Results and Discussion

CHAPTER-IV

RESULTS AND DISCUSSION

The result of the study on "**Economic Analysis of Solid Waste Management with Special Reference to Coimbatore City"** is presented under the following three heads:

I. The practice of solid waste management by the households.

II. An assessment of profile and working condition and health status of the sanitary workers.

III. The working condition of the recycling unit workers and working of the unit in Coimbatore district.

The first section in this chapter gives a broad outline on the socio-economic condition of the respondents and issues relating to solid waste at the household level. This is discussed under the following heads:

4.1 The socio-economic background of the respondents
4.2 Current practice of solid waste management
4.3 Problems encountered in the management of solid waste
4.4 Willingness to pay for solid waste management
4.5 Factors helps to combat the problem

4.1 Socio-Economic Background of the Respondents

The socio economic factors play a significant role in shaping the personality and characteristics of an individual. Hence to develop a proper perceptive analysis, all the components of socio-economic environment must be considered. The general notion is that the social environment is the combination of factors such as religion, caste, family structure, size of family and age, while economic environment is made up of factors such as education occupation, income etc. A clear insight into the socio- economic factors is of paramount significance to establish the influence of these factors on the life and activities of the respondents. The socio economic background of the sample respondents is presented in Table.4.1.1

Table 4.1.1

Socio-Economic Background of the Respondents

Socio –economic variables	Characteristics	Gandhi Park	Avinashi Road	Sathy Road	Total
Head of the family	Male	82 (84.5)	76 (80.9)	72 (81.8)	230 (82.4)
	Female	15 (15.5)	18 (19.1)	16 (18.2)	49 (17.6)
Age (in years)	Below 25	2 (2.1)	4 (4.3)	8 (9.1)	14 (5)
	25-50	81 (83.5)	81 (86.2)	74 (84.1)	236 (84.6)
	Above 50	14 (14.4)	9 (9.6)	6 (6.8)	29 (10.4)
Type of family	Nuclear	85 (87.6)	85 (90.4)	82 (93.2)	252 (90.3)
	Joint	12 (12.4)	9 (9.6)	6 (6.8)	27 (9.7)
Household size (Numbers)	Below 4	63 (64.9)	83 (88.3)	61 (69.3)	207 (74.2)
	4-6	24 (24.7)	2 (2.2)	21 (23.8)	47 (16.9)
	Above 6	10 (10.4)	9 (9.5)	6 (6.9)	25 (8.9)
Religion	Hindu	88 (90.7)	64 (68.1)	84 (95.5)	236 (84.6)
	Muslim	5 (5.2)	15 (16)	4 (4.5)	24 (8.6)
	Christian	4 (4.1)	15 (16)	0	19 (6.8)
Caste	SC	8 (8.2)	10 (10.6)	11 (12.5)	29 (10.4)
	MBC	85	59	48	192

		(87.6)	(62.8)	(54.5)	(68.8)
	FC	4 (4.1)	25 (26.6)	29 (33)	58 (20.8)
Education	School level	33 (34)	22 (23.4)	15 (17)	70 (25.1)
	Graduates	51 (52.6)	50 (53.2)	70 (79.5)	171 (61.3)
	Post graduates	13 (13.4)	22 (23.4)	3 (3.4)	38 (13.6)
Occupation	Government job	22 (22.7)	40 (42.6)	31 (35.2)	93 (33.3)
	Private firms	63 (64.9)	45 (47.9)	48 (54.5)	156 (55.6)
	Self employed	11 (11.3)	7 (7.4)	7 (8)	25 (9)
	Others	1 (1)	2 (2.1)	2 (2.3)	5 (1.8)
Income(in Rs)	Below 10000	6 (6.2)	5 (5.4)	3 (3.4)	14 (5.1)
	10001-15000	71 (73.2)	76 (80.8)	76 (86.3)	223 (79.9)
	15001-20000	13 (13.4)	9 (9.5)	5 (5.6)	27 (9.6)
	Above 20000	7 (7.2)	4 (4.3)	4 (4.5)	15 (5.4)

Source: Field survey, 2013
Figures within the parentheses indicate percentage

In Indian society, head of the family has a significant role in the decision making process in every aspect of a family life. Among the respondents surveyed, it was found that 82.4 percent of the respondents had male headed family and only 17.6 percent had female headed family. Similar finding was reported by Adepoju, and Salimonu (2013). With respect to age, majority (84.6 per cent) of the respondents belonged to the age group of 25 to 50 years. Similar result were found in the study by Amfo-out et.al (2012) stating a higher percentage of people in the most productive age group.

Family in India has been changing very fast both in terms of its structure and functions due to multiple factors. Joint family which used to characterise the Indian family system is gradually being replaced by the nuclear family consisting of husband, wife and their unmarried children. Information relating to type of family reveals that majority (90.3 percent) of the surveyed respondents belonged to nuclear family. This clearly shows that the joint family system is fast vanishing in the Indian family system.

Information gathered regarding the size of the households of the respondents was useful in quantifying the waste generated. The size of household is directly related to the quantity of waste generated in the household. Higher number of members in a family greater is the waste generation. Majority of the respondents (74.2 percent) in all three areas had only less than four members highlighting the predominance of nuclear family.

Religion is a way of life and an integral part of the Indian tradition. It has an important role in the socio economic profile of the people. Data pertaining to the religion shows that majority of the respondents were Hindus (84.6 percent), 8.6 percent of respondents were Muslims and only 6.8 percent belonged to the Christian community.

Yet another peculiar feature in Indian society is the caste system. Among the respondents the largest single group was the backward caste i.e. 68.8 percent followed by forward caste (20.8 percent) and 10.4 percent belonging to the scheduled caste. Scheduled tribes were not present in the study area.

Education is really a true indicator of the overall development of the society. It influences the decision making ability of the people. Higher education creates higher awareness level. In the environmental context, education creates awareness and imparts a sense of discipline, without which even the best infrastructure will be misused and would prove inadequate to improve the environmental situation. An educated person can understand the whole system of solid waste management, from generation to disposal including process, treatment, recovery and initiative taken by various organizations. Among the respondents, 61 percent are graduates and 25 percent had

higher secondary education. Only 13.6 percent of respondents had master's degree and other higher qualification.

Occupation refers to the type of work carried out by the person in order to earn his livelihood. It has direct bearing on socio economic condition of the people. The higher level of education tends to be reflected through occupational status since the two variables are intimately related.

In the study, among the samples, 56 percent of respondents were employed in various private firms, 33.3 percent of respondents were government employees and only nine percent earned their livelihood from self employment. Rests of them were leading a retired life and few have taken voluntary retirement. Most of the respondents depended on private firms to earn their livelihood.

Income is one of the most important means which raises the socio-economic status of the people and improve the standard of living. It directly influences the consumption level of the respondents. Higher the income level higher is the consumption of all items and higher is the waste generated. The income of any particular family presents an authentic diagnosis of the economic health of the family. Hence an analysis of income becomes the key stone of any comprehensive study. The survey revealed that the majority of the respondents (80 percent) were earning an income in the range of Rs 10000 - 15000 per month. Only five per cent had more than Rs 20,000/- income per month.

4.1.2 Environmental Conditions in the Selected Area

Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil. Pollution is the one of the important cause of environmental degradation. When environment become polluted, it means that toxic substance have entered into environment and become unhealthy. The United Nations International Strategy for Disaster Reduction defines environmental degradation as "The reduction of the capacity of the environment to meet social and ecological objectives and needs" (Chandrappa et.al 2009).

Environmental pollution is the biggest menace to the human race on this planet today. It means adding impurity to environment. The environment consists of earth, water, air, plants and animals. If it is polluted, then the existence of man and nature will be hampered. If pollution continues, the day is not far when our earth will be a boiling pan and become a desert or it will be covered with sea water causing destruction of mankind.

For analyzing the effect of solid waste on the environment in the selected area, a classification such as highly polluted, polluted and neutral was made, which is depicted in Table 4.1.2

Table 4.1.2

Environmental Conditions

Environment	Gandhi Park	Avinashi Road	Sathy Road	Total
Highly polluted	57 (58.8)	61 (64.5)	54 (61.4)	172 (61.6)
Polluted	39 (40.2)	33 (35.1)	34 (38.6)	106 (38)
Neutral	1 (1)	0	0	1 (.4)
Total	**97** **(100)**	**94** **(100)**	**88** **(100)**	**279** **(100)**

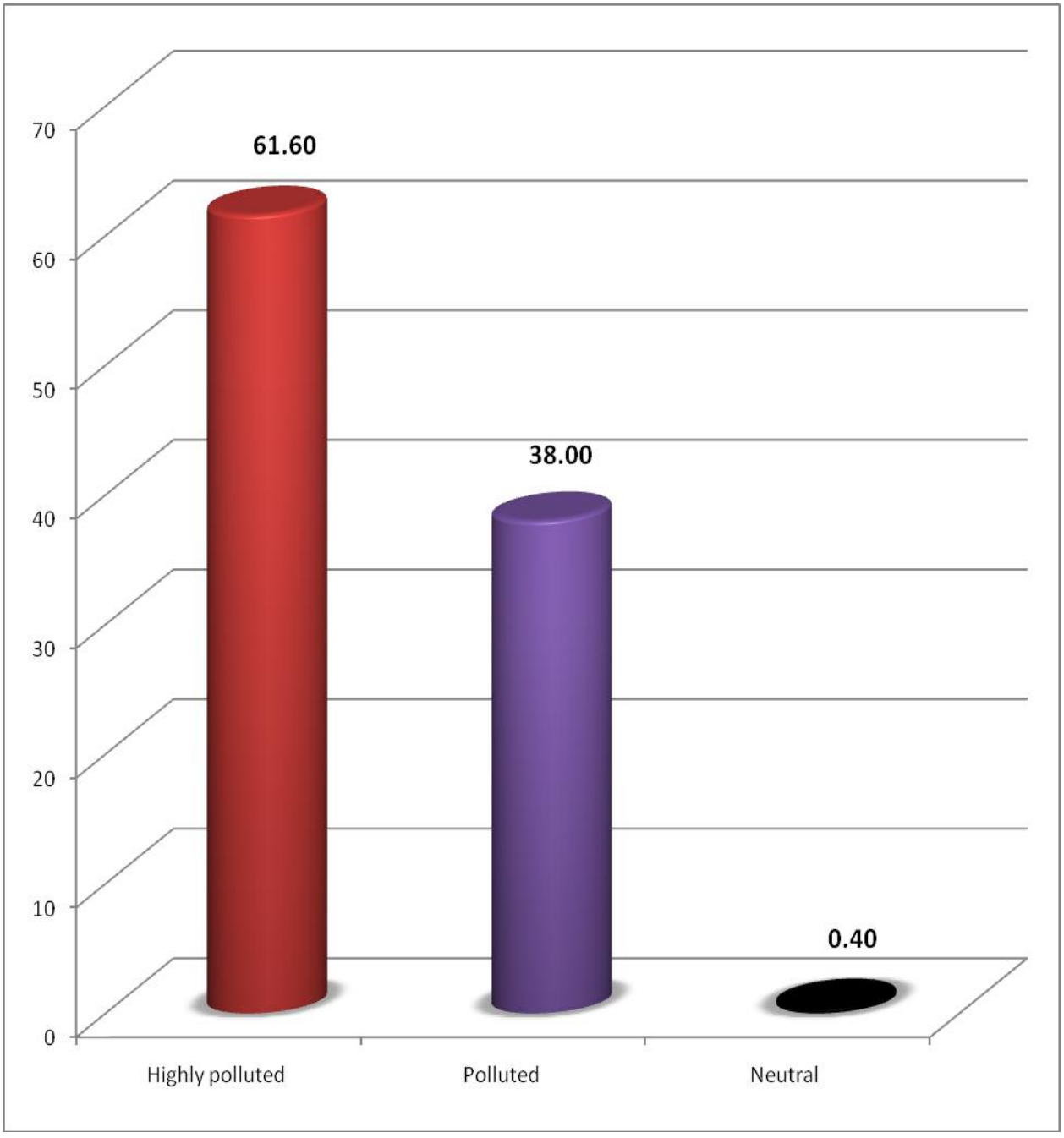
Source: Field survey, 2013
Figures within the parentheses indicate percentage

The respondent's opinion about the environmental conditions reveals that city is not very clean. Around 62 percent of respondents expressed that Coimbatore city is highly polluted, and 38 percent of respondents opined that city is polluted .Only one respondent were neutral in their opinion with regard to the environment. The respondents suggested that the government should take necessary steps to reduce the pollution.

The area wise analysis revealed that current environmental condition of city is much polluted.

Figure 4.1

Environmental Conditions



4.1.3 Environmental Problems

Impure air causes diseases and impairs health. Smoke pollutes the air. It is the root of air pollution. The smoke which is discharged from industries, automobiles and kitchens is the mixture of carbon monoxide, carbon dioxide, methane etc. These are all poisonous gases. These cause lung-cancer, tuberculosis etc. The foul smell emitting from the garbage, the decaying plants and animals also cause air pollution. Hence the doctors advise the patients having lungs trouble to settle in some rural places because the area or environment is pure and free from dirt, dust and pollution and is a better place to live.

Noise pollution is also a great threat. The harsh sounds of automobiles, factories, mills etc. affect our ears and causes trouble. The water of rivers and seas is being constantly polluted all over the world by various dangerous chemical and biological wastes. Mills and factories discharge very harmful waste waters into many rivers and sea. It is really very strange and laughable that large number of the Indians regard this water as holy. They even drink this water for salvation. There is no doubt that the fish that grow in such waters are poisonous too. Reckless application of chemical fertilizers, insecticides and pesticides pollutes the soil. Vegetables and fruits are quite injurious today, as they contain the poison of insecticides and pesticides (Sany. et.al 2013).

Solid waste has emerged as a major environmental concern from local level to global level. In the study area, the environment is quite bad as it is subject to all kinds of pollution. The environmental problems which cause the pollution are listed in Table 4.1.3.

Table 4.1.3

Environmental Problems

Problems	Average Score	Ranks
Air pollution	49.35	1
Noise pollution	37.04	6
Loss of biodiversity	35.51	7
Green house effect	20.71	10
Solid waste problem	46.82	2
Desertification	30.90	9
Deforestation	33.25	8
Land pollution	40.86	4
Water pollution	44.35	3
Sewage problem	39.51	5

Source: Field survey, 2013

Air pollution, water pollution, noise pollution, deforestation, desertification, land pollution, sewage problem etc are identified as the major environmental issues in the study area. The various environmental problems were ranked by the respondents as follows. Air pollution ranks 1st,solid waste problem is in 2nd order and water pollution is in the third position. The other problems namely land pollution (4th rank), sewage problem (5th rank), noise pollution (6th rank), loss of biodiversity (7th rank), deforestation (8th rank), desertification (9th rank), green house effect (10th rank) are also causes of severe environmental problem. After air pollution, solid waste problem is the second largest problem in the study area. Therefore solid waste management needs to be given a serious concern by the government.

4.1.4 Problems Due to Solid Waste

Environmental impact due to faulty handling of municipal solid waste is a serious problem (Ejaz and Janjua, 2012). There is continuous increase in industrial growth resulting in the production of waste which has been increasing in variety and vol. Indian cities are invariably filled with large amounts of garbage in open places, Roads and

empty lands or fields. Municipal system of waste collection has not reached all the areas, and wherever this provision is there, it has been irregular. The stray dogs, rodents and cats meddle with this, which spreads disease and it contaminates water and total environment.

The solid waste creates problems to environment mainly by contaminating water and pollutants directly or indirectly discharge into water bodies without adequate treatment to remove harmful compounds. Damage to eco system is also caused by pollution and over exploitation of natural resources. Degradation of flora and fauna, reduction of soil fertility sewage problem, unclean waste dumping, effect of inefficient recycling, bad smell and increasing disease are also caused by solid waste.

Since solid waste (Table 4.1.3) is identified as the second largest problem in Coimbatore city, factor analysis is used to examine damage caused due to solid waste. In factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were performed. The generated score of KMO was 0.541 and highly significant Bartlett's test of sphericity supported the appropriateness of using factor analysis to explore the underlying structure of various issues due to solid waste. Variables with communalities greater than 0.5 were regarded as significant and are included in the analysis.

Table 4.1.4.1

KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.541
Bartlett's Test of Sphericity	Approx. Chi-Square	123.721
	Degrees of freedom	36
	Significance	.000

Source: Field survey, 2013

The communalities for each variable were assessed to determine the amount of variance accounted by the variable to be included in the factor rotation and the results are shown in the table below.

Table 4.1.4.2

Communalities

Factors	Initial	Extraction
Contamination of water	1.000	.587
Damage to eco system	1.000	.583
Degradation of flora and fauna	1.000	.503
Reduction of soil fertility	1.000	.851
Sewage problem	1.000	.553
Unclean waste dumping	1.000	.585
Effect of inefficient recycling	1.000	.504
Bad smell	1.000	.540
Increasing diseases	1.000	.557

Extraction Method: Principal Component Analysis

All the variables had value greater than 0.050 signifying substantial portion of the variance accounted by the factors. Table 4.1.4.3 enlists the Eigen values, their relative explanatory powers and factor loading for 9 linear components identified within the data set.

Table 4.1.4.3

Rotated Component Matrix

Factors	Component			
	1	2	3	4
Contamination of water			.712	
Damage to eco system			.576	
Degradation of flora and fauna		.695		
Reduction of soil fertility				.915
Sewage problem	.726			
Unclean waste dumping		.566		
The effect of improper recycling			.701	
Bad smell	.726			
Increasing diseases		.725		
Eigen values	1.521	1.471	1.247	1.023
Percentage of variance	16.900	16.345	13.851	11.368
Cumulative percentage	16.900	33.245	47.097	58.464

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Factor 1 has significant loadings for two dimensions namely ‘sewage problem and bad smell. These dimensions explained nearly 16 percent of the variance. Factor 2 had significant loadings for three dimensions namely ‘Degradation of flora and fauna’ ‘Unclean waste dumping’ and ‘increasing diseases’ and 16 percent of variance. Factor 3 had significant loadings on three dimensions namely ‘Contamination of water, ‘Damage to eco system’ and ‘The effect of improper recycling’ and explains 13 percent of the variance. Factor 4 had significant loading on reduction of soil fertility explains 11 percent of variance.

The study made it clear that, bad smell, contamination of water, sewage problem, increasing disease and loss of soil fertility will increase due to solid waste.

4.2 Current Practice of Solid Waste Management of Coimbatore

Solid Waste Management (SWM) is a science associated with the management of generation, storage, collection, transportation, processing and disposal of solid waste using the best principle and practices of public health, economics, engineering, conservation, aesthetics and other environmental conditions. But, in most Indian cities, the MSWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. The current study has taken up all aspects of solid waste management which includes the quantity of waste generated, collection process, transportation and disposal of waste by selected households. Each of these are presented in the following sections.

4.2.1 Quantity of Waste Generated

The quantity of MSW (municipal solid waste) generated depends on a number of factors such as population, food habits, standard of living, degree of commercial activities and seasons. The quantity of waste generated helps in planning for collection and disposal systems. Indian cities now generate eight times more MSW than they did in 1947 because of increasing urbanization and changing life styles. The rate of increase of MSW generated per capita is estimated at 1 to 1.33 percent annually. MSW generation rates in small towns are lower than those of metro cities, and the per capita generation rate of MSW in India ranges from 0.2 to 0.5 kg/ day. It was also estimated that the total MSW generated by 217 million people living in urban areas was 23.86 million tonne / year in 1991, and more than 39 million ton in 2001(Kaushal, 2012). Household waste consists of paper waste, kitchen waste, garden waste etc. The quantity of waste generated by the households in the study area is presented in Table 4.2.1

Table 4.2.1

Quantity of Waste Generated

Quantity	Gandhi Park	Avinashi Road	Sathy Road	Total
Below 2kg	14 (14.4)	6 (6.4)	10 (11.4)	30 (10.8)
2kg-3kg	79 (81.4)	84 (89.4)	77 (87.5)	240 (86)
Above 3kg	4 (4.2)	4 (4.3)	1 (1.1)	9 (3.3)
Total	97 (100)	94 (100)	88 (100)	279 (100)

Source: Field survey, 2013
Figures within the parentheses indicate percentage

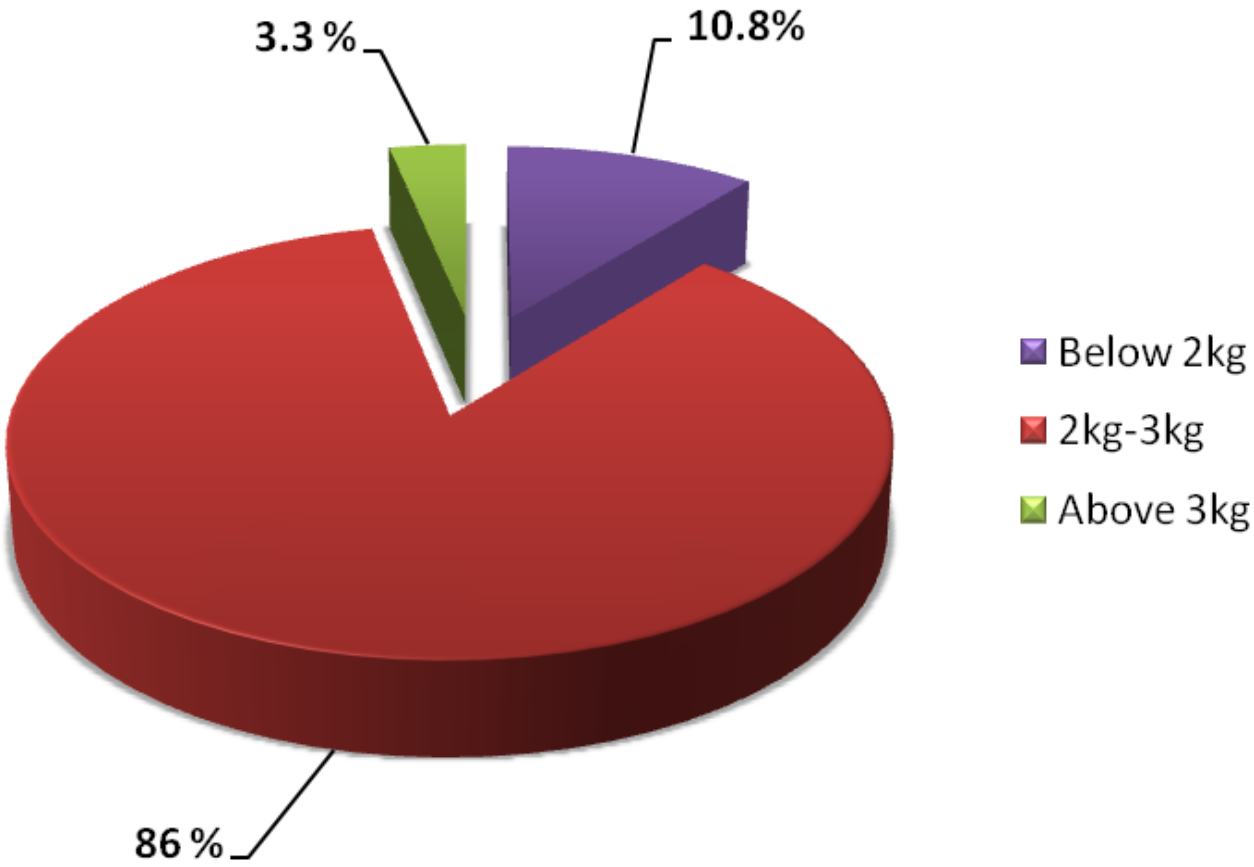
The data pertaining to the quantity of waste generated reveals that majority (86 percent) of respondents created 2kg to 3kg waste per day. Around 11 percent of respondents generated less than 2 kg of waste and only 3.3 percent of respondents generated above 3 kg of waste per day. Bernardo (2008) also found that households in Manila, Philippines had generated an average of 3.2 kg of solid waste per day.

The segregation and storage at source becomes the first touchstone for effective management of the municipal solid waste. The segregation of garbage at source is primarily meant to keep the two broad categories of solid waste generated separately in different containers, i.e. biodegradable waste in one container (green) and non biodegradable waste in the another (white). In order to ensure the segregation at household level the municipal authorities of local bodies provides two separate bins to each household, and this has been successfully carried in Coimbatore cooperation. The households were provided, green and white bins for separation of biodegradable and non biodegradable. However the usages of two bins by the selected households do not give a satisfactory result. Around 77 percent have made use of these bins to segregate the wastes. The rest of them use this bins for fetching water, washing clothes or even store water. This is due to ignorance or lack of knowledge regarding waste disposal. The area wise analysis showed that 97.8 percent of respondents were using the two

bins in Avinashi Road followed by 78.4 percent in Sathy Road and 54.6 per cent in Gandhi Park. The following figure explains this.

Figure 4.2

Quantity of Waste Generated



While most of the respondents were aware of the segregation at source and are using the bins, the rest need to be well informed to make use of the bins to separate the waste. Thanks to the corporation for the efforts taken in educating the general public the need to segregate waste and in keeping the waste in the proper container.

4.2.2 Collection of Solid Waste

After segregation at source, collection is the next important step in the solid waste management process. Proper and frequent collection of waste is necessary to reduce the environmental and health effect of solid waste. Collection includes temporary storage and containerization, transfer to a collection vehicle and transportation to a site where the wastes undergoes processing and finally disposes. Waste collection is the most expensive phase, largely because it is labour intensive. The street sweeping and collection of waste from the receptacles are carried out by sanitary workers.

The waste collection methods that are mainly adopted in India are door to door collection and Community method. Community bin method has been the most commonly adopted method in India. A study carried out in Indian Institute of Science (Sathishkumar, et al, 2002) describes that in community bin method, the improper placement of bins, bins not designed as per quantity of waste generated and bins not being covered causes problems like odour, stray dog nuisance and unaesthetic appearance. The various method of collecting waste from the selected area is given in table. 4.2.2

Table 4.2.2

Method of Primary Collection

Method of Primary Collection	Gandhi Park	Avinashi Road	Sathy Road	Total
Door to door	83 (85.6)	88 (93.6)	79 (89.8)	250 (86.6)
Community bins	12 (12.4)	0	0	12 (4.3)
Others	2 (2.1)	6 (6.4)	9 (10.2)	17 (6.1)
Total	**97 (100)**	**94 (100)**	**88 (100)**	**279 (100)**

Source: Field survey, 2013
Figures within the parentheses indicate percentage

In India, the responsibility of collection and disposal of waste has rested traditionally with municipalities. The municipal cooperation workers and the non-governmental organization are also engaged in the collection process. There are different types of collections like door to door, community bins and burning. Out of the total respondents, it is clear from Table 4.2.3 that 86.6 percent of respondents depend upon the door to door collectors, four per cent dumped their waste in community bins and nearly six percent of respondents disposed their waste in other ways, like burning and other improper methods of waste disposal.

Most of the respondents were giving over their waste to those who come for the door to door collection. Another notable feature is that all the selected households in Avinashi Road and Sathy Road depend upon door to door collectors and other means like burning or dumping, no one make use of community bins in this area. Only 12.4 per cent of respondents in Gandhi Park were using community bins.

For the effective solid waste collection, the frequencies of the waste collection attain the prime importance. Low frequency of waste collection becomes a breeding ground of rats, cats, rodents, mosquitoes and bacteria. Multiplication of uncollected waste attracts various animals such as cows, dogs, pigs and donkeys which further add to degradation of environment. Hot spots of waste get the favorable atmosphere for the survival and growth of microbes, which ultimately lead to the outbreak of various kinds of disease. To reduce their effect, the collection of waste is done in various ways. Though it is to be done on a regular basis or daily basis, it is not carried out properly. The frequency of the collection of waste in the study area is presented in Table 4.2.3

Figure 4.3

Method of Primary Collection

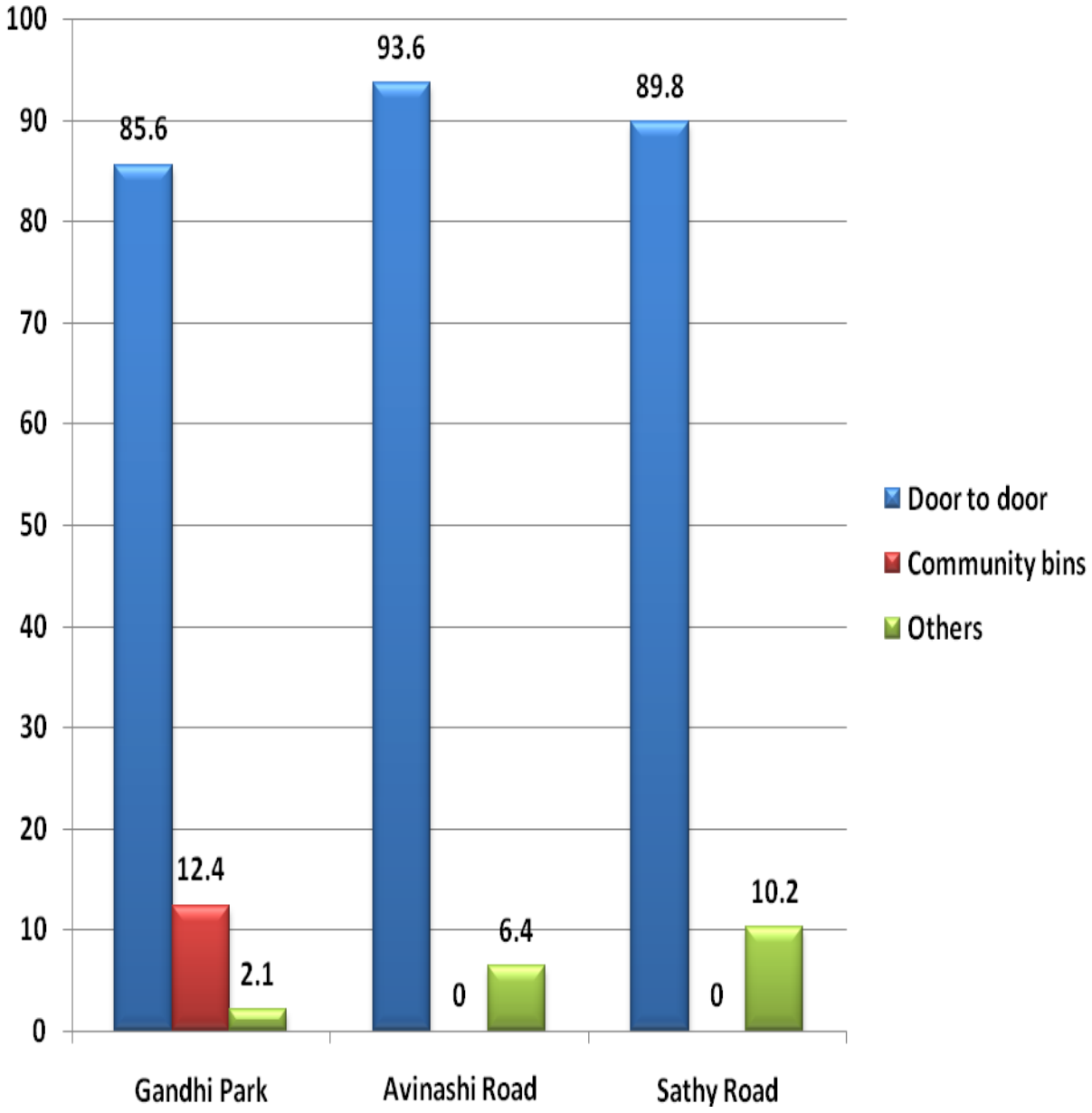


Table 4.2.3

Frequency of Collection

Frequency	Gandhi Park	Avinashi Road	Sathy Road	Total
Daily	8 (8.2)	0	0	8 (2.9)
Alternative days	54 (55.7)	77 (81.9)	71 (80.7)	202 (72.4)
Few days in a week	35 (36.1)	17 (18.1)	17 (19.3)	69 (24.7)
Total	**97 (100)**	**94 (100)**	**88 (100)**	**279 (100)**

Source: Field survey, 2013
Figures within the parentheses indicate percentage

Data pertaining to the frequency of waste collection reveals that collection on a daily basis is very poor. Only 2.9 percent of the households responded that collection of waste is done daily. The workers come to collect the waste in alternate days in 72.4 percent of the households. It was few days in a week for 24.7 percent of households.

Another notable feature is that only eight percent of respondents stated daily collection of the waste in Gandhi Park but there is none from Avinashi Road and Sathy Road who mentioned about the daily collection of waste. It implies that there is no facility to collect the waste daily in Avinashi Road and Sathy Road. Similar aspect of frequency of waste collection in Cachar District, Assam was estimated by a study done by Roy and Deb (2013), while Bernardo (2008) found waste collection is done twice a day, except Sundays, in Manila, Philippines which is credit worthy. The collection of waste needs to be done at least on a daily basis to keep the environment clean and also to protect people from health hazards.

The community storage system is usually practiced as a secondary storage in India. Individuals deposit their waste in bins located at street corners with specific

intervals. The containers generally are made of metal, concrete, or a combination of the two. Community storage may reduce the cost of waste collection, and can minimize problems associated with lack of onsite storage space. Due to the absence of adequate storage capacity for the refuse generated and poor discipline among the generators, the wastes are continually dumped on the Road (Bhoyar et al, 1996).

However, unless these community storage arrangements are conveniently located, householders tend to throw their wastes into the Roadside gutters for clearance by street sweeping crews. Even where storage arrangements are conveniently located, wastes tend to be strewn around the storage area, partly due to indiscipline and partly as a result of scavenging of the wastes by rag-pickers and stray animals. In a country like India, where cheap labour is available, the collection methods are labour intensive and cheaper compared to mechanized collection. The type of the community bins kept in the study area is presented in Table 4.2.4

Table 4.2.4

Type of Community Bin

Type of Community bin	Gandhi Park	Avinashi Road	Sathy Road	Total
Masonry bins	37 (38.1)	56 (59.6)	3 (3.4)	96 (34.4)
Cement concrete bins	37 (38.1)	37 (39.4)	49 (55.7)	123 (44.1)
Metal containers	16 (16.5)	1 (1.1)	36 (40.9)	53 (19)
Open site	7 (7.2)	0	0	7 (2.5)
Total	**97 (100)**	**94 (100)**	**88 (100)**	**279 (100)**

Source: Field survey, 2013
Figures within the parentheses indicate percentage

Nearly 44 percent of respondents uses cement concrete bins followed by 34.4 percent using masonry bin and 19 percent using metal or plastic containers respectively. However 2.5 percent of respondents throw the waste in open site.

In area wise analysis 60 percent of respondents use masonry bin in Avinashi Road, while 56 percent of respondents uses cement concrete bin in Sathy Road and 38.1 percent of respondents use Masonry bin and Cement bin in Gandhi Park. One of the important features is that in Gandhi Park, nearly seven percent of respondents throw waste in open site. It would cause serious environmental and health problems.

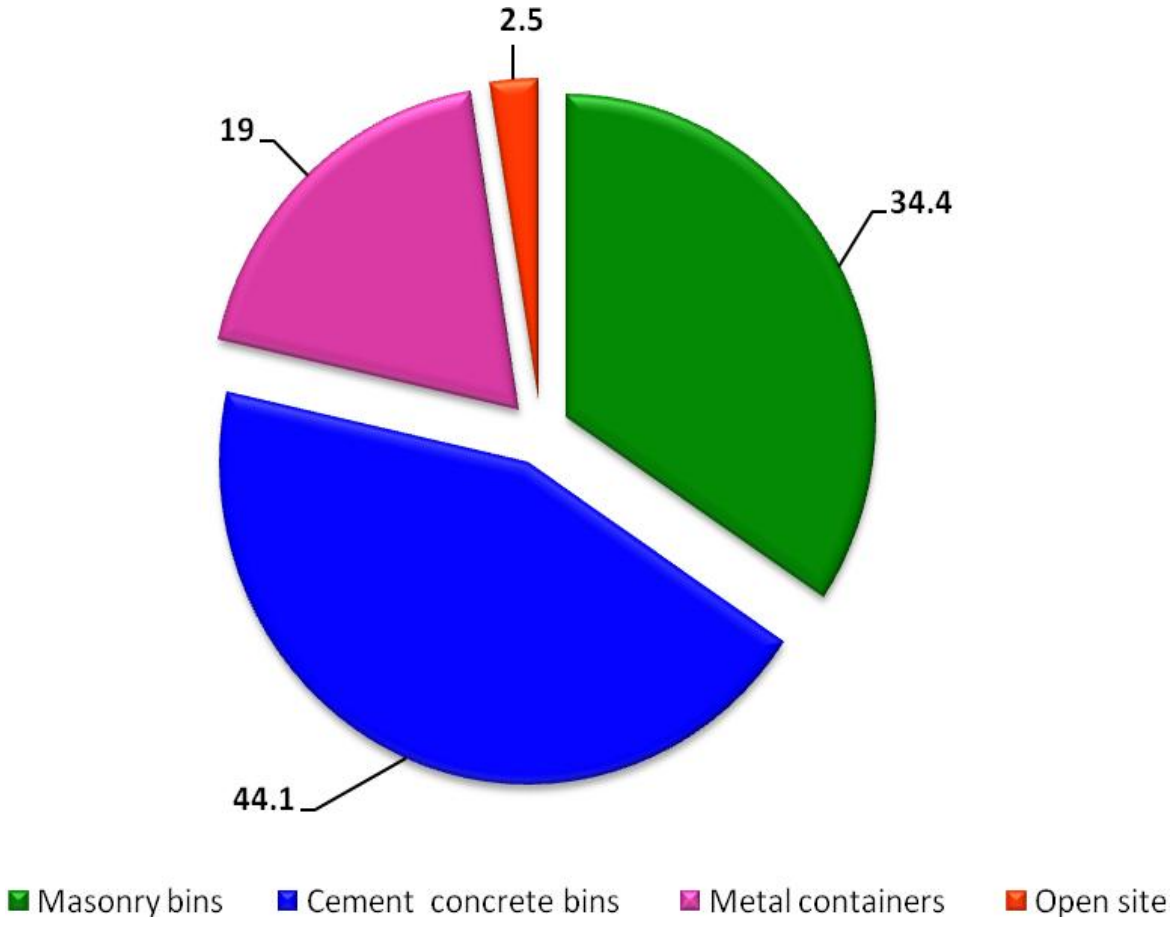
Generally community bins are placed near markets, apartments, Shopping complex, hotels, public places like gardens, religious places or other definite point sources. Vehicles collects large amount of waste from these point and then transport it to transfer stations and then to disposal sites. Manually or mechanically loaded compactors are often used in this stage. Placing communal bins at appropriate locations for deposit and storage of waste is important to manage waste properly. For better municipal solid waste management, waste should be lifted frequently from these community bins to the disposal site. Frequency in lifting garbage from these bins would reduce the evil effect of solid waste.

To understand the collection, the respondents were asked whether waste is normally collected or not. Around 46 percent stated in the affirmative. Nearly half of the respondents stated that the sanitary workers come to clean the community bins only after it overflow. And only 46.2 percent opined that sanitary workers come to collect the waste in time.

Area wise analysis shows that most of the respondents from Gandhi Park and Avinashi Road felt that waste collection from community bin is less efficient as the sanitary workers failed to collect the waste before it overflow. Around 67 percent of respondents from the Sathy Road stated the efficient working of the sanitary workers. Waste collection from Gandhi Park and Avinashi Road using community bin was very poor but in Sathy Road it was better.

Figure 4.4

Type of Community Bin



4.2.3 Transportation

Transfer refers to the movement of waste or materials from collection points to disposal sites. Transportation is carried out by using different types of vehicles depending on the distances to be covered by them. Small vehicles discharge waste at transfer stations where the wastes are loaded into larger vehicles for transportation to the disposal sites. In metro cities transfer stations are located at different places to support intermediate transfer of waste from the surrounding areas up to the dumping grounds. Transfer stations are centralized facilities where waste is unloaded from smaller collection vehicles and re-loaded into larger vehicles (including in some instances barges or rail roads) for transport to a disposal or processing site.

Transportation of waste is carried out by the municipalities employing vehicles like open trucks, tractor-trailers, tipper trucks and dumper placers. Transportation is done by various methods or it is handled by open hand cart, trucks, tractors or bin lifting system as is done in the study area. This is shown in Table 4.2.5

Table 4.2.5

Transportation of the Waste

Transportation	**Gandhi Park**	**Avinashi Road**	**Sathy Road**	**Total**
Open hand cart	6 (6.2)	0	0	6 (2.2)
Trucks	24 (24.7)	49 (52.1)	53 (60.2)	126 (45.2)
Tractors	65 (67)	45 (47.9)	35 (39.8)	145 (52)
Dumper place with bin lifting system	2 (2.1)	0	0	2 (.7)
Total	**97 (100)**	**94 (100)**	**88 (100)**	**279 (100)**

Source: Field survey, 2013.
Figures within the parentheses indicate percentage

For transporting waste mostly tractors were used (52 percent) followed by trucks (45.2 per cent) and only two percent were handled by open hand cart. However occasional use of dumper place with bin lifting system was also reported in the study area.

The respondents' satisfaction towards the waste transportation revealed that nearly 89 percent of respondents were not satisfied with transportation. The respondents reported that open vehicles used for the transportation causes bad smell and air pollution.Only11.5 percent of respondents were satisfied with the current way of waste transportation.

The data pertaining to the satisfaction level of respondents towards the current way of solid waste management revealed that, majority of the respondents were not at all satisfied (76 percent). Around 22 percent were neutral with regard to the satisfaction and only 3 percent revealed their full satisfaction in the process of solid waste management.

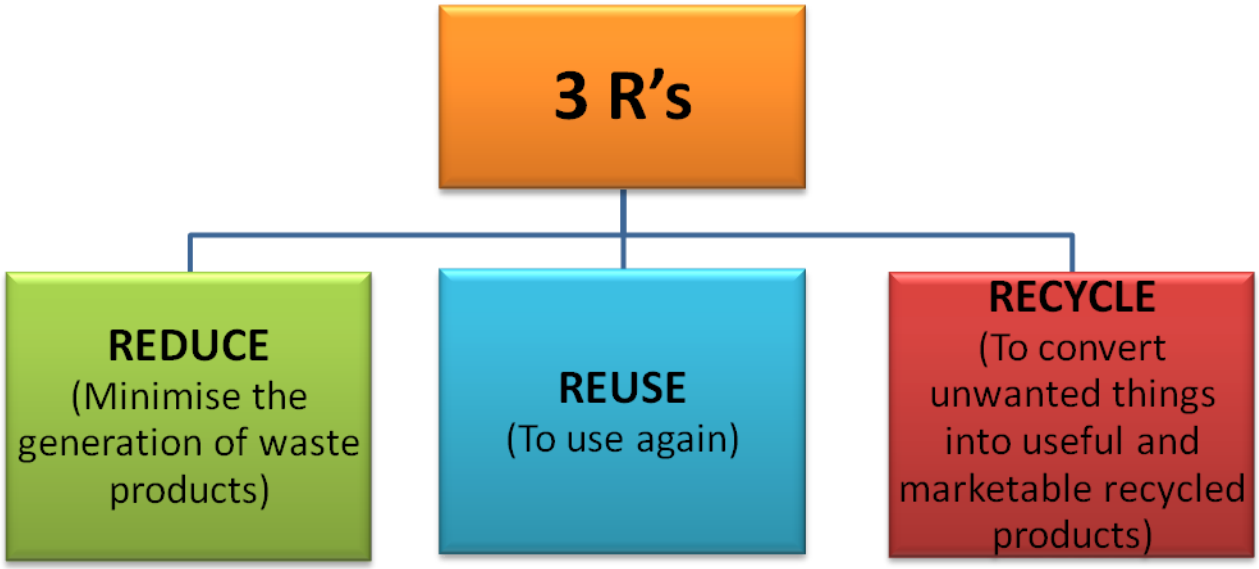
Area wise analysis showed that majority of the respondents were not at all satisfied (78 percent in Avinashi Road , 69 percent in Gandhi Park and 65 percentage in Sathy Road) with respect to solid waste management. There was no one who revealed full satisfaction in Avinashi Road and Sathy Road.

4.2.4 The concept of 3 R's

The "3R Initiative" was officially launched at the 3R Ministerial Conference hosted by the Government of Japan in April 2005, with an aim to promote global action on 3R. In March 2006, a Senior Officials Meeting on 3R was organized in Japan resulting in strong commitment of governments and other stakeholders to implement 3R at national, regional and local level.

Figure 4.5

Concept of 3 R's



Tackling solid waste issues in the developing countries could be one of the most complicated and cumbersome task. Without any formal source segregation and with minimum public participation, almost all of the waste ends up in one common container or in an open backyard. Resource recovery and recycling usually takes place in all components of the system predominantly by the informal sector "waste pickers" or by the solid waste management staff themselves for an extra income. Collecting, sorting, trading and recycling of disposed materials provide income to hundreds of thousands of

people and are usually conducted by these scavengers under labor-intensive and unhygienic ways irrespective of the toxicity. In rural and peri-urban areas, urban municipal wastes generate a steady income despite the risks involved in treating and down cycling them to other consumer products.

Many of these people work parallel to the formal solid waste system but in an informal manner. Recovered and recyclable products then enter a chain of dealers or processing before they are finally sold to manufacturing enterprises. However, the services of rag pickers often go unnoticed and issues concerning their livelihood are unaddressed. It has been estimated that about 20 to 30 percent of the waste generated in the cities of Asia Pacific region, are recycled by the informal sector. For example, in Bangladesh the informal sector is responsible for recycling about 4 to 15 percent of the total solid waste generated. The situation in industrialized countries is very different, since resource recovery is undertaken by the formal sector, driven by law and a general public concern.

Recently, the importance of recycling activities in reducing waste vol, recovering resources and its economic benefits are being acknowledged. Many non-governmental organizations (NGOs) and community based organizations (CBOs) are actively working on 3R related issues, often in a decentralized manner failing to fit in the bigger picture due to lack of communication, networking and other factors. As of today, a long-standing practice and a complex networking of informal source separation and recycling of materials exists. In most cases, they were compelled to focus more on reusing and recycling of waste than on source reduction. Prioritizing the 3Rs among themselves may not promise a drastic change within a short period, but will reap a significant reward in the long run (Visvanathan, 2007).

The respondents were enquired about the knowledge and opinions regarding the concept of 3R’s. Table 4.2.6 shows the respondents opinions regarding the 3R’s.

Table 4.2.6

Opinion of the Respondents on 3 R's

Practice	Gandhi Park	Avinashi Road	Sathy Road	Total
Reduce	1 (1)	26 (27.7)	0	27 (9.7)
Reuse	20 (20.6)	16 (17)	10 (11.4)	46 (16.5)
Recycle	76 (78.4)	52 (55.3)	78 (88.6)	206 (73.8)
Total	**97** **(100)**	**94** **(100)**	**88** **(100)**	**279** **(100)**

Source: Field survey, 2013
Figures within the parentheses indicate percentage

Waste minimization can be achieved in an efficient way by focusing primarily on the first of the 3R's, "reduce," followed by "reuse" and then "recycle." The waste hierarchy refers to the "3R's"i.e., reduce, reuse and recycle, which classify waste management strategies according to their desirability. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

The data revealed the respondent's opinion towards the 3R's. It showed that 73.8 per cent of respondents opined that recycling is the best way of reducing solid waste, followed by reuse (16.5 percent) and reduce (9.7 per cent) respectively.

Figure 4.6

Opinion of the Respondents on 3 R's

4.3. Problems Encountered in the Solid Waste Management

Solid waste management is an obligatory function of urban local bodies in India. Infrastructure development is not developed to keep pace with population growth and requirement. The urbanization and industrialization would cause increase of waste in the society. By considering the requirements, the technology introduced by the municipality is not enough to manage the waste. In the study area most of the respondents were dissatisfied with the current practice of the solid waste management. The study identified certain problems like, low level of waste collection efficiency, lack of financial resources, organizational weakness, improper choice of technology and public apathy towards waste management which made this service far from satisfactory.

Factor analysis is used to identify the problems encounter in solid waste management in the study area. In the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were performed. The generated score of KMO was 0.545 and highly significant Bartlett's test of sphericity supported the appropriateness of using factor analysis to explore the underlying structure of various issues in solid waste management. Variables having communalities greater than 0.5 were regarded as significant and included in the analysis.

Table 4.3.1

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.545
Bartlett's Test of Sphericity	Approx. Chi-Square	63.281
	Degrees of freedom	45
	Significance	.037

Source: Field survey, 2013

The communalities for each variable were assessed to determine the amount of variance accounted by the variable to be included in the factor rotation and the results are shown in the table below.

Table 4.3.2

Communalities

Factors	Initial	Extraction
Absence of organized primary collection	1.000	.589
Over flowing secondary collection units	1.000	.555
Manpower inadequacy	1.000	.592
Weak institutional set up	1.000	.669
Poor civic sense of the people	1.000	.632
Lack of laws	1.000	.572
Paucity of financial resources	1.000	.592
Poor co-operation from the people	1.000	.589
Absence of recycling unit	1.000	.767
Inefficiency of labour	1.000	.647

Extraction Method: Principal Component Analysis.

All the variables had value greater than 0.050 signifying substantial portion of the variance accounted by the factors. Table enlists the Eigen values, their relative explanatory powers and factor loading for 10 linear components identified within the data set.

Table 4.3.3

Rotated Component Matrix

Factors	Component				
	1	2	3	4	5
Absence of organized primary collection		.502			
Over flowing secondary collection units			.589		
Manpower inadequacy		.723			
Weak institutional set up			.512		.597
Poor civic sense of the people	.698				
Lack of laws		.584			
Paucity of financial resources	.658				
Poor co-operation from the people			.566		
Absence of recycling unit					.854
Inefficiency of labour				.794	
Eigen values	**1.277**	**1.261**	**1.170**	**1.124**	**1.072**
Percentage of variance	**12.771**	**12.612**	**11.698**	**11.244**	**10.716**
Cumulative percentage	**12.771**	**25.383**	**37.081**	**48.326**	**56.042**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 14 iterations.

For sample respondents, factor 1 had significant loadings for two dimensions namely Poor civic sense and paucity of financial resource. These dimensions explained nearly 12 percent of the variance. Factor 2 had significant loadings for three dimensions namely ‘Absence of organized primary collection, manpower inadequacy and lack of laws and 12 percentage of variance. Factor 3 had significant loadings on three dimensions namely ‘Over flowing secondary collection units’ ‘Weak institutional set up’ and ‘Poor co-operation from the people’, explaining 11 percent of the variance. Factor 4 had significant loading on inefficiency of labour and explains 11 percent of variance.

Factor 5 had significant loading on two factors namely Weak institutional set up and absence of recycling unit and 10 percent of variance. These are the main problems encountered in the solid waste management.

From the factor analysis, it was observed that lack of recycling unit, manpower inadequacy, and poor civic sense of people and paucity of financial resources as the major problems encountered in the solid waste management.

4.4 Willingness to Pay for Solid Waste Management

Economic Valuation is about “measuring the preferences” of people for an environmental good or against an environmental bad. The economic value of something is measured by a summation of many individuals` willingness to pay (WTP) for it. The WTP reflects individuals` preferences for the good in question. Valuation is in money terms because of the way in which preference is sought. i.e., by asking people how much they are willing to pay. Many of environmental goods and services are provided freely. Therefore, they have zero prices because no market place exists in which their true values can be revealed through acts of buying and selling. Projects and programmes appraisal cannot be sufficient or adequate without valuation. National priorities for environmental policies are better informed if economic values are known with a degree of certainty (Pearce, 1993). Economic valuation of environmental goods has found vast application in determining compensatory payments for environmental damage (Willis and Corkindale, 1995)

Lack of financial resources is one of the major obstacles in managing solid waste. Willingness to pay helps to find out the amount the households are willing to pay for waste management service. Though there was so much waste, all the surveyed population did not agree with paying for waste management. The response from the households, towards the willingness to pay for waste management service is recorded in Table 4.4.1

Table 4.4.1

Willingness to Pay for Solid Waste Management

Willingness to pay	Gandhi Park	Avinashi Road	Sathy Road	Total
Yes	96 (99)	86 (91.5)	81 (92)	263 (94.3)
No	1 (1)	8 (8.5)	7 (8)	16 (5.7)
Total	**97 (100)**	**94 (100)**	**88 (100)**	**279 (100)**

Source: Field survey, 2013

Figures within the parentheses indicate percentage

The data pertaining to whether households are willing to pay some amount to get a better solid waste management service reveals that, 94.3 percent of respondents were willing to pay and only 5.7 percent of respondents were not ready to pay any amount for the better management of solid waste. The respondents stated various reasons for their unwillingness to pay for solid waste management. Among those who were not willing to pay, most of them reported that people with higher income should pay and few of them were of the view that it is not necessary to pay the amount. Some of the respondents explained that payment will not help in reducing the solid waste problem and the money paid will be of no use.

Adepoju, and Salimonu (2013) and Amfo-out et.al (2012) found that majority of the respondents were willing to pay for solid waste management. A study done by Khattak et.al (2009) found that 53 percent were satisfied with the existing SWM services and were not willing to pay. The second most observed reason for avoiding monetary contribution for better SWM services was that 28 percent of the households thought that government is responsible to ensure the availability of basic amenities to its masses. Third major concern (14 percent) was that the proposed services will not be provided consistently and thus, the new system would not be reliable. While the least observed concern was that public was not satisfied with the quality of the services. This gives a

clear indication of induction of the issue of zero Waste treatment as done in Peshawar district Pakistan. Joel et.al (2012) also supported this view.

The amount of willingness to pay is verified in terms of the cost or the sacrifice which households are ready to make. When asked as to how much money they are ready to pay, the respondents expressed different amounts, which are presented in Table 4.4.2.

Table 4.4.2

Amount of Money the Households were Willing to Pay/ Month

Amount (in Rs.)	**Gandhi Park**	**Avinashi Road**	**Sathy Road**	**Total**
Below 25	70 (72.2)	53 (56.4)	40 (45.4)	163 (58.4)
25 -50	24 (24.7)	37 (39.4)	46 (52.2)	107 (38.3)
Above 50	3 (3.1)	4 (4.2)	2 (2.2)	9 (3.3)
Total	**97 (100)**	**94 (100)**	**88 (100)**	**279 (100)**

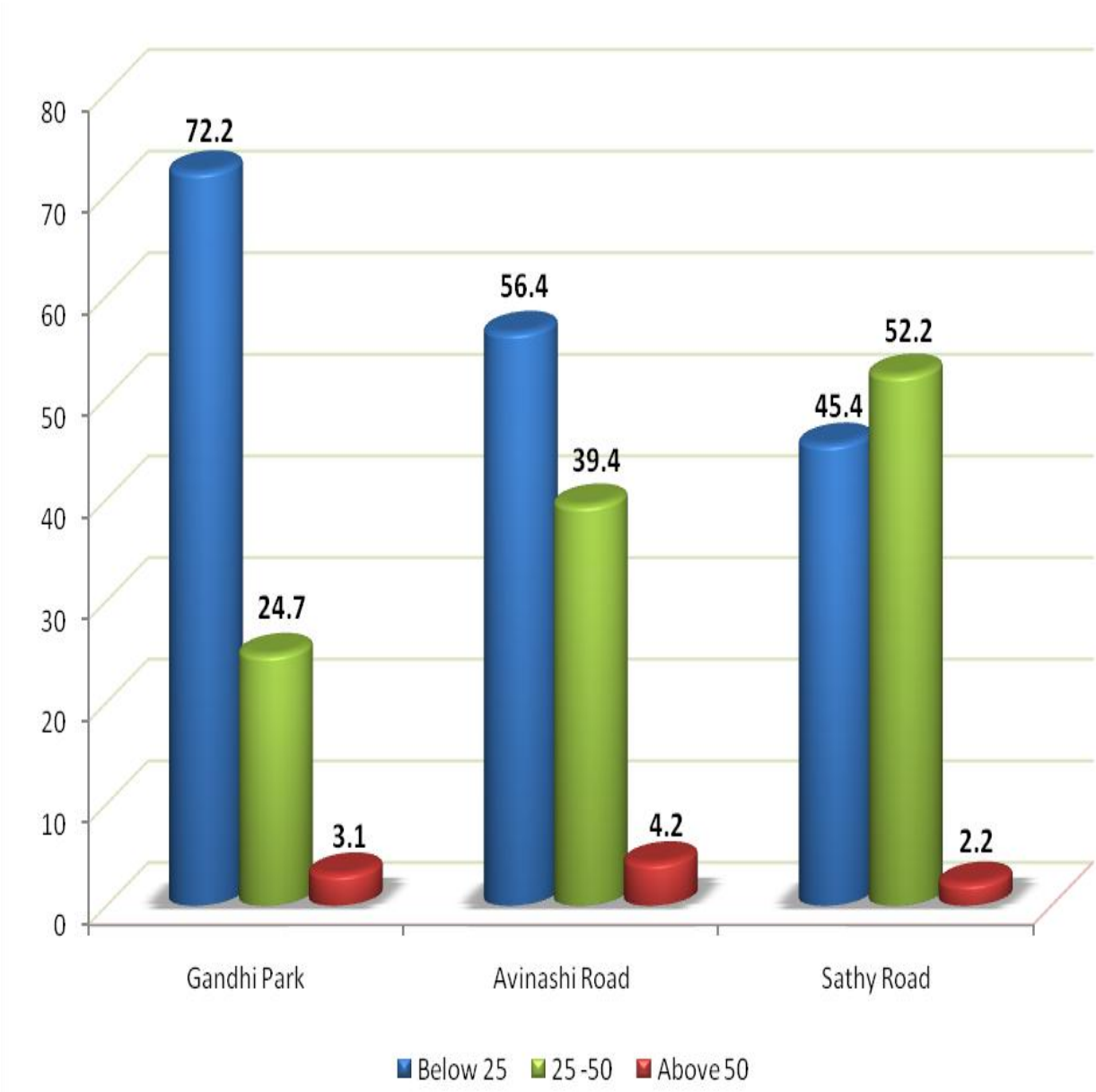
Source: Field survey, 2013

Figures within the parentheses indicate percentage

The amount the households were willing to pay for solid waste management revealed that majority were willing to pay below only Rs 25 per month followed by 38.3 percent who were willing to pay Rs 25-50 and only 3.3 percent of respondents were willing to pay above Rs 50 for managing solid waste. Area wise analysis showed that majority of the households from Gandhi Park (72.2 percent) Avinashi Road (56.4 percent) were ready to pay below Rs 25 per month but in Sathy Road 52.2 percent of the households were willing to pay Rs 25-50 per month for waste disposal. The findings of Yusuf (2007), Lokina (2011), Adepoju et.al (2012) were on similar line.

Figure 4.7

Amount of Money the Households were Willing to Pay/ Month



4.4.1 Multiple Regression

The multiple regression results of factors influencing willingness to pay for waste management is shown in Table 4.4.3.1 It explains the goodness of fit of this model which explains R^2 value is 0.59 percent .The factor which determine the dependent variable in simple linear regression are statically significant. The ANOVA table explains statistical significance of the constructed model .This is significant at one per cent level.

$Y= \alpha +\beta_1X_1+ \beta_2X_2+ \beta_3X_3……. \beta_nX_n+e$

Where,

Y = Willingness to pay for solid waste management

X_1 = Age of the Sample Respondents

X_2 = Sex of the respondents

x_3 = Educational level of the respondents

x_4 = Occupation of the respondents

x_5 = Type of the family

x_6 = Household size

x_7= Monthly income of the respondents

Table 4.4.3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.625[a]	.591	.375	9.56076

a. Predictors: (Constant), Income, Education, Sex, Occupation, Age, Household size, Type of family

Table 4.4.4

ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	15871.611	7	2267.373	24.805	.000[a]
Residual	24771.579	271	91.408		
Total	40643.190	278			

a. Predictors : (constant), income , education , sex, occupation , age, household size , type of family

b. Dependent variable: willingness to pay

Table 4.4.5

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	-10.409	4.521		-2.302	.022
Age	3.111	2.300	.100	1.353	.177
Sex	-1.548	1.516	-.049	-1.021	.308
Education	1.436	.977	.073	1.471	.143
Occupation	-.170	.913	-.009	-.186	.853
Type of family	-5.649	4.335	-.138	-1.303	.194
Household size	1.352	.734	.162	1.843	.066
Income	.002	.000	.548	8.104	.000

a. Dependent Variable: Willingness to pay

The nature and magnitude of various explanatory variables influence the willingness to pay as monthly tariff by the households reveals that age, educational level, household size, and income is positively significant at 1 percent level. Sex, Occupation, type of family of the sample respondents is statistically significant and has negative impact. However out of seven variables, only one variable i.e. income of the respondents in the model influenced the willingness to pay value significantly.

The majority of the respondents belonged to the age group of 25-50 years. Age of the respondents is a significant factor in determining the willingness to pay. The positive sign in the regression analysis shows the willingness to pay for solid waste management.

Education of the respondents is expected to have positive influence on willingness to pay. This is because educated members are supposed to have relatively higher levels of knowledge, awareness and interest in the management of solid waste. The positive sign confirms their willingness to pay.

Income is expected to have positive influence on willingness to pay. Therefore those with higher income will have greater willingness to pay than those with less income. The result of the regression proved this and also confirms the statistical significance of the variable.

The size of the household is expected to have positive relation with willingness to pay. The result of the study shows that, more the members of the household greater will be the quantity of solid waste and therefore the willingness to pay of those households would be greater than the households of smaller size.

The results of regression prove that first hypothesis of the study proves to be true, ie income of the respondents is the major determinant of willingness to pay for solid waste management.

A number of studies have identified several variables to be influencing one's willingness to pay for waste management. For instance, the findings of Yusuf et al (2007), Massito (2009),Rahji and Oloruntoba and Rahji (2009), Khattak et al (2013) ,

Ekere et al (2010). Banga et al (2011) Amiga (2002) and Adepoju and Salimonu (2009) were in the line with the findings of the current study.

4.4.2 The Analysis of Variance

In this study ANOVA is used to test the variation of willingness to pay that exists between areas. For this purpose, the following hypotheses are tested.

Ho: There is no significant variation among willingness to pay among the respondents in different areas.

H_1: The willingness to pay differs significantly among the respondents

Table 4.4.6

Analysis of Variance of Willingness to Pay among the Respondents

Source of variance	Sum of Squares	Degrees of freedom	Mean Square	F	Sig.
Between Groups	29.501	13	2.269	3.875	.000
Within Groups	155.208	265	.586		
Total	184.710	278			

Source: Field survey, 2013

The above Table depicts the results of the ANOVA. Since, the level of significance value .001 is less than 0.05, and the variance between two experimental conditions is significant, it is noticed that willingness to pay differs significantly among the respondents between areas.

4.4.3 Chi-Square Test

Chi-square test was done to examine the association between willingness to pay and other independent variables. Hence, Null hypothesis is framed as below:

Ho: There is no association between willingness to pay and other independent variables.

H_1: The variables are associated.

If the calculated value is less than the table value at different levels of degrees of freedom, the Null hypothesis will be accepted. On the contrary, if the calculated value is greater than the table value, the Null hypothesis will be rejected. The estimated Chi-square values are given in the following Table 4.4.7

Table 4.4.7

Association of Willingness to Pay and Other Independent Variables

Variables	DF	Level of significance	Calculated value	Significance	Result
Environmental conditions	26	5 percent	13.224	.982	Accepted
Current way of handling solid waste	26	5 percent	49.407	.004	Rejected
Satisfaction towards transportation	13	5 percent	46.443	.000	Rejected
Method of charging	39	5 percent	51.566	.086	Accepted
Organization preferred for solid waste management	78	5 percent	80.655	.396	Accepted

Source: Field survey, 2013

The factors i.e., State of environment, Method of charging for solid waste management and organization preferred for solid waste disposal had no significant influence with the willingness to pay. Only two factors namely current way of handling solid waste and satisfaction towards solid waste management has significant influence on willingness to pay.

4.5 Factors Help to Combat the Problem of Solid Waste Management

The problem of SWM has assumed considerable importance only lately. In fact the damages caused by the alarming growth of solid waste led to the acceptance of the need and significance of arresting the problem. The awesome scenario of littering the waste in public places, has led to a nation-wide concern for creating awareness among the people on the need to combat the solid waste. The several programmes initiated by the government have not been very successful in minimizing the waste. The current study took some suggestions from the selected households on the ways and means to combat solid waste. This is presented in Table 4.5.1 below.

Table 4.5.1

Factors Help to Combat the Problem of Solid Waste Management

Factors	Factors	Gandhi Park	Avinashi Road	Sathy Road	Total
Prohibit littering	Yes	97 (100)	92 (97.9)	88 (100)	277 (99.3)
	No	0	2 (2.1)	0	2 (.7)
Primary Collection	Door to door	93 (95.9)	76 (80.9)	84 (95.5)	253 (90.7)
	Community bins	4 (4.1)	18 (19.1)	4 (4.5)	26 (9.3)
Frequency of Collection	Twice a day	97 (100)	87 (92.6)	88 (100)	272 (97.5)
	Once in two days	0	7 (7.4)	0	7 (2.5)

Transportation	Trucks	4 (4.1)	0	0	4 (1.4)
	Tractors	10 (10.3)	3 (3.2)	10 (11.4)	23 (8.3)
	Closed vehicle	73 (75.3)	86 (91.5)	61 (69.3)	220 (78.9)
	Dumper placer with bin lifting system	10 (10.3)	5 (5.3)	17 (19.3)	32 (11.4)
Method of charging for solid waste management	User charge based on the amount of SW generated at the household level	14 (14.4)	57 (60.6)	70 (79.5)	141 (50.5)
	Flat rate charge for every household	68 (70.1)	21 (22.3)	16 (18.2)	105 (37.6)
	Charge based on the size of the household	15 (15.5)	16 (17)	1 (1.1)	32 (11.5)
	In the form of property tax	0	0	1 (1.1)	1 (.4)
Organization preferred for solid waste	Coimbatore corporation	28 (28.9)	10 (10.6)	8 (9.1)	46 (16.5)
	NGO	19 (19.6)	18 (19.1)	1 (1.1)	38 (13.6)

	Private sector	37 (38.1)	7 (7.4)	0	44 (15.8)
	Residence Association	0	5 (5.3)	0	5 (1.3)
	Self help group	13 (13.4)	12 (12.8)	19 (21.6)	44 (13.6)
	Corporate sector	0	5 (5.3)	0	5 (1.8)
	Separate authority	0	27 (28.7)	60 (68.2)	87 (31.2)

Source: Field survey, 2013

Figures within the parentheses indicate percentage

An important aspect of solid waste management is to keep the waste in its place otherwise it become litter. Litter would result in serious environmental problem. Majority (99.3 per cent) of the respondents suggested that abolition of littering would help reduce the solid waste problem. The government should take necessary steps in the form of fines and penalties to abolish the littering. All respondents from Gandhi Park and Sathy Road suggested complete abolition of littering.

In terms of collection of waste, majority (90.7 per cent) of the respondents suggested that door to door collection of waste is necessary to manage the waste problem in a proper way. Nearly 10 percent of respondents opined that community bins be placed in the proper area which would help to reduce the problem. Area wise analysis showed that majority of the respondents(95.9 percent in Gandhi Park, 80.9 per cent in Avinashi Road and 95.5 per cent in Sathy Road) suggested door to door collection of solid waste to reduce the waste problem.

The aim of sweeping is to make the city clean and it is done by the sanitary workers. The frequency of street sweeping is important to reduce the waste problem. Around 98 per cent of the respondents suggested that sweeping twice a day is

necessary to make the city clean. Nearly three percent of respondents opined street sweeping on alternate days. All the respondents from Gandhi Park and Sathy Road suggested sweeping twice per day is necessary to reduce the waste problem. Only 7.4 percent of respondents from Avinashi Road suggested alternative street cleaning to control the waste.

The respondent's suggestion regarding the transportation of the solid waste showed that majority of the respondents (69.3 percent) were for closed vehicle, 8.2 percent of respondents supported dumper place with lifting system and eight percent favored tractor. Only 4.1 one percent of respondents supported usage of trucks for transportation of solid waste.

The respondents suggestions towards the method of charging for solid waste management reveals that 50.5 percent of respondents supported for charges to be based on the amount of waste generated followed by flat rate (37.6 percent) and size of the household (11.5 percent). Only 0.4 percent suggested the method of charging based on the property tax.

In India solid waste management is the function of local authorities. By considering the effect of the solid waste, the respondents were asked about the organization preferred for effective management of solid waste. They suggested various organizations for managing solid waste, namely municipality, NGO, private contractor, residence association; self help group, Co-operative sector, and a separate authority.

Around 32 percent of respondents felt the need for a separate authority for managing solid waste followed by municipality (16.5 percent). The respondents also supported private contractor (15.8 percent), self help group (13.6 per cent), NGO (13.6 per cent) Residence Association (1.3 Per cent) and Co-operate sector (1.8 percent) as an agency to manage the solid waste.

II. An assessment of profile and working conditions and health status of sanitary workers

The second section of research portrays the socio-economic profile of the sanitary workers. The government sanitary workers play the most pivotal role in MSW. An important objective of the study is to understand the socio economic status, health problems and insurance facility of sanitary workers. Four units were randomly selected for the study. A total of 242 sanitary workers were randomly selected from different units like- P.N.Puthur (unit 1), Gandhi Park (unit 2), Poo Market (unit 3), Bharathi Park (unit 4).

An assessment of the socio economic conditions of the sanitary workers is presented under the following heads.

4.6 The socio-economic condition of the sanitary workers

4.7 Reason for selecting the job

4.8 Problems of sanitary workers

4.9 Nature of work

4.10 Safety measures

4.11 Health issues of sanitary workers

4.12 Insurance facility

4.13 Factors which help to improve the condition of the sanitary workers

4.6 Socio- Economic Condition of the Sanitary Workers

The socio economic condition of the selected sanitary workers from various sites were analyzed with respect to age, sex, type of family, family size, education and income which are the most obvious factors that determine their living conditions. This is presented in Table 4.6.1

Table 4.6.1

Socio Economic Condition of the Sanitary Workers

Socio-Economic Variables	Characteristics	Unit 1	Unit 2	Unit 3	Unit 4	Total
Age (in years)	Below 30	4 (10.5)	19 (35.2)	1 (1.2)	0	24 (9.9)
	30-40	23 (60.5)	20 (37)	36 (43.4)	13 (19.4)	92 (38)
	40-50	9 (23.7)	13 (24.1)	41 (49.4)	43 (64.2)	106 (43.8)
	50-60	2 (5.3)	2 (3.7)	5 (6)	11 (16.4)	20 (8.3)
Sex	Male	29 (76.3)	46 (85.2)	66 (79.5)	57 (85.1)	198 (81.8)
	Female	9 (23.7)	8 (14.8)	17 (20.5)	10 (14.9)	44 (18.2)
Type of family	Nuclear family	35 (92.1)	43 (79.6)	58 (69.9)	55 (82.1)	191 (78.9)
	Joint family	3 (7.9)	11 (20.4)	25 (30.1)	12 (17.9)	51 (21.1)

Household size (In numbers)	Below 4	28 (73.6)	15 (27.7)	15 (18)	3 (4.5)	61 (25.3)
	4-6	8 (14.8)	31 (57.5)	40 (48.2)	44 (65.7)	123 (50.8)
	Above 6	2 (5.2)	8 (14.8)	28 (33.8)	20 (29.8)	58 (23.9)
Education	Illiterate	25 (65.8)	27 (50)	64 (77.1)	62 (92.5)	178 (73.6)
	Primary	3 (7.9)	15 (27.8)	14 (16.9)	5 (7.5)	37 (15.3)
	Middle school	4 (10.5)	10 (18.5)	5 (6)	0	19 (7.9)
	High school	4 (10.5)	2 (3.7)	0	0	6 (2.5)
	Higher Secondary	2 (5.3)	0	0	0	2 (.8)
Religion	Hindu	38 (100)	54 (100)	83 (100)	67 (100)	242 (100)
Caste	SC	38 (100)	54 (100)	83 (100)	67 (100)	242 (100)
Total		**38 (100)**	**54 (100)**	**83 (100)**	**67 (100)**	**242 (100)**

Source: Field survey, 2013

Figures within the parentheses indicate percentage

Age is the basic factor that determines the efficiency of the workers. It is clear from the table that, nearly 44 percent of sanitary workers belonged to the age group of 40-50 years followed by 38 percent in the age group of 30-40 and rest were below 30 years (9.9 percent). Only 8.3 percent of sanitary workers belonged to the age group of 50-60 years. The studies done by Dhakal (2010) found that the average age group of the waste collectors is in the economically active age group (15- 59 years).

The sex wise classification of the sanitary workers showed that majority of the sanitary workers were males (81.8 percent). Hansen (1997) and Sarkar (2003) also found male domination among the sanitary workers.

Family is the basic unit of the society. The data relating to the type of family reveals that majority of the respondents had nuclear family structure (78.9 percent) and only 21.1 percent had joint nature of family. It indicates the basic change of Indian society i.e. the disintegration of the joint family structure. With regard to the size of the family 50.8 percent of respondents have 4-6 members in their family.

It is a well known fact that education is a vital instrument in the overall development of a person. Education is of great strategic importance in the process of development as educational achievements of disadvantaged groups can increase their ability to resist oppression to organize politically and get a fair deal (Dreze 1995). Low level of education limits their economic well being.

Educational status of the sanitary workers was found to be at a very low level with 73.6 percent being illiterate. These people did not get any formal education. Nearly 15 percent of respondents had education up to primary level followed by middle school (eight percent) and only 2.5 percent are having high school education. Only two workers had qualified above high school level of education. The findings are in tune with that of Dhankal (2010) who pointed out the low literacy rate among sanitary workers.

Irrespective of their poor education their salary seems to be quite nominal. This is given in Table 4.6.2

Table 4.6.2

Salary of the Sanitary Workers

Salary / month (in Rs)	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Total**
Less than 10000	3 (7.8)	5 (9.2)	8 (9.6)	7 (10.4)	23 (9.6)
10000-15000	19 (50)	40 (74.2)	35 (42.2)	34 (50.8)	128 (52.8)
Above 15000	16 (42.2)	9 (16.6)	40 (48.2)	26 (38.8)	91 (37.6)
Total	**38 (100)**	**54 (100)**	**83 (100)**	**67 (100)**	**242 (100)**

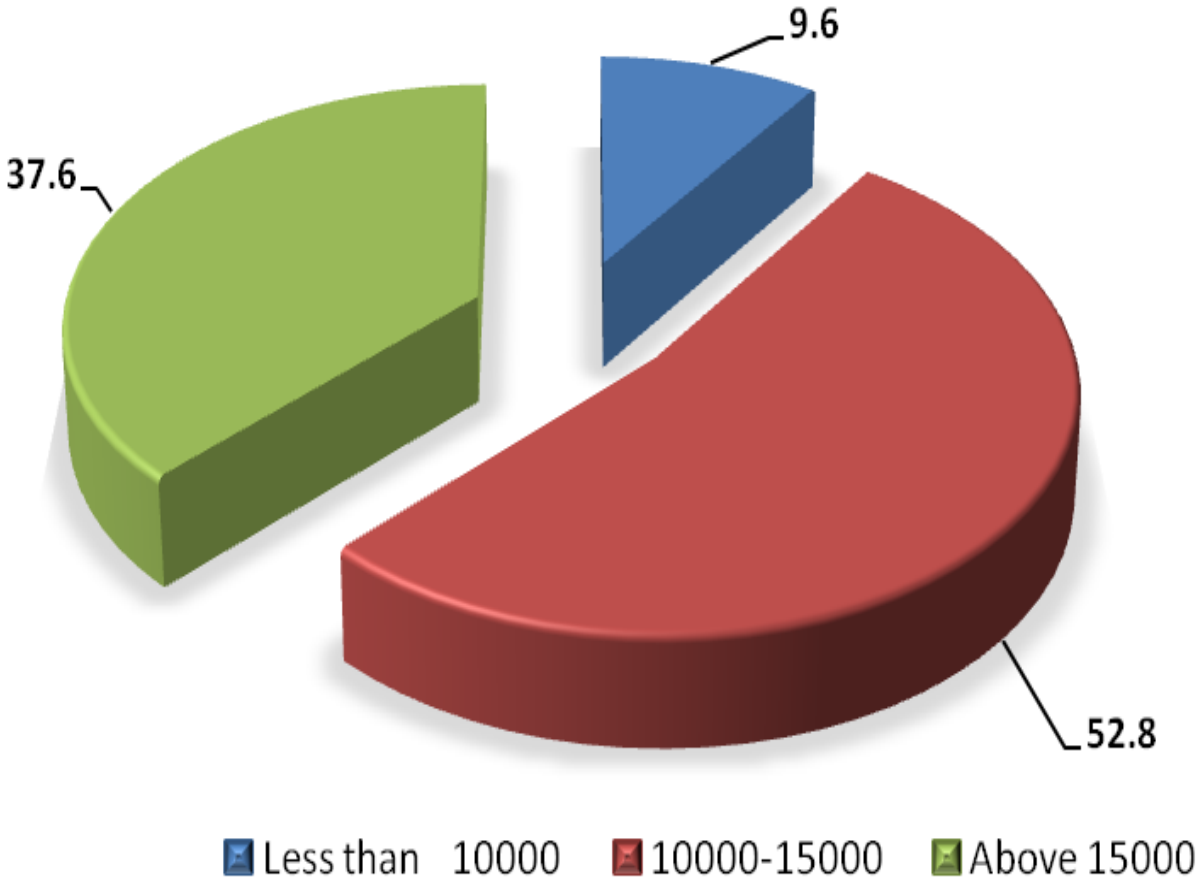
Source: Field survey, 2013

Figures within the parentheses indicate percentage

Income is the backbone for any family activity. Salary is the main source of income of the sanitary workers. Majority (52.8) of the worker's salary ranges between Rs10000-15000 and 37.6 percent of workers had salary above Rs15000. Only 9.6 percent of respondents had salary less than Rs 10000.Though salary seems to be good, most of them have taken loans from banks and private agents. A major portion of their income is used to repay the loans. Most of them have availed loans either for the marriage of their children or for any emergency. Another notable feature found is that most of the workers were unaware about their salary. When they were asked about the salary they were showing their salary certificate. Because of the lack of education, the sanitary workers were not able to read the amount. When they receive the salary they keep thumb impression and are pretty aware that their friends or relatives, who help them in withdrawing the money, do not cheat them. They have full faith in bank officials who do all transactions on their behalf.

Figure 4.8

Salary of the Sanitary Workers



4.7 Reason for Selecting Job

In the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were performed. The generated score of KMO was 0.313 and highly significant Bartlett's test of sphericity supported the appropriateness of using factor analysis to explore the underlying structure of various reasons for selecting the job by sanitary workers. Variables having communalities greater than 0.5 were regarded as significant were included in the analysis.

Table 4.7.1

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.313**
Bartlett's Test of Sphericity	Approx. Chi-Square	197.048
	Degrees of freedom	28
	Sig.	.000

Source: Field survey, 2013

The communalities for each variable were assessed to determine the amount of variance accounted by the variable to be included in the factor rotation and the result are shown in the table below.

Table.4.7.2

Communalities

Factors	Initial	Extraction
Poor economic condition	1.000	.687
Low educational qualification	1.000	.581
Community reasons	1.000	.733
Unemployment	1.000	.575
Reducing child labour	1.000	.587

To increase parental income	1.000	.571
Working hours	1.000	.708
Part of organized sector	1.000	.674

Extraction Method: Principal Component Analysis

All the variables had value greater than 0.050 signifying substantial portion of the variance accounted by the factors. Table 4.7.3 enlists the Egien values, their relative explanatory powers and factors loading for 8 linear components identified within the data set.

Table 4.7.3

Rotated Component Matrix

Factors	**Component**		
	1	2	3
Poor economic condition	.805		
Low educational qualification	.539		
Community reasons		.855	
Unemployment		.745	
Reducing child labour			.621
To increase parental income	.575		
Working hours			.837
Part of organized sector			.573
Eigen values	**1.588**	**1.452**	**1.176**
Percentage of variance	**19.853**	**18.149**	**14.699**
Cumulative percentage	**19.853**	**38.002**	**52.701**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 7 iterations.

For sample respondents factor 1 has significant loading for three dimensions namely poor economic condition, low educational qualification and to increase parental income. These dimensions explained nearly 19 percent of variance. Factor two had significant loading for two dimensions namely community reasons and unemployment and explained 18 percent of variance. Factor three had significant loading for three dimensions namely reducing child labour, increasing parental income and part of organized sector and explained 14 percent of variance.

From the factor analysis it was observed that poor economic conditions, working hours, community reasons and unemployment are the major reasons for selecting this type of job.

4.8 Problems Faced by the Sanitary Workers

Waste has no market value for the waste generator but it provides a means of livelihood to a particular segment of the society who works as sanitary workers. Doing waste collection and transport and disposal is the major activity done by this group. The sanitary workers were the most vulnerable section in the society. The sanitary workers are facing lot of problems while handling the waste. The factor analysis is used to find out the problems faced by the sanitary workers.

In the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were performed. The generated score of KMO was 0.459 and highly significant Bartlett's test of sphericity supported the appropriateness of using factor analysis to explore the underlying structure of various problems of sanitary workers. Variables having communalities greater than 0.5 were regarded as significant and included in the analysis.

Table.4.8.1

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.459**
Bartlett's Test of Sphericity	Approx. Chi-Square	158.297
	Degrees of freedom	45
	Sig.	.000

Source: Field survey, 2013

The communalities for each variable were assessed to determine the amount of variance accounted by the variable included in the factor rotation and the results are shown Table.4.8.2

Table.4.8.2

Communalities

Factors	**Initial**	**Extraction**
Non co-operation from the public	1.000	.612
Low salary	1.000	.637
Unpleasant working condition	1.000	.694
Lack of vehicles	1.000	.735
Shortage of equipment	1.000	.729
Poor safety measures	1.000	.741
Absence of health facilities	1.000	.814
Lack of legal support	1.000	.684
Discrimination from the public	1.000	.572
Lack of trade union	1.000	.546

Extraction Method: Principal Component Analysis.

All the variables had value greater than 0.050 signifying substantial portion of the variance accounted by the factors. Table 4.8.3 enlists the Egien values, their relative explanatory powers and factor loading for 10 linear components identified within the data set.

Table 4.8.3

Rotated Component Matrix

Factors	Component				
	1	2	3	4	5
Non co-operation from the public			.543		
Low salary		.757			
Unpleasant working condition				.775	
Lack of vehicles				.801	
shortage of equipment			.813		
Poor safety measures	.825				
Lack of health facilities					.882
Lack of legal support	.698				
Discrimination from the public		.564			
Lack of trade union	.643				
Eigen values	**1.503**	**1.488**	**1.372**	**1.087**	**1.013**
Percentage of variance	**15.027**	**14.875**	**13.720**	**10.871**	**10.128**
Cumulative percentage	**15.027**	**29.902**	**43.622**	**54.494**	**64.621**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 11 iterations.

For sample respondents factor 1 had significant loading for three dimensions namely poor safety measures, lack of legal support and lack of trade union. These dimensions explained nearly 15 percent of variance. Factor two had significant loading for two dimensions namely low salary and discrimination from the public and explained

14 percent of variance. Factor three had significant loading for two dimensions namely non cooperation from the public and shortage of equipment with 13 percent of variance. Factor four had significant loading on two dimensions namely unpleasant working condition and lack of vehicles with 10 percent of variance. Factor five had significant loading on lack of health facilities and 10 percent of variance.

Lack of vehicles, poor safety measures, shortage of equipment, lack of health facilities and unpleasant working condition are the major problems cited by the sanitary workers. Because of lack of education the respondents were unaware about the government scheme which provides health facility and safety measures to the sanitary workers.

4.9 Nature of work

The data pertaining to the nature of work is shown in table .4.9.

Table 4.9

Nature of work

Nature of work	Unit 1	Unit 2	Unit 3	Unit 4	Total
Collection and sweeping	29 (79.3)	39 (72.2)	62 (74.7)	61 (91)	191 (78.9)
Collection only	6 (15.8)	11 (20.4)	18 (21.7)	3 (4.5)	38 (15.7)
Drivers	2 (5.3)	3 (5.6)	1 (1.2)	1 (1.5)	7 (2.8)
Health worker	1 (2.6)	1 (1.9)	2 (2.4)	2 (3)	6 (2.4)
Total	**38 (100)**	**54 (100)**	**83 (100)**	**67 (100)**	**242 (100)**

Source: Field survey, 2013

Figures within the parentheses indicate percentage

It reveals that 79 percent of sanitary workers are doing the collection and sweeping. It includes the door to door collection and collection of waste from community bins and sweeping of major areas like bus stand, Roads, markets etc. Around 16 percent of workers were doing the waste collection, mainly door to door collection. The study also probed into the activities carried out by drivers and health workers. The drivers' main job is to transport the collected waste from dumping site to the recycling plant. Though his main job is driving, he is also engaged in loading and unloading the waste. Similarly the health workers also help in other activities of collecting and transporting, though they are exclusively appointed to spray the medicine or other liquids in the areas where waste is accumulated or collected, because these areas will be hot spots infected by bacteria and mosquito. Therefore, after clearing the waste, the area needs to be sprayed with medicine to prevent any outbreak of disease. The health workers do this job; apart from that they also help their fellow workers in collection and transportation.

4.10 Usage of Safety Measures

The term "safety measures" is used to denote all those measures which serve to minimise and compensate the effect of waste. The whole process of waste treatment includes lots of risk. Hence, the implementation of the safety measures place a vital role in reducing the adverse effect during collection, segregation, transportation and final disposal.

Safety measures play a prime role to reduce health issues of solid waste. The general safety measures are uniform, gloves, mask, shoes etc. In 1995 Coimbatore municipality took initiative to distribute uniform, gloves, mask and shoes to the sanitary workers. However many workers seems to be unaware of its importance and therefore they do not wear these to protect themselves. The usage of safety measures by sanitary workers are presented in table 4.10 below.

Table 4.10

Usage of Safety measures

Safety measures	Use	Unit 1	Unit 2	Unit 3	Unit 4	Total
Uniform	Yes	36 (94.7)	48 (88.9)	78 (94)	60 (89.6)	222 (91.7)
	No	2 (5.3)	6 (11.1)	5 (6)	7 (10.4)	20 (8.3)
Gloves	Yes	37 (97.4)	53 (88.9)	47 (56.6)	18 (26.8)	155 (64)
	No	1 (2.6)	1 (1.9)	36 (43.4)	49 (73.1)	87 (36)
Mask	Yes	36 (94.7)	43 (79.6)	35 (42.2)	20 (29.9)	134 (55.4)
	No	2 (5.3)	11 (20.4)	48 (57.8)	47 (70.1)	108 (44.6)
Shoes	Yes	20 (52.6)	19 (35.2)	31 (37.3)	21 (31.3)	91 (37.6)
	No	18 (47.4)	35 (64.8)	52 (62.7)	46 (68.7)	151 (62.4)
Total		**38 (100)**	**54 (100)**	**83 (100)**	**67 (100)**	**242 (100)**

Source: Field survey, 2013

Figures within the parentheses indicate percentage

Uniform helps to identify the sanitary workers. Most of the respondents (91.7 percent) were using uniforms. The usage of other means like gloves and shoes were practiced only by 64 percent and 56 percent respectively. This help to protect the worker from any injury or cuts while handling the waste, mask helps to prevent the bad smell. However, only 38 percent were wearing masks.

Though the government has taken initiative in providing the safety measures to the sanitary workers, they have not realized it fully and therefore do not make use of it.

This has resulted in the occurrence of several health issues such as eye disorders, communicable diseases, respiratory diseases etc. This is discussed in the following section.

4.11 Health Issues of the Sanitary Workers

Health is a major determinant of human development, as it has socio-economic relation with the quality of life. That is why health development is an integral part of national development. Sanitary workers live and work under extensive health risk, which are largely undocumented and suffer from severe exploitation and deprivation. The working conditions of the sanitary workers have remained virtually unchanged for over a century. Using only a stick broom and a small tin plate, the sanitary workers clear feces from public and private latrines onto baskets or other containers, which they then carry on their heads to dumping grounds and disposal sites. A few were provided with wheelbarrows or carts by the municipal authorities. The waste includes plastic, broken glass, bottles, bulbs, paper, old clothes, tins, vegetables, shoes and number of such items. While collecting these, the sanitary workers face lot of ordeal. When wastes are not properly segregated, it is all put together and the sanitary workers often get injured from glass, sharp bottles etc. Apart from the social atrocities that these workers face, they were also exposed to many health problems by virtue of their occupation. These health hazards include exposure to harmful gases, cardiovascular degeneration, musculoskeletal disorders, infections, skin problems and respiratory system problems. (Rajnarayan and Tiwari 2008) Disease can debilitate and reduce the quality of life. Possible health hazards include hand and leg injuries, communicable disease, respiratory disorders, eye disorders and allergic problems. Some of the health issues that affected the sanitary workers are given in Table 4.11

Table 4.11

Health Issues of the Sanitary Workers

Health issues	Workers Affected Or Not	Unit 1	Unit 2	Unit 3	Unit 4	Total
Injuries	Yes	6 (15.8)	11 (20.4)	13 (15.7)	18 (26.9)	48 (19.9)
	No	32 (84.2)	43 (79.6)	70 (84.3)	49 (73.1)	194 (80.1)
Communicable disease	Yes	3 (7.8)	13 (24.1)	14 (16.9)	19 (28.4)	49 (20.2)
	No	35 (92.2)	41 (75.9)	69 (83.1)	48 (71.6)	193 (80.1)
Respiratory disease	Yes	4 (10.5)	9 (16.7)	15 (18.1)	27 (40.3)	55 (77.3)
	No	34 (89.5)	45 (83.3)	68 (81.9)	40 (59.7)	187 (22.7)
Eye disorders	Yes	22 (57.8)	29 (53.7)	65 (78.3)	59 (88.1)	175 (72.6)
	No	16 (42.2)	25 (46.5)	18 (21.7)	8 (11.9)	66 (27.4)
Allergic problem	Yes	32 (84.2)	32 (59.3)	75 (90.4)	61 (91)	199 (82.6)
	No	6 (15.8)	22 (40.7)	8 (9.6)	6 (9)	42 (17.4)
Others	Yes	3 (7.8)	29 (53.7)	68 (81.9)	58 (86.8)	157 (65.1)
	No	35 (92.2)	25 (46.3)	15 (18.1)	9 (13.4)	84 (34.9)
Total		**38 (100)**	**54 (100)**	**83 (100)**	**67 (100)**	**242 (100)**

Source: Field survey, 2013

Figures within the parentheses indicate percentage

Out of total respondents nearly 20 percent of sanitary workers had some injuries when they were collecting waste. Around 21 percent of workers had communicable disorders,77.3 percent had respiratory disorders, 72.6 percent reported eye disorders , 82.6 percent reported allergic problem and 65.1 percent had other health problems like back pain, asthma etc. Studies done by Hanson (1997), Issever and Gual (2002) ,Gungor et.al (2002) Athanasiou (2010) also reported such cases of sickness or health disorders.

Their duration of working hours in the workplace and exposure may be contributing significantly to such impairments. There is increased potential for respiratory morbidity among these workers due to occupational exposure. Exposure to air pollutants including dust, air toxins and bio aerosols from fugitive and occupational sources are a major health concern for sanitary workers. All operations such as loading, unloading sweeping and collecting could expose workers to greater levels of impairments.

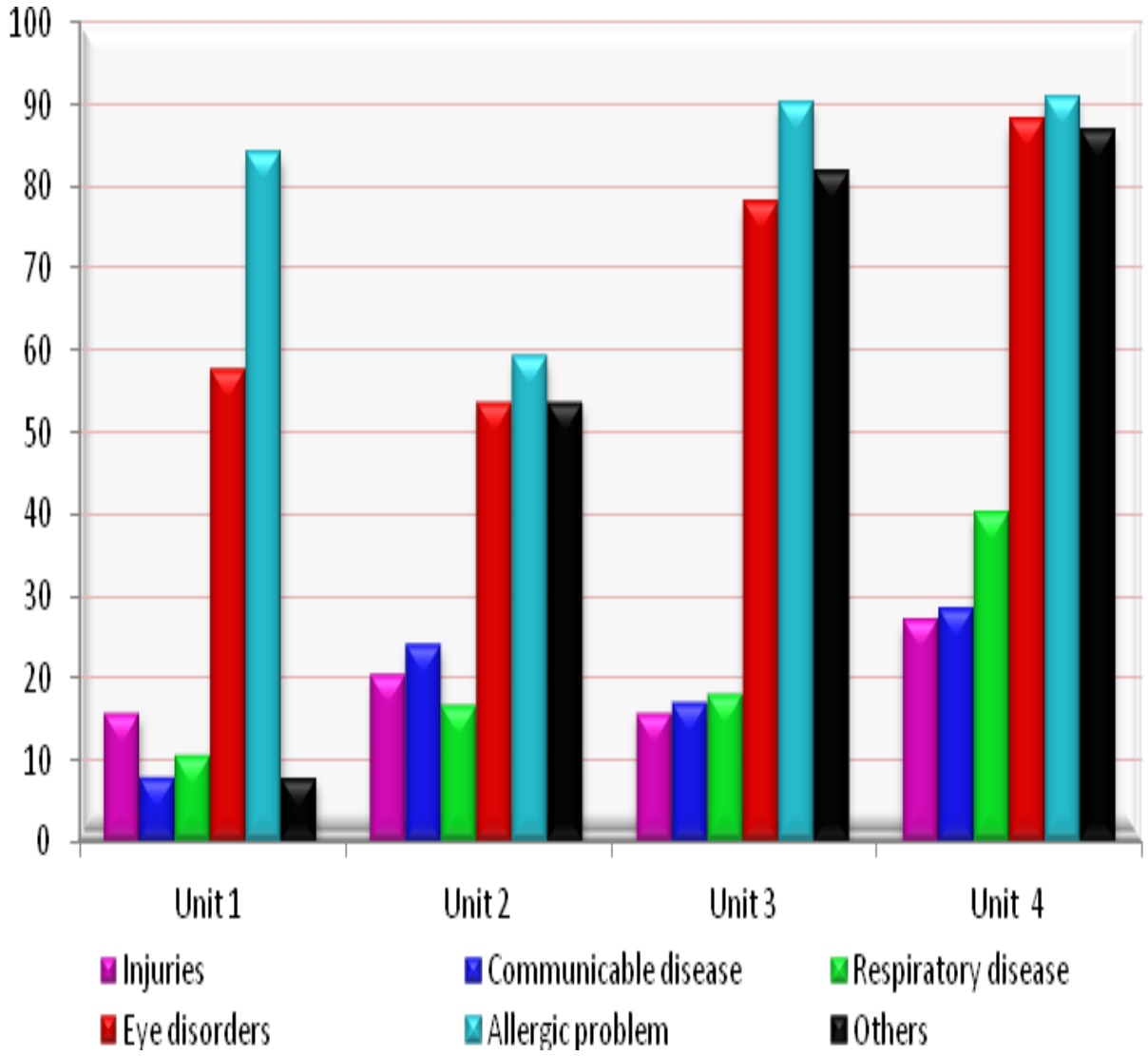
Yet another serious health issue that is very profound in them is that all of them are addicted to alcohol and chewing pan masala and tobacco based items regularly. When approached they stated that it is to overcome the foul smell emitting from the waste. Living with this waste everyday is a great menace and therefore they are addicted to such evil practice. Women worker also once in a while take alcohol and they chew pan masalas most of the time. It is lack of proper education, which has led them to adopt such practices.

The government has taken several steps to improve the working conditions of the sanitary workers. They are given training to segregate the waste and also keep it intact. When they do all this activities they will be mentally and physically tired. So to refresh them and also give them a boost to work better, many physical and psychological training and skills are imparted. Yoga is one such activity to relieve them from the stress and strain of daily chores. Many educational programmes were embraced to improve the living conditions of these sanitary workers. They are instructed to use safety measures to protect them from the bad effects of solid waste. The workers

are also taught to wear shoes and gloves and always keep themselves clean, have daily bath, and change the dress or uniform after the work.

Figure 4.9

Health Issues of the Sanitary Workers



4.12 Insurance Facility

In India the knowledge on insurance and especially with regard to health insurance is lacking not only among unorganized sector but also among the organized sector too. The need to create this awareness is to be taken on a war footing due to the escalating cost of medical expenses and occurrence of various types of diseases to which this particular sector is exposed to.

Among solid waste workers, majority (96.3 percent) of the workers has insurance benefits and only 3.7 percent are not covered under the insurance benefits. Insurance facility helps to protect the sanitary workers from any medical emergency which involve huge sum of money. The details regarding the insurance taken by the sanitary workers from the different units is presented in Table 4.12

Table 4.12

Type of Insurance Facility

Insurance Facility	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Total**
LIC	27 (79.4)	23 (44.2)	7 (8.4)	2 (3.1)	59 (25.2)
ESIC	2 (5.9)	10 (19.3)	17 (20.5)	25 (38.1)	54 (23.1)
Society Insurance	1 (2.9)	0	27 (32.5)	10 (15.5)	38 (16.1)
All the above	4 (11.8)	19 (36.5)	32 (38.6)	28 (43.3)	83 (35.6)
Total	**34 (100)**	**52 (100)**	**83 (100)**	**67 (100)**	**233 (100)**

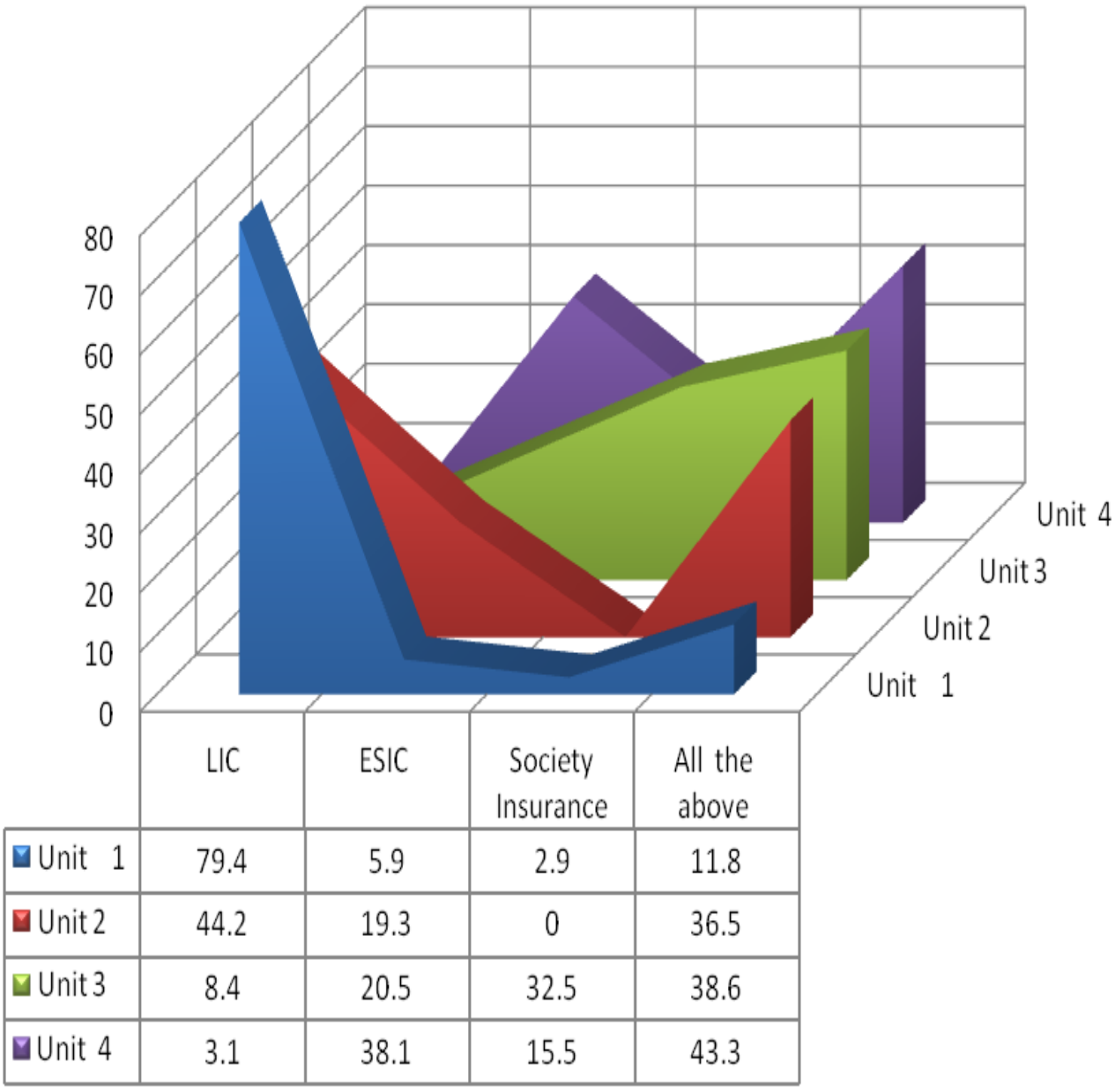
Source: Field survey, 2013

Figures within the parentheses indicate percentage

The life insurance policy and Employees' State Insurance Cooperation and society insurance are the main insurance facility provided by the municipality to the sanitary workers. Nearly 36 percent of sanitary workers were covered by insurance provided by Life Insurance Cooperation (LIC), Employees' State Insurance Corporation (ESIC) and society insurance protection followed by LIC (25.2 percent) and ESIC insurance (23.1 percent). Only 16.1 percent of sanitary workers have society insurance protection.

Figure 4.10

Type of Insurance Facility



	LIC	ESIC	Society Insurance	All the above
Unit 1	79.4	5.9	2.9	11.8
Unit 2	44.2	19.3	0	36.5
Unit 3	8.4	20.5	32.5	38.6
Unit 4	3.1	38.1	15.5	43.3

4.13 Factors which Help to Improve the Condition of the Sanitary Workers

In the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were performed. The generated score of KMO was 0.589 and highly significant Bartlett's test of sphericity supported the appropriateness of using factor analysis to explore the underlying suggestions to improve the condition of the sanitary workers . Variables having communalities greater than 0.5 were regarded as significant and included in the analysis.

Table 4.13.1

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.589**
Bartlett's Test of Sphericity	Approx. Chi-Square	330.627
	Degrees of freedom	78
	Sig.	.000

Source: Field survey, 2013

The communalities for each variable were assessed to determine the amount of variance accounted by the variable to be included in the factor rotation and the results are shown in the table below.

Table 4.13.2

Communalities

Factors	**Initial**	**Extraction**
Education	1.000	.883
Better pay	1.000	.686
More workers	1.000	.759
More vehicles	1.000	.770
Health insurance	1.000	.636

Legal support	1.000	.751
Union to be formed	1.000	.535
Improve working condition	1.000	.749
Pension scheme	1.000	.592
Festival benefits	1.000	.594
Loan facility	1.000	.657
Housing facility	1.000	.690
Others	1.000	.540

Extraction Method: Principal Component Analysis.

All the variables had value greater than 0.050 signifying substantial portion of the variance accounted by the factors. Table 4.12.3 enlists the Egien values, their relative explanatory powers and factor loading for 10 linear components identified within the data set.

Table 4.13.3

Rotated Component Matrix

Factors	**Component**					
	1	2	3	4	5	6
Education	.879			.		
Better pay					.758	
More workers					.754	
More vehicles				.863		
Health insurance				.597		
Legal support						.850
Union	.563					
Improve working condition		.842	.			
Pension scheme		.659				

Festival benefits			.692			
Loan facility	.790					
Housing facility			.816			
Others	.605					
Eigen values	**2.242**	**1.697**	**1.335**	**1.122**	**1.036**	**1.010**
Percentage of variance	**17.248**	**13.054**	**10.268**	**8.631**	**7.967**	**7.767**
Cumulative percentage	**17.248**	**30.302**	**40.570**	**46.200**	**57.168**	**64.935**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

For sample respondents factor 1 has significant loading for four dimensions namely education, housing facility, union and other changes. These dimensions explained nearly 17 percent of variance. Factor two had significant loading for two dimensions namely improve the working conditions and pension schemes and explained 13 percent of variance. Factor three has significant loading for two dimensions namely festival benefits and housing facility with 10 percent of variance. Factor four had significant loading on two dimensions namely more vehicles and health insurance and explained 8 percent of variance. Factor five had significant loading on two factors namely more workers and better pay and 7 percent of variance. Factor six had significant loading on legal support and explained 7 percent of variance.

From the factor analysis it was observed that education, legal support, improving working condition, more vehicles, housing facility and better pay are the major suggestions which emerged from the study in order to improve the condition of sanitary workers.

Results of factor analysis reveal that education helps to improve the condition of sanitary workers. The second hypothesis states that “education is the basic factor to improve the condition of sanitary workers” is found to be true.

III. The Working Condition of the Recycling Unit Workers and Working of the Unit

The third and the final section of the study is a probe into the recycling unit. The recycling sector in India has been in operation since the 1960's and while only a fraction of the total plastic waste is being recycled in most western countries (APME, 1995), around 75 percent of the plastic wastes are recycled in India (Haque, 1998). Rag pickers mainly carry out the recycling process in India and they play a vital role in the economy of solid waste recycling process (Agarwal, et al 2005). They feed the need of the intermediary buyers, who, in turn, meet the demand of factories using recyclable solid waste as raw materials. However, the rag pickers do not have sufficient protection and are exposed to waste and sometimes even the hazardous waste present in MSW. Even the quality of the successively recycled products in the informal sector in terms of their (i) physical appearance (ii) polymeric properties (iii) health hazards (for the recyclers and users of such products involved) are in serious question (Haque, 2000)

The recycling dump yard in Coimbatore Municipal Corporation was started in 2009-2010 as a part of Jawaharlal Nehru Nation Urban Renewal Mission. The estimate for the project then was Rs 5.2 crore, as the daily waste generated then was just about 3.36 metric tonnes. However, the 650-acre yard now receives 5.5 lakh metric tonnes of waste generated from the corporation limits and the total cost to cap it has escalated to Rs 12.5 crore. Funds are to be provided by the central and state government through JNNURM (Jawaharlal Nehru Nation Urban Renewal Mission scheme) scheme and Rs 3.67 crore from private bodies. The corporation provides just about Rs 41 lakh.

The 375 TPD (Tone per day) capacity compost plant at Vellalore has a pre-processing unit with covered sheds for the compost yards, thereby protecting the composting process from the ordeal of weather. The plant has a compost turner which helps in maintaining the windrow height/time to time turning of the piles, thus improving the process time as well as the process output. A landfill site for the initial five year period has been constructed at the Vellalore site by the concessionaire. It has a total capacity of handling 1,71,093 tons of inert waste, which has been calculated, considering maximum reject of 25 percent from the 375 TPD plant. In Coimbatore municipality four transfer stations have been set up by the concessioners at the

following locations Peelamedu, Sathy Road, Ukkadam and Ondipur. The waste from these transfer stations are transferred and dumped in Vellalore. The Segregation of the waste is done manually. There are a number of migrated workers working in the plant. The safety measures and health insurance are given to the workers to ensure protection from harmful effect of dealing with waste.

Among the total 80 workers who were working in the plant, 50 workers were randomly selected for the study. By using structured questionnaire the information were collected from these 50 workers.

Major findings are summarized under following heads

4.14 Socio-Economic Profile of the Workers in the Recycling unit

4.15 Reasons for Selecting the Job

4.16 Health Problems Related to the workers

Table 4.14.1

Socio-Economic Profile of the workers in the Recycling unit

Socio –Economic variables	**Characteristics**	**Number of workers**	**Percentage**
Head of the family	Male	33	66
	Female	17	34
Age (in years)	Below 25	2	4
	25-50	42	84
	Above 50	6	12
Type of family	Nuclear	22	44
	Joint	28	56
Household size	Below 4	5	10

(Numbers)	4-6	17	34
	Above 6	28	56
Religion	Hindu	40	80
	Muslim	6	12
	Others	4	8
Caste	SC	40	80
	MBC	5	10
	FC	5	10
Education	Illiterate	42	84
	School level	4	8
	High school	4	8

Source: Field survey, 2013

Among the respondents surveyed, it was found that 66 percent of the respondents have male heads and 44 percent have females heading the family. In the study majority (84 percent) of the respondents belong to the age group of 25 to 50 years. Information relating to the type of family, majority (56 percent) of the surveyed respondents belongs to joint family. The study found that majority of the respondents (56 percent) has family members above six.

Religion has an important role in the socio economic profile of the people. Data pertaining to the religion of the respondents shows that majority of the respondents were Hindus, (80 percent) and 12 percent of respondents were Muslims and only eight percent belonged to the Christian community.

Yet another peculiar feature in Indian society is the caste system. Among the respondents the largest single group was the scheduled caste i.e. 80 percent, followed by forward caste (10percent) and the remaining belonging to other backward caste.

Education is really a true indicator of the overall development of the society. It influences the decision making ability of the people. The educational status of the respondents showed that out of the total respondents, 84 percent of the respondents were illiterate.

The recycling unit employed both permanent and temporary workers. The temporary workers were taken as a contract basis. The contractors take big tasks and employs large number of workers for specific job, in the same way in the recycling unit also there were large number of contract workers. The classification of workers is shown in table 4.14.2

Table 4.14.2

Classification of Workers

Type of work	Number of workers	Percentage
Permanent	8	16
Contract	42	84
Total	**50**	**100**

Source: Field survey, 2013

The study found that majority (84 percent) of the workers is on a contract basis and only 16 percent are permanent workers. The contract workers are migrated workers from various northern states. A predominant feature of the labour class now is the inflow or migration of workers from north India to south India. These migrated workers are employed in all sectors irrespective of education and skill. Most of them are illiterate and they are put to different types of chores. These migrated workers are unaware about the daily wage because of their illiteracy.

Figure 4.11

Classification of Workers

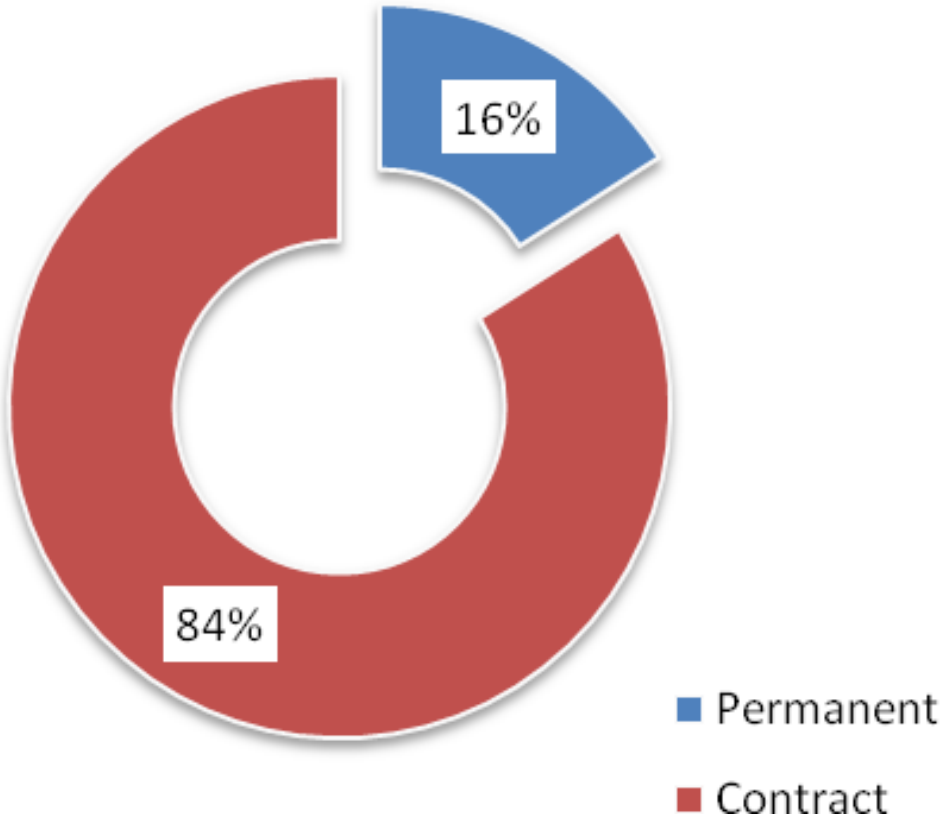


Table 4.14.3

Daily wages of the workers

Daily wages in Rs	Number of workers	Percent
Below Rs 300	12	24
300-500	32	64
Above 500	8	16
Total	**50**	**100**

Source: Field survey, 2013

The income of any particular family presents an authentic diagnosis of the economic health of the family. Hence an analysis of income becomes the key stone of any comprehensive study. Among the total respondents majority of the respondents (64 percent) earned Rs 300-500 daily. Around 12 members earned less than Rs 300 and only eight earned above Rs 500.

4.15 Reasons for Selecting the Job

Population explosion, growing illiteracy, abject poverty, spiraling of food prices, and lack of employment, economic and social backwardness are some of the underpinning problems faced by majority of poor and downtrodden in India. This makes many to move away from their native to other areas in search of job.

In the recycling unit majority of the workers were migrated workers, unemployment and poverty are two prime reasons for their migration into urban setups (Sarker 2003). Most of the migrated people are the youths and they get into any type of job.

In the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were performed. The generated score of KMO was 0.360 and highly significant Bartlett's test of sphericity supported the appropriateness of using factor analysis to explore the underlying

structure of various reasons for selecting job by sanitary workers. Variables having communalities greater than 0.5 were regarded as significant were included in the analysis.

Table 4.15.1

KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.360
Bartlett's Test of Sphericity	Approx. Chi-Square	43.933
	Degrees of freedom	28
	Sig.	.000

Source: Field survey, 2013

The communalities for each variable were assessed to determine the amount of variance accounted by the variable to be included in the factor rotation and the result are shown in the table below.

Table 4.15.2

Communalities

Factors	Initial	Extraction
Poor Economic condition	1.000	.571
low educational qualification	1.000	.729
Unemployment	1.000	.864
Community reasons	1.000	.806
Reducing child labour	1.000	.916
To increase the parental income	1.000	.576
Working hours	1.000	.582
Others reasons	1.000	.566

Extraction Method: Principal Component Analysis.

All the variables had value greater than 0.050 signifying substantial portion of the variance accounted by the factors. Table enlists the Eigen values, their relative explanatory powers and factors loading for 8 linear components identified within the data set.

Table 4.15.3

Rotated Component Matrix

Factors	Component			
	1	2	3	4
Poor economic condition		.621		
Low educational qualification		.666		
Unemployment			.867	
Community reasons		.635		
Reducing child labour				.750
To increase the parental income	.634			
Working hours	.668			
Others	.692			
Eigen values	**1.765**	**1.391**	**1.284**	**1.068**
Percentage of variance	**22.066**	**17.390**	**16.049**	**13.356**
Cumulative percentage	**22.066**	**39.456**	**55.505**	**68.861**

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

For sample respondents factor 1 has significant loading for three dimensions namely to increase the parental income, working hours,other reasons. These dimensions explained nearly 22 percent of variance. Factor two had significant loading for three dimensions namely poor economic

conditions,low educational qualification and reducing child labour and explained 17 percent of variance. Factor three had significant loading for one dimension unemployment and factor four has significant loading on reducing child labour and explained 13 percent of variance.

Among the recycling unit workers unemployment is the basic reason for selecting the segregating job in recycling unit. The third hypothesis of the study states that “unemployment is the predominant reason for selecting job in recycling unit” is found to be true.

4.16 Health Problems of the Workers

Regardless of the specific disposal process, processing of solid waste involves common hazards. Unidentified, highly hazardous materials are often mixed with normal waste, pesticides, flammable solvents, paints, chemicals and bio hazardous materials may all be intermixed with household waste. This hazard can be handled primarily through segregation of waste stream. This causes several health problems.

There is a large workforce employed in waste collection, sorting, loading uploading and disposal. Workers may be exposed to the same potential hazards as the general population, although the amount of exposure and risk may differ. The type of work varies between waste management options with some, such as landfill and incineration, being more automated than others, such as waste collection, sorting and recycling. The incidence of occupational accidents in waste collection workers has been found to be higher than the general workforce. (Poulsen, 1994). It has been suggested that increased exposure to bio-aerosols and volatile compounds may lead to elevated incidence of work-related respiratory gastrointestinal and skin problems among waste segregated workforce. Cross-sectional studies of workers in the waste sorting and recycling industries and in landfill sites were found to be great. (Poulsen, 1995). The health problems of selected workers are presented Table 4.16.

Table 4.16

Health Problems of the workers

Health issues	Workers Affected Or Not	Number of workers	Percentage
Injuries	Yes	42	84
	No	8	16
Communicable disease	Yes	17	34
	No	33	66
Respiratory disease	Yes	14	28
	No	34	68
Eye disorders	Yes	28	56
	No	22	44
Allergic problem	Yes	44	88
	No	6	12
Others	Yes	43	86
	No	7	14
Total		**50**	**100.0**

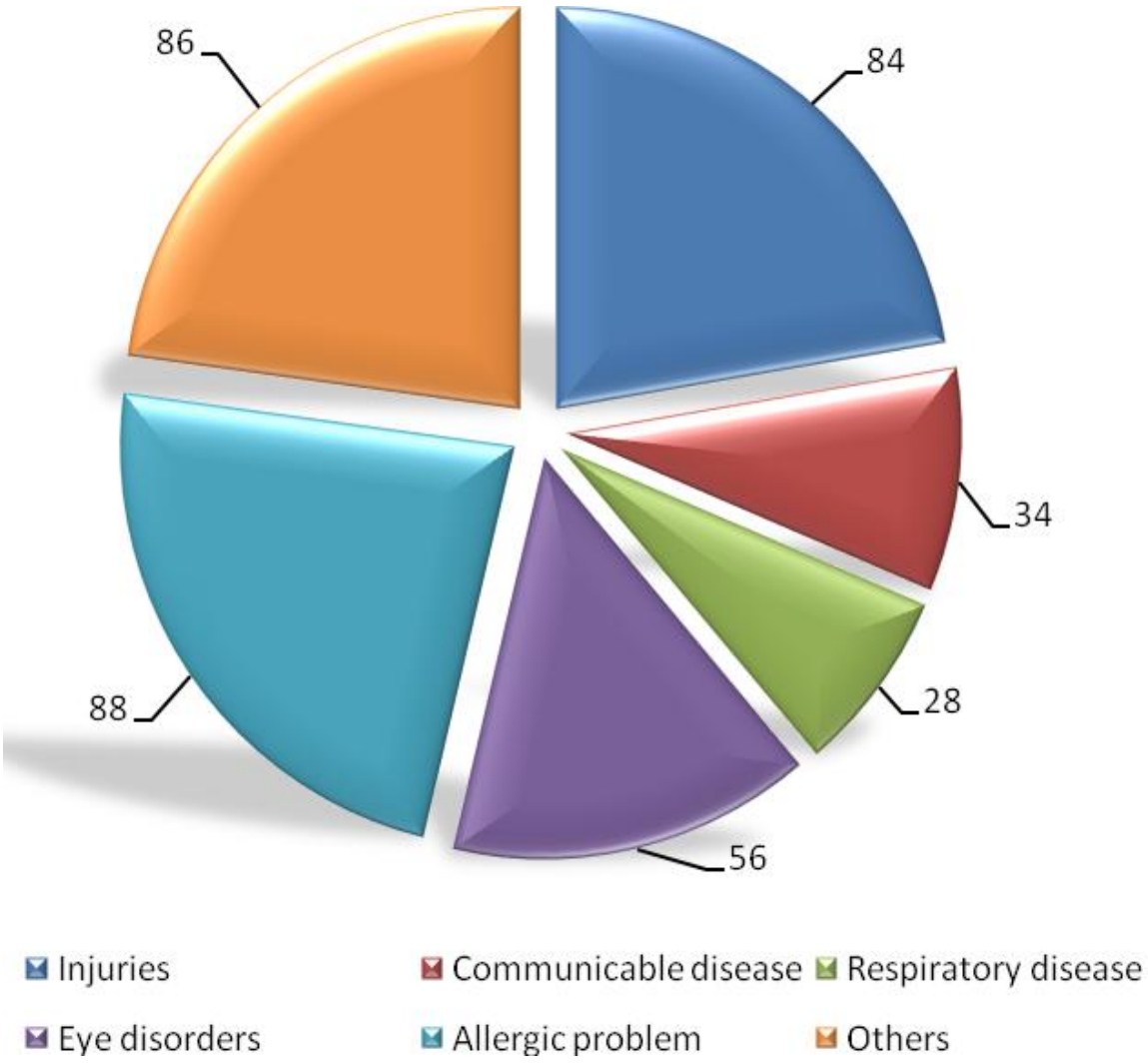
Source: Field survey, 2013

Out of total respondents nearly 84 percent of sanitary workers had injuries when they were collecting waste. Around 34 percent of workers reported communicable disorders,28 percent respiratory disorders 56 percent eye disorders,88 percent reported allergic problem and 86 percent had other health problems like back pain ,asthma etc. A similar study carried out has shown that 75 percent of workers engaged in waste separation have upper and lower respiratory symptoms (Bhattacharya, 2005).

Lack of education and lack of awareness about the diseases caused due to the continuous working with waste is the main reason for the health problems. The government took initiative to improve the working condition of the workers. All the workers have medical insurance schemes for treatment and compulsory medical checkup is been done every month in the district medical hospital.

Figure 4.12

Health Problems of the workers



After segregation of waste landfilling and waste to energy method was used as a disposal method in the plant. Uncontrolled landfilling has been mainly adopted for ultimate disposal of municipal solid waste in India; thereby causing numerous health, environmental and aesthetic hazards (Ambulkar, 2004). However, now landfilling is the most preferred method of disposal of solid wastes as it is an effective and low cost method of disposal (Nissim, 2005). Onionskin method lying i.e., alternate building rubbish of thickness 30cm and municipal waste with thickness of 1 to 3 m is adopted in few cities like Delhi, Chennai and Hyderabad (CPCB, 1998). However, the numbers of sanitary landfills are extremely low compared to the dumpsites, where uncontrolled dumping is observed, leveling and provision of earth cover is rarely provided. The rag pickers are further observed to be active at disposal site. Methane gas that is emitted at the landfills is not collected, hence adding to the GHG emissions (Kumar, S., et al 2004).

In Coimbatore the landfill has been designed in compliance with the MSW Rules 2000. It has a base line completed with leachate collection system and leachate monitoring well. The concessionaire has to dispose of the inert waste from the treatment plant into the landfill and regularly monitor as per the prevelant Rules. Scientific Closure of the Old Dump Sites in Coimbatore has been completed as part of the IMSWMP with private sector participation, under which the design and development of the three dump sites at Ondipur, Kavundampalayam, and Vellalore has been completed.

An engineered/sanitary landfill has been built by the private operator at Vellalore over the years. At the waste processing facility, once the waste is received from the transfer stations, all recyclable materials are segregated. Combustible bulk materials are segregated and shredded for making Refuse Derived Fuel. The biodegradable waste is taken through aerobic digestion process to make compost, while the inert material is sent to the landfill.

Steps involved in Construction of Sanitary landfill are as follows

1) Marking of the Foot print area Establishment of Sanitary Landfill Facility at Vellalore Dumpsite
2) Formation of Bunds (or) Providing of Embankment including compaction
3) Base preparation
4) Laying of Geo-synthetic Clay Liner (GCL)
5) Laying of HDPE Liner (Smooth Finish HDPE for the bottom and Textured for the slopes of the Landfill)
6) Providing 200 mm GSM Non-woven Geo-textile liner
7) Providing of 300 mm thick drainage Layer above Geo-textile liner) g g y
8) Providing of Leach ate collection network
9) Providing Brick Pitching to the side slopes
10) Providing 150mm thick protective soil Layer

As a part of waste-to- energy the plant has taken initiative to produce vermin compost from the waste. In vermin-composting, the aerobic decomposition of organic matter is made by using micro-organisms. It is the use of selected species of earthworms to help decompose and transform organic wastes into useful compost. In this method, earthworms play important role in fragmenting, mixing and aerating the waste. There are various methods of vermin-composting, making it impossible to present a definitive guide to best practice. Vermin-composting is carried out at relatively in low temperatures (under 25°C), compared with composting, where pile temperatures can exceed 70°C. With vermin-composting it is vitally important to keep low temperature; otherwise the earthworms will be killed. It is the joint action between earthworms and the aerobic microorganisms that thrive in these lower temperatures (mesophilic) that breaks down the waste. Hence it is common with vermin-composting systems to apply waste frequently in thin layers, a few centimeters thick, to beds or boxes containing earthworms in order to prevent overheating and to help keep the waste aerobic.

It is difficult to directly compare composting with vermin-composting in terms of the time taken to produce stable and mature compost products. With vermin-composting, particles of waste spend only a few hours inside the earthworm's gut and most of the decomposition is actually carried out by microorganisms either before or after passing through the earthworm. Hence, earthworms accelerate waste decomposition rather than being the direct agent. With in-vessel and windrow composting it usually takes at least six to twelve weeks to produce stable compost and research suggests that vermin-composting takes around the same time. However, processing rates crucially depend on many factors such as the system being used, the processing temperature and other factors, the nature of the wastes and the ratio of earthworms to waste. (CCMC 2014)

One advantage that vermin-composting has over other composting procedures is that a net excess of earthworms can be produced and these may be harvested for a variety of purposes. It should be noted that it can take many months or even years to build up a large working population of earthworms capable of vermin-composting significant quantities of waste. Vermin-composting does have one serious disadvantage and this relates to the destruction of human and plant pathogens that can be present in some wastes. Destruction of most pathogens is more easily achieved in windrow composting due to the high operating temperatures and the intense microbial reactions taking place. Although the destruction of human pathogens has also been shown to be very effective with vermin-composting, elimination of pathogens requires very effective management of the vermin-composting process. It is often recommended that wastes, such as sewage sludge, which are known to contain human pathogens, are either pre-composted before vermin-composting or else the resulting casts should be sterilized before use.(Ministry of Environment and Forest (2010)

As a part of waste-to- energy the plant has taken initiative to produce vermin compost from the waste, but the marketing for the vermin compost has not taken concrete steps. To find a solution to the problem of waste accumulating at the Vellalore dump yard, the Coimbatore Corporation has planned to establish a waste-to-energy plant.