Assessment and Planning of Solid Waste Management in Murree

By

Muhammad Waqas Ijaz

(NUST201261479MSCEE1513S)

A Thesis submitted in partial fulfillment of

the requirements for the degree of

Master of Science

in

Urban & Regional Planning

DEPARTMENT OF URBAN & REGIONAL PLANNING

NATIONAL INSTITUTE OF TRANSPORTATION

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY

SECTOR H-12, ISLAMABAD, PAKISTAN

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This is to certify that the

thesis entitled

Assessment and Planning of Solid Waste Management in Murree

Submitted by

Muhammad Waqas Ijaz

has been accepted towards the partial fulfillment of the requirements

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in

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Dr. Abdul Waheed

National Institute of Transportation

NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY, ISLAMABAD

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(2015)

DEDICATION

This Thesis is dedicated to my beloved Parents

Muhammad Ijaz Alvi & Raheela Sadia

for their unconditional support and prayers.

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List of Acronyms

LCA   Life Cycle Assessment

MSW   Municipal Solid Waste

PET   Polyethylene Terephthalate.

SPSS   Statistical Package for the Social Sciences

SW-EMS   Solid Waste Environmental Management Systems

SWM   Solid Waste Management

SWMS   Solid Waste Management System

SWOT   Strengths Weaknesses Opportunities Threats

Abstract

Solid waste management is one of the vital environmental services that modern world can deliver to its citizens. Nevertheless, management of solid waste in several developing countries like Pakistan is becoming a challenging issue because of rising volume of waste generated and associated adverse impacts on public health and environment. Likewise, Murree, a well-known tourist city of Pakistan has been encountering a burgeoning challenge of solid waste management due to lack of scientific information on the issue of solid waste. Therefore, Aim of this study was to assess the current situation of solid waste management and identify the different factors and barriers affecting waste management process in Murree. For this purpose, data was collected through questionnaires, interviews and field observations. In order to obtain a well representative sample, study areas was divided into seven sampling zones. Various analysis including waste generation and composition analysis, descriptive statistics, correlation analysis and SWOT analysis were performed. It was found that hotels were the major producer of waste in Murree. Waste generation was found varying in different seasons and it was also influenced by household size, income level and types of waste source. Waste collection services were found inadequate, because almost half of waste produced in the city is disposed off illegally. The study also revealed that effectiveness of waste management system was influenced by various socioeconomic factors such as income level, education, types of waste sources, distance between road and waste generation source, awareness about solid waste management, and attitude of population towards solid waste management. Low level of public awareness was identified as most important barrier in waste management followed by insufficient funds availability, inadequate laws regulating waste management, and poorly trained waste management workers. Therefore, there is need to shift the existing practices towards waste prevention, along with sustained public awareness programs.

Chapter 1:   Introduction

1.1 Introduction

Solid waste management (SWM) is considered as one of the most vital services delivered by municipal authorities all over the world. Improper handling of solid waste can result into public health as well as environmental risks (Aydamo et al 2012). A continuous growth in types and volume of solid waste due to rapid urbanization, industrialization and economic growth, is turning out to be a burgeoning challenge for local as well as national managements to ensure sustainable and effective waste management (Ngoc and Schnitzer, 2009; Shekdar, 2009). In 2006, about 2.02 billion tons of municipal solid waste (MSW) was generated worldwide, signifying 7% increase annually since 2003. In addition, it was projected that there will be 37.3% increase in production of municipal waste globally from 2007 to 2011, signifying approximately 8% annual increase. Albeit many governments and non-government organizations are doing substantial efforts to tackle with waste management problems, yet there are plenty of gaps that needed to be filled in this subject. According to estimates made by World Bank, in developing countries, 20-50 percent of municipalities' budget is usually spent on management of solid waste, despite the fact that population served is below 50% and approximately 30-60 percent of total urban wastes remain unattended (UNEP 2009).

Management of solid waste in many developing countries of Asia including Pakistan is becoming a challenging issue because of rising volume of waste generated and associated adverse impacts on public health and environment. This acceleration in waste generation is attributed to continuously rising population and economic growth rate in Asia. Currently, over 1 million tons/day solid waste is generated in Asia, and it is projected to be increased up to 1.8 million tons/day by 2025 (Norbu et al., 2005; Hoornweg and Bhada- Tata, 2012). It is estimated

that urban areas of Pakistan generate more than 55,000 tons of solid waste every day (Koica-World Bank 2007b).

Many Asian countries like Pakistan are presently facing shortcomings in their system of solid waste management due to lack of institutional capacity, shortage of human and financial resources, poor enforcement of environmental laws and regulations, and lack of education and awareness about environmental impacts (Visvanathan et al., 2004; Shekdar, 2009). These shortcomings resulted into illegal dumping of solid waste. At present, only 50 % of waste produced is collected in urban areas of Pakistan, and rest of the wastes remain unattended. In addition, only 40% of total solid waste generated in urban areas of Punjab is collected.

Murree is famous tourist point of Pakistan, and well known for its natural beauty all over the world. However, natural beauty of Murree has been badly spoiled by indiscriminate dumping of solid waste at residential, commercial as well as tourist locations (Daily Times 2014). The amount as well as types of solid waste of the city is increasing rapidly owing to increasing local and visitors' population, and growing commercial economy. Unfortunately, at present there is no scientific research available on the issue of solid waste in Murree, thereby leaving the city with no proper waste management strategy for mitigating the problem. Therefore, aim of this study was to assess the current situation of solid waste management and identify the different factors and barriers affecting waste management process in Murree.

1.2 Rational of Study

- Solid waste including plastic bags can be observed littered on slopes all over Murree Hills.

- It is not uncommon to see garbage being burnt along roadsides, the fumes from which are detrimental to the air quality of the area.

- Rainwater runoff and sewage carry part of the waste down the slopes to natural streams.

- Careless open dumping of waste creates unsanitary conditions within the municipality.

- Delay in delivery of waste collection services, results in unpleasant odor and attract flies and other vectors carrying infectious pathogens.

- Some categories of solid wastes can block the permeability of soil and drainage systems, including water courses, open drains and sewers, thus posing difficulties in functioning and maintenance of such facilities.

1.3 Objectives

Aim of this study was to assess the current situation of solid waste management and identify different factors and barriers affecting proper waste management in Murree. Objectives of this study are;

- To examine the existing waste management system in Murree.

- To identify the factors affecting the waste management in Murree.

- To highlight the issues in solid waste management system.

- To make suggestions to improve solid waste management.

1.4 Research Questions

1- What are the existing practices for solid waste management in Murree?

2- How much effective is the present system of solid waste collection?

3- How the collected waste is treated/disposed?

4- What are the factors affecting waste management in Murree?

5- What are the barriers to effective solid waste management?

1.5 Scope and Limitation of the Study

Due to financial and time constraints, scope of this work is restricted to urban area of Murree only. Therefore, results of this study will not be applicable to other geographical areas. Moreover, although various types of solid waste are produced in the study area, this study focuses only on municipal solid waste. Therefore, output of this research does not provide confidence to generalize them to other types of wastes.

Chapter 2:   Literature Review

2.1 Introduction of Solid Waste Management

Solid waste management is one of the vital environmental services that modern world can deliver to its citizens. Solid waste can be defined as, "materials which are abandoned by being disposed off, burned, incinerated, accumulated, stored or treated, but not recycled" (EPA 2012a). Solid waste that is produced within the limits of municipality is known as Municipal solid waste (MSW). Managing these discarded materials by using various tools and programs is knows as solid waste management. Solid waste management is a system that encompasses all the activities related to management of solid waste ranging from its generation to its final disposal. Tchobanoglous et al (1993) comprehensively defined the solid waste management as "discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations and that is also responsive to public attitudes."

Solid waste management is not a new domain; it has been in practice since the start of civilizations. But in the past, there was a different situation altogether, because availability of land was in abundance and population was very low. Whereas recent trends of population increase and decline in land availability calls for drastic measures to evolve the practices of solid waste management (Ahmad and Ali 2002). The system of SWM should be efficient, affordable, simple, economic, environmental friendly, socially acceptable and sustainable, and it should serve both the wealthy and poor households equally (Rouse 2008).

Developing countries are facing a major challenge of waste management, as amount of solid waste is growing rapidly in several cities. Therefore, solid waste management is very vital and

resource intensive public amenity delivered by local administrations, and it is also key element of urban sanitation. Solid waste can be a useful resource if used properly. However, solid waste can have detrimental effects on public heath as well as environment if it is not managed properly (ENPHO, 2008). Unscientific disposal of solid waste at dumping sites creates unhygienic conditions such as breeding of pathogens or vectors, odor and emissions of greenhouse gases in surrounding environment. These unscientific dumping practices can contaminate the water resources of urban areas and pose sever health as well as environmental risks to population living in surrounding areas (Bhuiyan, 2010). Solid waste management comprises of all activities that facilitate to minimize environmental, health and aesthetics effects of solid waste (Zhu et al, 2008).

2.2 Classification of Solid Waste

Solid waste can be classified by variety of ways based on its sources, characteristics, and risk potential. Based on its sources, solid waste can be categorized into household or residential, commercial, industrial, institutional, municipal, agricultural, construction and demolition wastes (Tchobanoglous et al., 1993; Ezeah, 2006). Solid waste can also be categorized as biodegradable (garden waste, paper, food waste) and non – biodegradable (plastic, glass, metal) with respect to their characteristics. In addition, solid waste can be classified into organic and inorganic waste. Organic waste is easily compostable such as food waste, paper and wood waste, whereas inorganic waste is non compostable such as plastic, leather, metal, rubber, glass etc. Moreover, another classification of solid waste can be hazardous and non-hazardous waste with regards to it risk potential (CED, 2003).

2.3 Evolution of Solid Waste Management

Solid waste management is not new; it has been in practice since ages. In the past, practices of solid waste management were very conventional; solid waste was only hauled out of the bounds

of cities and dumped. However, waste generation is increasing as a result of rapid urban expansion, which in turn increasing the cost of solid waste collection, transportation and disposal (Ahmad and Ali 2002).

Solid waste management has gone through vigorous evolution since past 35 years; decision making, policies and planning of solid waste management have become complex. This evolution in waste management is attributed to changes in trends of solid waste generation. In 1970s most solid waste management models were aimed at optimizing the collection of solid waste, fixing the route of vehicles for waste transportation, and dealing with problems of transfer stations (Truitt et al. 1969). In 1980s the focus of solid waste management has shifted towards minimizing economic cost and management at system level (Hasit and Warner 1981).

2.4 Strategies for Solid Waste Management

Waste management planning including reduce, reuse, recycle and appropriate disposal of waste can be helpful in minimizing the socioeconomic as well as biophysical impacts (Morris and Holthausen 1994). It is believed that waste management planning can never be successful only by government or municipality, therefore a collective effort of all the stakeholders such as municipality, local communities, and other concerned organizations is required. Moreover, in order to ensure better practices of solid waste management, comprehensive policies and legal supporting structure are strongly recommended (Ezeah and Roberts 2012).

In order to improve the municipal waste management, Canada has developed Solid Waste Environmental Management Systems (SW-EMS). Low cost institutional SW-EMS were initiated in 1994 with the name of 'go green at work place' to minimize the generation of solid waste. Dowie (1998) regards the waste auditing as critical to check the effectiveness of SW-EMS. The audits examine 1) weights of waste produced 2) composition of waste and its sources 3) potentials of upgrading waste management action plan (Hammer 1995). In addition, Life

Cycle Assessment (LCA) is also another valuable environmental management instrument to evaluate the waste management system. LCA takes into account of impacts of every input and output of a product throughout its life cycle, and pinpoints the drawbacks and potential for improvement of system (Arena et al. 2003).

In the modern world, recycling is considered as best solution to many problems of waste management. For instance a research conducted in Dar es Salam, a city of Tanzania, revealed that almost 600 scavengers in the city were attached to business of selling scavenged recyclables, and they were earning well above the minimum official wage. This clearly depicts that recycling of solid waste has great potential, and can be advantageous for the states to minimize environmental impacts and unemployment as well (Refsgaard and Magnussen 2009).

Solid waste segregation is very essential for proper recycling. Source separation is one of technique employed to segregate solid waste. This technique is used to segregate solid waste at source by making use of various ways and means such as use of labeled bags, bins or shelves to contain waste of different categories (EPD-HK 2009). Segregation of waste is helpful in disposing of solid waste as per its recycling potential (Charuvichaipong and Sajor 2006). Source separation of waste is one of the best integrated solid waste management strategy. Separation of waste into different categories is beneficial in many ways; it increases the quality of compost and recyclables; it improves incineration; it enhances the financing of management of solid waste; it reduces the labor force relating to downstream management of solid waste; and it reduces the energy usage (Murray 1999).

Curbside recycling is another strategy being practiced in several developed countries. In this practice, different components of wastes such as PET bottles, paper and yard waste are separated by households, and stored into different containers available along the streets. Curbside recycling is accessible to approximately 139 million American population, and the

numbers are increasing rapidly. California is among the states where curbside recycling is mostly practiced. Curbside recycling came into effect as a result of integrated waste management act 1989, and it has undergone various reforms since its implementation (Calrecycle 2002).

Many social enterprises are operating in developed countries for recycling and have played important role in success of recycling. For instance, Kerbside social enterprise in UKis working for recycling and several other environmental and social reforms. Kerbside is providing recycling collection services to 25,000 households. According to a survey conducted from households at London, kerbside recycling service is used twice a week by around 51% of respondents (Robinson and Read 2005). This reflects the importance of social enterprises in bringing reforms in waste recycling process. Developing countries like Pakistan should also encourage social enterprises for recycling reforms.

Various studies has showed that organic waste is major component of solid waste stream (Tiew et al. 2009). There is great potential that exists in organic waste to produce biogas through a process known as anaerobic digestion. In the process of anaerobic digestion, anaerobic bacteria decompose the organic waste in absence of oxygen, and produce methane which is known as biogas. This methane is Greenhouse gas and harmful for stratospheric ozone. This gas is considered as alternative energy, as it can be utilized as fuel because of its combustibility (Tilche and Galatola, 2008).

2.5 Attitude and Behavior of Population towards Solid Waste Management

Attitude of population towards waste management should be known for better planning and implementation of waste management strategy. Attitude can be either positive or negative about a particular object, and behavior of population is highly influenced by their attitude

(Fabrigar 2004). Knowledge of population about waste management is important in shaping their attitude and behavior (Perrin and Barton 2001). Lack of knowledge and social norms are few barriers to improved solid waste management practices.

Behavior and attitude of people are two important elements to evaluate the success of solid waste management system. Success of waste management strategy, whether it is proper disposing of solid waste or reduce, reuse and recycle strategy, is highly influenced by attitude and behavior of people. Ajzen's theory maintained that positive attitude of people regarding waste management is associated with satisfactory behavior (Beghum et al. 2009). It is important to know the factors affecting the attitude of population, because behavior of population is greatly influenced by positive attitude of stakeholders. Knowledge is decisive factor to evaluate whether the attitude of general public would be positive or negative towards waste management. It is maintained that stakeholders having more awareness about waste management plan would show positive attitude while implementing that plan (Perrin and Barton 2001). Therefore, masses should be imparted with education as well as awareness about waste management for better solid waste management.

Attitude and behavior of people regarding waste management is also affected by their life style. Usually people prefer comfort and luxuries, and are unwilling to alter their way of living for better environment (Diekmann and Preisendorfer 1998). Therefore there is dire need to make people realize that they should alter their lifestyle to make it environment friendly.

2.6 Solid Waste Management in Context of Pakistan

South Asian countries including Pakistan are facing several environmental challenges due to population expansion, rapid urbanization and increasing industrialization. One of the most critical environmental problems is ineffective management of solid waste. World Bank had predicted in 1999 that generation of total municipal solid waste will be increased twofold by

2025 in Asia Pacific region only. Mishandling of solid waste can result into various health and environmental problems such as contamination of soil and water (UNEP 2012). Population of urban areas of Pakistan is growing at the growth rate of 3.7% to 7.4%, which has resulted into increased generation of solid waste. Approximately 55,000 tons total solid waste is generated daily in Pakistan, and only 40% of generated waste is collected in urban areas of Punjab (Koica-World Bank 2007b).

Solid waste collection in developing countries like Pakistan is carried out only at primary and secondary level, and almost 90% of waste collected is disposed into open dumpsites. Whereas uncollected waste remains in depressions, vacant plots, along roads, streets and railway lines (Morris and Holthausen 1994). Major barriers in effective management of solid waste in Pakistan include, absence of legal framework, unavailability of reliable data, dearth of skilled staff, insufficient equipment, incompetent operators and poor administration (KOICA – World Bank 2007a).

In Pakistan, there are number of shortcomings in solid waste management system due to various technological and financial deficiencies. Therefore the government is seen seeking out financial support from donor agencies. Proper dumping of solid waste is major obstacle encountered by Pakistan in solid waste management (Kasseva and Mbuligwe, 2000).

There is large potential of recycling that exists in Pakistan. Mostly informal sector is involved in recycling activities in Pakistan. Poor scavengers collect recyclables from solid waste at dumpsites and then carry them to recycling units. In Delhi, there are approximately 85,000 individuals engaged in recycling activities with little or no support from government (Datta, 1997). Similar situation exists in Lahore, and informal sector earns up to $30,875 per month through recycling in Lahore (Asim et al. 2012.). Therefore, in these cities recycling should be done at government level to benefit both economy and environment as well.

2.7 Solid Waste Management in Murree.

Although all the major cities of Pakistan are heavily polluted and the problem is multiplying, resulting in poor waste management. However, in the context of Murree, the situation is more severe, due to the landscape and fragile ecosystem of the area. In context of Murree; solid waste includes plastics, paper, textile, glass, metal (these may be collectively called garbage) and organic waste (food left overs and garden trimmings). Hospital waste is minimal but needs to be properly disposed off. It is not uncommon to see heaps of garbage along the slopes, facing the picnic spots. This open dumping has its own impact on the environment since it is exposed to rain and snow. The waste carelessly flows down the hill and find its way into streams, reservoirs and springs with disastrous consequences on drinking water (Dawn 2012).

Unfortunately, there is lack of availability of data on the solid waste management of Murree city. Therefore, it's dire need of hour to conduct a comprehensive study on the solid waste management of Murree to explore the issues in solid waste management system. This study is aimed to generate a baseline data on solid waste management of Murree city and formulate a strategy to promote integrated solid waste management.

Chapter 3:   Research Methodology

3.1 Study Area

This study has been conducted in the city of Murree, Pakistan. Murree, a unique abode with lofty peaks towering above, green pine covering the slopes, also known as Malika-e-Kohsar, which means "the Queen of Hills", has become one of the prime tourist destinations in Pakistan. It has been envisaged in recent years, the town is at unembellished loss of its inherent scenic characteristic. Murree situated at only an hour's drive northeast of Islamabad and 4.5 hour's drive from Lahore (about 46 km from Islamabad and 410Km from Lahore), with an altitude of 2,286 meters offers tourists an easily accessible destination thus attracting an ever growing number of visitors. Murree urban area spreads along the top of a ridge extending over about five kilometers and covering 17.9 Sq. Km whereas Murree Tehsil covers 380 sq. Km i.e. at its northeast end is Kashmir Point, with views across the valley of the Jhelum River into Azad Kashmir and southwest end is Pindi Point, looking back towards Rawalpindi and Islamabad. Between the two runs highly commercialized famous "The Mall", always remained a shopping attraction for tourists as well as a social and recreational node where most people congregate in foggy evenings.

According to 1998 Census, Murree Tehsil had a population of 176,426 (90,780 male, 85,646 female) including 155,051 inhabitants of rural areas and 21,371 urban dwellers. The civilian and military component of urban population includes 13,462 and 7,400 persons respectively. Murree town comprises of Murree Urban union council and two cantonment areas. The annual growth rate it reflected was 0.68 percent during the period from 1981 to 1998.

3.2 Study Population

Sample population of this study was households and commercial units located in urban area of Murree. Commercial units include hotels, restaurants and shops. One member from each residential or commercial units was selected for collecting information regarding solid waste management in area. Selection of households and commercial units for administration of questionnaire was random. Both male and female participated in this study, however, male respondents were in majority because many females were reluctant to take part in study owing to cultural restrictions.

3.3 Data Collection

For the purpose of collection of primary data, following instruments of data collection were employed:

1- Questionnaire

2- Waste Samples Collection

3- Interviews

4- Field Observations

3.3.1 Questionnaire

A questionnaire was designed through extensive literature review to collect data from study population. This questionnaire was used to assess the present situation of solid waste management in study area and understand attitude of population towards waste management. Questionnaire comprised of five sections. First section of questionnaire comprised of socioeconomic information of participants such as gender, education level, income level, household size etc. Second section dealt with current situation of solid waste management in study area. In this section questions regarding current practices of waste generation, collection

and disposal were asked. Third section was used to assess satisfaction level of people about waste management system. Fourth section was helpful in understanding the attitude of population towards waste management. This section asked the willingness of population about waste separation, pay for improved services and participate in waste management related activities. Last section of questionnaire was used to assess the knowledge or awareness of people about different concepts of waste management such as recycling, waste separation, drawbacks of plastic shopping bags etc.

3.3.2 Waste Sample Collection

In order to quantify the solid waste generation, solid waste samples were collected daily for a week both from households and business areas. For this purpose, households and commercial units were given trash bags. These bags were collected daily by private waste collectors, and these waste samples were sorted into different types and their weights were measured as well.

3.3.3 Interviews

In order to understand various aspects of solid waste management system in Murree, officials and staff of concerned authorities were interviewed. These interviews were conducted to seek out information about waste characterization, management structure, human and financial resources, availability and condition of equipment, system of waste collection, transportation, disposal and treatment, major barriers in waste management process, future plans to improve quality of waste management, efficiency and capacity of the existing waste management system.

3.4 Pre-testing of Questionnaire

In order to pre-test the questionnaire before field survey, a pilot study was conducted. This pilot study tested 10 questionnaires in the study area. This study was helpful in checking the

relativity, clarity and comprehensiveness of questionnaire with respect to target population. This pilot study identified that some questions had to be revised before final survey, which were then modified.

3.5 Sampling Procedure

In order to obtain a well-distributed representative sample, urban area of Murree was divided into seven sampling areas or zones. These sampling zones were Motor Agency, Lower Mall, Pindi Point, Sunny Bank, Kashmir Point, Kuldana, and Mall Road (Figure 3.1).
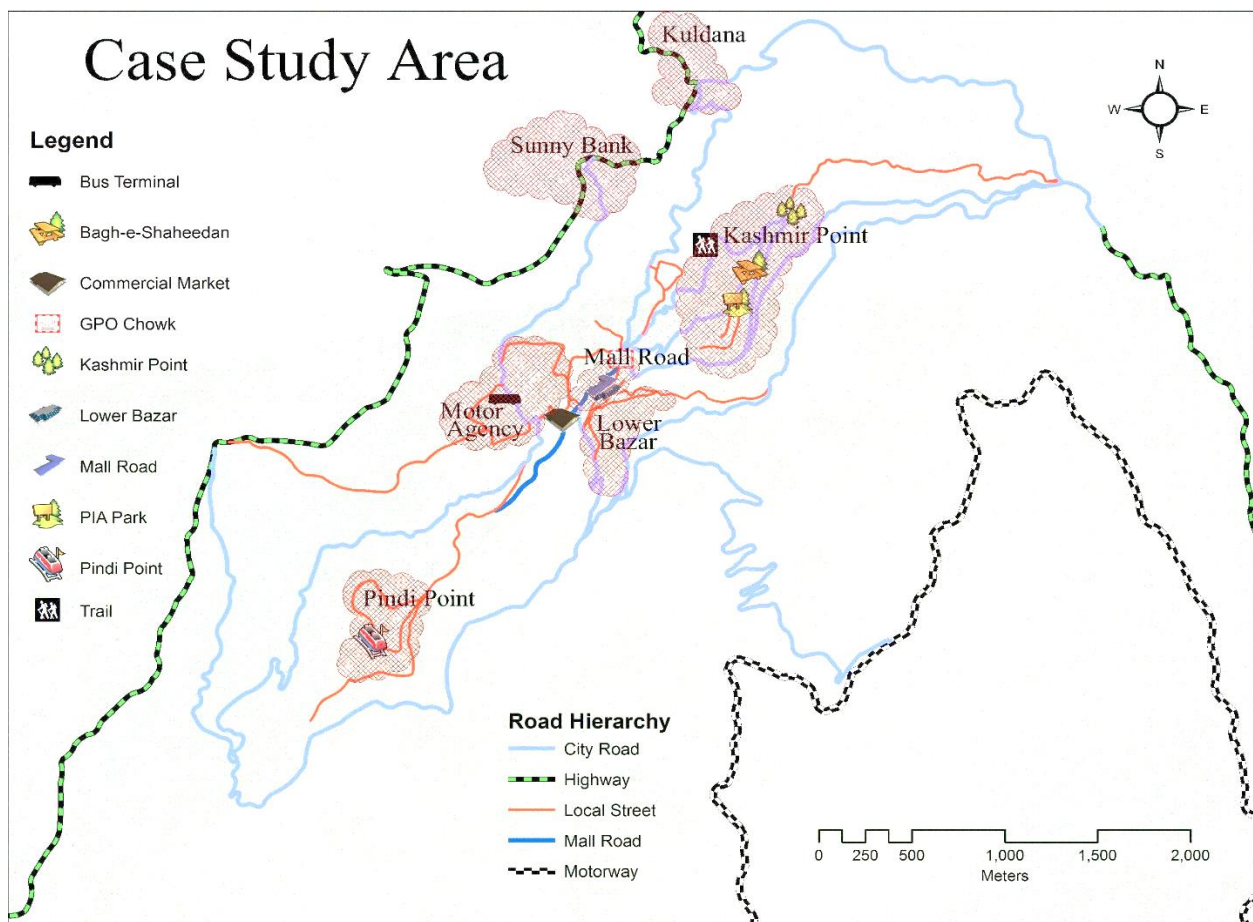
Figure 3.1: Case Study Area

A well-representative sample from each of these sampling area was collected. Households and commercial units were selected randomly for conducting questionnaires. The sample size in study area was calculated by using following formula at ±10% precision levels where

confidence level is 95% and p=.5. Where N is the population size, n is the sample size, and e is the level of precision.

$$n = \frac{N}{1 + Ne^2}$$

Based upon the values, a total of 150 questionnaires were conducted in entire city of Murree. 100 questionnaires were completed among the households, and 50 questionnaires were interviewed from commercial units such as hotels, restaurants, and shops etc. Only one member was interviewed for a questionnaire from each household or commercial unit.

3.6 Analysis

Data collected through field survey was analyzed by using Microsoft Excel and Statistical Package for the Social Sciences (SPSS). Waste generation and composition analysis was done with the help of Microsoft Excel, Whereas SPSS was used to analyze the descriptive as well as inferential statistics.

Descriptive statistics were used to describe characteristics of participants, variables and present situation of solid waste management. Frequencies, percentages and means were analyzed for different variables of this study. Cross tabulation of different variables was also done. Results of these analysis were presented graphically using tables, bar chart and pie chart etc.

Inferential statistics were used to reach conclusions and establish an association between different variables of the research. Correlation Analysis was performed to map the association of amount of solid waste generated with socioeconomic aspects of community.

SWOT Analysis was performed to highlight the issues pertaining to existing SWMS in Murree along with strengths and potentials. SWOT Analysis helped in formulating strategies to convert systems' weaknesses into strength and similarly threats into potential.
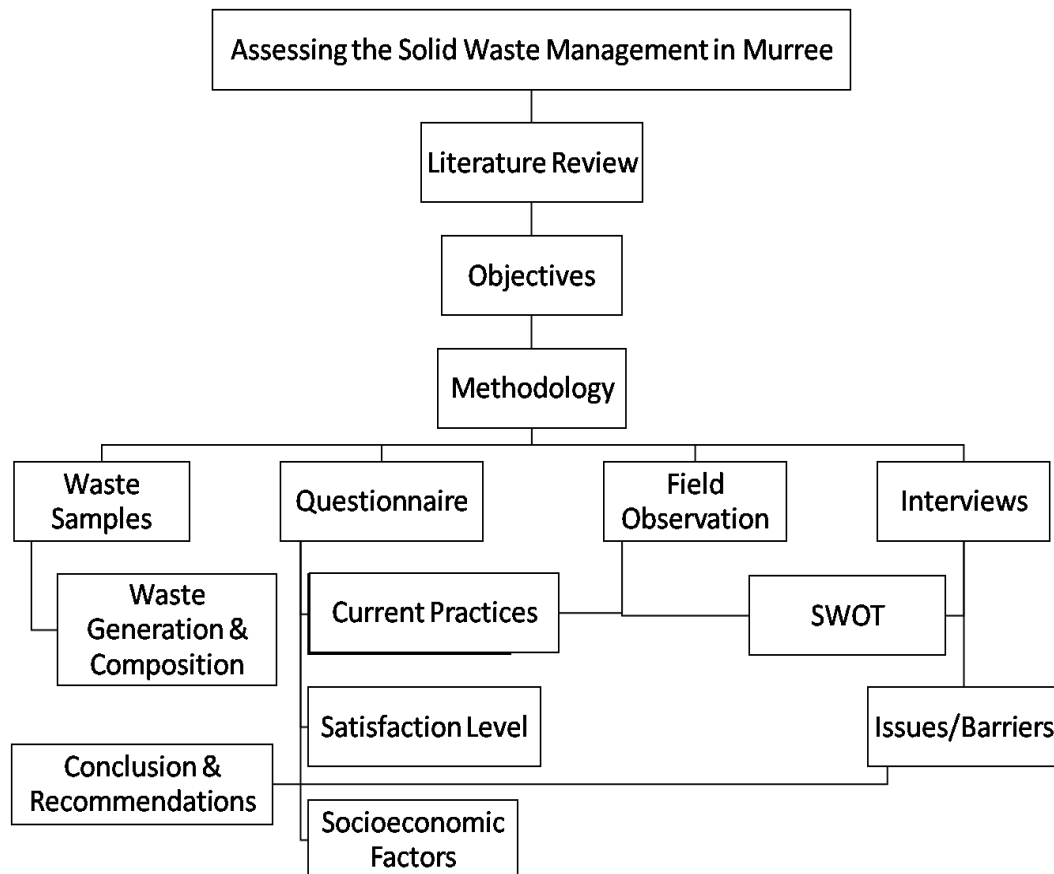
Figure 3.2: Research Design

Chapter 4: Results

4.1 Socioeconomic Profile of Study Area

Socioeconomic characteristics of sampling areas are presented in table 4.1. Average household size in Murree is 7.1. Sunny Bank has the highest average household size (8.0), whereas Kashmir point has lowest average household size (5.8). Murree city has representation of all three income classes i.e. low (31.7%), medium (44.2%), and High (24.1%). Motor Agency, Lower Mall, Pindi Point, Sunny Bank and Kuldana are low to medium income areas, whereas Kashmir Point and Mall Road are predominantly High income areas.

<div align="center">Table 4.1: Socioeconomic profile of study Area</div>

Sr. No.	Area	Average household size	Gender		Income classification		
			Male	Female	Low (%)	Medium (%)	High (%)
1	Motor Agency	7.5	91.3%	8.7%	30.4%	52.2%	17.4%
2	Lower Mall	6.9	72.0%	28.0%	48.0%	36.0%	16.0%
3	Pindi Point	6.2	88.9%	11.1%	33.3%	55.6%	11.1%
4	Sunny Bank	8.0	57.1%	42.9%	47.6%	47.6%	4.8%
5	Kashmir Point	5.8	72.7%	27.3%	9.1%	27.3%	63.6%
6	Kuldana	7.8	90.9%	9.1%	18.2%	72.7%	9.1%
7	Mall Road	n/a	100.0%	0.0%	0.0%	9.1%	90.9%
8	Murree (total)	7.1	80.0%	20.0%	31.7%	44.2%	24.1%

Education level of sampling area is shown in figure 4.1. Educational status of sample respondents ranged from unschooled to master level. Of the total respondents, 5% were

illiterate, 8.3% were primary schooled, 15.8% were middle, 31.7% were metric, 20% were intermediate, 15 % were bachelor, and 4.2 % were master.
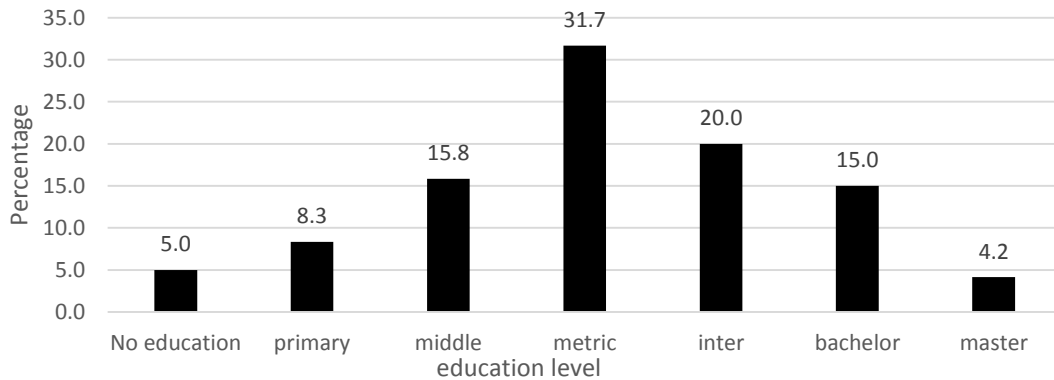
Figure 4.1: Education level of respondents

4.2 Waste Generation

This study estimated the daily solid waste generation rate of urban area of Murree. The estimated rate of solid waste generation of city was about 0.47 kg/capita/day (Figure 4.2). The estimated daily waste generation was about 85 tons/day.
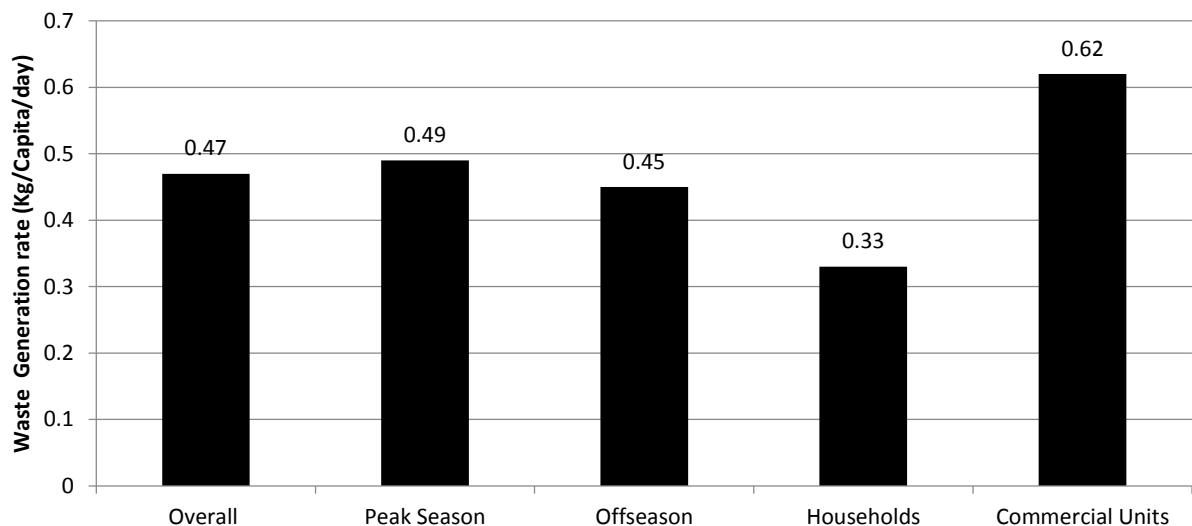
Figure 4.2: Waste generation rate in Murree

As Murree is a tourist city, waste generation rate varies across the seasons. In Peak season, solid waste is generated at the rate of 0.49 kg/ capita/day. Whereas in off season, waste is generated at rate of 0.45 kg/capita/day. Difference in generation rate was also observed in

households and commercial units. Estimated waste generation rate of households and commercial units were 0.33 kg/capita/day and 0.62 kg/capita/day, respectively. This evidently indicates that commercial units such as hotels and shops are major sources of solid waste generation in Murree.

4.3 Waste Composition

Components of solid waste produced in Murree include vegetables waste, wood, grass & leaves, paper, glass, metals, and plastics (Figure 4.3). Major components of this waste were vegetable/kitchen waste (38%), Plastics (30%), and Paper (21%). Data sheet for waste composition is presented in table 4.2.

Table 4.2: Data sheet for Waste Composition

Category	Day							Total Weight (kg)	Composition (%)
	1	2	3	4	5	6	7		
vegetable/kitchen waste	46.7	48	45	39.5	42	54	51.8	326.9	38.4
wood	1.3	0.7	1	1.5	0.4	0.7	1.3	6.9	0.8
Grasses & leaves	9.5	7.3	5.3	10.5	9.5	8.5	8.2	58.9	6.9
Paper	27.5	30	24.5	27	29	22.8	20	180.9	21.2
Glasses	0.7	0.5	0.5	0.6	0.8	0.4	0.5	3.9	0.5
Metals	3.5	1.5	2	1.7	1.8	2.5	1.7	14.9	1.8
Plastics	33.3	39	37.5	40.5	32.7	33	42	258.9	30.4
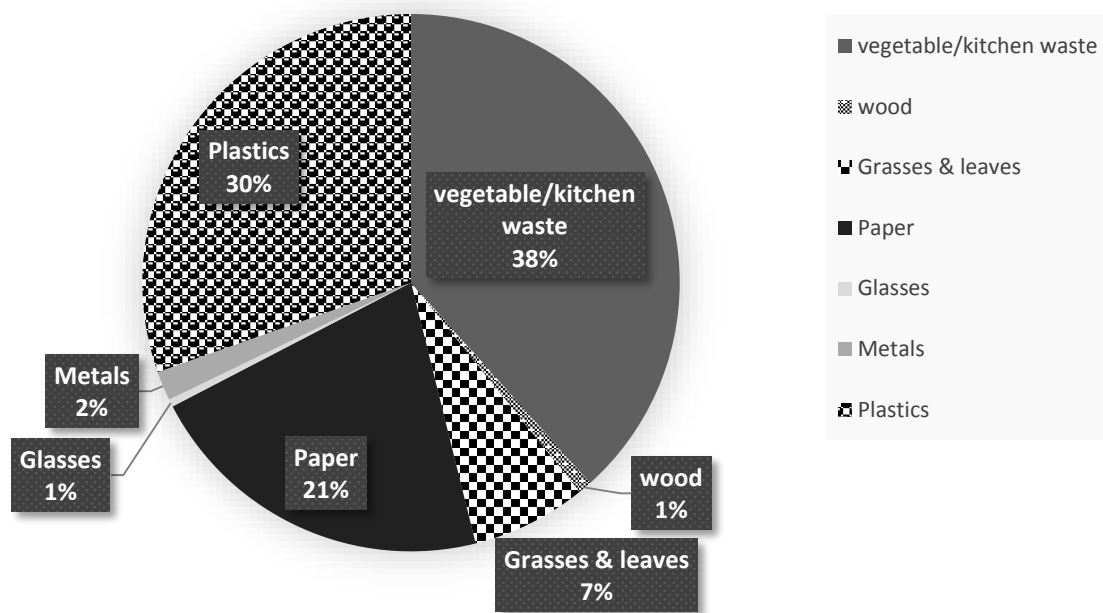
4.4 Household Solid Waste Disposal Practices

This study determined the waste disposal practices adopted by households. In Murree, both legal and illegal practices regarding disposing of household waste were observed. Hand over to waste collectors at door (21.7%) and disposal in nearby waste container (30%) were legal practices (Figure 4.4). Open dumping (15%), Burning (10.8%) and dumping in nallah/sewerage (21.7%) were among the illegal practices.
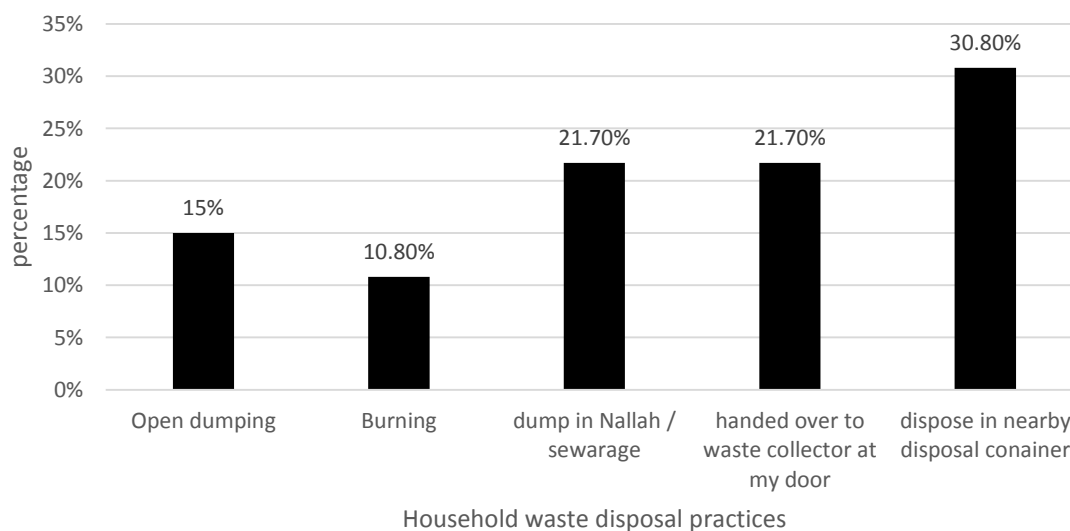
Figure 4.4: Household Solid Waste Disposal Practices

Solid waste disposal practices varies within and across the different localities of Murree (Figure 4.5). Dumping in Nallah/ sewerage drain was most common practices in Motor Agency (52.2%) and Sunny Bank (52.4%). Majority of people at lower Mall (40%) and Kuldana (45.5%) dumped their waste in open spaces. At Pindi point and Kashmir point, disposing of waste in container was most followed practice. People at Mall road either handover their waste to waste collectors (45.5%) or dispose in nearby waste container (45.5%). This difference in waste disposal practices in different areas is because of disparity in level of services in different areas.
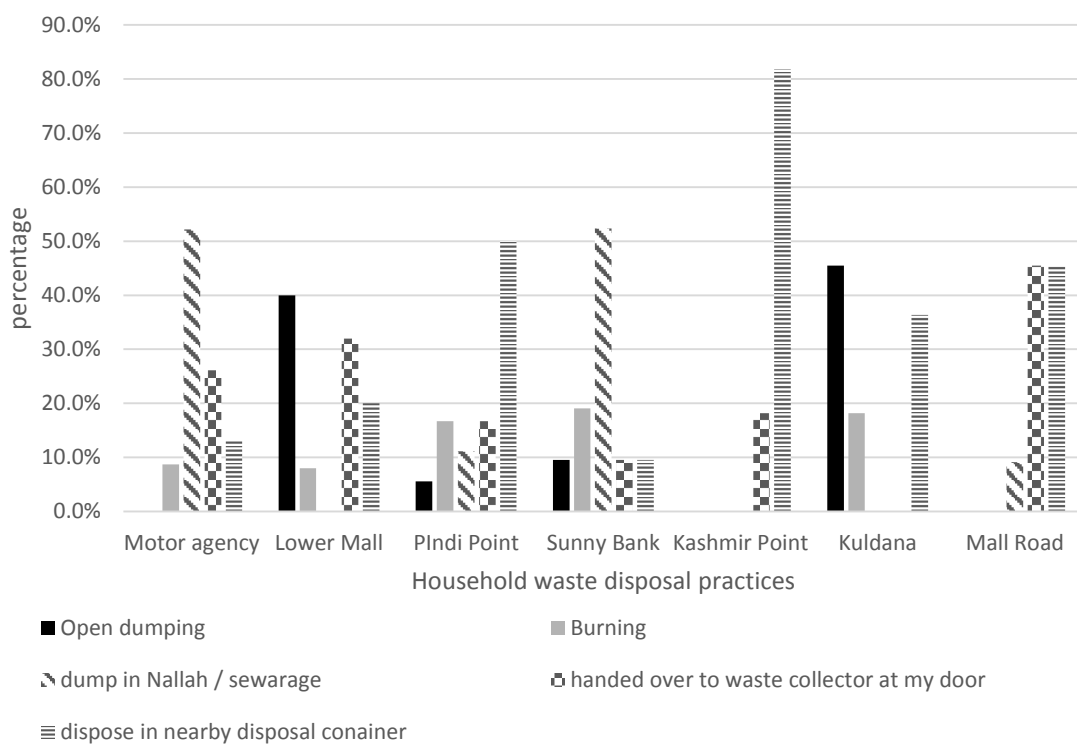
Figure 4.5 Practices followed regarding disposing of household waste in different localities of Murree

4.5 Effectiveness of Waste Collection System

These results indicate the effectiveness of waste collection system. Because, legal practices such as door to door waste collection service and disposal in nearby disposal container led to proper collection of waste from authorized places. Whereas illegal dumping at unauthorized

places point- out the failure or ineffectiveness of waste collection system. Effectiveness of solid waste collection system was about 52.5% (Figure 4.6).
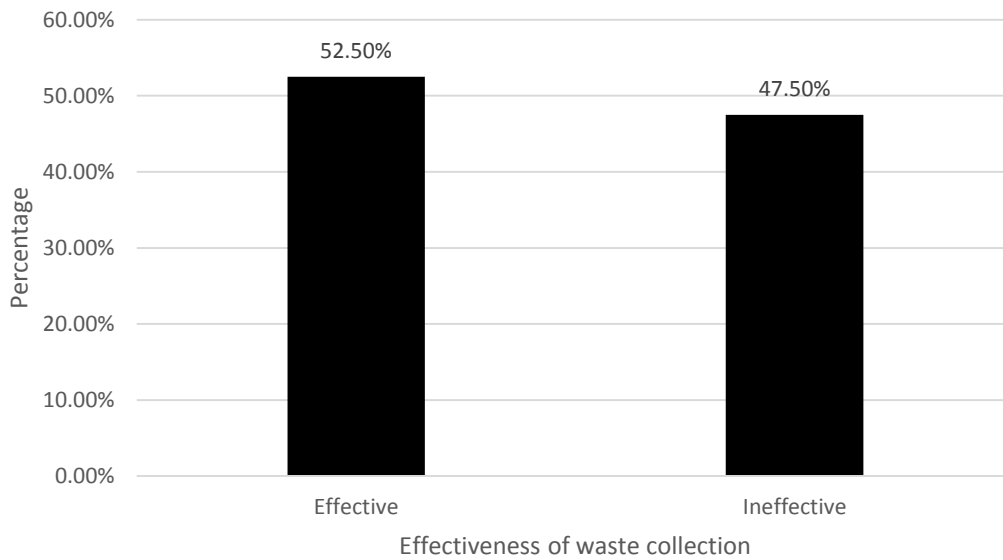
Figure 4.6 Effectiveness of solid waste collection system.

Effectiveness of waste collection system was not the same in all areas. It varied from location to location. Waste collection was found very effective in some areas such as Kashmir point (100%) and Mall Road (90.9%).
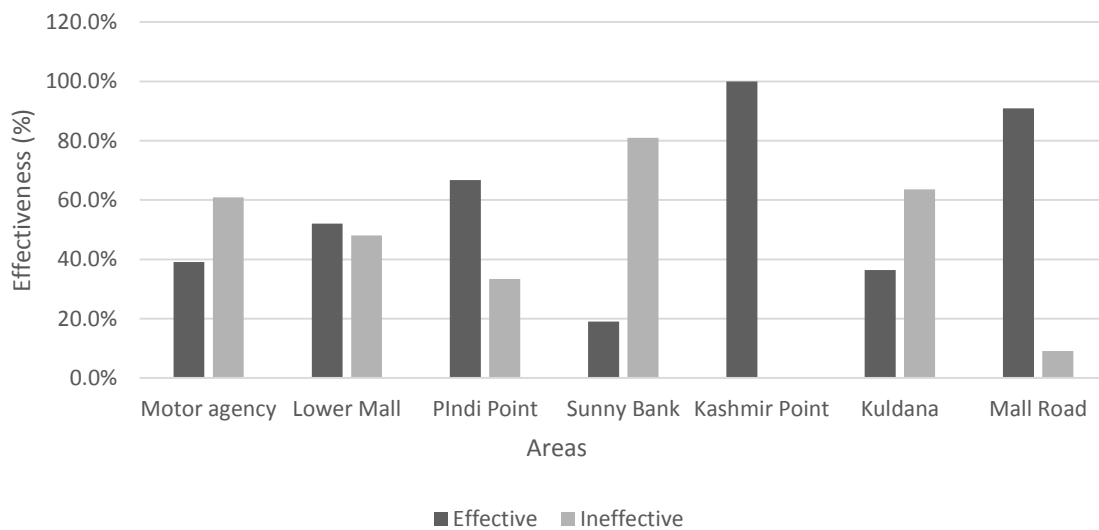
Figure 4.7: Effectiveness of waste collection system in different localities of Murree

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Only 52% and 66.7% of solid wastes generated were collected effectively in Lower Mall and Pindi Point, respectively. Some areas such as Sunny Bank, Kuldana and Motor Agency were witnessed to ineffective collection of solid waste (Figure 4.7). Effectiveness of waste collection system varied in different areas due to various socioeconomic factors and difference in level of services.

4.6 Frequency of Waste Collection

Most of the respondents reported that their household waste is collected daily (43.30%). whereas, 24.20% of people said that waste collection staff never visits their area for waste collection (Figure4.8).
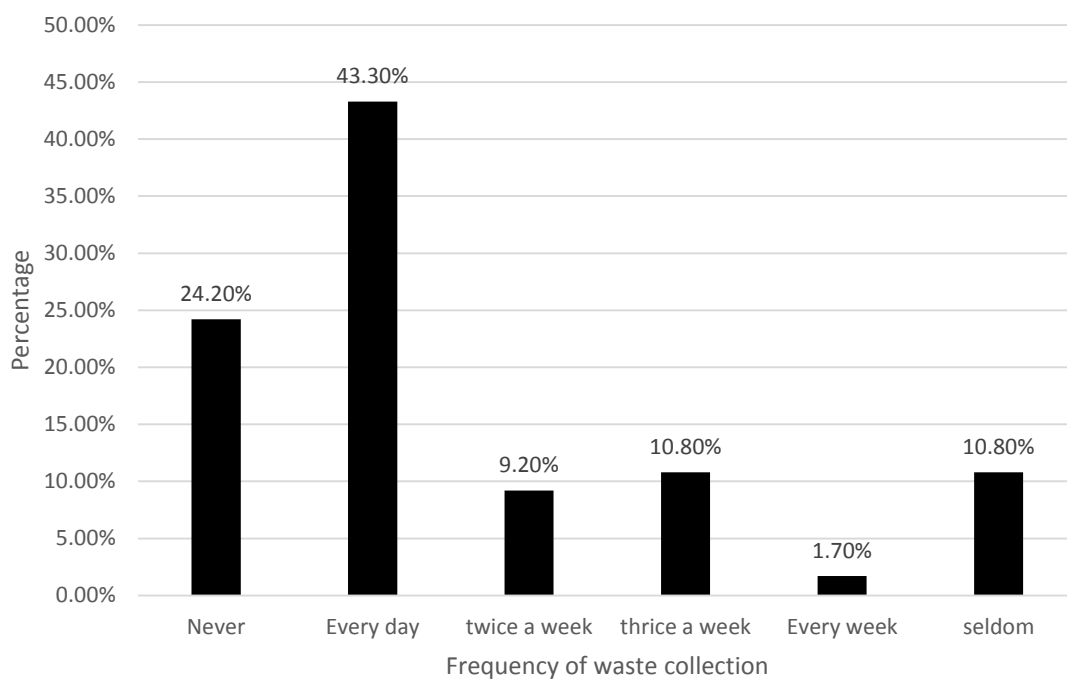
Figure 4.8: Frequency of waste collection in Murree.

Although, solid waste was collected daily in general (Figure 4.8), but there were few areas where no or little attention regarding collection of waste was paid. Among the areas, where frequency of waste collection was very low were Sunny Bank, Motor Agency and Kuldana as

presented in Figure 4.9. On the other hand, frequency of waste collection services was high in Kashmir point and Mall Road.
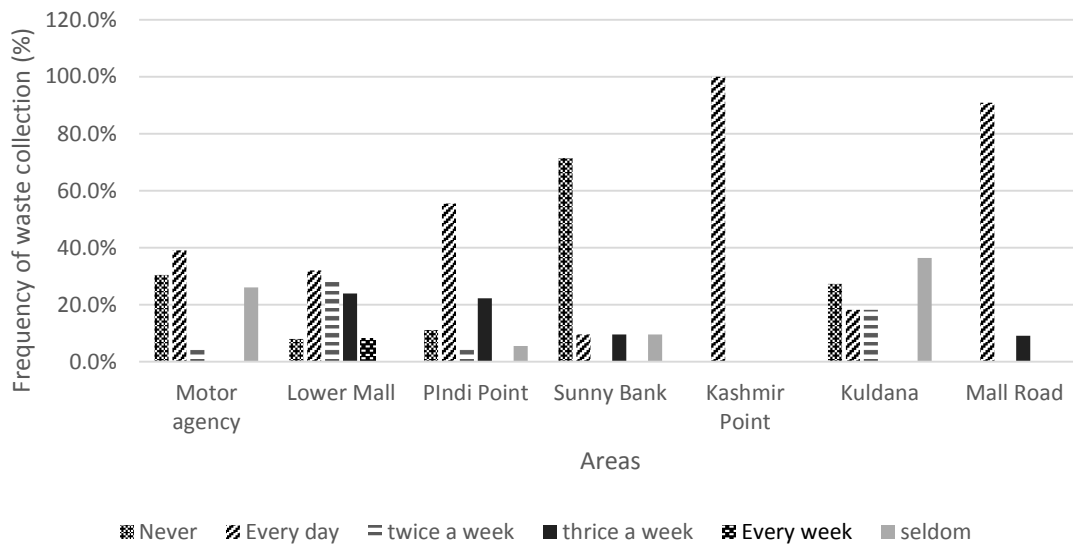
Figure 4.9: Frequency of waste collection in different areas of Murree

4.7 Availability of Communal Waste Disposal Container

Availability of adequate number of solid waste disposing container is important to collect and manage waste in effective manner. Number of solid waste disposing container available in Murree was not adequate, because nearly half of the respondents (45.8%) reported that they had no solid waste container in their neighborhood.
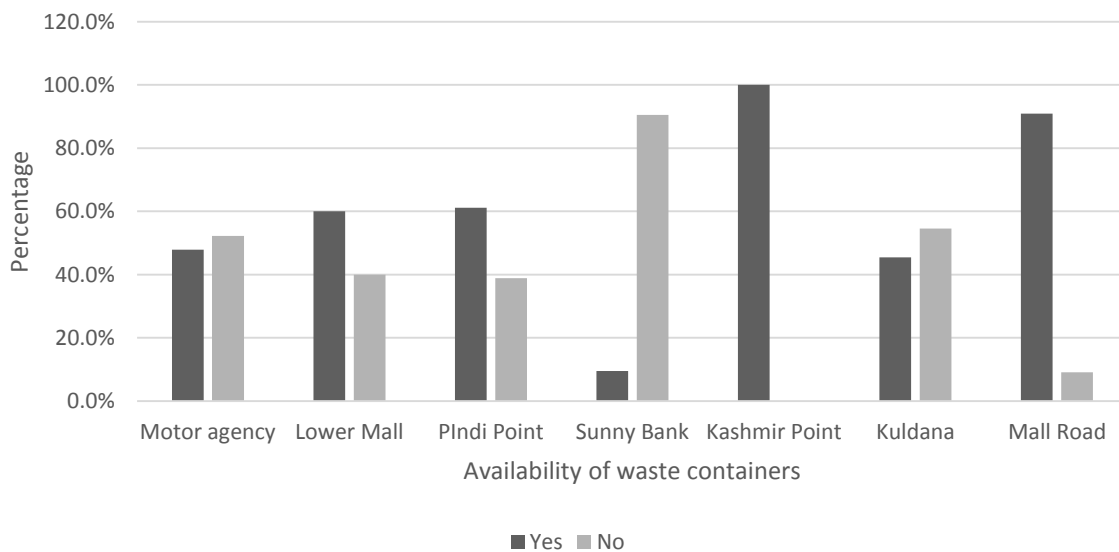
Figure 4.10: Availability of solid waste disposal containers in different areas of Murree

Availability of solid waste disposing container varied from location to location (Figure 4.10). Kashmir Point and Mall Road were found having sufficient number of disposal container. On the other hand, a severe shortage of disposal containers was spotted in Sunny Bank.

4.8 Waste Transfer and Final Disposal

For the purpose of solid waste collection and transportation, first communal containers are unloaded to transfer station with the help of compactors and mini dumpers by Waste Management Authority. There are currently two compactors and four mini dumpers available in Murree. Compactors have the capacity of six ton, whereas mini dumpers have capacity of one tone. These compactors and mini dumpers lift the waste and transport it to the dumping site at Kuldana. This dumping site is being used as transfer station, where waste collected from different collection points of Murree is stored temporarily. Then this waste transferred to a landfill site at Losar, Rawalpindi for final disposal. At this landfill, waste is being disposed openly. No facility for waste recycling and composting is available at this site.

4.9 Satisfaction Level of the Community

When asked to rate the performance of Waste management authority of Murree, Most of respondents were not satisfied with the performance of waste management authority (Figure 4.11).
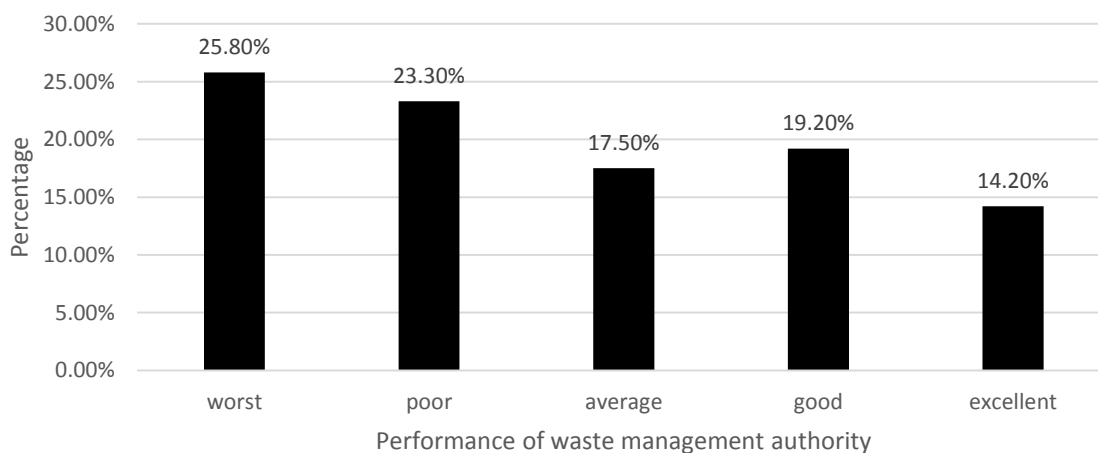
Figure 4.11: Satisfaction level of community on performance of waste management authority in Murree.

Of total respondents, percent of respondents who rated their performance as worst and poor were 25.8% and 23.3% respectively. While 17.5% of respondents assessed their performance as average. Whereas, 19.2% and 14.2% of respondents appraised the performance of waste management authority of Murree as good and excellent respectively.

The performance of waste management authority of Murree varied from location to location. Majority of respondents from Kashmir point and Mall Road positively appraised the performance of waste management authority. Whereas, most of respondents from Sunny Bank, Motor agency and Kuldana regarded their performance as poor. (Figure 4.12).
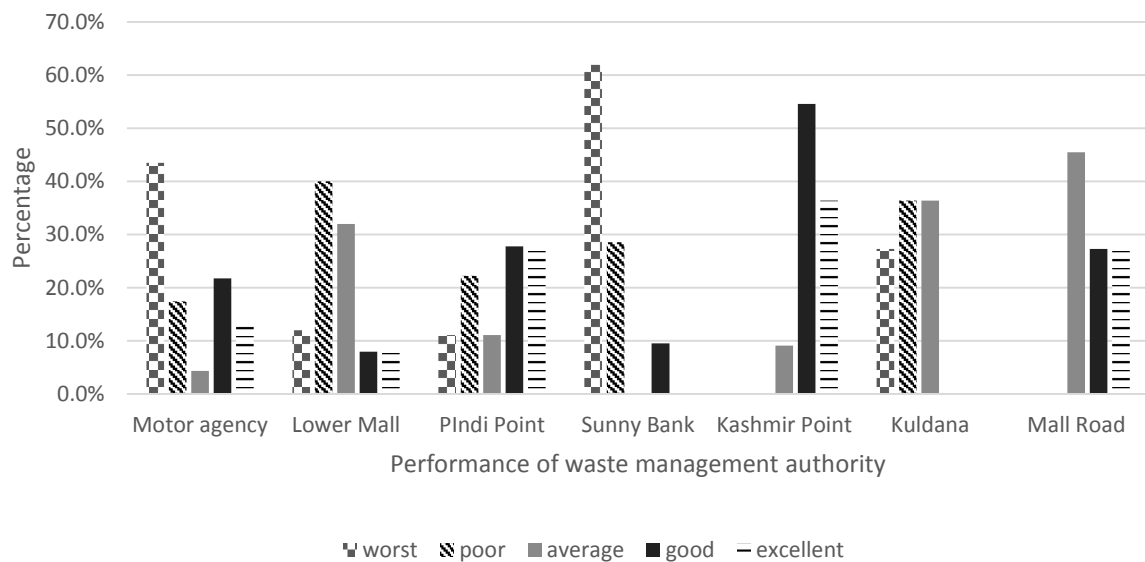
Figure 4.12: Satisfaction level of community on performance of waste management authority in different areas of Murree

Satisfaction level of households and commercial units about the performance of waste management authority was different. Most of commercial units rated the performance of waste management authority as good (45%) and excellent (30%). 20% of commercial units regarded the performance of waste management authority as average (Figure 4.13). whereas only, 5% of commercial units rated their performance as poor. on the other hand, most of the households rated the performance of waste management authority as worst (31%) and poor (27%). 17% of

households regarded the performance as average. whereas, 14% and 11% of households rated the performance of waste management authority as good and excellent respectively.
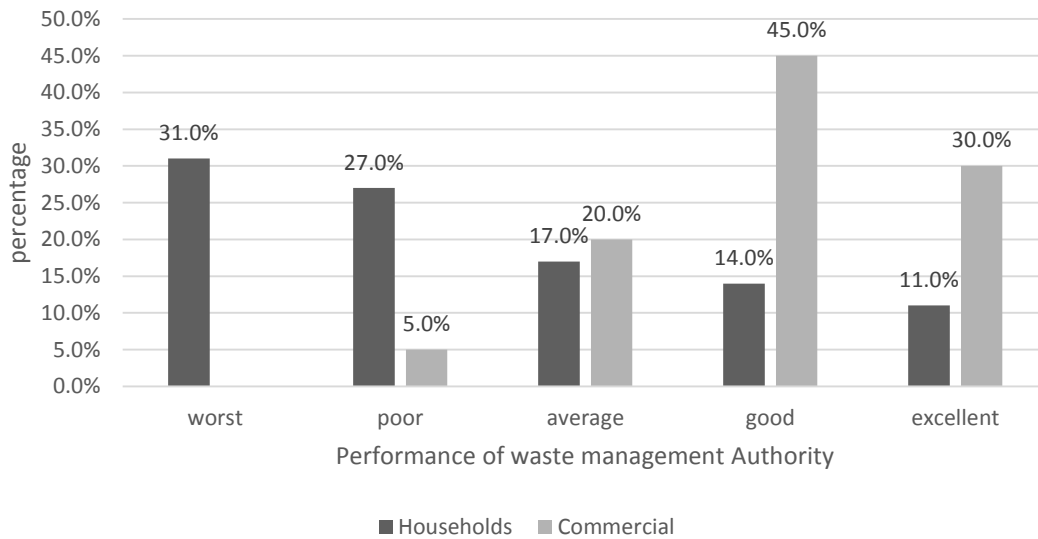
Figure 4.13: performance of waste management authority in households and commercial units.

It was observed that performance of waste management authority declined with the increase in distance of households from roadside (Figure 4.14). Most of households located at road rated the performance of waste management authority as good (44.2%) and excellent (25.6 %). however, most of households located away from roadside regarded the performance of waste management authority as poor and worst.
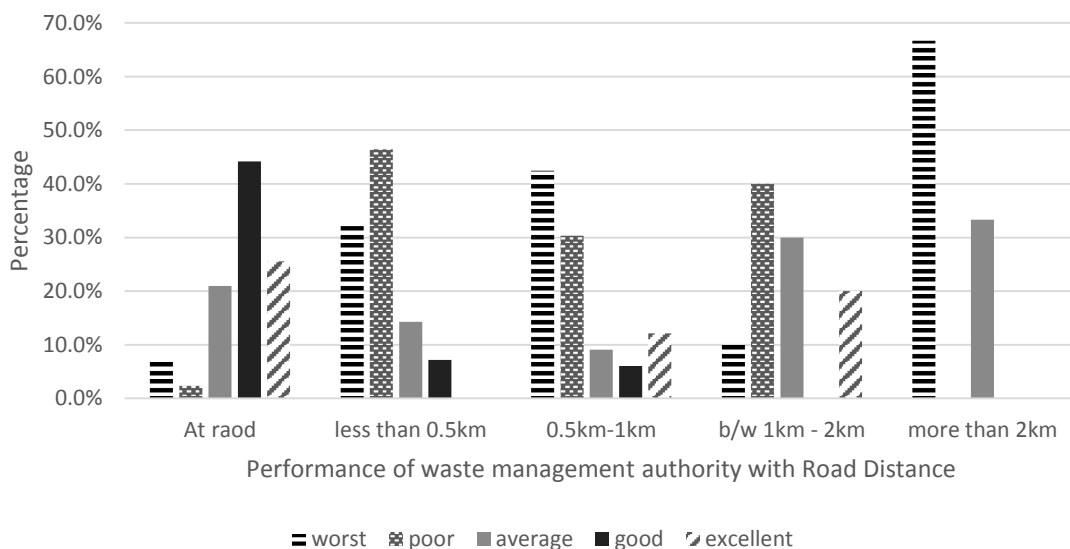
Figure 4.14: Effect of road distance on performance of waste management authority.

4.10 Formal Waste Segregation Practices

There were almost no waste separation Practices observed at source level in Murree (Figure 4.15). Merely 1.7% of respondents were found practicing waste separation. Whereas, 98.3% of respondents were not practicing any kind of waste segregation at source level.
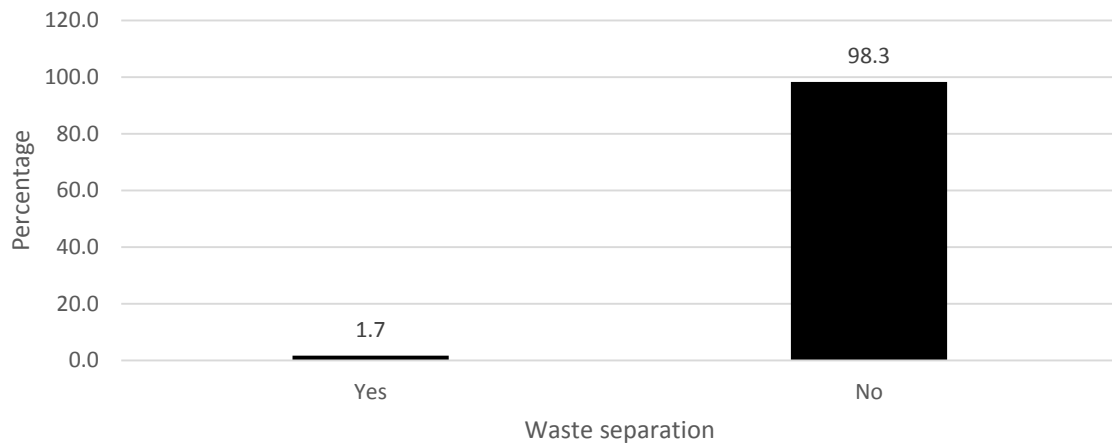
Figure 4.15: Waste separation Practice in Murree

Lack of understanding about waste separation (50%) was major reason of not practicing waste separation (Figure 4.16). A significant amount of respondents (25%) blamed on waste collection authorities for not carrying out waste separation, as households were not asked by waste collectors to do source separation. Some of respondents (14.2%) did not regard waste separation as their responsibility. A small number of respondents (9.2%) did not visualize the importance of waste separation.
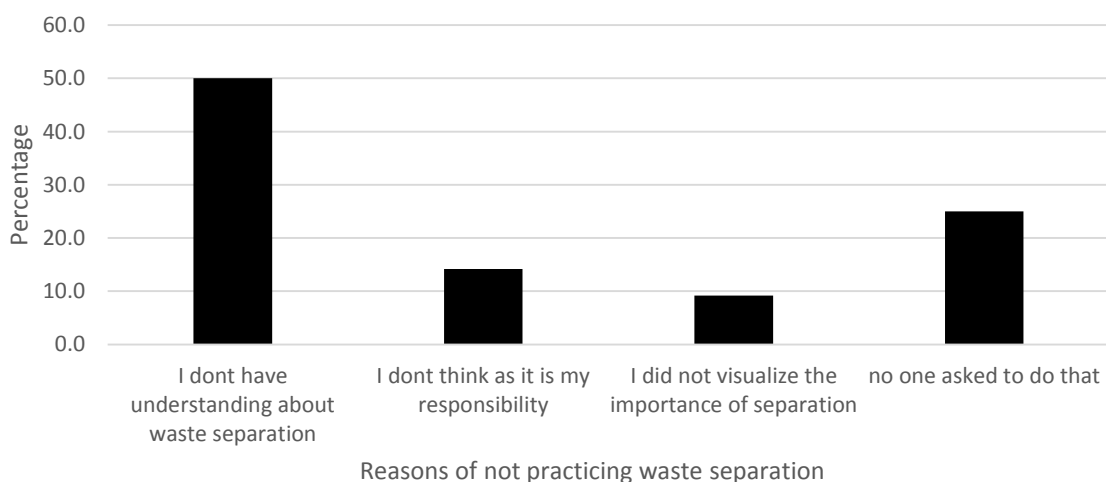
Figure 4.16: Reasons of not practicing waste separation

4.11Attitude of Community about Waste Management

Attitude of the population is vital element in successful implementation of waste management strategy of an area. Attitude of people towards different aspects of solid waste management was determined. Majority of Population (77.5%) of Murree had positive attitude towards waste separation, as they were willing to separate solid waste at household level (Figure 4.17). Only 22.5% of respondents were reluctant about waste separation. Willingness to pay for improved services of solid waste management was not much high; only 55% of population was willing to pay for improved services, while 45% of Inhabitants were unwilling to pay for upgraded services. Most of the people (61.7%) depicted negative attitude regarding willingness to participate in any waste related activity, as they were reluctant to participate in waste management related activity. only 38.3% respondents were willing to participate in waste management related activity.
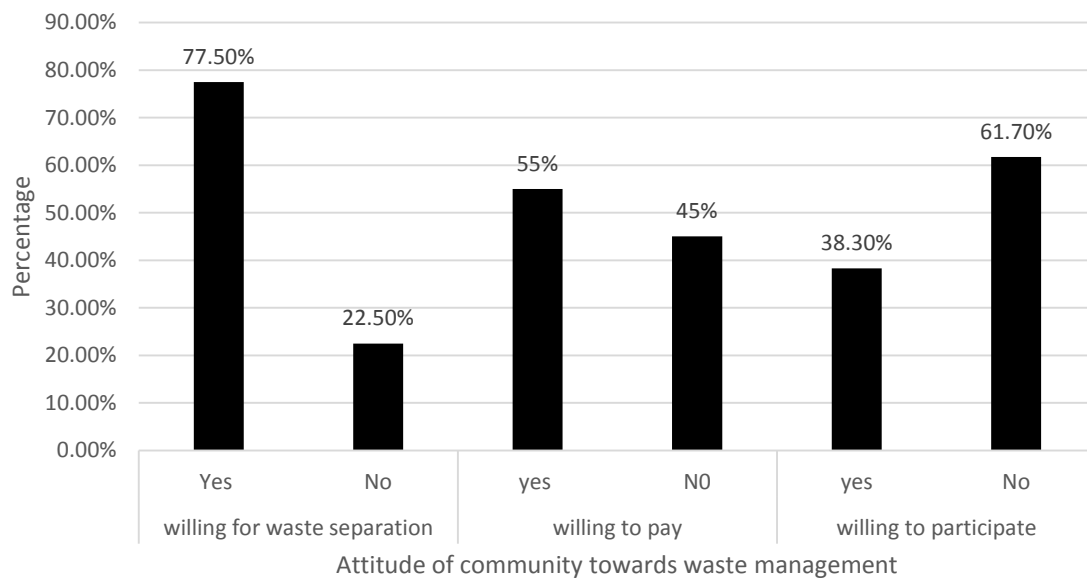
Figure 4.17: Attitude of Population of Murree towards solid waste Management.

Chapter 5:   Discussion

A Pearson product-moment correlation coefficient was computed in order to assess the association of amount of waste generation with different socioeconomic aspects of community. Table 5.1summarizes the relationships among amounts of waste generation, household size, income level, types of waste source, dissemination of awareness about solid waste management. Correlation analysis indicates that quantity of waste generation, household size, income level, type of waste source has significant relationship with each other, whereas dissemination of awareness about waste management has no significance relationship with any of these variables.

Table 5.1: Correlation of different socioeconomic variables with waste generation

Item	X1	X2	X3	X4	X5
X1	1	.610**	.189*	.379**	-0.109
X2		1	.187*	.180*	-0.015
X3			1	.454**	-0.075
X4				1	-0.08
X5					1

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

*. Correlation is significant at the 0.05 level (2-tailed).

X1-- daily waste generated

X2--Household size

X3--Income Level

X4--Type of waste source

X5--Dissemination of awareness about solid waste management

Household size has strong positive correlation with quantity of waste generation, (r = .610, n = 120, p = 0). It means that higher the household size, higher will be the solid waste generation. In broader context, it implies that quantity of solid waste generation is directly dependent on

population size of the area. Household size also has significant relationship with income level, (r = 0.187, n = 120, p = 0.041). A positive relation between household size and income level denotes that income level rises with increase in household size. This increase in income level may be due to more number of earning members in bigger families. This increase in income level can affect the generation of solid waste, as income has great influence on lifestyle of people. Similarly, there is significant relationship between household size and type of waste source. Household size has no significant relationship with dissemination of awareness about solid waste management.

There is significant positive correlation between income level and amount of waste generation (r = 0.189, n = 120, p = 0.039). This relationship signifies that higher the income level, more will be solid waste generation. This increase in waste generation with rise in income is due the fact that income has great influence on lifestyle of people. Increase in income can change the buying power of people which in turn changes the consumption pattern that leads to increase in waste generation. Income level has also significant relationship with type of waste source (r = 0.180, n = 120, p = 0.454). It means that income level varies between different types of waste source. Commercial units have higher income level than households, and produce more waste than households. There was no significant relationship was found between income level and dissemination of awareness about solid waste management.

Types of waste source is positively correlated with amount of waste generation (r = 0.397, n = 120, p =0). A significant relationship between these two variables denotes that quantity of waste generated varies with type of waste source such as households, hotels, restaurants, shops etc. commercial units produce more waste than households. Types of waste source had no significant relationship with dissemination of awareness about solid waste management.

Although correlation exist between amount of waste generation and dissemination of awareness about solid waste management (r = -0.109, n = 120, p = 0.238), but it is not significant. The negative value claims that amount of waste generation and dissemination of awareness about waste management has inverse relation. It means that if more awareness is provided to public regarding waste management, less will be amount of waste generation.

5.1 Factors affecting the solid waste management

There are number of socioeconomic factors that can influence the solid waste management of Murree. These factors include income level, education, types of waste sources, distance between road and waste generation source, awareness about solid waste management, and attitude of population towards solid waste management. These factors are very important in planning and execution of solid waste management strategy of an area.

Income level is important factor that can influence the solid waste management of an area. It was observed that that solid waste management in Murree was income biased. A positive relationship between income level and effectiveness of waste collection system was observed (Figure 5.1), as effectiveness increases with increase in income. Solid waste collection was more effective in High income areas such as Kashmir Point and Mall Road as compared to lower income and middle income areas, because they had better services than other areas.
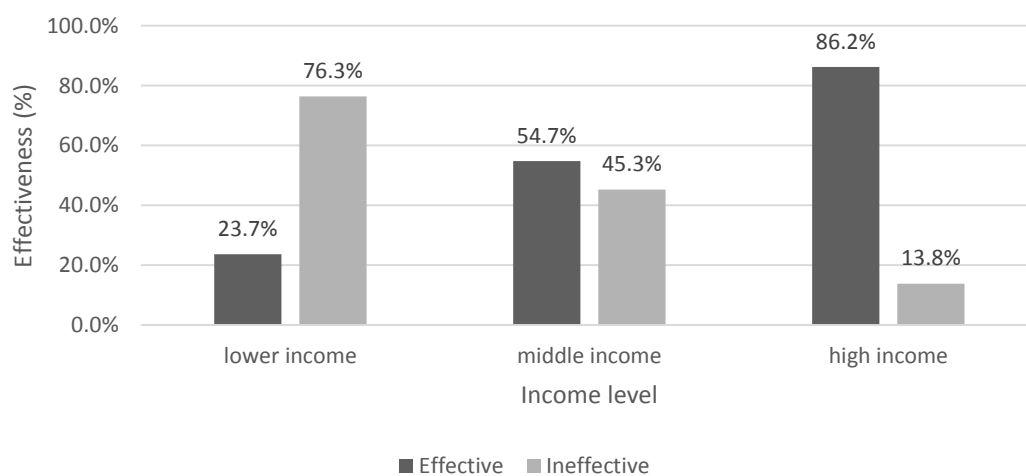
Figure
5.1: Effect of income level on Effectiveness of waste collection system

When compared the frequency of waste collection services, this was evident from the results that high income area had higher frequency of waste collection services as compared to lower income and middle income areas (Table 5.2).Also it was noted that high income area were equipped with more number of disposing containers with respect to other lower income areas. For that reason, performance of waste management authorities varied with income level. Performance of waste management authorities was assessed as good in high income areas, whereas their performance was evaluated as poor in lower income areas.

Table 5.2: Influence of Income level on waste management

parameter	Description	Income Classification		
		Low	Medium	High
Waste Disposal Practices	Open dumping	23.7%	15.1%	3.4%
	Burning	23.7%	7.5%	
	dump in Nallah / sewerage	28.9%	22.6%	10.3%
	handed over to waste collector at my door	13.2%	11.3%	51.7%
	dispose in nearby container	10.5%	43.4%	34.5%
Effectiveness of waste collection	Effective	23.7%	54.7%	86.2%
	Ineffective	76.3%	45.3%	13.8%
Frequency of waste collection	Never	42.1%	20.8%	6.9%
	Every day	18.4%	37.7%	86.2%
	twice a week	10.5%	11.3%	3.4%
	thrice a week	10.5%	15.1%	3.4%
	Every week	5.3%		
	seldom	13.2%	15.1%	
Availability of waste disposing container	Yes	26.3%	56.6%	86.2%
	No	73.7%	43.4%	13.8%
Satisfaction Level	worst	31.6%	32.1%	6.9%
	poor	44.7%	17.0%	6.9%
	average	13.2%	18.9%	20.7%
	good	2.6%	17.0%	44.8%
	excellent	7.9%	15.1%	20.7%

Disparity of services between residential and commercial units was evident in Murree (Table 5.3). Commercial areas were equipped with more effective waste management services as compared to households. Frequency of waste collection services was high in commercial areas. Moreover, commercial areas were provided with adequate number of waste disposal containers. That is why commercial units followed legal practices regarding disposing of solid waste. On the other hand, indiscriminate dumping of waste at unauthorized places such as streets, roads, sewerage/Nallah etc. was most common in residential units (Figure 5.2).
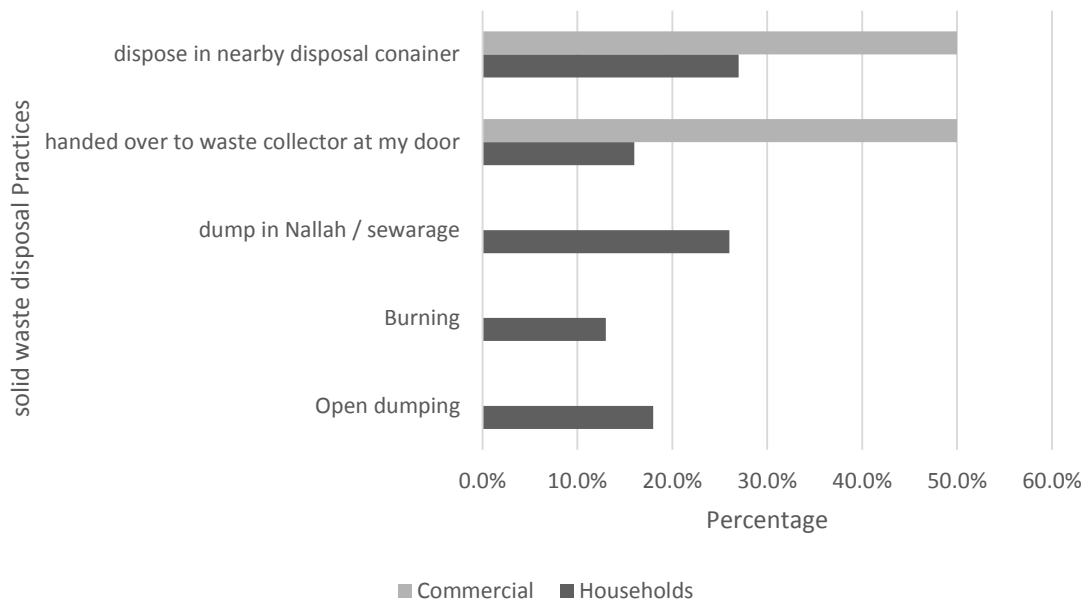
Figure 5.2 waste disposal practices by households and commercial units

This unauthorized dumping can be attributed to inadequate services of solid waste management in residential areas, as frequency of waste collection services and availability of waste disposal containers were very low in residential area. This low frequency of waste collection services and inadequate amount of disposal containers compelled the households to dump their waste at unauthorized places.

Table 2.3: Disparity of waste management services between households and commercial units.

Parameter	Description	Waste Source	
		Households	Commercial
Waste Disposal Practices	Open dumping	18.0%	
	Burning	13.0%	
	dump in Nallah / sewarage	26.0%	
	handed over to waste collector at my door	16.0%	50.0%
	dispose in nearby disposal container	27.0%	50.0%
Effectiveness of waste collection	Effective	43.0%	100.0%
	Ineffective	57.0%	
Frequency of waste collection	Never	29.0%	
	Every day	33.0%	95.0%
	twice a week	11.0%	
	thrice a week	12.0%	5.0%
	Every week	2.0%	
	seldom	13.0%	
Availability of waste disposal container	Yes	45.0%	100.0%
	No	55.0%	
Satisfaction Level	worst	31.0%	
	poor	27.0%	5.0%
	average	17.0%	20.0%
	good	14.0%	45.0%
	excellent	11.0%	30.0%

Distance of Households from the road is very key aspect in solid waste management of a city. Effectiveness of solid waste management system is expected to vary with distance. Table 5.4 summarizes the effects of road distance on waste management services in Murree. It was observed that most of people at road legally dispose their solid waste at authorized places (Figure 5.3). Illegal dumping of waste at unauthorized places was increased as the distance

between road and household increased. Households are motivated to dump their waste illegally at unauthorized places, when they are located far away from roads.
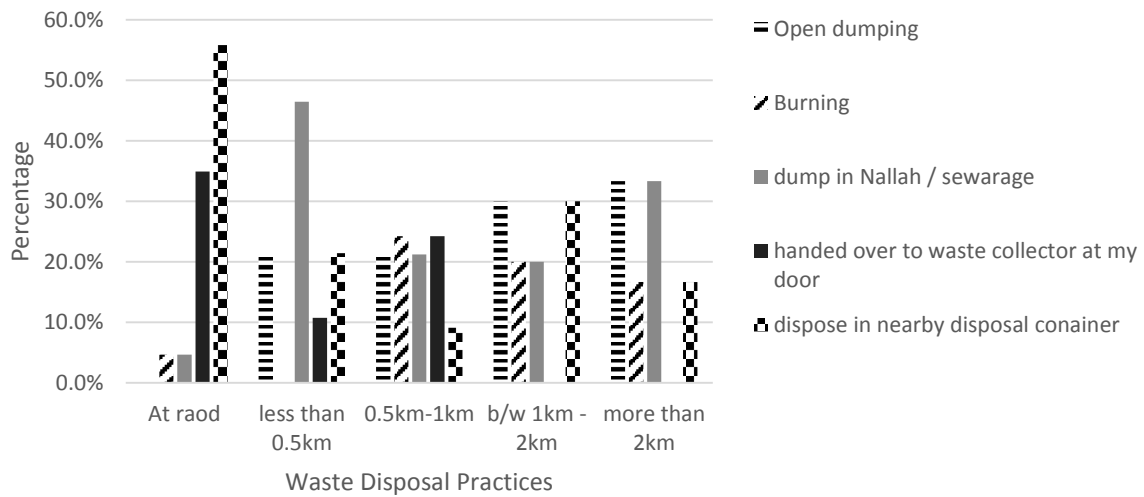
Figure 5.3: Effect of distance between road and home on waste disposal practices

Table 5.4: Effect of distance of household from roadside on solid waste management services

Parameter	Description	Distance of Road from Household				
		At Road	less than 0.5km	0.5km-1km	b/w 1km - 2km	more than 2km
Waste disposal Practices	Open dumping		21.4%	21.2%	30.0%	33.3%
	Burning	4.7%		24.2%	20.0%	16.7%
	dump in Nallah / sewerage	4.7%	46.4%	21.2%	20.0%	33.3%
	handed over to waste collector at my door	34.9%	10.7%	24.2%		
	dispose in nearby disposal container	55.8%	21.4%	9.1%	30.0%	16.7%
Effectiveness	Effective	90.7%	32.1%	33.3%	30.0%	16.7%
	Ineffective	9.3%	67.9%	66.7%	70.0%	83.3%
Frequency of waste collection	Never	2.3%	28.6%	42.4%	30.0%	50.0%
	Every day	88.4%	17.9%	15.2%	40.0%	

	twice a week		7.1%	15.2%	10.0%	50.0%
	thrice a week	2.3%	14.3%	21.2%	10.0%	
	Every week			6.1%		
	seldom	7.0%	32.1%		10.0%	
Availability of waste disposal container	Yes	93.0%	39.3%	27.3%	40.0%	16.7%
	No	7.0%	60.7%	72.7%	60.0%	83.3%
Satisfaction Level	worst	7.0%	32.1%	42.4%	10.0%	66.7%
	poor	2.3%	46.4%	30.3%	40.0%	
	average	20.9%	14.3%	9.1%	30.0%	33.3%
	good	44.2%	7.1%	6.1%		
	excellent	25.6%		12.1%	20.0%	

Figure 5.4 shows that effectiveness of solid waste collection system varies with distance of road from household. Solid waste collection in Murree is very effective (90.7%) at roads. on the other hand, effectiveness of solid waste collection declines as the location of households moves away from roads. this falloff in effectiveness is result of poor services of waste collection. waste collection staff usually collect waste daily form roadsides, whereas they don't bother to visit regularly in areas away from roads. Furthermore, households located far away from roadsides are motivated to throw their waste in open spaces and sewerages due to dearth of solid waste disposal containers.
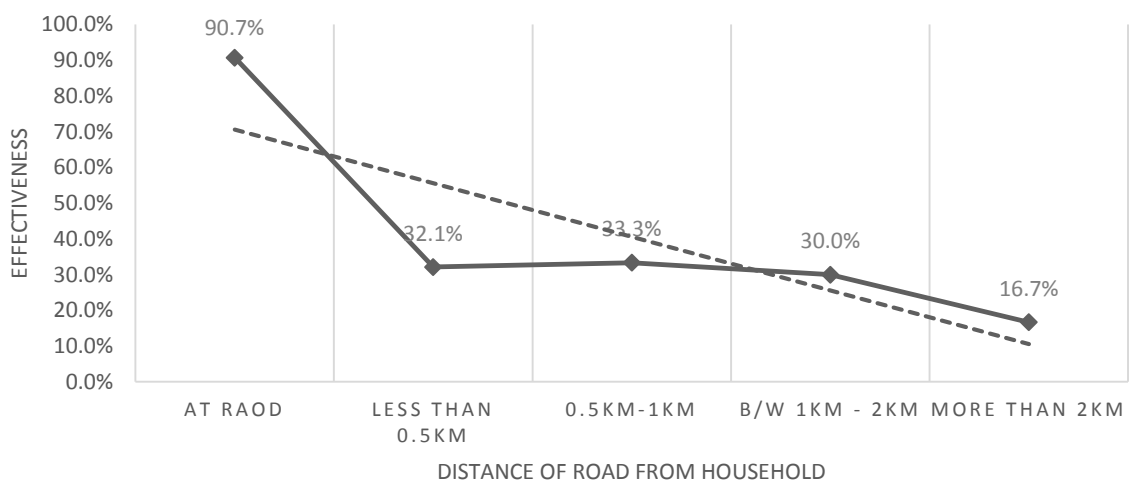
Figure 5.4: Relationship between distance of road from household and effectiveness of waste collection

Education brings positive behavior among stakeholders towards waste management, as it enhances civic sense. Figure 5.5 indicates that behavior of stakeholders regarding disposing of their solid waste varies with education level.
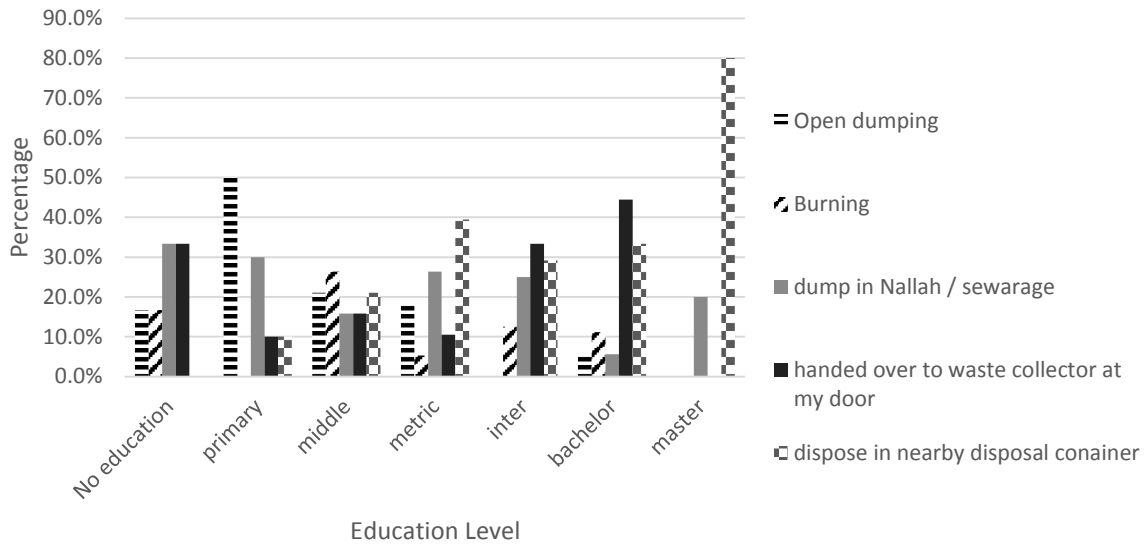
Figure 5.5: Influence of education level on waste disposal practices

It was observed that stakeholders having more education often used legal means of disposing their solid waste, such as to hand over it to waste collectors or dispose it in nearby disposal container. Whereas people having low education indiscriminately dispose their waste at unauthorized places due to lack of civic sense.
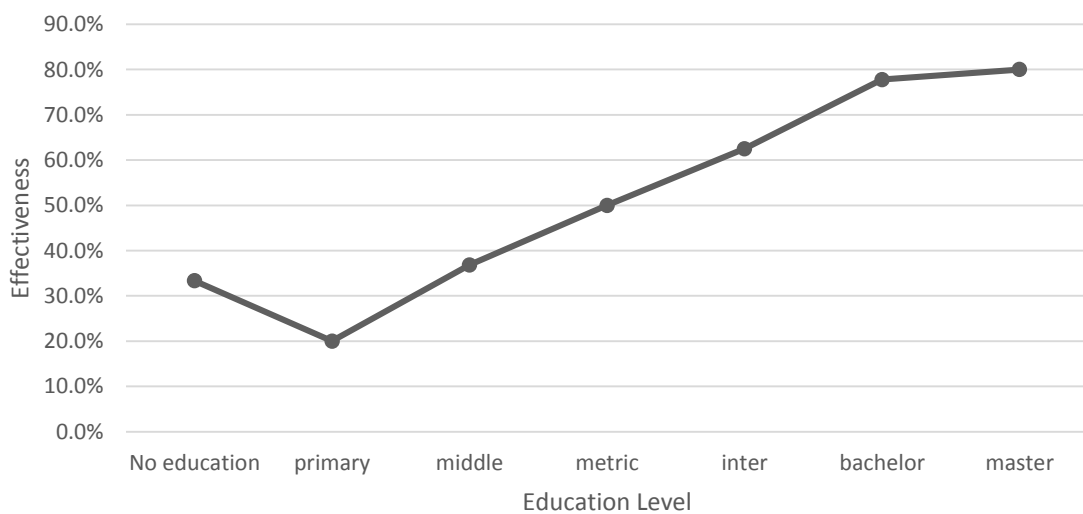
Figure 5.6: relationship between education level and effectiveness of waste management system.

Education plays a vital role in effective implementation of waste management strategy. Education level and effectiveness of solid waste management are positively related. Results had depicted that effectiveness of solid waste management improves with improvement in education level of stakeholders (Figure 5.6).

Education is important determinant to judge the attitude of population towards solid waste management. Figure 5.7 shows that when the education level of household improves, willingness to participate in waste related activities also improves. This establishes that the higher the education level of households, more positive will be the attitude of population towards waste management. That is why education is basic factor in implementing the waste management strategy.
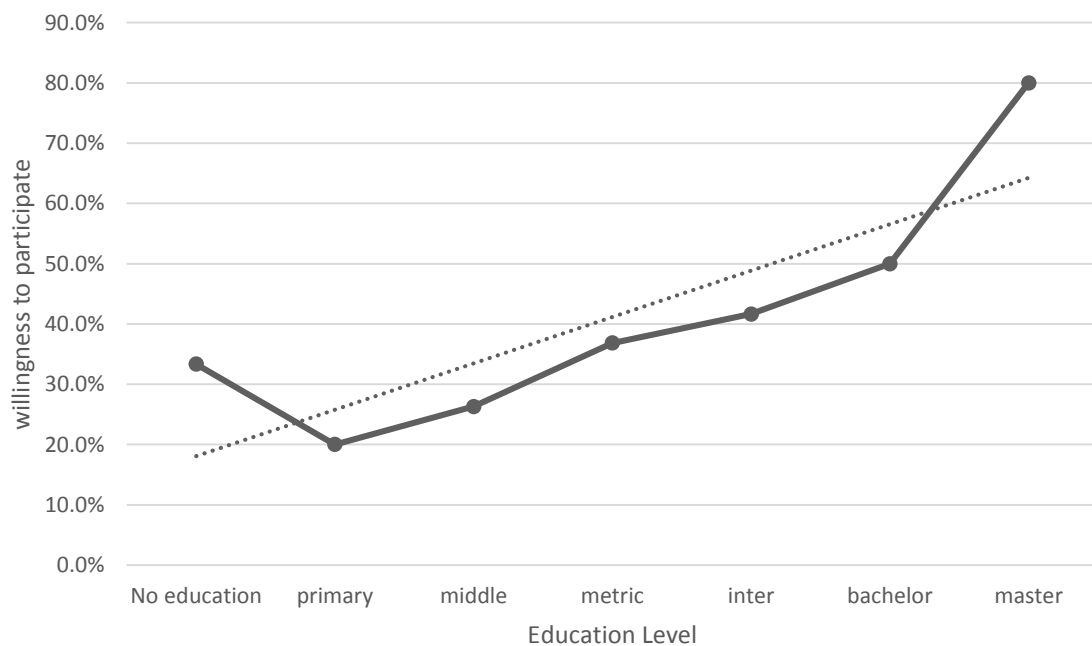
Figure 5.7 Relationship between education level and attitude of population

Awareness of population about solid waste management and their education level are two important aspects which shape the attitude of people when implementing the waste management strategy. This study had revealed that awareness of population about waste

management is directly dependent on education. This means that education level and awareness level have positive relationship; higher the education level, higher will be awareness about solid waste management (Figure 5.8).
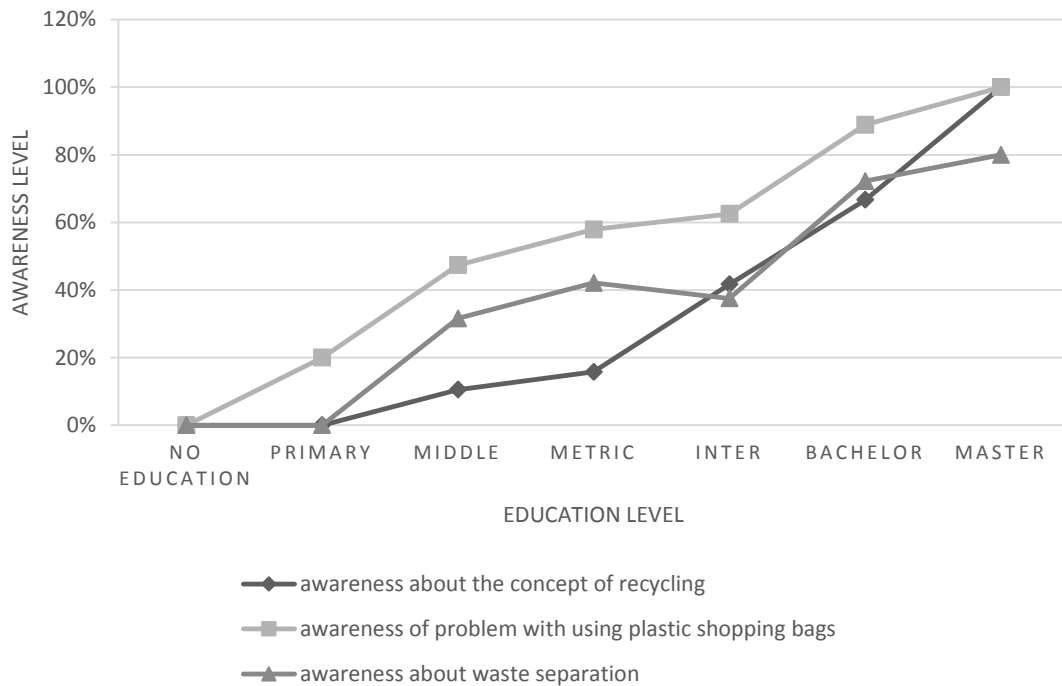
Figure 5.8: Relationship between education and awareness about waste management.

Awareness of Population about solid waste management is necessary for effective functioning of solid waste management system. Figure 5.9 shows that awareness about solid waste management and effectiveness of waste management system has positive relationship, because Effectiveness of solid waste management system improves with increase in awareness level of population. Therefore, awareness about solid waste management should be imparted among the population for effective waste management.
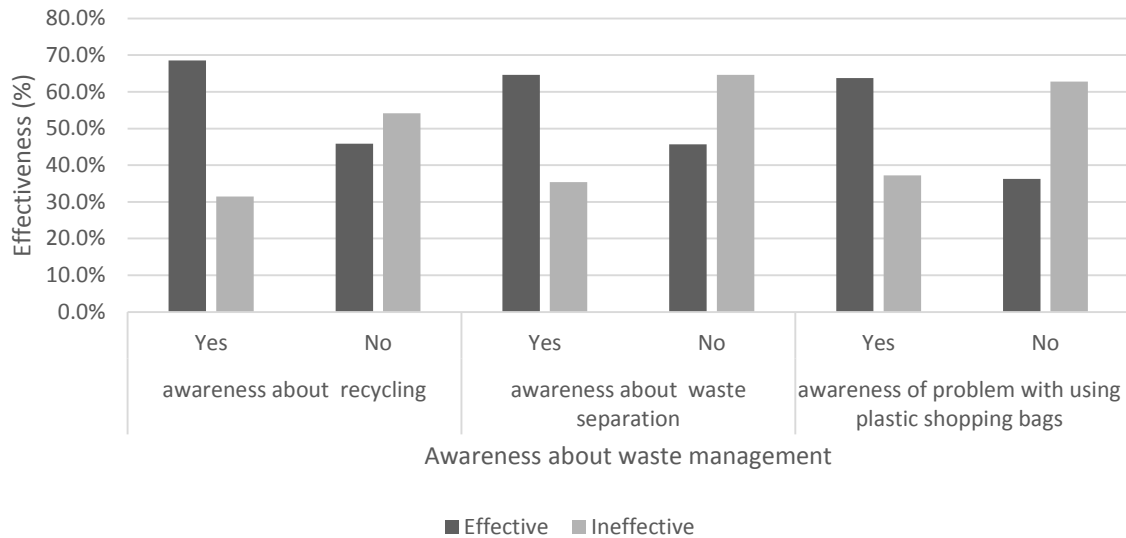
Figure 5.9: Relationship between awareness and effectiveness of solid waste management.

Attitude towards solid waste management varies among different stockholders. It was noticed that households showed more willingness about waste separation, pay for improved services, and participate in waste related activities, as compared to commercial units. Alternatively, commercial units were mostly unwilling to separate waste, pay for improved services and participate in waste related activities. So these observations establishes that households had more positive attitude than commercial units (Figure 5.10).
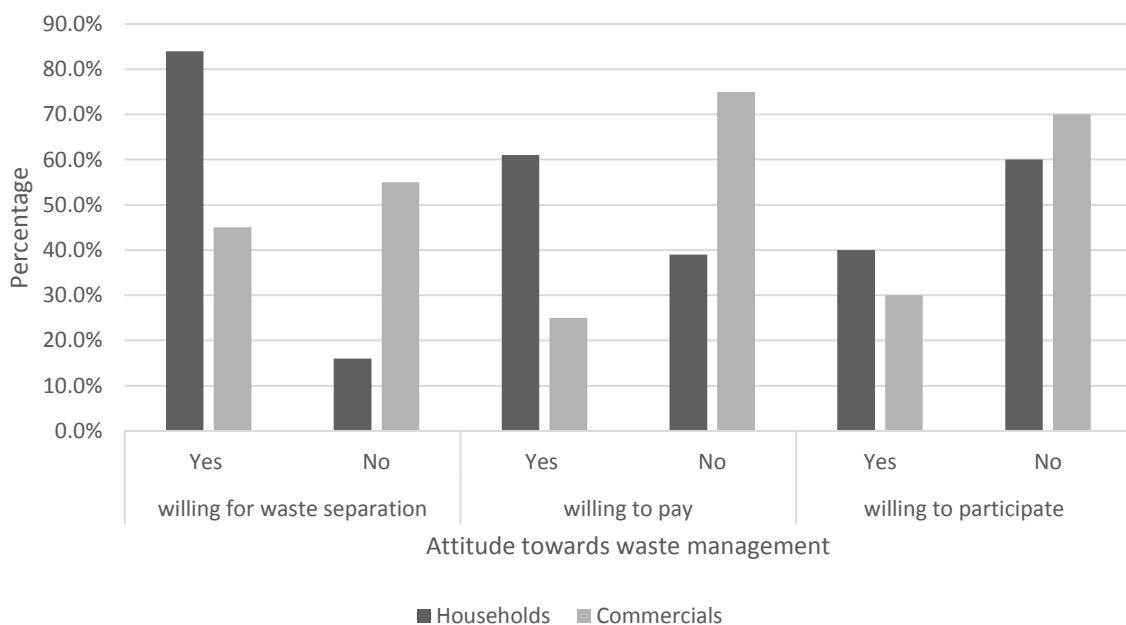
Figure 5.10: Attitude of different stakeholders towards solid waste management

Gender is one of the important characteristic that can influence the attitude of population towards waste management. It can be seen in figure 5.11 that females had more effective attitude towards solid waste management as compared to males. These findings affirm that females have higher interest in cleanliness and waste management, as they were more willing for waste separation, pay for improved services, and participate in waste related activities than males.
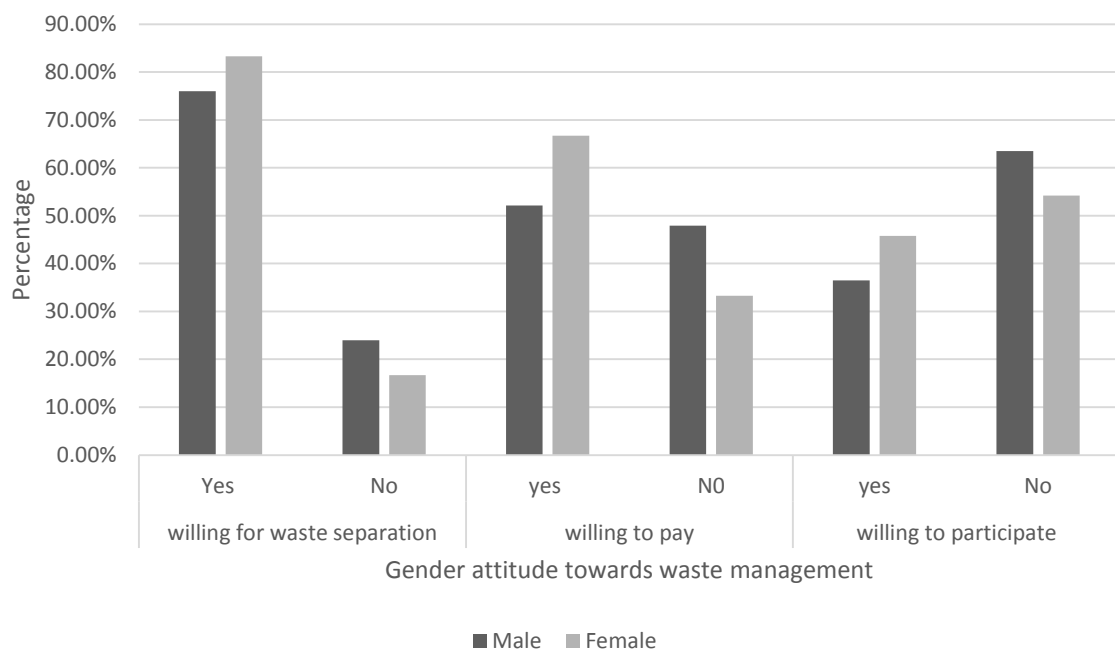
Figure 5.11: Gender attitude towards Waste Management

5.2 Barriers

This study has identified nine important barriers in solid waste management of Murree (Figure 5.12). These barriers include: (1) Insufficient funds availability. (2) Ambiguous waste management strategies/ action plans. (3) Inadequate laws regulating waste management. (4) Weak institutions of waste management. (5) Low public awareness regarding waste management. (6) Poorly trained waste workers. (7) Obsolete operational equipment. (8). Unplanned aspects of the city make waste collection difficult. (9) Misuse of limited funds.

These barriers were rated on a scale of values ranging from 1 to 5 based upon their importance by officials and staff of concerned authorities. 1 being the least important barrier and 5 being the most important barriers.
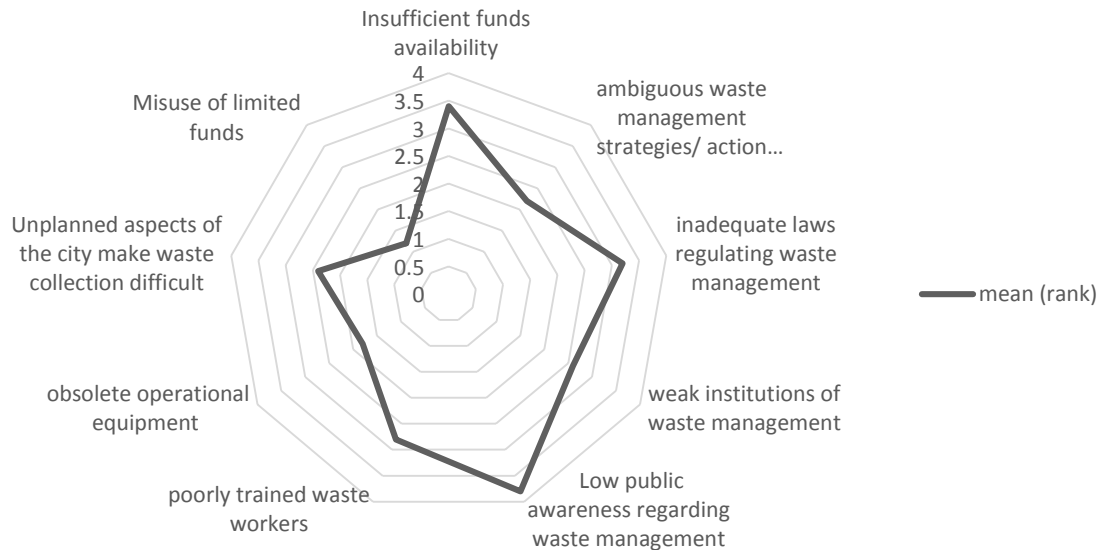
<p align="center">Figure 5.12: Barriers</p>

Table 5.5 shows ranking of these barriers in waste management in accordance to their importance based on their mean values. It is obvious from table that most important barrier in solid waste management of Murree is low level of public awareness about waste management. Whereas misuse of limited funds is least important barriers in waste management of Murree.

<p align="center">Table 5.5: Ranking of Barrier</p>

Sr.no	Barriers	mean RANK
1	Low public awareness regarding waste management	3.8
2	Insufficient funds availability	3.4
3	inadequate laws regulating waste management	3.2
4	poorly trained waste workers	2.8
5	weak institutions of waste management	2.6
6	Unplanned aspects of the city make waste collection difficult	2.4
7	ambiguous waste management strategies/ action plans	2.2

8	obsolete operational equipment	1.8
9	Misuse of limited funds	1.2

SWOT Analysis was performed to highlight the issues pertaining to existing SWMS in Murree along with strengths and potentials. SWOT Analysis helped us to formulate strategies to convert systems' weaknesses into strength and similarly threats into potential.

Table 5.6: SWOT analysis of solid waste management system in Murree

<u>Strengths</u>	<u>Weaknesses</u>
- Private sector involvement - Availability of Operational equipment in good condition. - Being tourist city, political interest to keep city clean. - Availability of professionals in SWM - Free service of waste collection is provided to households. - Effective waste collection on main roads and commercial areas.	- non-availability of data - Insufficient funding - Strikes of workers due to nonpayment of salaries. - Poorly trained workers - Weak institution of waste management - Laws regulating waste management are inadequate. - Public education on waste management is low - Unplanned aspects of the city make waste collection difficult.
<u>Opportunities</u>	<u>Threats</u>
- Majority of solid waste generated in Murree is organic in nature. Organic waste is compostable, and also has potential to produce biogas. - Recyclables are produced in large in quantity in Murree, therefore, a great potential of recycling exists which can benefit both economy and environment.	- environmental risks such as air quality deterioration , emission of greenhouse gases, contamination of water resources, due to unscientific disposal of solid waste at dumping sites - public health risks (creates unhygienic conditions such as breeding of pathogens or vectors, odor) - Aesthetic Beauty has been badly marred by the presence of garbage heaps, solid waste filled

• Revenue can be generated by levying a collection charges, as majority of people in Murree are willing to pay for improved services.	drains, & unpicked litter at major tourist hot spots & commercial as well as residential areas. • Population and economic growth has resulted into increase in type and volume of waste.

Table 5.6 shows SWOT analysis of solid waste management in Murree. In order to improve the solid waste management in Murree, major weakness identified in the SWOT analysis should be avoided. Funding constraints can be managed by public private partnership. Also solid waste management system should generate revenue by collecting operational charges for its services. Vocational training should be provided to workers to overcome the mishandling of solid waste. Institutions dealing with solid waste management should be strengthen through their capacity building. For this purpose, they should be provided with necessary funds, adequate and qualified staff, and clear and supporting policies and regulations. Public awareness about solid waste management is necessary for successful implementation of waste management plan. Therefore, various programs for enhancing public awareness regarding solid waste management such as seminars, corner meetings, awareness walk, and advertisement campaign, pamphlets should be initiated.

Unscientific dumping practices at dumping sites threaten the environment as well as health of population living in surrounding areas. These threats can be mitigated by adopting sanitary landfill practices in which waste is daily covered. Growing volume and types of solid waste in municipality due to urbanization and economic growth is also a serious challenge faced by waste management authorities. Therefore various planning and environmental measures should be taken to manage the population and economic growth. 3Rs principle (reduce, reuse, recycle) should be employed to reduce volume of waste to be dumped at dumping site.

Chapter 6: Conclusions and Recommendation

Conclusion

Murree being a tourist city has growing hoteling industry which is major source of waste generation in the city. Waste generation rate in Murree is about 0.47 kg /capita/day, however it varies across the seasons due to tourist activities. Major components of this waste generated were vegetable/kitchen waste, plastics, and paper. This study also found that quantity of waste generation has significant relationship with different socioeconomic variables, such as household size, income level, types of waste sources etc.

Waste collection services in Murree were inadequate, as both legal as well as illegal practices were observed. Effectiveness of waste collection varies from location to location. This study analyzed that effectiveness of waste collection and management systems in Murree was influenced by various socioeconomic factors. These factors include Income level, Education, types of waste sources, distance between road and waste generation source, awareness about solid waste management, and attitude of population towards solid waste management. Waste management in Murree was income biased, because high income areas had better waste collection services as compared to other areas. Disparity of services was also evident between residential and commercial areas. That is why, dumping of waste at unauthorized places was common in residential areas. Distance of households from road is also important aspect, because households are motivated to dump their waste illegally at unauthorized places, when they are located far away from roads. Awareness of population about solid waste management and their education level are two important aspects which shapes the attitude of people for effective implementation of waste management strategy.

This study has identified and analyzed the barriers in solid waste management of Murree, and rank them in order of importance. Low level of public awareness was the most important barrier

in solid waste management in Murree. Among other major barrier were insufficient funds availability, inadequate laws regulating solid waste management, poorly trained waste management workers, and weak institutions of waste management. On the other hand, misuse of limited funds and obsolete operational equipment were minor barrier in solid waste management of Murree.

Recommendations

- At present, there is dearth of accurate data regarding solid waste management in Murree. Therefore it is recommended that waste management authorities should record and maintain data, because availability of data is vital for formulating an effective waste management strategy and future planning. For this purpose, a research and monitoring unit should be established in waste management institution.

- In order to reduce the volume of solid waste to be dumped at dumping site, waste management authorities should come up with a comprehensive strategy or plan of action for waste prevention and waste minimizations employing 3Rs principal. This strategy should lay down the targets for waste prevention, composting and recycling.

- Public awareness about solid waste management is necessary for successful implementation of waste management plan. Therefore, various programs for enhancing public awareness regarding solid waste management such as seminars, corner meetings, awareness walk, and advertisement campaign, pamphlets should be initiated.

- In order to make a self-sustaining system of solid waste management, revenue should be generated through collecting service charges to cover up operation and maintenance cost of waste management.

- Vocational training should be provided to workers to overcome the mishandling of solid waste.

- Institutions dealing with solid waste management should be strengthen through their capacity building. For this purpose, they should be provided with necessary funds, adequate and qualified staff, and clear and supporting policies and regulations.

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Annexure

Annexure 1: Questionnaire used to collect data from study area

National University of Science and Technology

*Dear respondents, I would like to inform you that this questionnaire is prepared for academic purpose only; that is, I am conducting a research, which is entitled on **"Assessment and Planning of Solid Waste Management in Murree",** for the fulfillment of MS Degree in Urban and Regional Planning ; NUST, Islamabad. Therefore, any answers given shall be treated as confidential. I kindly request you to fill this questionnaire honestly without any hesitation. Thank you in advance for your cooperation!!!!*

Respondents information							
1.	Gender	a) Male b) Female					
2.	Education						
3.	Household monthly income						
4.	Household size						
5.	What is the distance to the road from your house						
Current situation							
6.	What is estimated daily waste generated of your household?						
7.	What are the major solid wastes that your household averagely generates per month? (Rankthem in terms of higher proportion in volume of all of the wastes)		1	2	3	4	5
		Organic or vegetable waste					
		Wood					
		Grasses & leaves					

		Paper				
		Glass				
		Metals				
		plastics				
		others				
8.	Do you have a temporary solid waste storage in your house	a) Yes b) No				
9.	If No, what do you do with the problem of solid waste storage?					
10.	What practice you follow regarding disposing of your household waste?	a) Open dumping b) burning c) dump in nallah/sewerage d) handed over to waste collectors at my door e) dispose in nearby disposal container				
11.	Who is responsible for the collection of waste generated from your home?	a)Municipality b)Private c) Contractors d)Scavengers e) other_____				
12.	How often do the waste collectors collect solid wastes from your house/area?	a) Every day b) twice a week c) Thrice a week d) Every week e) Every two weeks e) Once a month				
13.	How much do you pay for the waste collection services?					
14.	If you are not getting the door to door services, do you believe that the location of your home/village/ is one factor to prevent you from such services?	a) Yes b) No				
15.	Other than location, What do you think could be the possible reasons of not getting the door to door waste collection services?					

16.	How frequently do you usually dispose your wastes?	a) Every day b) twice a week c) Thrice a week d) Every week e) Every two weeks e) Once a month		
17.	Is solid waste disposing container available in your neighborhood?	a) Yes b) No		
18.	If no, What do you do with the solid waste of your household when you find your temporary storage full, and you either did not get door to door services or waste collectors did not come at the right times?	a) I keep the waste at home until the collectors are coming by using other storage materials b) I burn it in the back of my home c) I dump it on open space, which is far from the main road d) I dump it in sewerage e) Indicate if any other alternatives		
Satisfaction				
19.	Does provider of waste collection services Treats all households equally?	a) Yes b) No		
20.	Does waste collecting staff to collect and manage household wastes effectively?	a) Yes b) No		
21.	Waste management authorities Collect wastes from households at the right / needed time	a) Yes b) No		
22.	The payment they receive from household is fair	a) Yes b) No		
23.	How do you rate overall performance of waste management authority in your area?	a) worst b) poor c) average d) good e) excellent		
24.	Do you observe disparity in service provision between:	Yes	No	If yes, which one?
a)	Lower income and higher income residents			
b)	The area at or near the main road (the			

	center of the city) and the area far from the center of the city (main road)			
c)	The area of higher official residents and the ordinary people			
d)	The residential area and the commercial area			
Attitude				
25.	Does your household practice waste separation?	a) YES b) NO		
26.	If YES, how do you separate it?			
27.	If NO, what do you think the reason behind?	a) I do not have the understanding about waste separation b) I did not think as it is my responsibility c) I did not visualize the importance of separation d) if any other reason, please specify it _____		
28.	If you are asked to throw waste in a set of dustbins, each labeled to contain different type of waste; would you accept it	a- Yes b- No		
29.	Have you ever provide any complain to the municipality when the private waste collectors or the municipality truck did not come in your household at the right time?	a) Yes b) No		
30.	If no, what action did you take to solve such problem?			
31.	Are you willing to pay more for the waste collectors" service in order to improve solid waste disposal practice in your town?	a- Yes b- No		

32.	Are you willing to participate in any waste related activities arranged in your area?	a- Yes b- No
33.	Some people dump waste in un-authorized places because	a) No facilities b) Inadequate information c) No penalty d) To save cost
Knowledge/ Awareness		
34.	Are you aware of concept of recycling?	a) Yes b) No
35.	If waste is separated at household level, do you think it will be helpful in waste management?	a) Yes b) No
36.	Do you aware of any problem with using plastic shopping bags?	a) Yes b) No
37.	Have you ever been educated on solid waste management?	a) Yes b) No
38.	If yes, in what way?	a) Seminar b) workshop c) Pamphlets d) awareness walk e) other _____

Annexure 2: Questionnaire used to conduct structural interview from waste management authorities.

National University of Sciences and Technology, Islamabad

*Dear respondents, I would like to inform you that this questionnaire is prepared for academic purpose only; that is, I am conducting a research, which is entitled on **"Assessment and Planning of Solid Waste Management in Murree"**, for the fulfillment of MS Degree in Urban and Regional Planning ; NUST, Islamabad. This information will be kept anonymous and used only for study purposes. Your cooperation in this regard will be acknowledged and appreciated.*

Waste Characterization		
1.	What are the major sources of solid waste generation in Murree?	
2.	What is the estimated total amount of solid waste generated in city?	
3.	What is the daily rate of solid waste generation	
4.	What is the composition of solid waste generated	
Management structure		
5.	What is present institutional set up for solid waste management?	
6.	What is the number of staff available in providing solid waste management services?	
7.	What is the source of your income for solid waste handling services?	a) budget from the federal government

		b) fees collected from the services
		c) budget from the Ambo city administration
		d) please specify, if any other
8.	Have you ever faced budget deficit? If Yes, from where did you get subsidy to solve such problem or?	
9.	What is the amount of the total City recurrent budget for all services?	
10.	What types of vehicles are used in waste collection and transportation?	
11.	What is the capacity of vehicles used in data collection and transportation?	
12.	What is the condition of vehicles used for data collection and transportation?	
Waste collection		
13.	What is the system of solid waste collection	
14.	What are the means of collection of solid waste	
15.	do you believe that number of solid waste disposal containers is enough for the city's people	
16.	From which points/ locations solid waste is collected	
17.	What percentage of the total quantity of solid waste generated in the whole City is collected?	

18.	What percentage of total area is covered by waste collection team?	
19.	Is there any charges/fee of collection of solid waste	
20.	How much revenue is collected from these charges?	
21.	What is the frequency of waste collection (daily/ weekly)?	
22.	Total amount of fuel used for waste collection?	
23.	Are the vehicles currently in use enough to collect solid wastes in the town?	
Disposal/treatment		
24.	Where the collected waste is transported?	
25.	Is there any proper landfill site available?	
26.	What is the type of landfill site?	
27.	What is method of disposal for the solid wastes collected?	
28.	What is the average distance from the City center to a disposal site?	
29.	Is there any composting facilities available?	
30.	Is there any recycling facility available	
31.	Is there any treatment facility available?	
General		
32.	Do waste separation is practiced in the city? If yes, at which level? If no, do you have	

	any plan in future regarding waste separation?					
33.	What are difficulties you face in solid waste management?					
34.	Do you have any plan to raise awareness among communities about solid waste management?					
35.	How do your rate overall performance of your organization?					
36.	Do you have any future plan to improve the quality of waste management?					
Barriers						
37.	Please use the scale to indicate how the following barriers affect waste management in Murree. A value of 1 will imply minor barrier while 5 implies factor is a major barrier to waste management in the city					
		1	2	3	4	5
a)	Insufficient funds availability					
b)	Waste policies lack clear strategies for action					
c)	Laws regulating waste management are inadequate					
d)	Waste management institutions are weak					
e)	Public education on waste management is low					
f)	Waste workers are poorly trained					
g)	Operational equipment are obsolete and insufficient					
h)	Unplanned aspects of the city make waste collection difficult					
i)	Limited funds available are sometimes misused					

Annexure 3: Data sheet of daily waste generation

HH Size	Daily waste generation (Kg)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
5	2.5	1.5	1.7	2	2.2	1.9	2
8	3.4	2.8	2.8	3	3.7	2.5	3.2
6	1	1.2	1	1.6	0.8	1	0.9
4	1	1.7	0.5	1	0.7	1.3	0.8
3	0.5	0.7	0.5	1.2	0.5	0.4	0.5
20	5	6	3	7	5	3.7	5.5
8	3.5	2	2.8	4	4.5	4.8	5
8	2.2	1.8	2.4	2	2.1	1.7	2
6	5.7	4.5	4	4.2	5.3	6	5
6	1.5	2.2	2.5	1	1.6	2.9	2
6	2.5	2	1.4	2.5	2.4	2.2	2
8	2	2.2	2.4	2.7	1.3	1.8	1.9
8	3	3.3	3.5	2	4	2.7	1.5
5	0.7	0.5	1	1.1	0.5	0.7	0.6
9	2.4	1.5	1.4	2.5	2	2.2	2
6	0.8	1.2	1	1.6	1	1	0.9
5	0.5	0.5	0.7	0.5	0.4	0.5	0.7
9	2	2.3	1.7	2.7	2.1	0.8	2.6
5	10	7	8	11	10	9.4	9.7
7	5.5	5	3	4.7	3.9	4.7	5.3
9	4.2	4.3	2.2	3.7	5	4	4.3
10	5	4.8	5.2	3.8	5.6	4.6	5
9	5.5	3.6	4.9	5.2	6	5.8	5.7
5	0.5	0.5	0.7	0.3	0.5	0.6	0.5
5	1	1.2	1.2	1.6	0.7	0.5	1
5	1.5	2	1.3	1.8	2.2	1	1.3
5	0.7	0.5	0.5	1	0.7	0.8	0.9
9	2	3.1	2.5	1.2	2.2	2.1	1.7

6	1	0.5	0.5	1.2	1.4	1.8	0.8
5	0.5	0.3	0.5	0.7	1	0.9	0.5
9	2	0.5	0.8	2.8	1.5	3	2.7
5	11.5	8	9.5	13	8	6	12
7	5.3	2.9	3.8	7	5	6	5
9	3.3	4.5	4.2	3.5	4	4.5	4
10	5	6	6.3	4.2	4.6	4.9	3.9
9	5.5	5	6	4.6	4.5	5	5.5
5	0.5	0.7	0.3	0.5	0.5	0.4	0.8
5	1	0.5	0.5	1.2	1.4	1.8	0.8
4	2.8	3	2	1.5	1.6	1.7	1.9
5	0.8	0.5	0.7	0.5	1	0.5	0.8
4	0.7	0.8	0.5	0.9	0.5	1	0.7
6	1	0.8	0.5	1	1.4	1.2	1.4
10	4	3.8	4.3	4	4.6	3.9	3
8	1.5	1	1.5	1.2	0.5	0.7	1
8	0.5	0.8	0.4	0.4	0.6	0.5	0.5
5	0.5	0.5	0.7	0.4	0.8	0.4	0.3
4	3.5	4	3.8	4.5	4	3.5	5
7	5	5	3.6	3.9	5.5	4.5	4.6
2	0.2	0.3	0.5	0.2	0.5	0.2	0.2
6	0.5	0.5	0.7	0.8	0.3	0.4	0.5
10	1.8	2.1	2.5	1.5	2	1.8	1.9
4	2	1.8	1.5	2.4	2.9	2.3	1.5
8	1	1.3	1	1.2	0.7	0.8	1
8	3.8	2.6	3.3	1.9	2.5	3.3	3
11	2	2.4	2.2	1.5	2.8	2	2.1
5	0.5	0.3	0.5	0.7	0.5	0.6	0.5
4	0.5	0.5	0.2	0.6	0.8	0.4	0.5
7	3	3.4	3.5	2.6	2.3	2.8	3
9	3	2.4	3.5	3.4	3	2.7	3.2
3	0.2	0.3	0.2	0.5	0.2	0.2	0.3
8	6.5	5	7	5.3	7.4	7	8
22	9.3	8	5.5	7	6.3	5.8	7.5
5	0.8	0.7	1	0.5	0.8	1.2	0.6

6	0.8	0.5	0.5	0.7	1.3	1	0.5
8	3	3.2	3.2	2.5	3.5	3.2	2.7
11	2.5	2	3.4	1.5	1.5	2	1.7
5	0.5	0.5	0.7	0.4	0.6	0.3	0.5
4	0.5	0.3	0.5	0.6	0.9	0.4	0.5
7	3	3.3	2.6	2.9	2.7	3.5	3
9	3	3.5	3.2	2.5	3.2	2.8	2.9
3	0.2	0.3	0.2	0.4	0.3	0.2	0.2
22	6.5	8.5	8.3	7.5	6.3	7	5.8
5	0.8	0.7	0.5	1.2	0.8	0.7	1
6	0.8	0.6	0.7	1.3	1	0.7	0.5
6	4.4	3.5	4	3.7	4	4.2	3.8
8	2	2.5	1.7	2.2	1.8	1.5	2.4
4	0.8	0.7	0.5	1.2	0.8	0.7	1
6	0.5	0.3	0.6	0.5	0.8	0.4	0.5
7	1	1.3	0.7	0.8	1.5	1	0.9
10	1.7	1	1.3	0.8	0.7	0.8	1
6	3.4	2.8	2.6	3	3	3.5	2.8
6	1	1.3	1.1	0.7	0.8	1	1.3
13	5.5	4.3	5	5	4.8	4.8	5
10	1.4	1	1	0.8	1.5	1	0.7
6	3.2	2.7	3.5	3	2.8	3	3.2
6	1	1.3	0.8	1.4	1.5	1	0.7
13	4.7	5	4.8	5	5.5	5.2	5.3
6	2.8	2.5	3	3.5	3.3	3	2.8
9	3.3	3	2.7	2.8	3.2	3.4	3.3
9	1	1.5	1.2	0.8	1	0.6	1
4	1.5	1.3	1.7	1	1.4	2	1.7
4	1	0.5	0.8	0.7	1.4	1.3	1.5
2	0.5	0.2	0.5	0.7	0.4	0.5	0.8
10	2.5	2.3	2.5	1.5	1.7	1.8	2.4
4	3	2.5	2.2	3.3	3	2.8	2.7
8	5.5	5	4.8	5.4	3.9	5	5.5
7	0.5	0.8	0.6	0.5	0.4	0.5	0.5
4	0.7	1	0.7	0.5	0.5	0.8	0.7

6	1	1.3	1.5	0.7	0.5	0.8	1.3
10	4.2	4	4.2	5	3.8	3.3	4.4

Annexure 4: Household solid waste disposal practices

Area	Waste disposal practices				
	X1	X2	X3	X4	X5
Motor agency		8.7%	52.2%	26.1%	13.0%
Lower Mall	40.0%	8.0%		32.0%	20.0%
Pindi Point	5.6%	16.7%	11.1%	16.7%	50.0%
Sunny Bank	9.5%	19.0%	52.4%	9.5%	9.5%
Kashmir Point				18.2%	81.8%
Kuldana	45.5%	18.2%			36.4%
Mall Road			9.1%	45.5%	45.5%

X1 = Open dumping, X2 = Burning, X3 = Dump in Nallah/ sewerage, X4 = Handed over to waste collectors at door, X5 = Dispose in nearby disposal container

Annexure 5: Frequency of waste collection in different localities of Murree.

Area	Frequency of waste collection					
	Never	Every day	twice a week	thrice a week	Every week	seldom
Motor agency	30.4%	39.1%	4.3%			26.1%
Lower Mall	8.0%	32.0%	28.0%	24.0%	8.0%	
Pindi Point	11.1%	55.6%	5.6%	22.2%		5.6%
Sunny Bank	71.4%	9.5%		9.5%		9.5%
Kashmir Point		100.0%				
Kuldana	27.3%	18.2%	18.2%			36.4%
Mall Road		90.9%		9.1%		

Annexure 6: Availability of waste disposal containers in different localities of Murree.

Area	Availability of solid waste disposing container	
	Yes	No
Motor agency	47.8%	52.2%
Lower Mall	60.0%	40.0%
Pindi Point	61.1%	38.9%
Sunny Bank	9.5%	90.5%
Kashmir Point	100.0%	0%
Kuldana	45.5%	54.5%
Mall Road	90.9%	9.1%

Annexure 7: Performance of waste management authority

Area	Performance of waste management authority				
	worst	poor	Average	good	excellent
Motor agency	43.5%	17.4%	4.3%	21.7%	13.0%
Lower Mall	12.0%	40.0%	32.0%	8.0%	8.0%
Pindi Point	11.1%	22.2%	11.1%	27.8%	27.8%
Sunny Bank	61.9%	28.6%		9.5%	
Kashmir Point			9.1%	54.5%	36.4%
Kuldana	27.3%	36.4%	36.4%		
Mall Road			45.5%	27.3%	27.3%