अहिलेको फोहोर मैला उठाउने तथा प्रशोधन गर्ने व्यवस्थापनको वारेमा
- अहिलेको वातावरणीय मुद्दाहरुको वारेमा
- हालको फोहोर मैला व्यवस्थापनले तपाइको स्वास्थ्यमा पार्ने प्रभावको वारेमा

तपाइको सहभागिता हाम्रो लागि धेरै मुल्यवान छ । तपाइको विचारहरु भविष्यमा गएर फोहोरमैला व्यवस्थापन सम्वन्धि निति निर्माण गर्न असाध्यै उपयोगी हुनेछ । सबै भन्दा पहिले यस सर्वेमा भाग लिनको लागि तपाइको अनुमति लिन चाहन्छौ । तपाइलाई कुनै कुराको उत्तर दिन अपठ्यारो भएमा त्यसको उत्तर नदिन पनि सक्नु हुनेछ । यसमा यहि सहि वा बेठीक भन्ने हुदैन केवल तपाईले दिनु भएको उत्तर नै हाम्रो लागि सहि हुने छ । यहाँले दिनुभएको हरेक विचारहरु तथा तपाइको परिच गोप्य राखिने छ । यस सर्भेमा तपाईले हामीलाई करिब ४५ मिनेटको समय दिनुपर्ने छ। तपाइको समय र सहयोगको लागि हामि आभारी छौ ।

Center	काठमाडौं	1	ललितपुर	2	किर्तिपुर	3	भक्तपुर	4	ठिमी	5

II. के तपाईको उमेर १८ बर्ष पुग्यो ? यदी सहभागी र्भखरको देखिनुहुन्छ भने मात्र यो प्रश्न सोध्ने

१८ बर्ष वा १८ बर्षभन्दा बढी	1 (सर्भे सुरु गर्ने)
१८ बर्ष भन्दा कम	2 (घरमा अन्य बयस्क सदस्य हुनुहुन्छ कि सोध्ने)

<u>अर्न्तवार्ताकारलाई नोटः</u> सर्भेमा प्रयोग हुने नम्बरहरु अंग्रेजीमा लेख्नुपर्नेछ ।

PSU कोडः................................ HH No.:...	अर्न्तवार्ता लिएको मितिः.. (दिन/महिना/बर्ष) (eg. 14 july 2012)
उत्तरदाताको नामः..	अर्न्तबार्ता लिनेको नामः...
सम्पर्क फोन नम्बरः...	अर्न्तबार्ताकारको कोडः..................
ठेगानाः..	हस्ताक्षरः..
वडा नम्बरः.................	
ठाउको नामः...	सुपरभाइजरको नामः..
टोलको नामः...	सुपरभाइजरको कोडः..
लेण्डमार्कः..	हस्ताक्षरः...
घर नम्वर (अत्यन्त जरुरी):...	
अन्तरवार्ता सुरु गरेको समयः	डेटा इन्टी गर्नेको नामः.......................................
अन्तरवार्ता सकिएको समय :	हस्ताक्षरः..

Back Checked : 1	Accompanied : 2	Scrutinized : 3

Q A. अन्तरवार्ता दिने व्यक्तिको घरमुलीसगको नाता सम्वन्ध:

घरमुली / आफैं	1
श्रीमान / श्रीमती	2
छोरा / छोरी	3
नाती / नातीनी	4
आमा / बुवा	5
दाजुभाई / दिदी बहिनी	6
सासु / ससुरा	7
भीनाजु / भाउजु	8
बुहारी / ज्वाई	9
भतीजा / भतीजी	10
अन्य नातेदार	11
अन्य …………………	12

Q B. जात / जाती

ब्राम्हण	1	मधेशी	5
क्षेत्री	2	मधेशी दलित[67]	6
नेवार	3	पहाडी दलित[68]	7
जनजाती[69]	4	अन्य, खुलाउनु होस ………..	8

सेक्सन १: फोहोर मैला व्यवस्थापन सम्वन्धी हालको व्यवहार

Q1. तपाइको विचारमा तपाइको नगरपालीकाको हालको फोहोरमैला व्यवस्थापन, यदि समस्या हो भने, कति ठुलो समस्या हो ?

समस्या होइन	खासै ठुलो समस्या होइन	अलि अलि समस्या हो	धेरै ठुलो समस्या हो
1	2	3	4

[67] (10) Kuche, (11) Chyame, (12) Pode, (13) Chamar, (14) Dhobi, (15) Paswan (Dusadh), (16) Tatma, (17) Batar, (18) Khatbe, (19) Musahar, (20) Santhal, (21) Satar, and (22) Halkhor. Satar and Santhal is the same indigenous nationality but they are listed as *Dalit*s because they are treated as untouchables by some "high caste" people in some villages and towns in the eastern Terai region.

[68] (1) Lohar, (2) Sunar, (3) Kami, (4) Damai, (5) Kasai, (6) Sarki, (7) Badi, (8) Gaine, (9) Kusule,

[69] Magar,Tamang, Rai, Gurung, Limbu, Sherpa, Bhote, Walung, Buansi, Hyolmo, Gharti/Bhujel, Kumal, Sunuwar, Baramu, Pahari, Adivasi Janajati, Yakkha, Shantal, Jirel, Darai, Dura, Majhi, Dunuwar, Thami, Lepcha, Chepang, Bote, Raji, Hayu,Raute, Kasunda

अब तपाइको परिवारको फोहोरमैला व्यवस्थापन सम्वन्धी केही प्रश्नहरु सोध्न चाहन्छु ।

अन्तरवार्ताकारलाई नोट : यहा फोहोर मैला भन्नाले हरेक घर परिवारमा दैनिक जम्मा हुने नचाहिने फोहोर मानिन्छ, जस्तै भान्सामा जम्मा हुने फोहोर, पुराना पत्रिका, कागज, खाली वोतल, ग्लास, प्लाष्टिक, फलाम, खाली कार्टुन आदि भन्ने बुझिन्छ । यसरी निस्किएका फोहोरहरु ३ किसिमका फोहोर हुन्छन १) कुहिने खालका फोहोर जस्तै भान्सामा जम्मा हुने फोहोर, २) नकुहिने तर पुन प्रयोग गर्न मिल्ने खालका फोहोर जस्तै कागज, ग्लास, प्लाष्टिक, फलाम आदि तथा ३) अन्य खालका फोहोर ।

Q2. प्रायजसो, तपाइको परिवारबाट १ हप्तामा कति के. जी. फोहोर जम्मा हुन्छ ?

.... के. जी.

Q3. तपाइको परीवारबाट नीस्कने जम्मा फोहोर मध्ये, भान्साबाट निस्कने वा कुहिने फोहोरहरु १ हप्तामा कति के. जी. जम्मा हुन्छ ?

.... के. जी.

Q4. तपाइको परीवारबाट नीस्कने जम्मा फोहोर मध्ये, नकुहिने तर पुन प्रयोग गर्न मिल्ने फोहोरहरु १ हप्तामा कति के. जी. जम्मा हुन्छ ?

.... के. जी.

Q5. तपाइको घरमा प्राय जसो दिनभरी घरमा वस्ने परिवार सदस्य कति जना हुनु हुन्छ ?

....जना

Q6. तपाइको टोलमा तल दिएका मध्ये कुन कुन सेवाहरु उपलब्ध छन ? M. A Read Aloud

निजी क्षेत्रबाट संचालित घरदैलोबाट फोहोर उठाउने सेवा	1
नगरपालिकाबाट संचालित घरदैलोबाट फोहोर उठाउने सेवा	2
नगरपालिकाको ट्रक,भ्यान वा रिक्साले टोलको चोक चोक बाट फोहोर उठाउने सेवा	3
सडक छेउमा भएको सानो वा ठुलो कन्टेनर	4
फोहोर फाल्न तोकिएको खाली ठाउं	5
अन्य, उल्लेख गर्नुहोस	6
केहि पनि छैन	7

Q7. तपाइको घरबाट देखिने वा हिडेर पुगिने ठाउमा तल दिएका फोहोर थुपार्ने ठाउहरु छन ? M. A read aloud

	छ	छैन
घर दैलो सेवाले उठाएर ल्याएको फोहोर थुप्रीने ठाउ	1	2
खोलाको किनारमा भएको फोहोर थुप्रीने ठाउ	1	2
नतोकिएको वा जथाभावी रुपमा फालिएको फोहोर थुप्रीने ठाउ	1	2
नगरपालिका वा अन्य फोहोर उठाउने संस्थाले तोकिदिएको फोहोर थुपार्ने खाली ठाउ	1	2

Q8. तपाई आफ्नो घरबाट निस्किएको फोहोरलाई के के गर्नुहुन्छ ? सवैभन्दा वढी प्रयोग हुने विधिहरु रोज्नुहोस ।

M. A Read aloud

घर दैलोबाट फोहोर उठाउनेलाइ दिने	1
नगरपालीकाको गाडीमा लगेर हाल्ने	2
सडक छेउमा भएको कन्टेनरमा लगेर हाल्ने	3
तोकिएको खाली ठाउमा फाल्ने	4
सडकमा वा कुनै पनि नतोकिएको खाली ठाउमा फाल्ने	5
खोलाको किनारमा फाल्ने	6
पुन प्रयोग गर्न मिल्ने फोहोर जम्मा पारेर बेच्ने	7
कुहिने फोहोरलाई गाड्ने र त्यसबाट मल बनाउने	8
कुहिने फोहोरलाई कम्पोस्ट गरेर मल बनाउने	9
जलाउन मिल्ने फोहोर जस्तै कागज, प्लास्टिक आदिलाई जलाउने	10
अन्य विधि उल्लेख गर्नुहोस	11

Q9A. के तपाइको घरको कम्पाउण्ड भित्र फोहोर थुपार्ने खाली ठाउ छ ?

छ	1	छैन	2

Q9B. तपाइको घरको कम्पाउण्ड भीत्र जम्मा पारेको फोहोरलाइ फोहोर उठाउनेले आफै टीपेर लान्छ?

फोहोर उठाउनेले टीपेर लाने	1	आफैले दिने	2

Q10. प्रायजसो, तपाइले वातावरणीय सरसफाई सम्वन्धी सवैभन्दा प्रभावकारी सुचना तथा जानकारीहरु कहाँ कहाँबाट पाउनुहुन्छ ? M. A Read aloud

स्कुल, क्याम्पस, युनिर्भसीटी	1
रेडियो	2
टि.भि.	3
पत्र पत्रिका	4
पर्चा , पमप्लेट , सुचना पाटी	5
साथीभाई तथा परिवारका सदस्यहरु	6
नगरपालीका वा वार्ड कार्यलय	7
सामुदाय तथा वातावरण सम्वन्धि संघसंस्था	8
जनचेतना मुलक कार्यक्रम	9
कुनै पनि छैन	10
अन्य श्रोतहरु उल्लेख गर्नुहोस	11

Choice experiment

अन्तरवार्ताकारलाइ नोट : तलका कुराहरु अनिबार्य रुपमा पढेर सुनाउनु पर्नेछ।

अब म उपत्यकाको फोहोरमैला व्यवस्थापन सुधार सम्बन्धि केही कुरा गर्न चाहन्छु।

काठमाण्डौ उपत्यकाको हालको फोहोरमैला व्यवस्थापनलाई सुधार गर्न विभिन्न किसिमका सुझावहरु आइरहेका छन । यसरी आएका सुझावहरु मध्ये हामीले ५ महत्वपुर्ण कुराहरु लिएका छौं । ति कुराहरु हुन्:

- फोहोर उठाउने समय ।
- सामुदायिक फोहोरमैला व्यबस्थापन कार्यक्रम ।
- हप्तामा कतिचोटि फोहोर उठाउने भन्ने कुरा ।
- तपाइले आफनो घरको फोहोर छट्याउने तरीका ।
- थप महिनावारी सेवा शुल्क ।

तपाइको हालको फोहोरमैला व्यवस्थापन सेवा वाहेक माथि दिएका कुराहरु विभिन्न मात्रामा राखेर अन्य २ वटा सुधारिएका सेवाहरु तयार पारिनेछ। ति सेवाहरु मध्ये तपाइले आफ्नो सवैभन्दा मन परेको सेवा रोज्नु पर्नेछ। यसरी मन परेको सेवा छान्नु अघि माथि दिएका कुराहरुको वारेमा छोटकरीमा परिचय दिन चाहन्छु।

१. फोहोर उठाउने समय

तपाईको घरदैलोबाट फोहोर उठाउदा २ किसिमले फोहोर उठाउन सकिन्छ : १) घरदैलोबाट उठाउने, जुनसुकै बार तथा समयमा उठाउने २) घरदैलोबाट उठाउने, तोकिएको बार तथा समयमा उठाउने । जुनसुकै बार तथा समयमा फोहोर उठाउदा समय थाहा नभएर वा आफु घरमा नभएको बेलामा तपाईको घरको फोहोर नउठ्न पनि सक्छ। तोकिएको समयमा फोहोर उठाउदा त्यस्तो समस्या हुदैन ।

Q 11. अहिले तपाईको घरको फोहोर कसरी उठाउने गरेको छ ? SA

घरदैलोबाट उठाउने, जुनसुकै बार तथा समयमा उठाउने	1
घरदैलोबाट उठाउने, तोकिएको बार तथा समयमा उठाउने	2
ट्रकले उठाउने, जुनसुकै बार तथा समयमा उठाउने	3
ट्रकले उठाउन, तोकिएको बार तथा समयमा उठाउने	4
तोकीएको खाली ठाउमा थुपारेर उठाउने, जुनसुकै बार तथा समयमा उठाउने	5
तोकीएको खाली ठाउमा थुपारेर उठाउने, तोकिएको बार तथा समयमा उठाउने	6
केहि पनि छैन	7

Q12 . तपाइको घरबाट फोहोर फाल्ने ठाउँ सम्म हिडेर पुग्न कति समय लाग्छ ?

......................मिनेट (घरदैलो बाट उठाउनेलाई ० राख्ने)

२. सामुदायीक फोहोरमैला व्यबस्थापन कार्यक्रम

तपाइको टोलबासी तथा फोहोर उठाउने संस्था मीलेर सामुदायीक फोहोरमैला व्यबस्थापन कार्यक्रम गरीनेछ। यस कार्यक्रममा बीशेष गरी तीन महत्वपुर्ण काम हुनेछ : १. टोलमा समय समयमा फोहोरमैला व्यबस्थापन सम्बन्धी जनचेतनामुलक कार्यकम सन्चालन गर्ने। २. समय समयमा टोलभरीको फोहोर सकंलन गर्ने। ३.जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने। यस सस्थामा टोलबासीले स्वयम्सेवक भएर काम गर्नुहुन्छ र नगरपालीकाले आबश्यक सहयोग गर्नेछ। हालको सेवालाइ प्रभाबकारी बनाउन तपाइले तिर्नुभएको शुल्कबाट निश्चीत रकम यस काममा खर्च गरीनेछ।

Q13. तपाइको टोलमा माथी भनेजस्तो कार्यक्रम भएमा तपाई त्यस कार्यक्रममा स्वयम्सेवक भएर काम गर्न इच्छुक हुनुहुन्छ?

छु	1	छैन	2

Q14. के तपाईको टोलमा माथी भनेजस्तो सरसफाई तथा बातावरण सुरक्षा संम्वन्धि कार्यक्रमहरु हुन्छन?

छु	1	छैन	2

Q15. तपाईको घरको फोहोर उठाउने जिम्मेवारी कस्ले लिएको छ ?SA

नगरपालिका	1
निजी क्षेत्र	2
कुनै पनि छैन	3
थाहा छैन	4

३. हप्तामा कति चोटि फोहोर उठाउने ?

फोहोर उठाउनेले तपाइको घर वा टोलबाट हप्तामा कति चोटि फोहोर उठाउछ भन्ने पनि फोहोरमैला व्यवस्थापनको एक महत्वपर्ण करा हो।

Q16. तपाईको घरको फोहोर प्रायजसो हप्तामा कति पटक उठाउने गरेको छ ?............. पटक

४. तपाइले आफनो घरको फोहोर छट्याउने तरीका

तपाइको घरको फोहोर फाल्नु अघि फोहोरलाई छुट्यायो भने ल्याण्डफिल साइटमा परेको फोहोरको चापलाई कम गर्न सकीन्छ। तपाइले फोहोर छुट्याउने तिन उपायहरु छनः १) फोहोर नछुटयाउनेः कुनै पनि किसिमको फोहोर नछुट्याउने। २) दुइ खालको फोहोर छुट्याउने : कुहिने र नकुहिने, ३) तिन खालको फोहोर छुट्याउने: कुहिने, पुनः प्रयोग गर्न मिल्ने र अन्य फोहोर।

Q17. तपाईले फोहोर फाल्दा कति किसिमका फोहोरहरु छुट्याएर फाल्नु हुन्छ ? Read aloud, SA

फोहोर छुट्याउदिन	1
कुहिने तथा नकुहिने फोहोर छुट्याउछु	2
कुहिने, पुनः प्रयोग गर्न मिल्ने (वा जम्मा पारेर बेच्न मिल्ने) र अन्य फोहोर छुट्याउछु	3

Q18. गएको ६ महिनामा तपाईले आफ्नो घरको पुन प्रयोग गर्न मिल्ने फोहोर जस्तै पत्रिका,प्लाष्टिक तथा शिसाहरु वेच्नु भयो ?

बेचें	1
बेचिन	2

Q19. प्रायजसो एक हप्तामा तपाइको घर वरिपरि पुन प्रयोग गर्न मिल्ने समान जस्तै कागज,पत्रिका,प्लाष्टिकको वोतल तथा शिसाको वोतल आदि किन्ने मान्छे कराउदै आएको तपाइले कतिको सुन्नु भएको छ ?

कहिल्यै सुनिन	महिना महिनामा	हप्ता हप्तामा	दिन दिनै	एक दिनमै धेरै पटक
1	2	3	4	5

५.थप महिनावारी सेवा शुल्क

हालको फोहोरमैला व्यवस्थापनलाई सुधार गरी माथि भनिएका कुराहरु राख्नको लागि थप पैसाको जरुरत पर्न सक्छ। यसरी चाहिने थप पैसा हरेक घरबाट महिनावारी सेवा शुल्कको रुपमा उठाइनेछ। तपाइले अहिले पनी दुइ किसिम मध्ये कुनै एक तरीकाले सुल्क तीरीरहनुभएको छ : १. महीनावारी रकम तीर्ने, वा २. महीनावारी सुल्क नर्तीने तर नगरपालिकालाई बीभीन्न कीसीमको कर तीर्ने। हालको फोहोरमैला व्यवस्थापनलाई सुधार गर्न तपाइले अहीले तीरेको सुल्कमा अरु केही थप रकम तीर्नु पर्नेछ। तपाइले रोज्नु भएको सेवामा लाग्ने महिनावारी सेवा शुल्क साच्चिकै दिनु पर्ने हुन सक्छ। त्यसैले सेवा रोज्नु अघि तपाईको घरको आम्दानी तथा खर्चको पनि लेखाजोखा गर्नुहोला।

Q20. तपाइको परिवारले आफ्नो फोहोर उठाए वापत महिनावारी कति शुल्क तिर्नु हुन्छ ? रु ....

Q21. तपाई आफ्नो टोलको फोहोर उठाउने सेवाबाट कत्तिको सन्तुष्ट हुनुहुन्छ ?

अत्यन्त असन्तुष्ट	केही मात्रामा असन्तुष्ट	ठिकै	केहि मात्रामा सन्तुष्ट	अत्यन्तै सन्तुष्ट
1	2	3	4	5

<u>**तल दिएका मध्ये कुन फोहोरमैला व्यवस्थापन सेवा रोज्नु हुन्छ ?**</u>

अन्तरवार्ताकारलाइ नोट : सहभागीलाइ नजीकै बोलाएर तलका तालीकाहरु देखाउदै अर्न्तबार्ता लिनुहोला ।

अव तपाइलाई हालको फोहोरमैला व्यवस्थापन सेवा समेत गरेर ३ वटा सेवाहरु मध्ये एउटा सेवा छान्न दिइनेछ । हरेक सेवाहरु अगाडी भनिएका कुराहरुको विभिन्न मात्रा राखेर वनाइएको छ । **ति तिन किसीमका सेवाहरु हुन् : फोहोर मैला व्यवस्थापन सेवा A, B र हालको सेवा C .** यी ३ सेवाहरु मध्ये तपाइलाई सवैभन्दा मन परेको सेवा रोज्नु होला । तपाइलाई हालको सेवा मन परेको छ भने हालको फोहोरमैला व्यवस्थापन सेवा रोज्न सक्नु हुनेछ । यदि तपाईलाई कुनै पनि सेवा मन परेन भने पनि दिएका तिन सेवाहरु मध्येको सबैभन्दा राम्रो सेवा रोज्नु होला । यसरी सेवा छान्नु अघि आफ्नो आम्दानी तथा खर्चको पनि लेखाजोखा राख्नु होला किनकी तपाईले रोजेको सेवामा लाग्ने महिनावारी सेवा शुल्क तपाईले वास्तवमै तिर्नु पर्ने हुन सक्छ ।

1	**फोहोरमैला व्यवस्थापन सेवा A**	**फोहोरमैला व्यवस्थापन सेवा B**	**हालको फोहोरमैला व्यवस्थापन सेवा C**
फोहोर उठाउने समय	घर दैलोबाट फोहोर उठाउने, जुनसुकै बार तथा समयमा उठाउने	घर दैलोबाट फोहोर उठाउने, जुनसुकै बार तथा समयमा उठाउने	हालको व्यवस्था
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **हुने**	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **नहुने**	हालको व्यवस्था
हप्तामा कति पटक फोहोर उठाउने ?	हप्तामा सातै दिन	हप्तामा १ पटक	हालको व्यवस्था
तपाइको घरको फोहोर छुट्याउने तरिका	फोहोर नछुट्याउने	तिन खालको फोहोर छुट्याउने- कुहिने,रिसैकल गर्न मिल्ने र अन्य फोहोर	हालको व्यवस्था
थप महिनावारी सेवा शुल्क	रु १०० थप शुल्क	रु २० थप शुल्क	हालको व्यवस्था

Q22A. माथि दिएको टेवलमा कुन सेवा रोज्नु हुन्छ ? SA

- फोहोरमैला व्यवस्थापन सेवा A
- फोहोरमैला व्यवस्थापन सेवा B
- हालको फोहोरमैला व्यवस्थापन सेवा C

Q22.1 तपाइले भर्खरै रोजेको सेबामा के के कुरा मन परेर यो सेबा रोज्नु भएको हो? MA

फोहोर उठाउने समय	1
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	2
हप्तामा कति पटक फोहोर उठाउने ?	3
तपाइको घरको फोहोर छुट्याउने तरिका	4
थप महिनावारी सेवा शुल्क	5

Q23A. अघिल्लो प्रश्नमा तपाइले सेवा रोज्दा तपाई आफु कत्तिको नीश्चीत भएर सेवा रोज्नु भएको हो ?

धेरै अनिश्चित	केही मात्रामा अनिश्चित	ठिकै	केहि मात्रामा निश्चित	धेरै निश्चित
1	2	3	4	5

2	**फोहोर मैला व्यवस्थापन सेवा A**	**फोहोरमैला व्यवस्थापन सेवा B**	**हालको फोहोरमैला व्यवस्थापन सेवा C**
फोहोर उठाउने समय	घर दैलोबाट फोहोर उठाउने, तोकिएको बार तथा समयमा उठाउने	घर दैलोबाट फोहोर उठाउने, जुनसुकै बार तथा समयमा उठाउने	हालको व्यवस्था
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **नहुने**	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **हुने**	हालको व्यवस्था
हप्तामा कति पटक फोहोर उठाउने ?	हप्तामा ३ पटक	हप्तामा १ पटक	हालको व्यवस्था
तपाइको घरको फोहोर छुट्याउने तरिका	दुइ खालको फोहोर छुट्याउने: कुहिने र नकुहिन	तिन खालको फोहोर छुट्याउने-कुहिने,रिसैकल गर्न मिल्ने र अन्य फोहोर	हालको व्यवस्था
थप महिनावारी सेवा शुल्क	रु २० थप शुल्क	रु ५० थप शुल्क	हालको व्यवस्था

Q22B. माथि दिएको टेवलमा कुन सेवा रोज्नु हुन्छ ? SA

- फोहोरमैला व्यवस्थापन सेवा A
- फोहोरमैला व्यवस्थापन सेवा B
- हालको फोहोरमैला व्यवस्थापन सेवा C

Q22.1 तपाइले भर्खरै रोजेको सेबामा के के कुरा मन परेर यो सेबा रोज्नु भएको हो? MA

फोहोर उठाउने समय	1
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	2
हप्तामा कति पटक फोहोर उठाउने ?	3
तपाइको घरको फोहोर छुट्याउने तरिका	4
थप महिनावारी सेवा शुल्क	5

Q23B. अघिल्लो प्रश्नमा तपाइले सेवा रोज्दा तपाई आफु कत्तिको निश्चीत भएर सेवा रोज्नु भएको हो ?

धेरै अनिश्चित	केही मात्रामा अनिश्चित	ठिकै	केहि मात्रामा निश्चित	धेरै निश्चित
1	2	3	4	5

3	**फोहोर मैला व्यवस्थापन सेवा A**	**फोहोरमैला व्यवस्थापन सेवा B**	**हालको फोहोरमैला व्यवस्थापन सेवा C**
फोहोर उठाउने समय	घर दैलोबाट फोहोर उठाउने, तोकिएको बार तथा समयमा उठाउने	घर दैलोबाट फोहोर उठाउने, जुनसुकै बार तथा समयमा उठाउने	हालको व्यवस्था
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **हुने**	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **नहुने**	हालको व्यवस्था
हप्तामा कति पटक फोहोर उठाउने ?	हप्तामा सातै दिन	हप्तामा ३ पटक	हालको व्यवस्था
तपाइको घरको फोहोर छुट्याउने तरिका	दुइ खालको फोहोर छुट्याउनेः कुहिने र नकुहिने फोहोर	नछुट्याउने	हालको व्यवस्था
थप महिनावारी सेवा शुल्क	रु १० थप शुल्क	रु ४० थप शुल्क	हालको व्यवस्था

Q22C. माथि दिएको टेवलमा कुन सेवा रोज्नु हुन्छ ? SA

- फोहोरमैला व्यवस्थापन सेवा A
- फोहोरमैला व्यवस्थापन सेवा B
- हालको फोहोरमैला व्यवस्थापन सेवा C

Q22.1 तपाइले भर्खरै रोजेको सेबामा के के कुरा मन परेर यो सेबा रोज्नु भएको हो? MA

फोहोर उठाउने समय	1
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	2
हप्तामा कति पटक फोहोर उठाउने ?	3
तपाइको घरको फोहोर छुट्याउने तरिका	4
थप महिनावारी सेवा शुल्क	5

Q23C. अघिल्लो प्रश्नमा तपाइले सेवा रोज्दा तपाई आफु कत्तिको निश्चीत भएर सेवा रोज्नु भएको हो ?

धेरै अनिश्चित	केही मात्रामा अनिश्चित	ठिकै	केहि मात्रामा निश्चित	धेरै निश्चित
1	2	3	4	5

4	**फोहोर मैला व्यवस्थापन सेवा A**	**फोहोरमैला व्यवस्थापन सेवा B**	**हालको फोहोरमैला व्यवस्थापन सेवा C**
फोहोर उठाउने समय	घर दैलोबाट फोहोर उठाउने, तोकिएको बार तथा समयमा उठाउने	घर दैलोबाट फोहोर उठाउने, जुनसुकै बार तथा समयमा उठाउने	हालको व्यवस्था
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **हुने**	टोलमा फोहोरमैला सम्बन्धी जनचेतना दीने, टोलभरीको फोहोर सकलन गर्ने र जथाभाबी फोहोर फाल्नेलाइ निगरानी राख्ने र त्यस्तो गर्नेलाइ कारबाही गर्ने कार्यक्रम **नहुने**	हालको व्यवस्था
हप्तामा कति पटक फोहोर उठाउने ?	हप्तामा १ पटक	हप्तामा सातै दिन	हालको व्यवस्था
तपाइको घरको फोहोर छुट्याउने तरिका	दुइ खालको फोहोर छुट्याउनेः कुहिने र नकुहिने फोहोर	तिन खालको फोहोर छुट्याउने- कुहिने,रिसैकल गर्न मिल्ने र अन्य फोहोर	हालको व्यवस्था
थप महिनावारी सेवा शुल्क	रु ५० थप शुल्क	रु १० थप शुल्क	हालको व्यवस्था

Q22D. माथि दिएको टेवलमा कुन सेवा रोज्नु हुन्छ ? SA

- फोहोरमैला व्यवस्थापन सेवा A
- फोहोरमैला व्यवस्थापन सेवा B
- हालको फोहोरमैला व्यवस्थापन सेवा C

Q22.1 तपाइले भर्खरै रोजेको सेबामा के के कुरा मन परेर यो सेबा रोज्नु भएको हो? MA

फोहोर उठाउने समय	1
सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम	2
हप्तामा कति पटक फोहोर उठाउने ?	3
तपाइको घरको फोहोर छुट्याउने तरिका	4
थप महिनावारी सेवा शुल्क	5

Q23D. अघिल्लो प्रश्नमा तपाइले सेवा रोज्दा तपाई आफु कत्तिको नीश्चीत भएर सेवा रोज्नु भएको हो ?

धेरै अनिश्चित	केही मात्रामा अनिश्चित	ठिकै	केहि मात्रामा निश्चित	धेरै निश्चित
1	2	3	4	5

Q24. तपाइको अघिल्लो प्रश्नको सेवा रोज्नको लागी तल दिएका कुराहरुले कत्तिको महत्वपुर्ण भुमिका खेल्यो ?

	अति कम महत्वपुर्ण	अलि अलि महत्वपुर्ण	ठीकै	धेरै महत्वपुर्ण
तपाइले अघिल्लो प्रश्नको सेवा रोज्दा **कुन समयमा फोहोर उठाउने भन्ने कुरा** कत्तिको महत्वपुर्ण थियो ?	1	2	3	4
तपाइले अघिल्लो प्रश्नको सेवा रोज्दा **सामुदायीक फोहोरमैला व्यवस्थापन कार्यक्रम हुने की नहुने भन्ने कुरा** कत्तीको महत्वपुर्ण थियो ?	1	2	3	4

तपाइले अघिल्लो प्रश्नको सेवा रोज्दा **हप्तामा कति पटक फोहोर उठाउने भन्ने कुरा** कत्तिको महत्वपुर्ण थियो ?	1	2	3	4
तपाइले अघिल्लो प्रश्नको सेवा रोज्दा **तपाइको घरको फोहोर छुट्याउने भन्ने कुरा** कत्तिको महत्वपुर्ण थियो ?	1	2	3	4
तपाइले अघिल्लो प्रश्नको सेवा रोज्दा **थप महिनावारी सेवा शुल्क कति लाग्ने भन्ने कुरा** कत्तिको महत्वपुर्ण थियो ?	1	2	3	4

Q25. (हालको सेवा C रोजेको छ भने सोध्ने) अघिल्लो प्रश्नमा तपाइले सुधारिएको व्यवस्थापन (सेवा A र B) को सट्टा हालको सेवा C रोज्नुभयो, त्यसको कारण के थियो ?

महिनावारी सेवा शुल्क धेरै भएकाले	1
सुधारिएको व्यवस्थाप्रति विश्वास नभएकाले	2
सरकारको जिम्मेवारीको काम भएकाले	3
हालको व्यवस्थाबाट सन्तुष्ट भएकाले	4
अन्य कारण......................................	5

वातावरण सम्वन्धी ज्ञान तथा विचार

Q26. तपाइले कहिल्यै वातावरण सुरक्षा सम्वन्धि कार्यक्रम(जस्तै पोस्टर प्रदर्शन, सामाजिक भेला, व्यानर प्रदर्शन,सडक -याली, सडक नाटक,सरसफाई कार्यक्रम)आदिमा भाग लिनुभएको छ ?

छ	1	छैन	2

Q27. के तपाई वा तपाईको परिवारमा कोही फोहोरमैला व्यवस्थान तथा वातावरण सुरक्षा संम्वन्धि सस्थामा सकियरुपमा काम गरि रहनुभएको छ ?

छ	1	छैन	2

Q28. के तपाईले कहिल्यै तल दिएका कुराहरुमा सार्बजनिक सुचना पढ्नु ,सुन्नु वा हेर्नु भएको छ ? read aloud

	छ	छैन
जथाभावी फोहोर फाल्न नहुने नियमको बारेमा	1	2
जथाभावी फोहोर फाल्नाले स्वास्थ्य तथा वातावरणमा पर्ने प्रभावको बारेमा	1	2
प्लास्टीकको प्रयोगले स्वास्थ्य तथा वातावरण्मा पर्ने प्रभावको बारेमा	1	2
खाने पानी सुद्दिकरणका विधिहरुको बारेमा	1	2
फोहोरको पुन प्रयोग, कम्पोस्ट बिधि तथा यसको महत्वको बारेमा	1	2

Q29. यसरी सार्वजनिक सुचना सुनेपछि तपाईले आफ्नो फोहोर फाल्ने विधि बदल्नु भएको थीयो ?

बदलें	1	बदलीन	2

Q30. के तपाईको टोलमा तल दिएका कुराहरुसंग संम्वन्धित सामुदायीक संस्थाहरु छन ?

	छ	छैन	थाहा छैन
सरसफाई तथा बातावरण सुरक्षा संम्वन्धि	1	2	3
खेल , कसरत वा अन्य मनोरन्जनका कार्यक्रम संम्वन्धि	1	2	3

Q31. के तपाइले आफ्नो टोलमा "यहा फोहोर फाल्न मनाही छ , यदि फोहोर फालेमा जरिवाना लाग्नेछ" भन्ने वोर्ड देख्नु भएको छ ?

छ	1	छैन	2

Q32. तपाईको विचारमा तल दिएका मध्ये कुन कुन फोहोरलाइ पुन प्रयोग गरेर नया सामान बनाउन मिल्छ? read aloud

	हो	होइन	थाहा छैन
पत्रीका	1	2	3
प्लास्टीकका बोटल	1	2	3
फोहोर खाना	1	2	3
सिसाको बोटल	1	2	3

Q33. तल दिएका भनाईहरु संग तपाई कत्तिको सहमत हुनुहुन्छ ? १ देखि ५ अकंमा मापन गर्नुहोस । १ भन्नाले पटक्कै सहमत छैन भन्ने बुझिन्छ भने ५ भन्नाले धेरै सहमत छु भन्ने बुझिन्छ र ६ ले यस बारेमा मलाई थाहा छैन भन्ने अर्थ लाग्छ ।

	पटक्कै सहमत छैन	अलिअलि सहमत छु	ठिकै	केही सहमत छु	धेरै सहमत छु	थाहा छैन
1.घरको फोहोर छुट्याउने भनेको अत्यन्तै दिक्क लाग्दो र झन्झटिलो काम हो	1	2	3	4	5	6
2. फोहोर छुट्याउने कामले धेरै समय खान्छ	1	2	3	4	5	6
3.मेरो घरको फोहोर छुट्याएर मलाई धेरै फाईदा हुन्छ	1	2	3	4	5	6
4.मैले मेरो घरको फोहोर राम्रो संग फालेर टोल सफा राख्न मद्दत गर्छु	1	2	3	4	5	6
5.मेरा साथीभाई, परिवार र छिमेकीहरु मैले वा हामीले जथाभावी फोहोर फाल्न हुदैन भन्ने सोच्छन्	1	2	3	4	5	6
6.मेरा छिमेकीहरुले जथाभावी फोहोर थुपार्न बन्द नगरे सम्म म पनि बन्द गर्दिन	1	2	3	4	5	6
7. थुपारेको फोहोरमा आउने झिंगा, मुसा, काग अदिले रोगहरु फैलाउने बारेमा मलाई चिन्ता लाग्छ	1	2	3	4	5	6
8. फोहोर छुट्याउने तथा पुन प्रयोग गर्ने कि नगर्ने भन्ने मेरो ब्यात्तिगत फैसला हो	1	2	3	4	5	6
9. नगरपालीकाले हामी नागरिकहरुले जथाभावी फोहोर नफालुन भन्ने चाहान्छ	1	2	3	4	5	6
10. मेरो टोल सफा राख्नु मेरो कर्तव्य हो	1	2	3	4	5	6

11. यदि फोहोर छुट्याउन लाई अलग्गै भाँडो दिने हो भने म धेरै फोहोर छुट्याउने थिएं	1	2	3	4	5	6
12. सके सम्म म आफ्नो घरको फोहोर राम्रो संग फाल्छु	1	2	3	4	5	6
13. जथाभावी थुपारिएको फोहोरले मेरो घर वरिपरि नराम्रो देखिन्छ भन्ने कुरामा मलाई चिन्ता लाग्छ	1	2	3	4	5	6

Q34. हाल तपाईको नगरपालिकाले घरायसी फोहोरलाई कम्पोस्ट गर्न सस्तो मुल्यमा कम्पोस्ट बिनहरु बितरण गरीरहेको कुरा तपाईलाई थाहा छ ?

छ	1	छैन	2

Q35. तपाईले कुनै खालको कम्पोस्ट गर्ने भाँडोको प्रयोग गर्नु भएको छ कि छैन ?

छ	1 (go to Q37)
छैन	2

Q36. यदि छैन भने तपाई कम्पोस्ट गर्ने भाँडो किन्न तयार हुनुहुन्छ ?

छ	1	छैन	2

Q37. काठमाडौं उपत्यकाको वातावरण मन्त्रालयले वातावरण संम्वन्धि जनचेतना जगाउन सामुदायीक परिचालन इकाई संचानल गरेको कुरा तपाईलाई थाहा छ ?

छ	1	छैन	2

Q38. तपाईले कहिल्यै काठमाडौं महानगरपालिकाले चलाएको फोहोर मैला सरसफाई संम्वन्धि टि भी कार्यक्रम *हाम्रो काठमाडौं* वा मेट्रो एफ एम को फोहोर मैला सम्वन्धि कार्यक्रम कत्तिको हेर्नु वा सुन्नु भयो ?Read aloud

	कहिल्यै हेरिन / सुनीन	कहिले काहिं हेरें /सुने	धेरै जसों हेरें / सुने	संधै हेरें / सुने	कार्यक्रमको बारेमा मलाई थाहा छैन
टि भी कार्यक्रम *हाम्रो काठमाडौं*	1	2	3	4	5
मेट्रो एफ एम को फोहोरमैला सरसफाई संम्वन्धि कार्यक्रम कत्तिको हेर्नु वा सुन्नु भयो	1	2	3	4	5

Q39. नगरपालिकाले हालसालै चलाएको विषेश सरसफाई कार्यक्रमको बारेमा सुन्नु भएको वा भाग लिनु भएको छ ?

	सुनेको	भाग लिनु भएको
छ	1	1
छैन	2	2

<u>आफ्नो तथा परिवारको स्वास्थ्य</u>

अब तपाई तथा तपाईको परिवारको स्वास्थ्य समस्याको बारेमा केही प्रश्नहरु सोध्न चाहान्छु ?

परिवार सदस्यहरुमा ० देखी १८ वर्ष सम्मको उमेर लाई बच्चा र सो भन्दा माथिको लाई वयस्क भन्ने बुझिन्छ ।

Q40. गएको ३० दिनमा, तपाई वा तपाईको परिवारको कोही सदस्यहरु तल दिएका रोगबाट बिरामी पर्नु भयो ?
Read aloud

	बिरामी परें	बिरामी परेनन	बिरामी परेको वयस्कको संख्या	बिरामी परेको बच्चाको संख्या
झाडा/बान्ता	1	2	....	....
जन्डीस	1	2	....	....
टाईफाईड	1	2	....	....
धुलोबाट छालामा हुने एलर्जी	1	2	....	....
वाकवाक आउने, रुघा लाग्ने, आँखा चिलाउने, टाउको दुख्ने	1	2	....	....
स्वासप्रस्वास संम्वन्धि समस्याहरु (जस्तै : दम, सास फेर्न अप्ठयारो हुने आदि)	1	2	....	....

Q41A. माथि दिएका रोगहरुका कारण, विरामीले गएको ३० दिनमा, कति दिन जती काम, स्कुल वा साधारण काम छोडनु परयो ? (काम वा स्कुल छोड्नु नपरेको लाई ० लेख्ने)

	स्कुल छोडेको दिन	काम छोडेको दिन	साधारण काममा बाधा परेको दिन
जम्मा दिन उल्लेख गर्नुहोस	.... दिन	.... दिन	.... दिन
लागु नहुने	99	99	99

Q42B. माथीको रोगको उपचारको लागी तपाइको परीवारले कति खर्च गर्नु पर्‍यो ?
रु...................................

Q42. तपाईको घरको पिउने पानीको मुख्य स्रोत के हो ?

स्रोतहरु	
महानगरपालीकाको पाईपको पानी	1
किनेको बोटलको पानी वा जारको पानी	2
ट्याङकर वा ट्रकमा ल्याएको पानी	3
ईनारको पानी	4
ट्युवेलको पानी	5
ढुङ्गेधारा को पानी	6
बोरीगं गरेको पानी	7
कुवाको पानी	8

Q43. तपाईको घरको खानेपानीको स्वाद, रङ र गन्ध तपाईलाई कस्तो लाग्छ ? read aloud

	धेरै नराम्रो	नराम्रो	ठिकै	राम्रो	धेरै राम्रो
पानीको स्वाद	1	2	3	4	5
पानीको रङ	1	2	3	4	5
पानीको गन्ध	1	2	3	4	5

Q44. तपाईको घरको खानेपानी तपाईलाई कत्तिको स्वस्थ्यकर लाग्छ ?

धेरै फोहोर	अलिअलि फोहोर	ठिकै	सफा	धेरै सफा
1	2	3	4	5

Q45. तपाई आफ्नो घरको खानेपानीलाई सफा गर्न तल दिएका कुन कुन बिधिहरु प्रयोग गर्नु हुन्छ ?
read aloud

	छ	छैन
पानीलाई फिल्टर गर्ने	1	2
पानीलाई उमाल्ने	1	2
पानी सफा गर्न केमीकल हाल्ने (जस्तै : वाटरगार्ड वा पिउस)	1	2
पानी सफा गर्नलाई मेशीन राख्ने (जस्तै : युरोगार्ड)	1	2
अन्य……………………		

आर्थिक, सामाजिक तथा अन्य सामान्य जानकारी

अव म तपाईको घरपरिवार संम्वन्धि आर्थिक, सामाजिक तथा अन्य सामान्य जानकारी लिन चाहान्छु ।

Q46. तपाइको घरमा प्रायजसो परिवारको कुन सदस्यले फोहोर जम्मा पार्ने तथा फाल्ने काम गर्नुहुन्छ ?

परिवारमा जो पनि हुनसक्छ	1
घरमुली	2
घरमुली बाहेकको आईमाई मान्छे	3
घरमुली बाहेकको लोग्ने मान्छे	4
काम गर्ने नोकर	5

Q47. के तपाइको घरमा फुलवारी अथवा करेसाबारी (तरकारी बारी) छ ?

छ	1	छैन	2

Q48. तपाईको पुरा उमेर कति भयो ? .... बर्षमा लेख्नुहोस ।

Q49. तपाईको वैबाहिक अवस्था के हो ?

अविवाहित	1	पारपाचुके भएको	3	विधवा/विदुर	5
विवाहित	2	छुट्टिएर बसेको	4	संगै बस्ने तर विवाहित हैन	6

Q50. तपाईको घरमा एउटै भान्सामा खाना खाने र संगै बस्ने जम्मा कति जना परिवारहरु हुनुहुन्छ ? ....जम्मा परिवार संख्या ।

भर्खरै जन्मिएको देखी ५ वर्ष उमेर सम्मका बच्चाहरुको संख्या	....
६ वर्ष देखी १८ वर्ष उमेर सम्मका बच्चाहरुको संख्या	....
१८ वर्ष भन्दा माथिका मानिसहरुको सख्या	....
जम्मा परिवार संख्या मध्ये कमाउने मानिसको संख्या	....

Q51. तपाईको घरमा तल दिएका सामानहरु के के छन र कति वटा छन् , कृपया बताईदिनुहोस ?

सामानहरु	छ	छैन	कति वटा	सामानहरु	छ	छैन	कति वटा
रेडिया, टेप, सी. डि. प्लेयर	1	2	....	लुगा सिउने मेशीन	1	2	....
साईकल	1	2	....	क्यामरा	1	2	....
मोटरसाईकल, स्कुटर	1	2	....	मोटर कार	1	2	....
फ्यान वा पंखा	1	2	....	फ्रिज	1	2	....
डेक वा टि भी	1	2	....	वासीङ मेशीन	1	2	....
टेलीफोन वा मोवाईल फोन	1	2	....	कम्पुटर वा प्रिन्टर	1	2	....

Q52. तपाईको शैक्षिक योग्यता कति हो ? (नोटः १ कक्षा उत्तिर्ण गर्नेलाई १ कोड गर्नुहोस,२ कक्षा उत्तिर्ण गर्नेलाई २, ५कक्षा उत्तिर्ण गर्नेलाई ५ कोड गर्ने र सोही अनुसार कोड गर्दै जानुहोस ।)

एस.एल.सी. भन्दा कमको लागि उत्तिर्ण गरेको कक्षा रेकर्ड गर्नुहोस्	....
एस.एल.सी पास	10
११ कक्षा पास	11
१२ कक्षा पास	12
वि.ए. पास	13
एम.ए. पास	14
सीपमुलक तालीम (खुलाउने)...	15
पढ्न लेख्न नआउने	16
पढ्न लेख्न सम्म आउने	17

Q53. तपाईको पेशा के हो ? तल दिएका मुख्य किसिमका कामहरुको बाँडफाँडको आधारमा आफ्नो पेशा रोज्नुहोस ?

शिक्षा संम्वन्धि पेशा (स्कुल,क्याम्पस,इन्स्टीच्युट, युनर्भसीटी, ट्युसन सेन्टर	1
सरकारी प्रशासन संम्वन्धि पेशा (प्रशासन, कानुन, राजनिती, संस्थान आदि)	2
स्वास्थ्य संम्वन्धि पेशा (जस्तै : डक्टर, नर्स, अहेव, अनमी आदी)	3
सुचना तथा संन्चार प्रबिधि सम्वन्धि	4
व्यापार व्यवासाय	5
नोकरी	6
देनिक रोजगारी	7

बेरोजगारी वा काम खोज्दै	8
गृहिणी	9
विद्यार्थी	10
अन्य पेशा खुलाउनुहोस	11

Q54. तपाइको परिवारमा कोही सदस्य स्वास्थ्य सेवासंग सम्वन्धित पेशामा कार्यरत हुनुहुन्छ ? जस्तै : डक्टर, नर्स, अहेव, अनमी आदी ।

छन्	1	छैनन्	2

Q55. तपाई अहिले बसिराखेको घर भाडामा लिनु भएको हो वा आफ्नै घर हो ?

भाडामा लिएको घर	1
आफ्नै घर	2

Q56. तपाई काठमाडौंमा बस्नु भएको कति वर्ष भयो ?

५ वर्ष भन्दा कम	1
५ वर्ष देखी १० वर्षको विचमा	2 (go to Q58)
११ वर्ष देखी २० वर्षको विचमा	3 (go to Q58)
२० वर्ष भन्दा धेरै भयो	4 (go to Q58)

Q57. यदि तपाई विगत ५ वर्ष भित्रमा काठमाडौंमा अन्यत्र बाट सरेर आउनु भएको हो भने यसरी सरेर आउनुको कारण के हो ?

नोकरीको अवसरले गर्दा	1
व्यबसाय गर्नका लागी	2
शिक्षाको अवसरले गर्दा	3
विदेसी मुलुकबाट सरेको	4
अन्य जिल्लाबाट सरेको	5
अन्य कारणहरु......................................	6

Q58. तपाईको परिवारको सालाखाला मासिक खर्च कति हन्छ ?

खानामा मात्र हुने खर्च	रु...............................
जम्मा खर्च	रु...............................

Q59. तपाईको परिवारको सालाखाला मासिक आम्दानी कति हन्छ ? आम्दानी बताउदा परिवारका सबै सदस्यहरुले कमाउने आम्दानी जोडेर भनिदिनुहोस् ।

आम्दानी रु..

यदि तपाइले आफ्नो परिवारको मासिक आम्दानी भन्न सक्नुभएन भने, तल दिएका आम्दानीका समुहबाट आफ्नो परिवारको मासिक आम्दानी रोज्नुहोस्

रु ५००० भन्दा कम	1
रु ५,००१ देखी १०,००० सम्म	2
रु १०,००१ देखी २०,००० सम्म	3
रु २०,००१ देखी ३०,००० सम्म	4
रु ३०,००१ देखी ४०,००० सम्म	5
रु ४०,००१ देखी ५०,००० सम्म	6
रु ५०,००१ देखी ६०,००० सम्म	7
रु ६०,००१ देखी ७०,००० सम्म	8
रु ७०,००१ देखी ९०,००० सम्म	9
रु १,००,००० भन्दा वढी	10
थाहा छैन	11
आम्दानी बताउन नमानेको	12

Q60. तपाइको बिचारमा हालको फोहोरमैला व्यवस्थापनमा सुधार गर्नु पर्ने ३ महत्वपुर्ण कुराहरु के के हुन?

1)
2)
3)

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