R4D PROJECT:

CHALLENGES OF MUNICIPAL WASTE MANAGEMENT: LEARNING FROM POST-CRISIS INITIATIVES IN SOUTH ASIA

PROJECT WORKING PAPER #10

SOCIAL STRUCTURE AND SOLID WASTE MANAGEMENT PRACTICES

FINDINGS OF A HOUSEHOLD SURVEY IN ALAPPUZHA, KERALA (INDIA)

AUTHORS: NEELAM RANA & NC NARAYANAN

Ashank Desai Centre *for* Policy Studies
Indian Institute of Technology Bombay
Insight ♦ Dialogue ♦ Impact

PUBLISHED: August 2023

ONLINE: HTTP://LIFEOFWASTE.COM

AUTHORS: Neelam Rana & NC Narayanan

Acknowledgements

We would like to thank our field team Mr. Rohit Joseph, Ms. Geethu M.G. and Ms. Nikhila Nelson for supervising and facilitating the survey and Ms. Ann Treasa, Ms. Reshmi GR, Ms. Navya Cathereen, Ms. Jesna Sathar, Ms. Nermin Nizam, Ms. Sulaikha, Mr. Muhammed Shahid for carrying out survey. We also thank are ward level survey volunteers Ms. Aneesha, Ms. Rajani, Ms. Shefna, Ms. Soniya, Ms. Athira, and Mr. Jaganath.

The study was conducted with financial support from the Swiss National Science Foundation and the Swiss Agency for Development Corporation under the r4d project “challenges of municipal solid waste management; learning from post-crisis governance initiatives in South Asia”.

Project Partners

Janathakshan

CED

Centre for Integrated Urban Development (CIUD) .....fostering liveable cities

UNIL | Université de Lausanne

Project Funders

Swiss Programme for Research on Global Issues for Development

FNSNF Swiss National Science Foundation

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Contents

Table of Tables

Table of Figure

1. INTRODUCTION

Alappuzha in South India, described as the Venice of the East by Lord Curson, has a unique landscape with a densely populated coastal region. Vembanad Lake on one side, Kuttanad to the east and the Arabian Sea on the other. The city is known for its iconic, well-planned canals, built over a century and a half ago with three main canals and 104 sub-canals. Affecting the health of the canals were various developmental interventions. A part of urban waste also started coming into the canals and made the water unsuitable for various purposes. The town witnessed indiscriminate solid waste dumping at random locations. The local government, moving from the 'waste-to-disposal' to 'waste-to-resource' paradigm, set up a centralized windrow composting plant in Sarvodayapuram in the early 2000s. The facility, however, could not achieve the desired results. The mismanagement at the dumping site resulted in a public health and environmental health scare, making the solid waste issue a socio-political issue. This led to local protests demanding the closure of the centralized facility, which led to garbage crisis.

This led to governance crisis forcing the local government to look beyond the centralised solutions. Both local governments and the state government (of Kerala) gradually started to experiment with alternative technology options under the Nirmala Nagaram Nirmala Bhavanam (roughly translates to Clean City Clean Home) programme. With active citizen participation as its core, the approach has three key pillars: technological, institutional, and behavioural change innovations. This resulted in the adoption of the idea of waste segregation at source. The adoption of decentralised technologies promoting waste management at household level and community level witnessed gradual progression to suit the context and the needs of the people and the city. For example, after the Sarvodayapuram plant closure (in 2012), the Alappuzha town introduced decentralised solutions such as household level biogas plants and pipe composting technology to process wet waste (waste from kitchen)[1]. However, biogas plants did not work because of the higher per unit cost, and per unit land requirement, lack of proper operations and maintenance and lack of technical support and know how[2]. The pipe composting technology also failed due to lack of proper operations and maintenance. The town then adopted Thumboormuzhy aerobic bins – commonly known as community aerobic bins - a technology specifically developed for Kerala's agro-ecological zones by the Kerala Agricultural University (IIT Mumbai, 2022)[3]. The provision of funds from the state government led to a subsidy scheme, hence, large-scale adoption of kitchen bins and bio-bins at the household level.

The institutional innovation and the adoption of decentralised technologies warranted the involvement of a larger workforce. This led to the involvement of private companies and

[1] Kitchen bins process kitchen waste without any external inoculum as opposed to the bio-bins. Bio-bins, hence, are more effective and produce less odour.

[2] For a family of 5 a bio-bin requires 0.16sqm land whereas 1 m3 bio-gas plant requires 2 sqm land.

[3] It was developed by Dr Francis Xavier of Kerala Veterinary and Animal Sciences University, located at Thumburmuzhi (hence the name). *Thumburmuzhi* model aerobic bins are rectangular structures built with spaced ferrocement bars and wire mesh, covered with a roof.

Kudumbashree - a women's self-help group network- and Haritha Karma Sena (HKS) - the enterprise model of Kudumbashree in waste management.4, in door-to-door collection of inorganic waste (dry waste). To achieve the goal of bringing behavioural change for effective solid waste management (SWM), awareness generation campaigns including WATSAN (Water and Sanitation) parks were introduced. The efforts started receiving attention locally and globally. The 'Alappuzha model' received a United Nations Development Programme (UNDP) award in 2017, and was presented at a climate change convention in Paris in 2015..

The IIT-Bombay research team as part of the r4d project conducted a survey in 300 households of Avalookunnu and Thathamppally wards of Alappuzha town to examine the household SWM practices disaggregated by socio-economic structure, and capture the perceptions about present SWM services, as well as those after the Sarvodayapuram crisis and during the COVID lockdown. This working paper discusses the findings of the survey and makes recommendations.

The paper is structured in seven sections. The next (second) section mentions specific objectives of the study. The third section describes study area. Methods are discussed in the fourth section. The fifth section discusses the survey findings under two sub-headings: waste management practices and perceptions. The sixth section discusses the key findings and makes some suggestions. The seventh section contains the conclusions.

4 For more on Kudumbasree check https://www.kudumbashree.org/pages/17. For more on Haritha Karma check https://www.kudumbashree.org/pages/677.

2. OBJECTIVES

The main purpose of the study was to examine the relationship between the social structures (class, caste, religion, and gender) and solid waste management practices and perceptions at household level. The specific objectives were:

- To map wet and dry waste management practices
- To capture perceptions about changes in the SWM services post Sarvodayapuram crisis and during the COVID lockdown period
- To examine the relationship between the socio-economic profile of sample households and their SWM practices and perceptions
- To examine gender dimension in solid waste management practices

3. STUDY AREA

Alappuzha municipality has a total of 52 wards and a population of 240,991 inhabitants (Census 2011) of which 116,439 are males and 124,552 are females. The municipality has about 57,000 Households (HHs) as per Census 2011[5]. As per Census 2011, the municipality's population is predominantly Hindu (49.85%), followed by Christian (26.2%) and Muslim (23.6%) religion. The Schedule Caste (SC) and Schedule Tribe (ST) constitutes only 2.33 % and 0.28% of the total population.

For our survey, Avalookunnu and Thathamppally wards were selected (figure 1). Avalookunnu ward has 818 households and about 4,000 inhabitants. The ward has an approximate area 0.4 of sqkm, and has water bodies and canals. Thathamppally ward (area = 1.54 sqkm) has Punnamada lake to its east. With 705 households and total population of 6620, the ward's population is predominantly middle class and Christian.

As part of the public solid waste management infrastructure and services, Thathamppally ward has one community aerobic bin whereas Avalookunnu has no community aerobic bin[6]. Two nearest community aerobic bins for sampled households are located at the mean distance of 0.8 km and 1.06 km (figure 2).

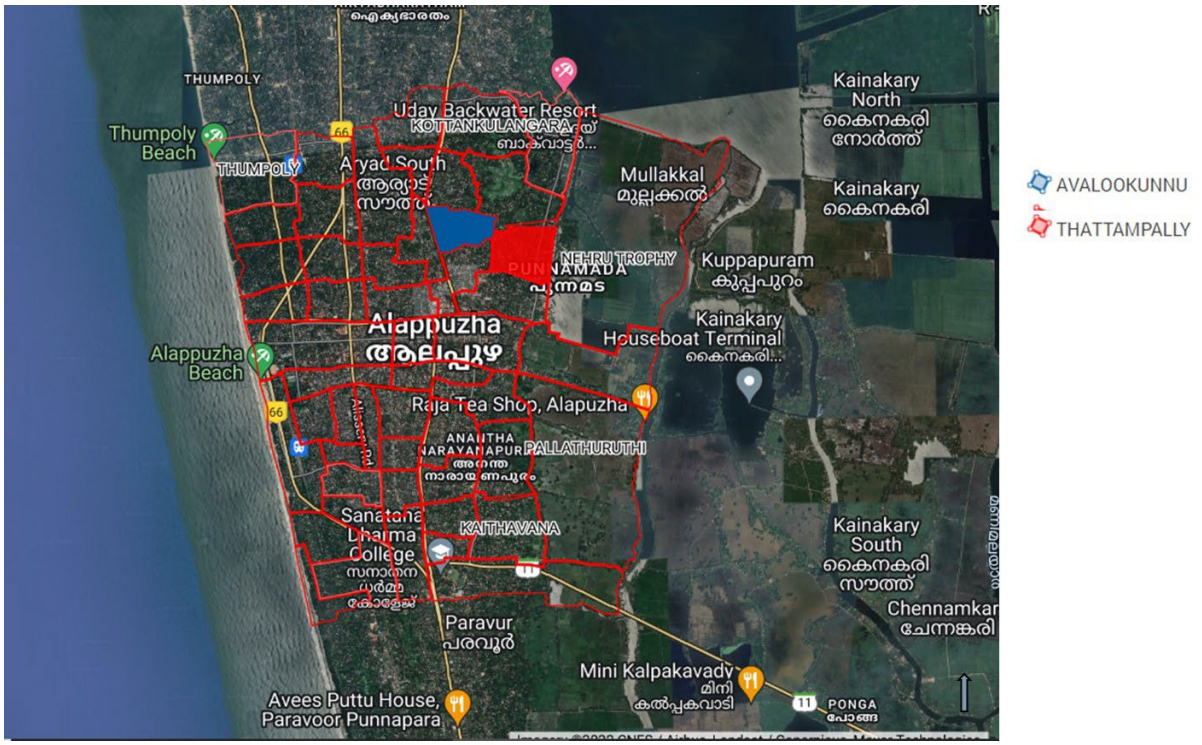

Figure 1: Avalookkunnu and Thathampally Ward Boundary on Google MyMaps

[5] https://www.census2011.co.in/data/town/803299-alappuzha-kerala.html

[6] There is a dispute about physical boundary between Thathampally ward and adjoining ward (District court). Leading to both wards making their claims over the community aerobic unit.

4. METHODS

4.1 Sampling Strategy

The wards were selected in consultation with the ward councillors. The wards were selected to represent heterogenous population in terms of class, caste and religion. The survey followed a non-probability sampling i.e., a random walk procedure wherein the interviewers were instructed to begin the interview process at some random location in the ward and follow a specified path of travel to select the households to interview (guidelines by the Department of Economic and Social Affairs, United Nations, 2005).

4.2 Survey Tool

A questionnaire comprising of semi-structured qualitative & quantitative questions was designed on ODK collect – open-source mobile data collection application. For comparison purposes, the questionnaire was designed on similar lines to that of Nepal and Sri Lanka – countries participating in the r4d project. The definition and explanation of key terms used in the questionnaire is provided in Annexure -1.

Questions related to socio-economic status, solid waste management practices and expenditure on management and services of solid waste, perceptions about services and changes in SWM practices and services during COVID lockdown were incorporated. To understand the gender dimension in both SWM, questions such as gender of the services providers, and gender of the person involved in management of solid waste at household level were asked.

4.3 Data Collection

ODK collect was used by the interviewers for data collection. Interviewers were also asked to take field notes to record qualitative information and observations related to solid waste dumps and hotspots etc.

4.4 Survey Execution

To deal with the interviewer bias, an experienced instructor from our CANALPY team trained 10 interviewers how to ask questions, to approach respondents and HHs and to use the ODK mobile app[7] . The interviewers were told not to suggest answers to the respondents. The second way of dealing with interviewer bias is to tell interviewers to strictly follow the sequence prescribed by the questionnaire (Department of Economic and Social Affairs, 2005). This was ensured through the ODK app that gives option of keeping questions mandatory and sequential. Further, we gave the option of 'do not know' or 'do not wish to answer' in the questionnaire to deal with the respondents' hesitancy in responding to certain questions.

The interviewers conducted a pilot test in 10 HHs helping us understand the modifications needed in the questionnaire and sampling strategy. The sample survey happened in two phases: 28 January – 5 February 2022 covered Avalookunnu ward and 17 March - 11 April 2022

[7] Initiated by IIT Bombay , CANALPY is a local initiative in Alappuzha District started with the aim to enable local youth to work on the local water and sanitation problems. Youngsters from different social and educational backgrounds obtain hands-on training on problem identification, problem defining, and solution formulation. For more on CANALPY and its work refer https://www.kila.ac.in/category/canalpy/

covered Thathampally ward. The survey was monitored and supervised by the two supervisors from our local field team (CANALPY).

4.5 Data Collation & Analysis

The volunteers sent the collected data to a google drive at the end of each survey day. The data cleaning and collation, as well as exploratory and descriptive analysis, were conducted primarily on MS-Excel. Data collected include continuous, discreet, and categorical data types that demanded different types of analysis (refer Table 1).

Table 1: Type of Collected Data and Corresponding Analysis/Tests

Type of Data	Variables	Analysis/Tests	Inferences/Remarks
Continuous	• number of people • number of children • Household monthly income • plot size, household area • user fee for door-to-door kitchen waste and plastic waste collection • money spent on O&M of waste processing unit • profit from selling of waste • households latitude-longitude	• Descriptive Statistics to know central tendency, skewness • Box plots to visually know the mean, median, dispersion in data set and skewness • Bar/Column charts to compare the responses with socio-economic variables • Lat-longitude data was converted to get distance between community aerobic bins and households • plot size, household area used to determine the vacant land available (plot size- household area)	Data found to be not normally distributed
Dichotomous	• if a household receive money from selling different types of waste to a third party. Options given were: Yes/No • Do you think the waste collection has improved compared to 5 years ago? Options given were: Yes/No	• Pie charts to know the percentages • Bar/Column charts to compare the responses with socio-economic variables	Chi-square test of association was carried out (on JASP) for category variables. However, analysis showed that none of the variables met the assumptions needed for having a valid Chi-

Ordinal	• Are you satisfied with the waste collection nowadays? Options given were: 1 (yes), 2 (somewhat yes), 3 (somewhat no), 4 (no) • What do you think about the cleanliness of your neighbourhood? Options given were : 1 (clean) , 2 (somewhat clean), 3 (somewhat dirty), 4 (dirty), 5 (no opinion)	• Pie charts to know the percentages • Bar/Column charts to compare the responses with socio-economic variables	square test. Hence, study relied upon percentages and bar/column charts
Nominal	• Rest of the data set was nominal kind. • Age • gender of the service provider for different types of waste • respondent's sex • primary source of income • religion (Hindu, Muslim, Christian, Other) • caste (General, SC,ST, OBC, Other) • Class (Ration card types- non priority, above poverty line (APL), Below poverty line (BPL), Most economically backward) • primary decision maker of the HH • who deals with SW at HH • Primary method of SW (kitchen, mixed, glass, plastic, paper, carboard, medical etc.) disposal • What is the frequency of O&M of kitchen bin/biogas plant? • How was the installation of kitchen bin/biogas plant? • Type of the (door-to-door) service provider for different types of waste? • How often does door-to-door collection happen? • How often kitchen waste is disposed? • House type • Highest education in household • Does SW get segregated at HH. Yes/No/Do not Know • Is the kitchen waste disposal unit at home working fine? Yes/No/Do not Know • Do you think waste management services have changed after the Sarvodayapuram disaster? (Blockade – Garbage Strikes). Yes/No/Do not Know	• Pie charts to know the percentages • Bar/Column charts to compare the responses with socio-economic variables	

	• Have you changed waste practices in your household after the blockade/garbage strike in Sarvodayapuram/Alappuzha? Yes/No/Do not Know • Did the waste collection activities change amidst the SARS COV19 Virus lockdown period? Yes/No/Do not Know • Did the household waste management activities change in the SARS COV19 Virus lockdown period? Yes/No/Do not Know		
Qualitative Questions	• Reason for Kitchen Waste Disposal System working or not working fine? • Problems with the waste management service? If so, what are the problems you encounter? • Problems with the waste worker (Municipality Sanitation worker)? If so, what are the problems you encounter? • Perception about changes in the waste management and services in last 5 years and post Sarvodayapuram garbage crisis.	• Bar charts to show the count or pie to show the percentages	

5. RESULTS

A total of 380 households – 204 out of 818 households in Avalookunnu and 176 out of 705 households in Thathampally - were surveyed. 24.95% of the households were covered in the survey. Figure 2 shows the geographical spread of the survey. The response rate was low due to COVID related restrictions. The percentage of female respondents was 73%.

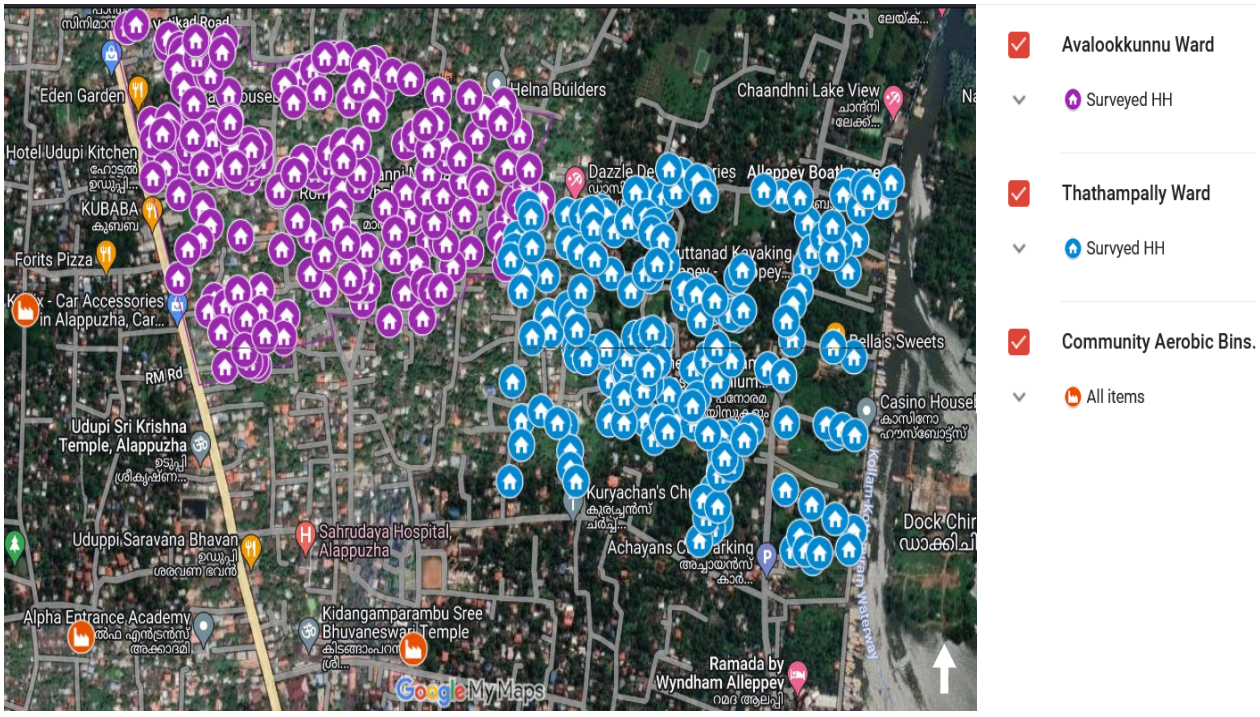

Figure 2:Geographical Spread of the Survey Households and Three Community Aerobic Bins in Avalookkunnu and Thathampally Wards

Table 2 shows general statistics. About 45% of the surveyed HHs belonged to the priority category i.e., most economically backward section and Below Poverty Line (BPL).

Table 2: Overview of Survey Coverage

Variable	Results
Total Households (HHs)	1523
HH surveyed (n)	380
HHs priority category (most economically backward section and below Poverty Line)	45%
Female respondents	73%
Age of respondents	Avg = 53.5yr ; Max = 88yr ; Min= 12 yr; 50% of the respondents' age fall below 53yr.

5.1 Demographic and Socio-economic Profile

The section discusses key demographic details and socio-economic profile of the sampled households. Under these two, we discuss household size, number of children, and caste, class,

religion, house area and plot area, and homeownership. Additionally, we try to understand and examine the relationship between above listed variables.

5.1.1 Household Size

As shown in figure 3, 75% of the data (Q3 value) fall below 5 family members i.e., $\frac{3}{4}^{th}$ of the surveyed households have 5 or fewer family members, and 25% of the data (Q1) i.e., $\frac{1}{4}^{th}$ of the surveyed households have fewer than 3 family members. Median is 4, which means 50% of these households have more than 4 family members and rest of the 50% have members below 4. Only four outlier households were seen to have 9-11 family members. This indicates that the households in the ward are mostly nuclear families. This almost matches with the state level figures of average household size in urban areas of 4.2 (Government of Kerala, 2012).

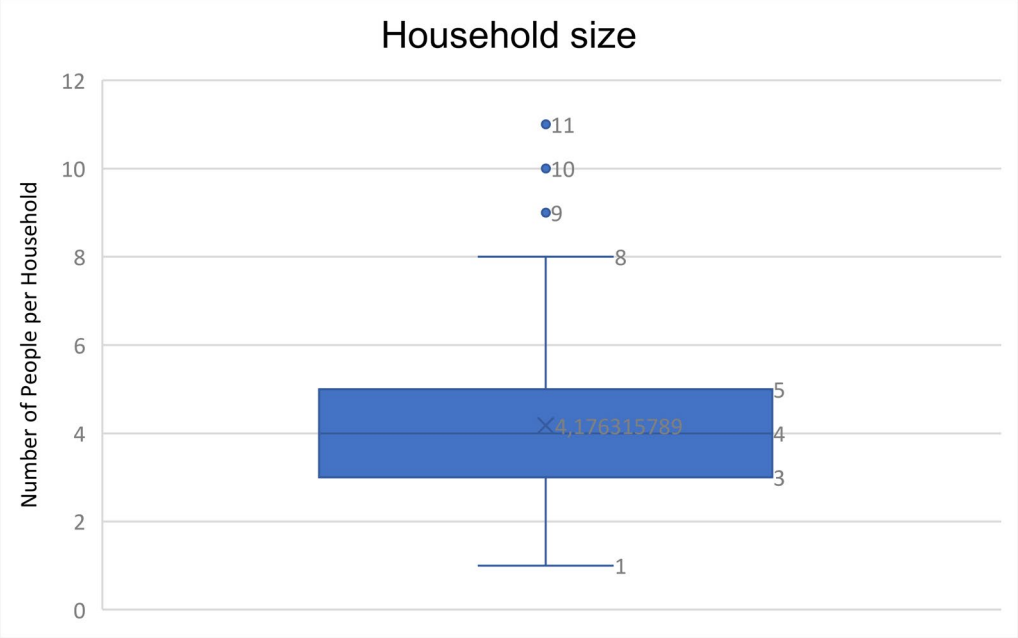

Figure 3 : Household Size (number of family members)

5.1.2 Class

For ascertaining the class of the sample HHs, the study relied upon ration card types. Assigned by the state government, these are multi-purpose documents that are used for availing government subsidies in food items (rice, wheat, sugar), fuel (Kerosene, LPG) and fertilisers. It also serves as an address proof. These are assigned based on the household income and occupation. Kerala currently has 4 ration card types that are colour coded as Yellow= Priority-Most economically backward section of society. Antyodaya Anna Yojana Beneficiaries; Pink = Priority or Below Poverty Line (BPL) Homes; Blue = Non – Priority subsidy or Above Poverty Line (APL); and White = Non – Priority Homes. Our survey showed that about 45% of the surveyed HHs belonged to the priority homes category i.e., BPL and most economically backward section (figure 4). As shown in figure 5, the geographical spread of the sampled households belonging to different class category is rather uniform. Our experience in Alappuzha district shows that ration card as proxy indicator for class is a reliable indicator in context of Alappuzha. Furthermore, data on house ownership and household income helps in triangulation.

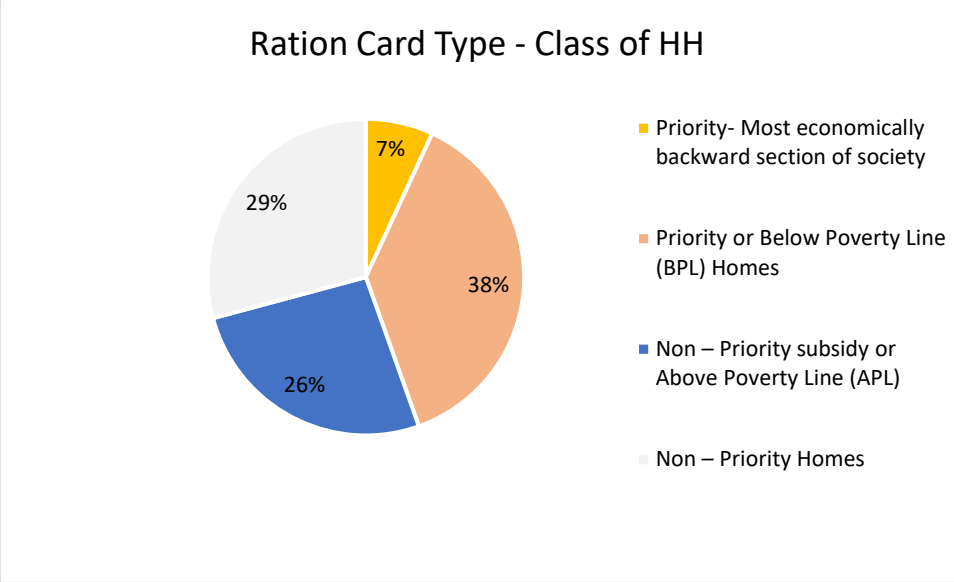

Figure 4 : Class (Ration Card Type) of Sampled Households

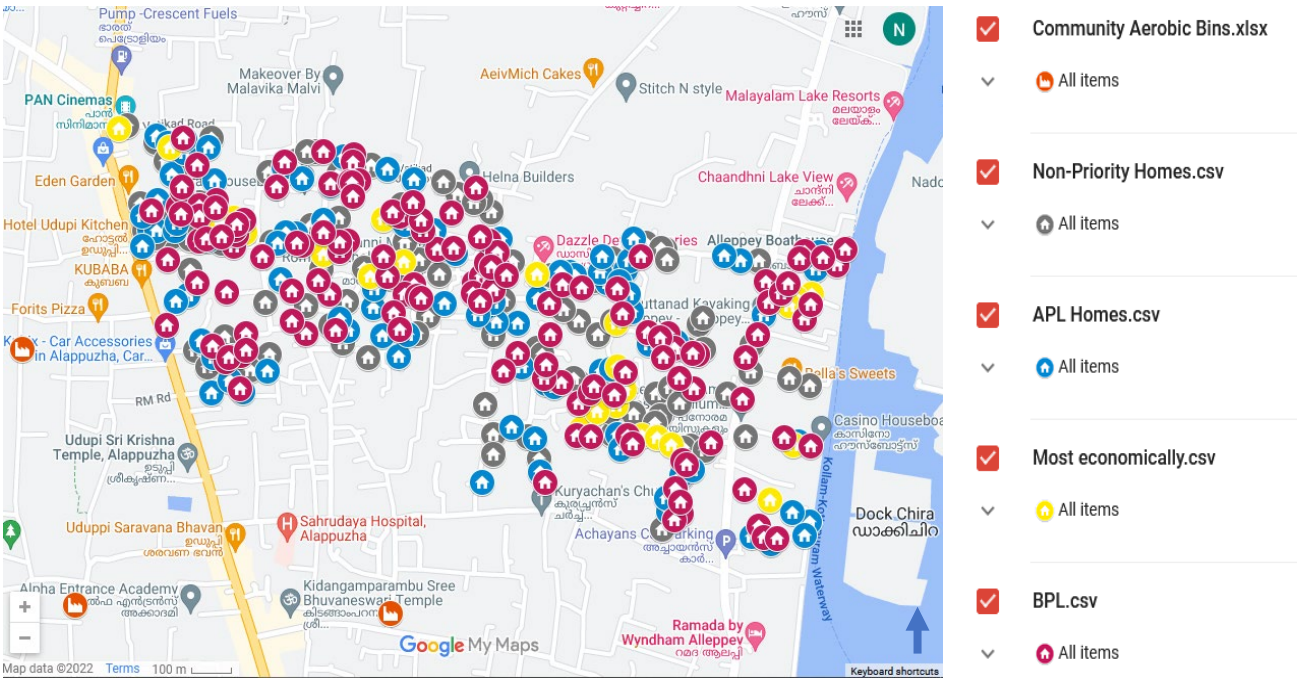

Figure 5: Geographical Spread of Sampled Households Belonging to Different Class Category

5.1.3 Religion

Majority of the households follow Hindu (46%) faith. This is in line with the city level population trends. The Christian and Muslim households make 45% and 9% of the sample households respectively. Figure 6 shows the geographical spread of sampled households belonging to different religion categories. It shows even spread of the Hindu and Christian category households whereas majority of the Muslim are clustered in the top left corner. The clustering (or religious segregation) is more visible for religious categories than the ration card types. As shown in figure 6, 49% of the Hindu households and 53% of the Muslim households belong to priority category (BPL and most economically backward section). Majority (61%) of the

Christian households belong to the non-priority home category. For religion and ration card (class), the Cramer's V is 0.145 indicating statistically insignificant association between the two category variables.

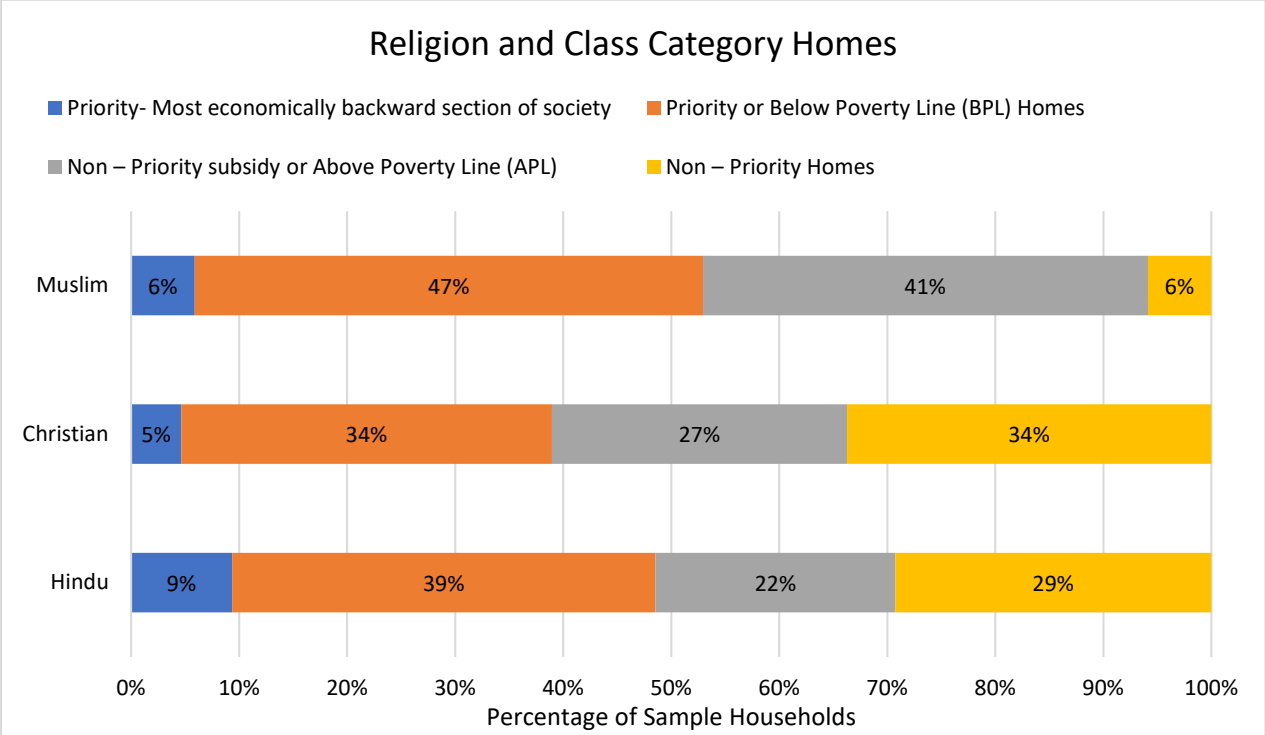

Figure 6: Religion and Class of Sample Households

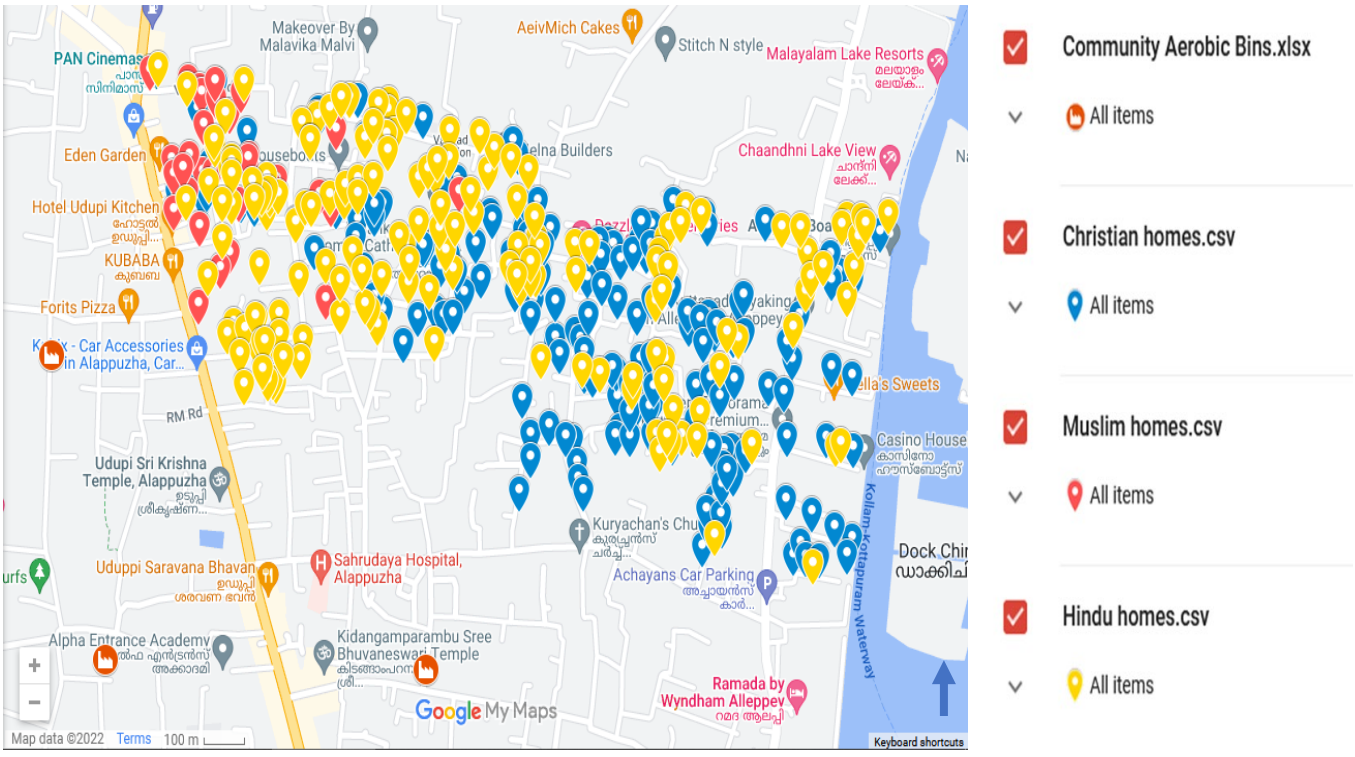

Figure 7 : Geographical Spread of Sampled Household in Different Religion Categories

5.1.4 Caste

Caste and class are interconnected structural features of the Indian society. The information is widely used in many of the official documents such as education enrolments, account opening, ration cards etc and/or to avail subsidies or government support. Five major castes have been identified by the government namely: General, Other Backward Classes (OBC), Schedule Caste (SC), Schedule Tribe (ST).

Survey showed that majority (53%) of the sampled HHs belong to the general category, followed by OBC households (38%). Whereas SC forms 5% of the sampled HHs, the ST households are only 1%. Figure 8 shows the geographical spread of sampled households belonging to different cast categories. General category households are rather evenly spread whereas OBC and other category households mostly located towards the top left side. Most of the SC households are towards the bottom right side of the map.

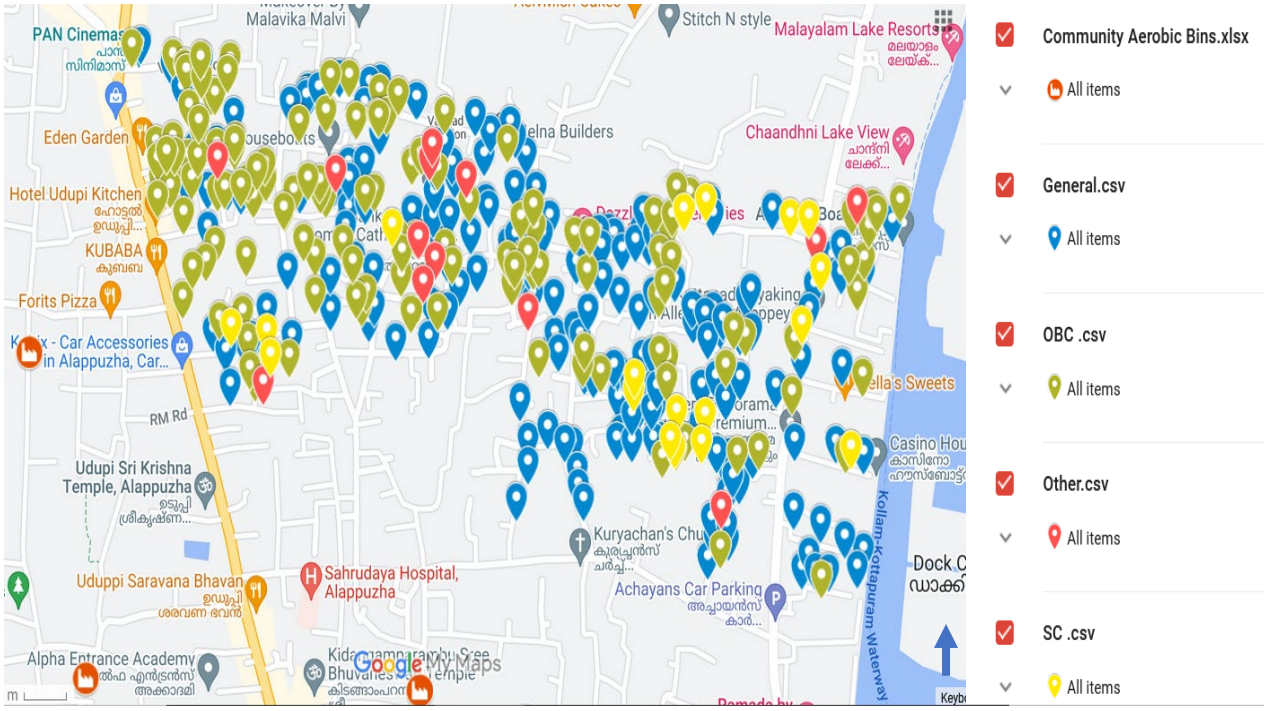

Figure 8: Geographical Spread of Sampled Households belonging to Different Caste Category

Whereas about 68% of the General HHs belong to Christian religion, majority (56%) of the OBC households belong to Hindu religion. SC and ST households belonged to Hindu religion. Majority (97%) of the Muslim households belong to OBC caste. For caste and religion, the Cramer's V is 0.415 indicating moderate association between the two category variables.

Figure 9 shows caste and class variations for the sample households. Majority (66.17%) of the General households belong to non-priority and APL category homes. 57 % of the OBC sampled households, and 50% of the sampled SC households belong to the priority category (BPL and most economically backward section). For caste and class (ration card types), the Cramer's V is 0.226 indicating statistically insignificant association between the two category variables.

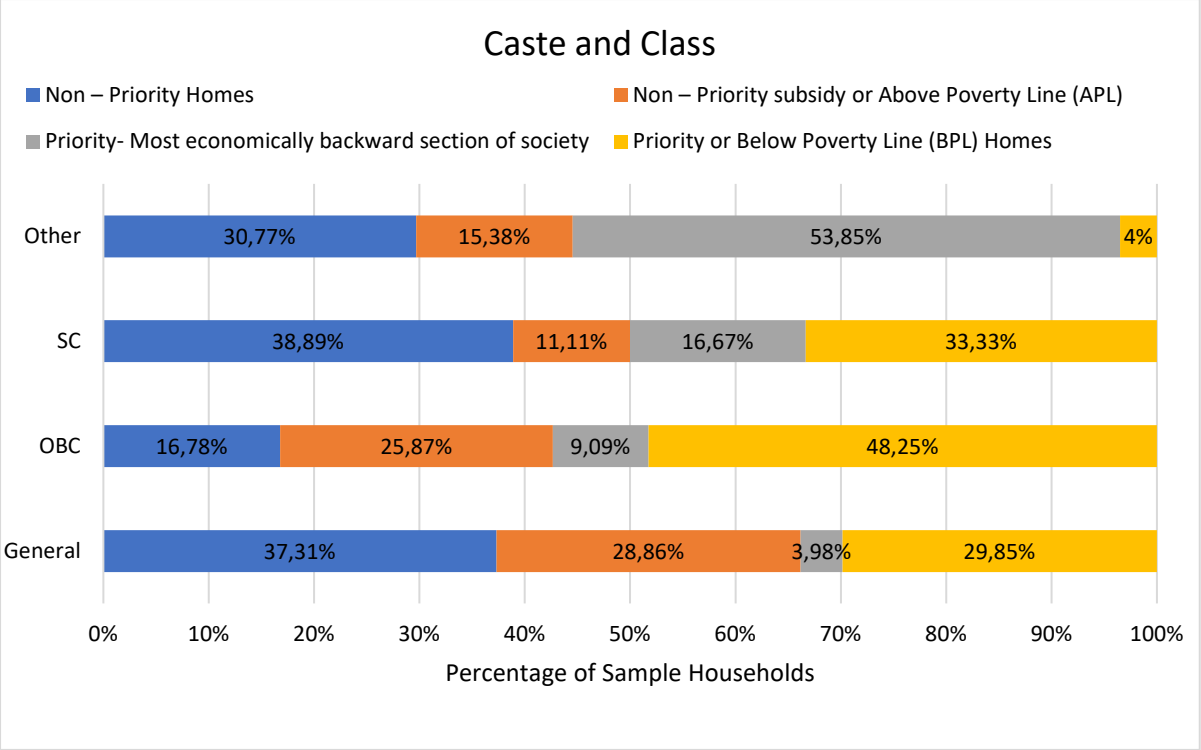

Figure 9 : Caste and Class Variations in Sampled Households

5.1.5 Homeownership

The homeownership stats show that 85% of the HHs have their own homes, and other 13% have rented homes. Majority of the General (89.5%), OBC (78.77%) and SC (83.3%) category households have their own home. Rented homes are most common for OBC households. About 52% of the rented homes belong to Hindu households, followed by Christian households (29.7%). About 69.5% of the rented homes belong to the priority category (BPL and most economically backward section).

5.1.6 Education Status

47.6 % of the households have graduate level (bachelor's degree) education as the highest education followed by primary education (kindergarten + 5 years of elementary school+3 year of middle school) and secondary education (4 years of education till 12th standard) – see figure 10. Very small percentage (1.6%) of respondents received formal education.

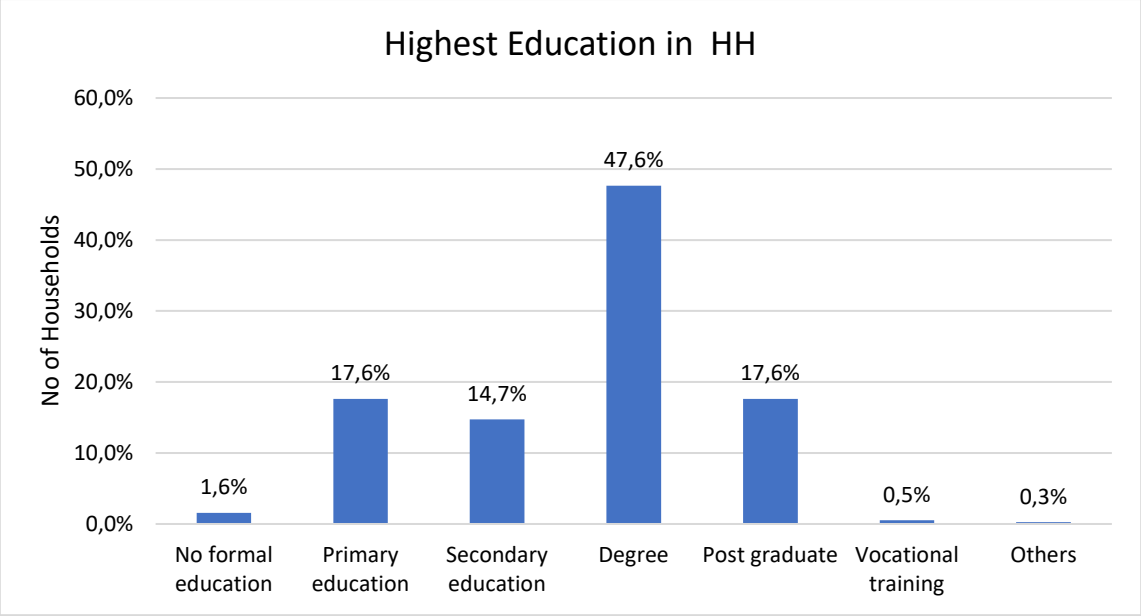

Figure 10: Highest level of education in Households

As shown in figure 11, the highest level of education in majority of the Christian and Hindu households is the graduate degree. Very small percentage of sampled Christian and Hindu households reported to have members with no formal education. The highest degrees i.e., graduate, and post-graduate are found to be relatively higher for the Hindu households and lowest for Muslim households. For religion and education status, the Cramer's V is 0.093 indicating statistically insignificant association between the two category variables.

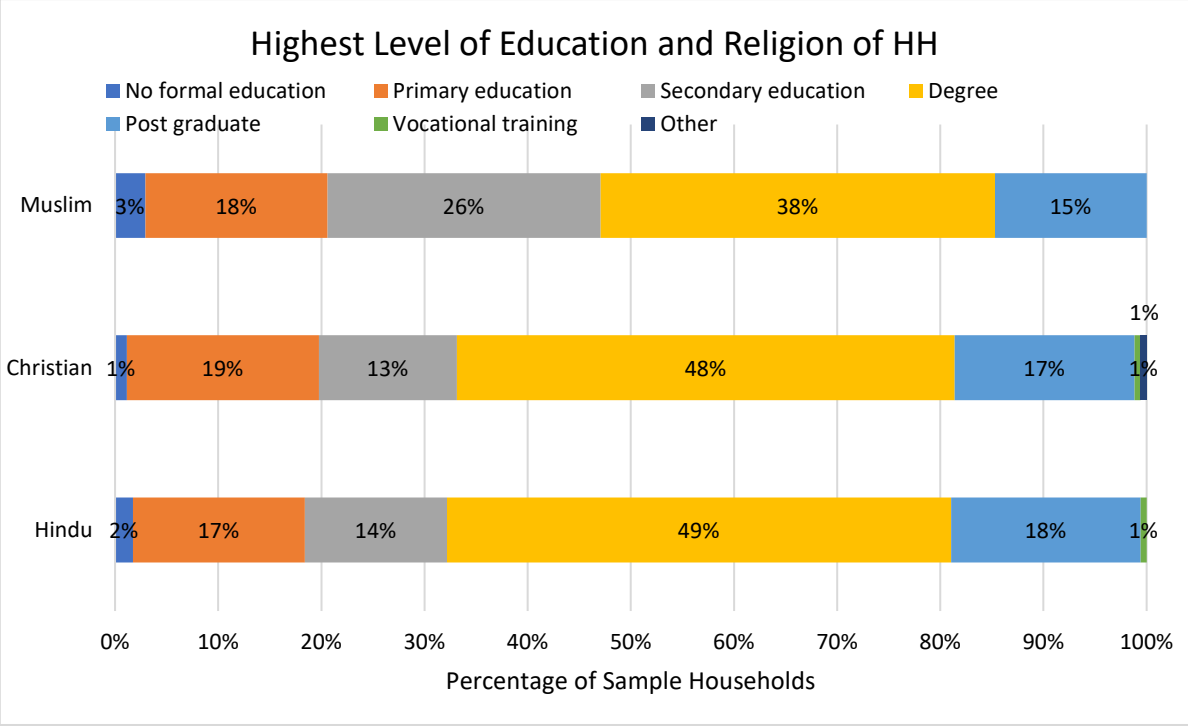

Figure 11: Highest Level of Education Among Households Practicing Different Religions

Highest level of education for majority of the OBC and other category households is the graduate degree (figure 12). For majority of the SC households the highest education level reported to be primary education. Very small percentage of sampled OBC and General households reported to have members with no formal education. For caste and education status, the Cramer's V is 0.217 indicating statistically insignificant association between the two category variables. However, the Cramer's value is higher than the Cramer's value for religion and education.

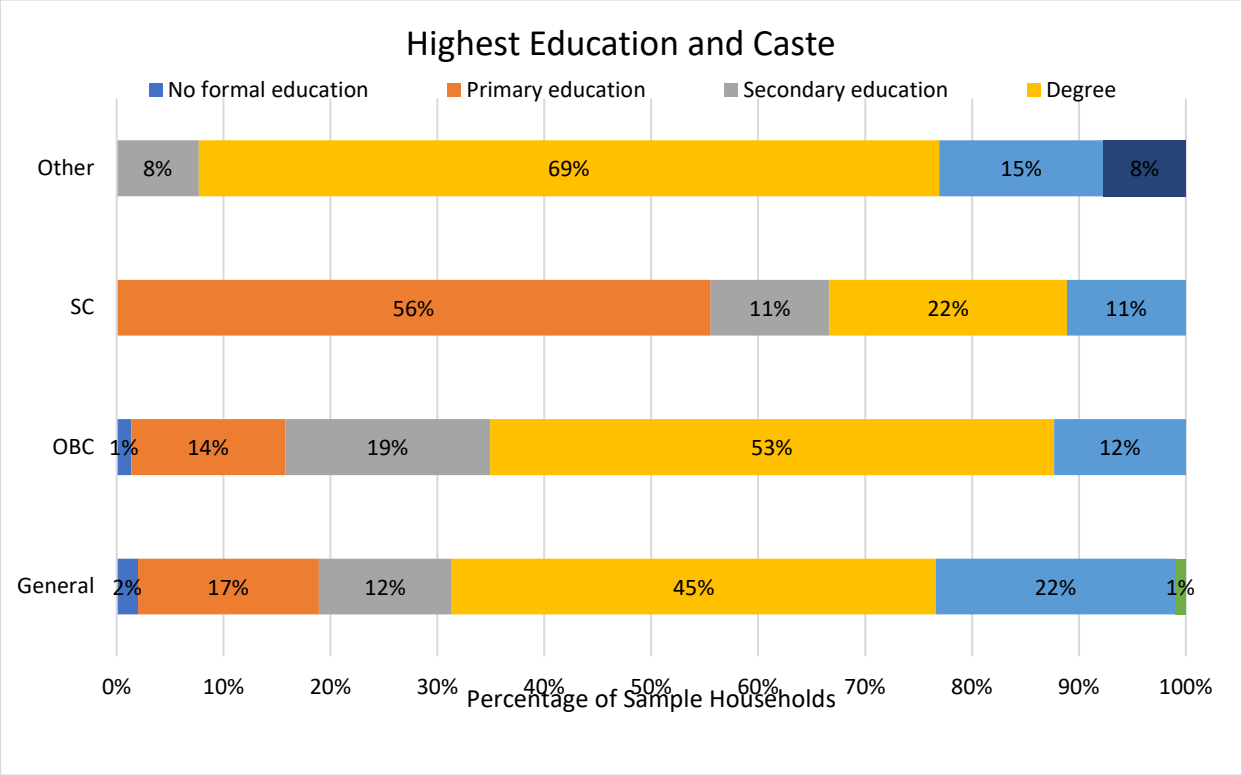

Figure 12: Highest Level of Education Among Households Belonging to Different Cast Category

As seen in figure 13, the highest level of education for majority of the non-priority homes and most economically backward class is the graduate degree. No-formal education is highest among most economically backward class and BPL homes. For ration card and education status, the Cramer's V is 0.151 indicating statistically insignificant association between the two category variables.

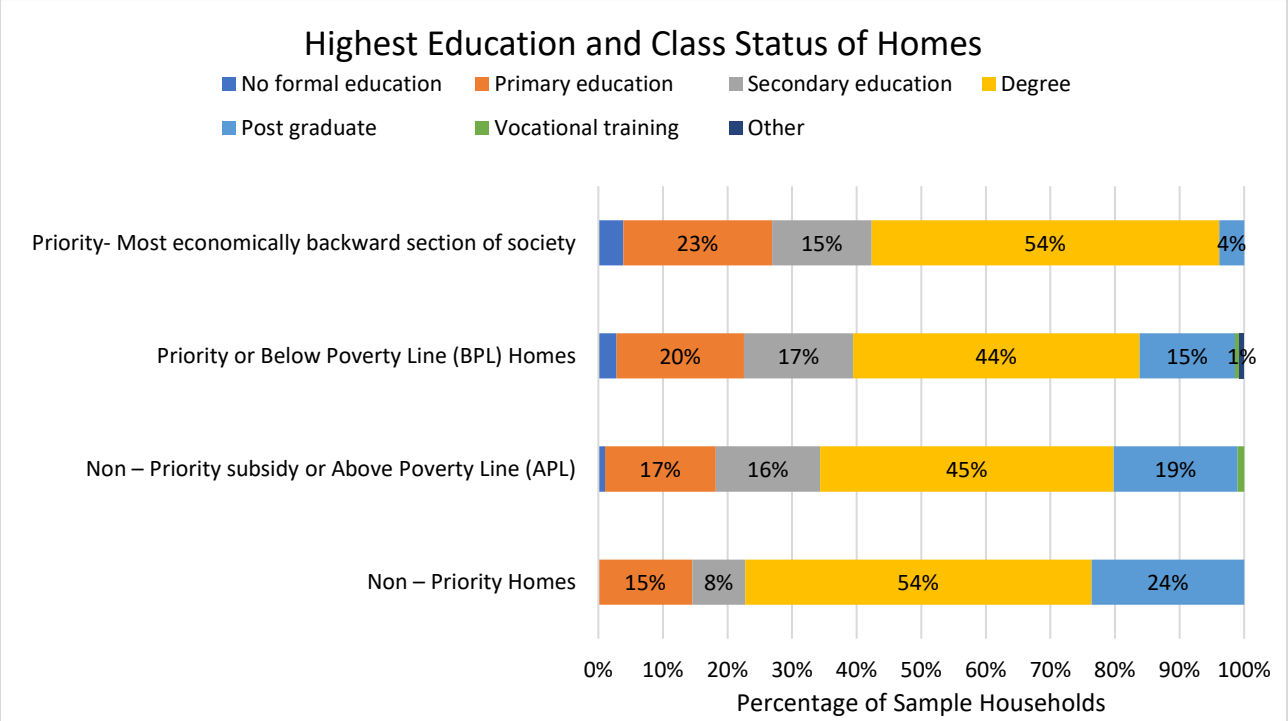

Figure 13: Highest Education for Different Class Homes

5.1.7 Primary Source of Income

As seen in figure 14, for 31% of the households the primary source of income is daily wage employment. Service sector as primary source of income was for 25% of the households. 16% of the households reported to have own businesses as their primary source of income whereas 15% reported to be living on various government pension schemes.

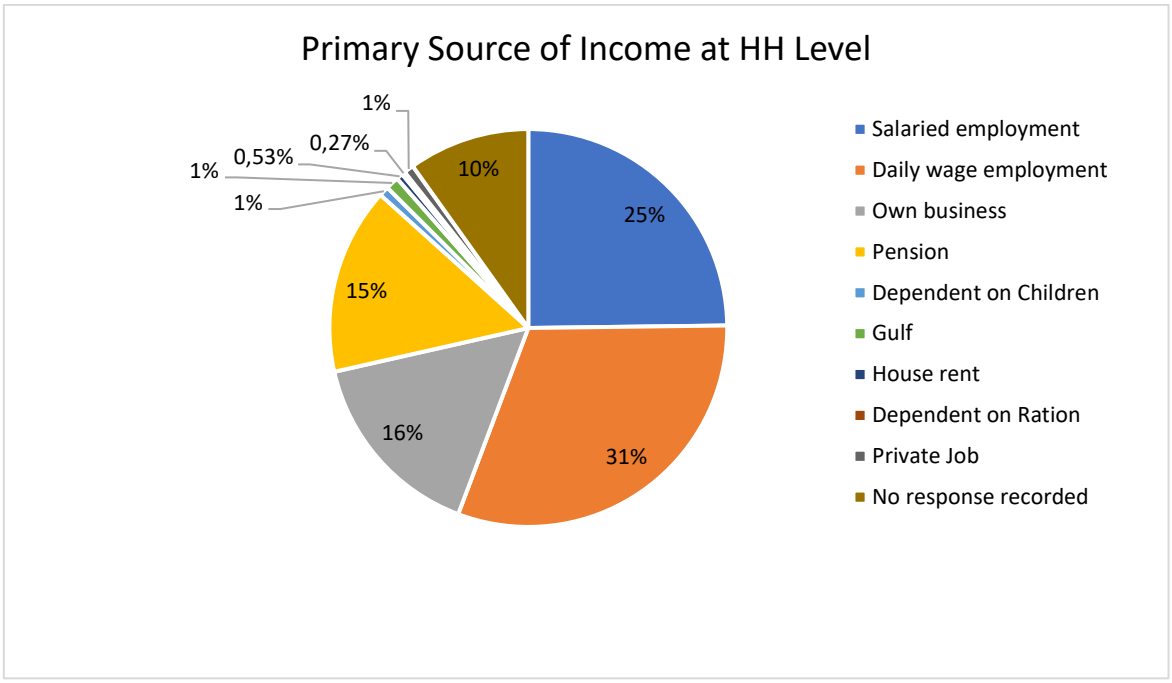

Figure 14: Primary Source of HH Income

Daily wage employment as primary source of income is highest among priority homes i.e., BPL and most economically weaker section (figure 15). The Cramer's V is 0.221 indicating statistically insignificant association between the two variables.

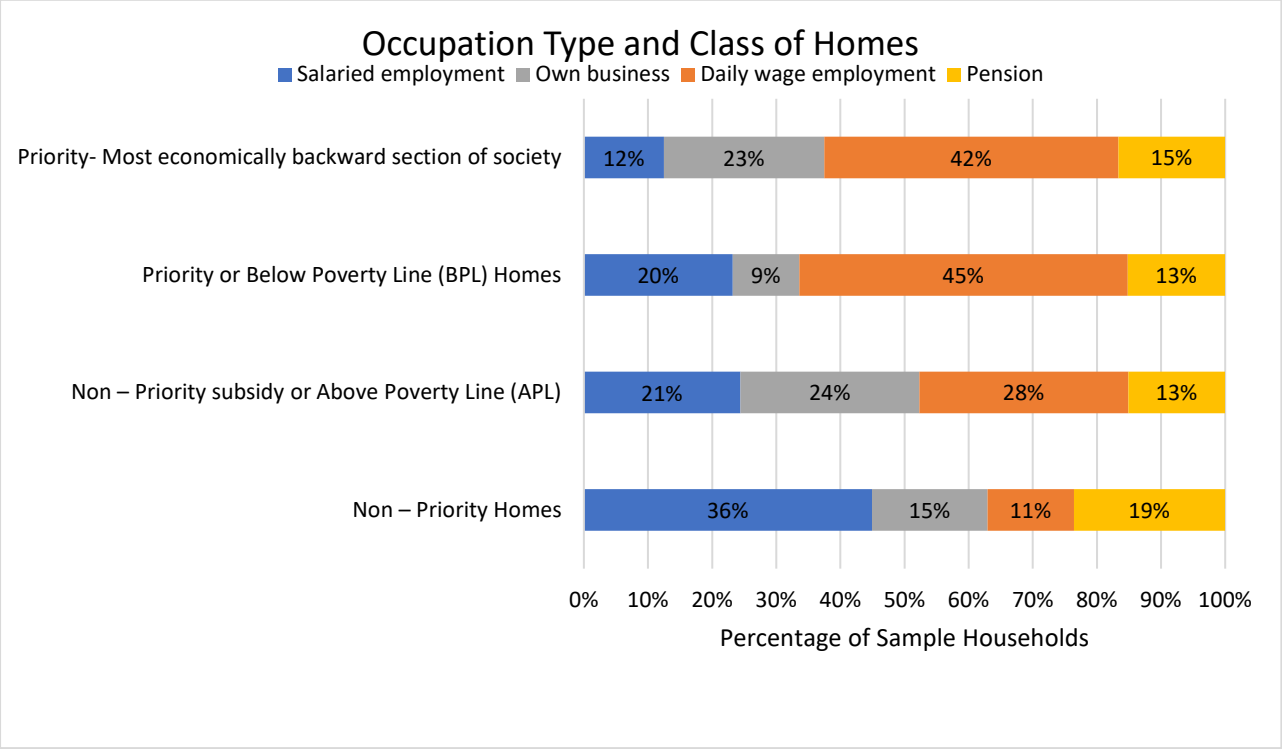

Figure 15: Primary Source of Household Income in Different Class Homes

Daily wage employment as primary source of income is highest for OBC and SC category homes (figure 16). Salary employment is highest for General and Other category homes. The Cramer's V is 0.161 indicating statistically insignificant association between the two variables.

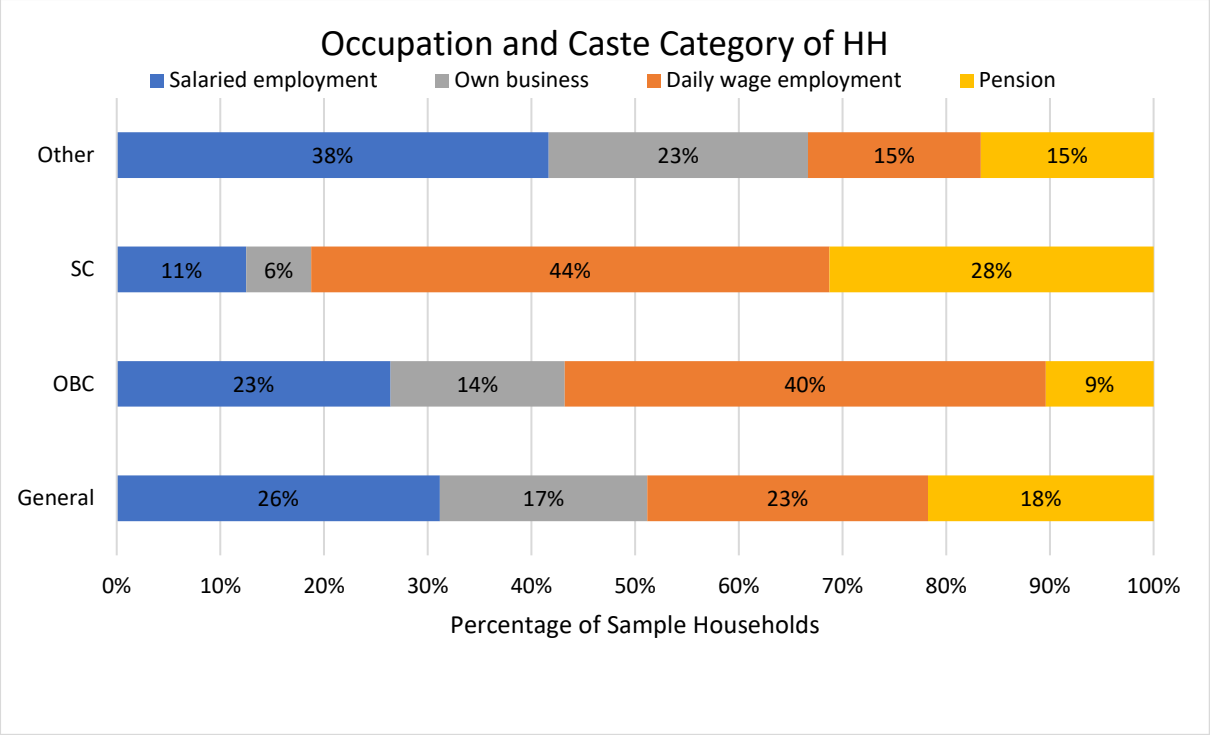

Figure 16: Primary Source of Household Income in Different Caste Homes

Daily wage employment as primary source of income is highest for Muslim households (figure 17). Salary employment is comparable for Christian and Hindu households. The Cramer's V is 0.107 indicating statistically insignificant association between the two variables. The results indicate that religion has the weakest association with the occupation.

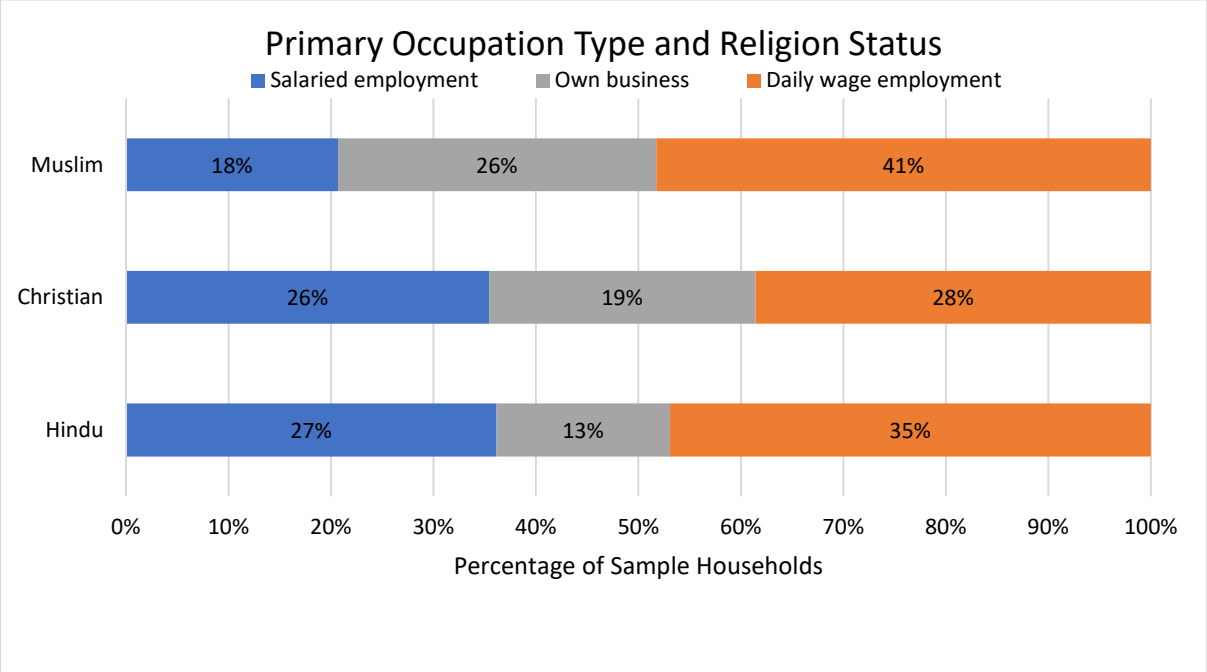

Figure 17: Primary Source of Household Income in Different Religion Homes

5.1.8 Primary Decision Maker of Households

As seen in figure 18, 46% of sampled HHs have husbands as the primary decision makers. Male members (husband and elderly male person) as the primary decision makers were reported by 49 % of the HHs as opposed to 24% HHs having female members (wife and elderly female person) as the primary decision makers. Joint decision making was reported to be followed by 26% of the HHs.

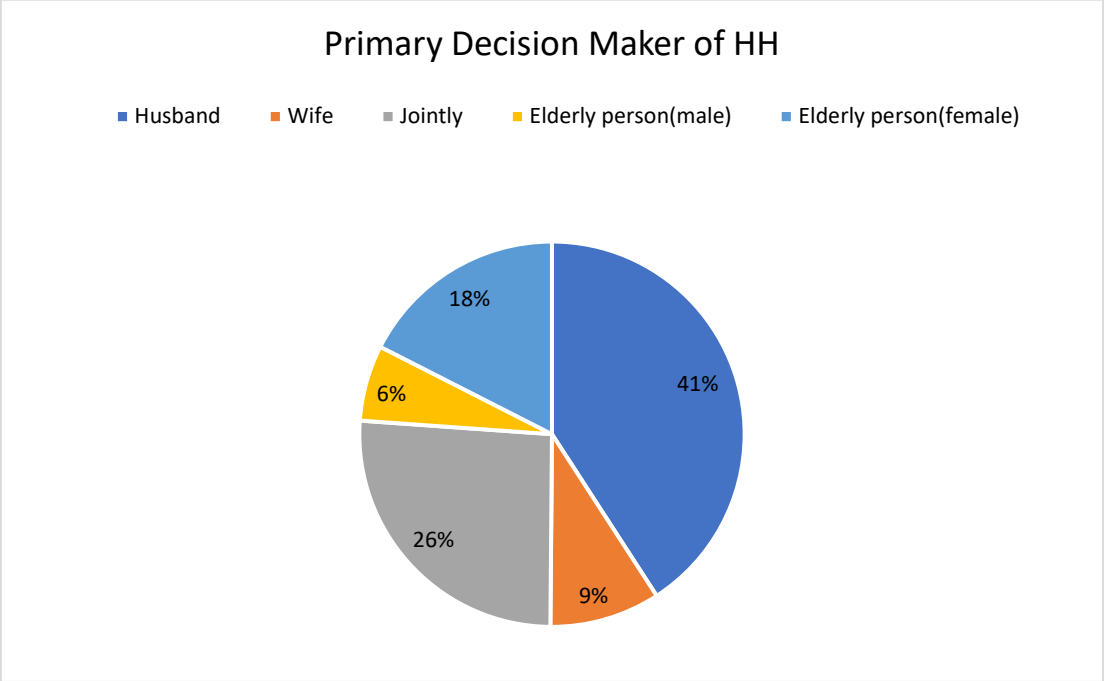

Figure 18: Primary Decision Maker at Home

As shown in figure 19, husbands as primary decision makers are highest for SC caste households. Female members (wife and elderly female person) as the primary decision makers are comparable for General (27.86%) and SC (27.7%) households. Joint decision making is reported to be highest in OBC households.

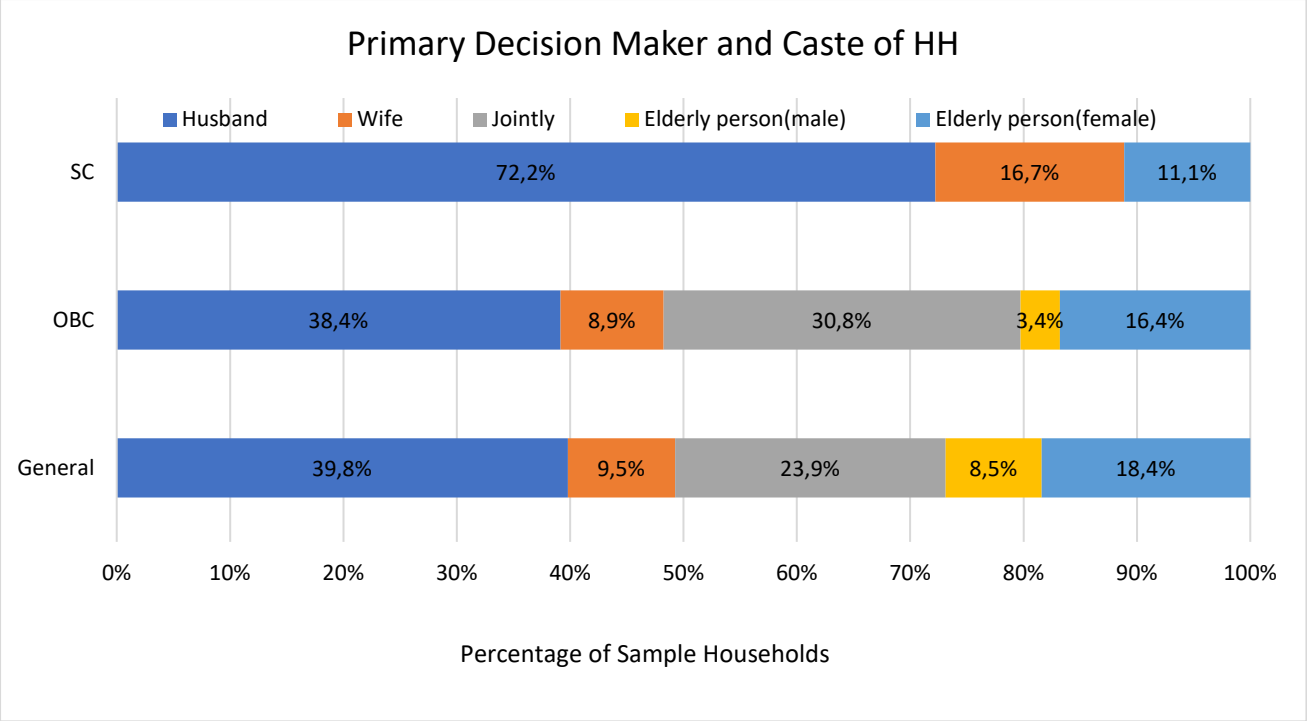

Figure 19: Primary Decision Maker in Different Caste Category Households

As shown in figure 20, husbands as primary decision makers are reported to be highest for non-priority and APL homes as compared to priority BPL and most economically backward homes. Female members (wife and elderly female person) as the primary decision makers are highest for BPL homes (32.86%) followed by most-economically backward (26.9%) homes. Joint decision making is reported to be highest in most-economically backward homes (38.46%) followed by non-priority homes (32.73%).

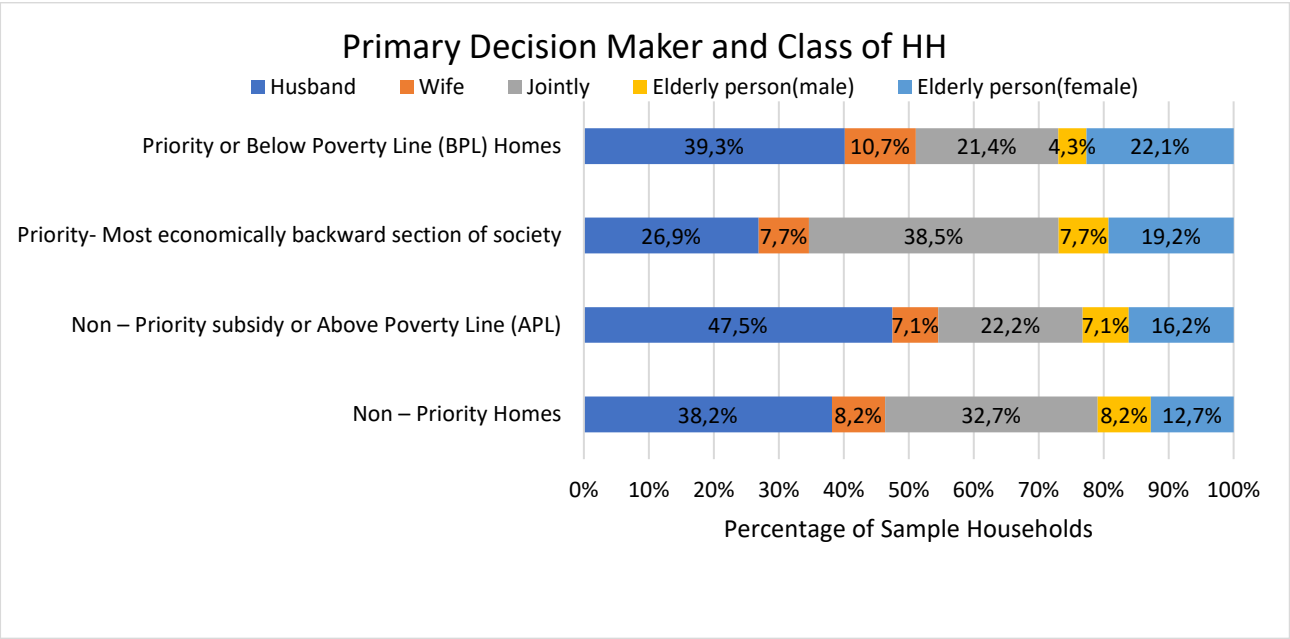

Figure 20: Primary Decision Maker in Different Class Homes

In majority of the Muslim (67.65%), Hindu (40.8%) and Christian (34.88%) households, husbands are the primary decision makers. The joint decision making is highest among Christian households (30.23%) followed by Hindu households (24.7%). Female members (wife and elderly female person) as the primary decision makers are highest in Christian households (29.65%), followed by Hindu (24.7%) and Muslim (20.59%) households.

5.2 Solid Waste Management Practices at Household Level

5.2.1 Primary Responsibility of Waste Management

Figure 21 shows that the female members (wife, daughter, elderly female, domestic worker) reported to be primarily responsible for the waste management at the household level. About 88.86% of the households rely upon their female members for waste management as opposed to 5.26 % of the households that primarily rely upon their male members. Only 6.05% of the households reported to have joint responsibility towards SWM.

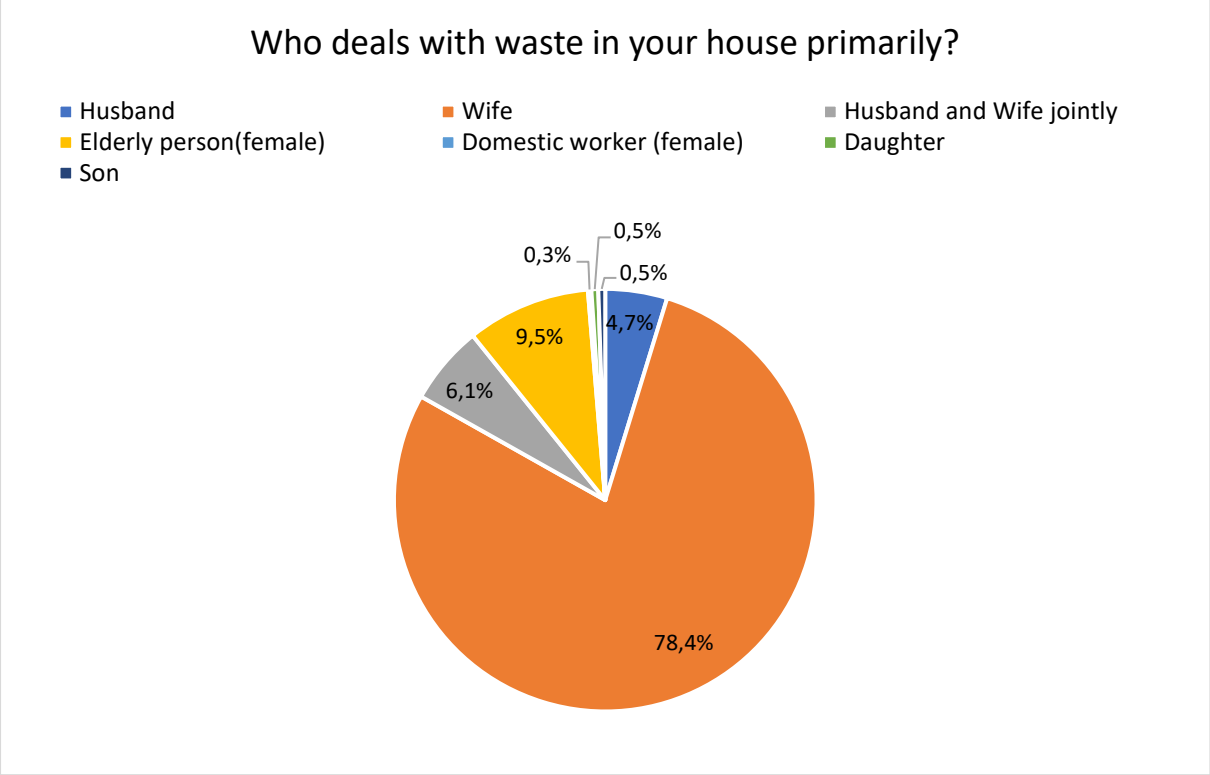

Figure 21: Primary Responsibility of Waste Management at Household Level

Table 3 shows waste management responsibilities for different class, caste, and religion. The waste management responsibilities at the HH level are comparable for different religion households i.e., about 88% of the Hindu, Christian and Muslim HHs have female members as the primary responsible person for SWM. The difference is somewhat visible in case of caste categories with average 88% of the General and OBC households having female members as the primary responsible person for SWM as compared to 94% of SC households. This difference is more visible and clearer for priority and non-priority homes categories. On an average about

92% of the priority (BPL and economic weaker section) homes have female members as the primary responsible person for SWM as compared to average 85% of the non-priority homes (APL and non-priority).

Table 3: Primary Responsibility of Waste Management in Different Religion, Caste, Class Category Households

	Religion			Caste				Class			
	Christian	Hindu	Muslim	General	OBC	SC	ST	Non – Priority	APL	Most economically backward	BPL
Husband	4.65%	4.60%	5.88%	5.47%	4.11%	5.56%	0.0%	7.3%	8.1%	3.8%	0.7%
Wife	80.23%	76.44%	79.41%	79.60%	76.03%	88.89%	50.00%	78.2%	74.7%	92.3%	78.2%
Husband and Wife jointly	5.23%	6.90%	5.88%	5.47%	6.85%	0.00%	0.0%	7.3%	6.1%	3.8%	5.6%
Elderly person(female)	8.72%	10.92%	5.88%	8.46%	10.96%	5.56%	50.00%	5.5%	9.1%	0.0%	14.8%
Domestic worker(female)	0.0%	0.0%	2.94%	0.0%	0.68%	0.00%	0.00%	0.0%	1.0%	0.0%	0.0%
Daughter	0.0%	1.15%	0.00%	0.50%	0.68%	0.00%	0.00%	0.9%	0.7%	0.0%	0.7%
Son	1.16%	0.00%	0.00%	0.50%	0.68%	0.00%	0.00%	0.9%	1.0%	0.0%	0.0%

5.2.2 Segregation of waste

94% of the households (359/380) reported to be practicing waste segregation. 2% of the respondents were not aware of such practices at their homes (figure 22).

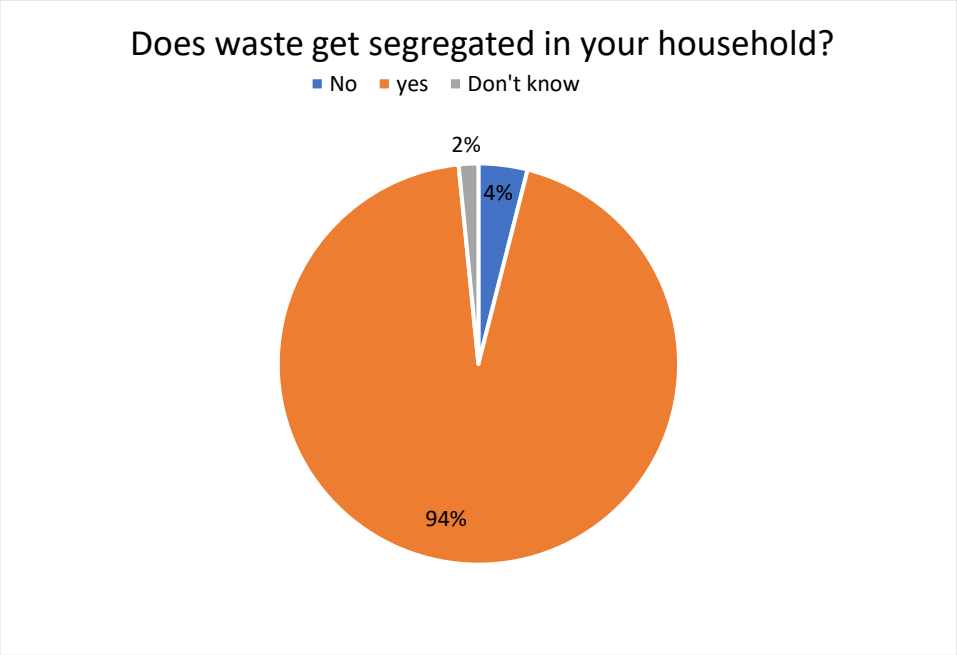

Figure 22: Waste Segregation at Household Level

The data shows strong relationship between the waste segregation practices and the gender of the person primarily responsible for dealing with the waste at the household level. As figure 23 shows, the waste segregation practices found to be more prevalent for households where female members are primarily responsible for the waste management i.e., 86% of the sample households that practice waste segregation. The waste segregation found to be practiced in only 5% of the households having male members as primarily responsible person for the waste management.

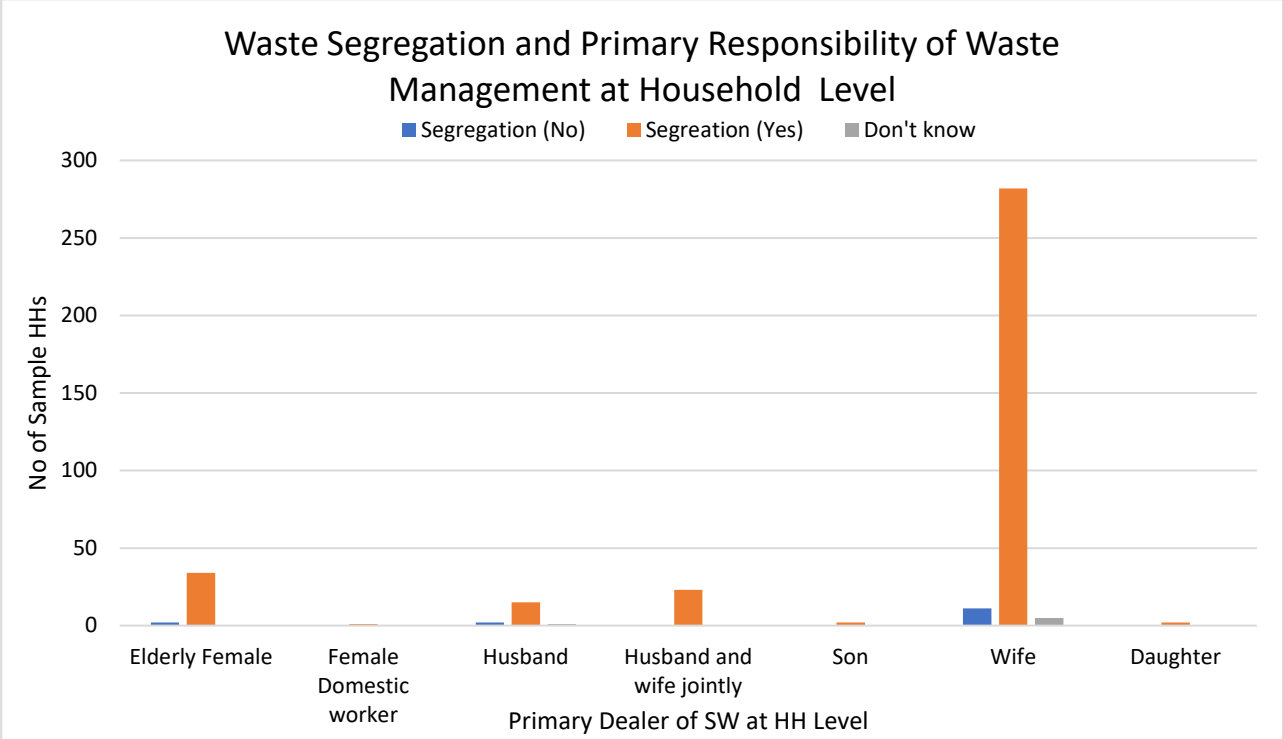

Figure 23: Waste Segregation and Primary Responsibility of Waste Management at Household Level

A comparison of waste segregation practices at household level with the highest education level is given in figure 24. The analysis does not provide clear indication of the relationship between the two variables. However, it shows that the households not practicing waste segregation have higher percentage of no-formal education households (13.33%) as compared to households practicing waste segregation (1.1%).

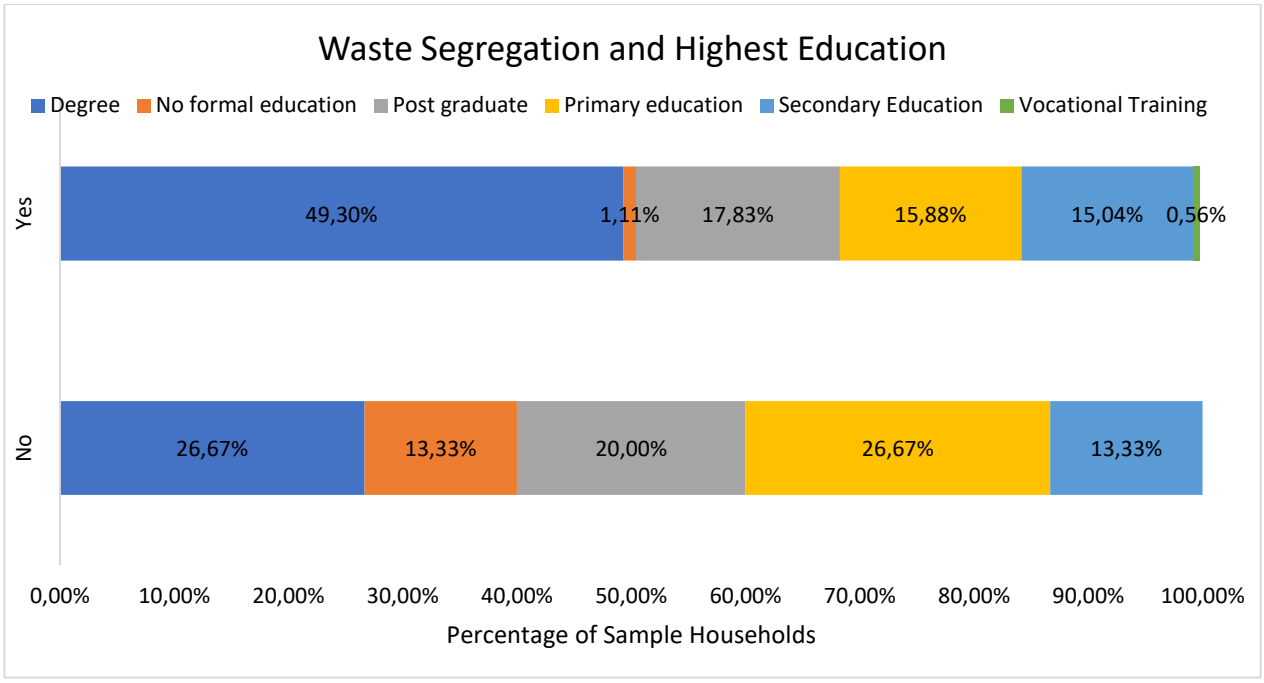

Figure 24: Waste Segregation Practices at Household Level and Highest Education Level

As shown in table 4, the waste segregation practices found to be more prevalent in the non-priority and APL homes as opposed to BPL and most economically backward homes. The waste segregation practices are comparable for General (96.02%) and OBC (95.21%) households. The segregation practices are more prevalent in Christian (97.09%) households. Waste segregation is lowest among Hindu households i.e., 91.9% of the households.

Table 4: Waste Segregation Practices in Different Class, Caste, and Religion Households

	Class				Caste				Religion		
Waste Segregation	Non – Priority Homes	Non – Priority subsidy or APL	Priority- Most economically backward	Priority or BPL	General	OBC	SC	ST	Christian	Hindu	Muslim
No	2.73%	1.01%	7.69%	6.34%	2.99%	4.79%	5.56%	50.00%	1.74%	5.75%	5.88%
Yes	95.45%	96.97%	88.46%	92.96%	96.02%	95.21%	72.22%	50.00%	97.09%	91.95%	94.12%
Don't know	1.82%	2.02%	3.85%	0.70%	1.00%	0.00%	22.22%	0.00%	1.16%	2.30%	0%

5.2.3 Kitchen Waste Management

Figure 25 shows primary kitchen waste disposal practices at household level. There is no door-to-door collection service for kitchen waste in Alappuzha town. And, there is no selling of kitchen waste as well. 90% of the households that segregate their waste (359/380) are engaged in safe disposal of kitchen waste. This includes practices like burying within building premises (54%), household level kitchen bins (6%), biogas plants (10%), community aerobic bins (18%), and feeding animals, waste dumping near plants and composting (8%). The higher percentage of HHs practicing waste disposal within building premises is perhaps because the houses in Alappuzha are individual independent units with enough open land unlike bigger cities with apartment model of housing. The usage of bio-gas plants is low only 26 household despite 92% of the households (330/359) having minimum required vacant land area (0.05 cents) for biogas installation.

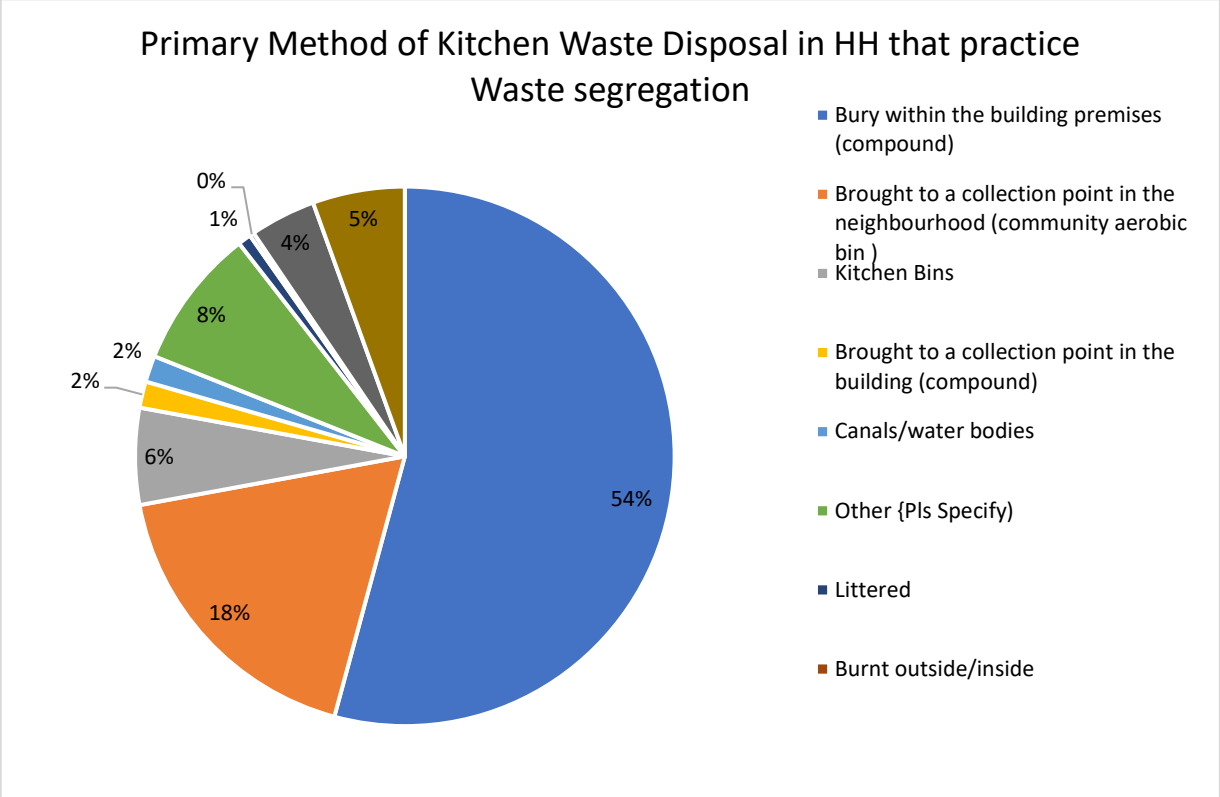

Figure 25 : Primary Method of Kitchen Waste Disposal in HHs

Figure 26 shows kitchen waste disposal frequency for different types of methods. Majority of the households, for most of the methods, dispose kitchen waste daily. This is because of the putrefying nature of the waste. Daily usage of community aerobic bins and bio-gas plants is relatively lower than the rest of the methods.

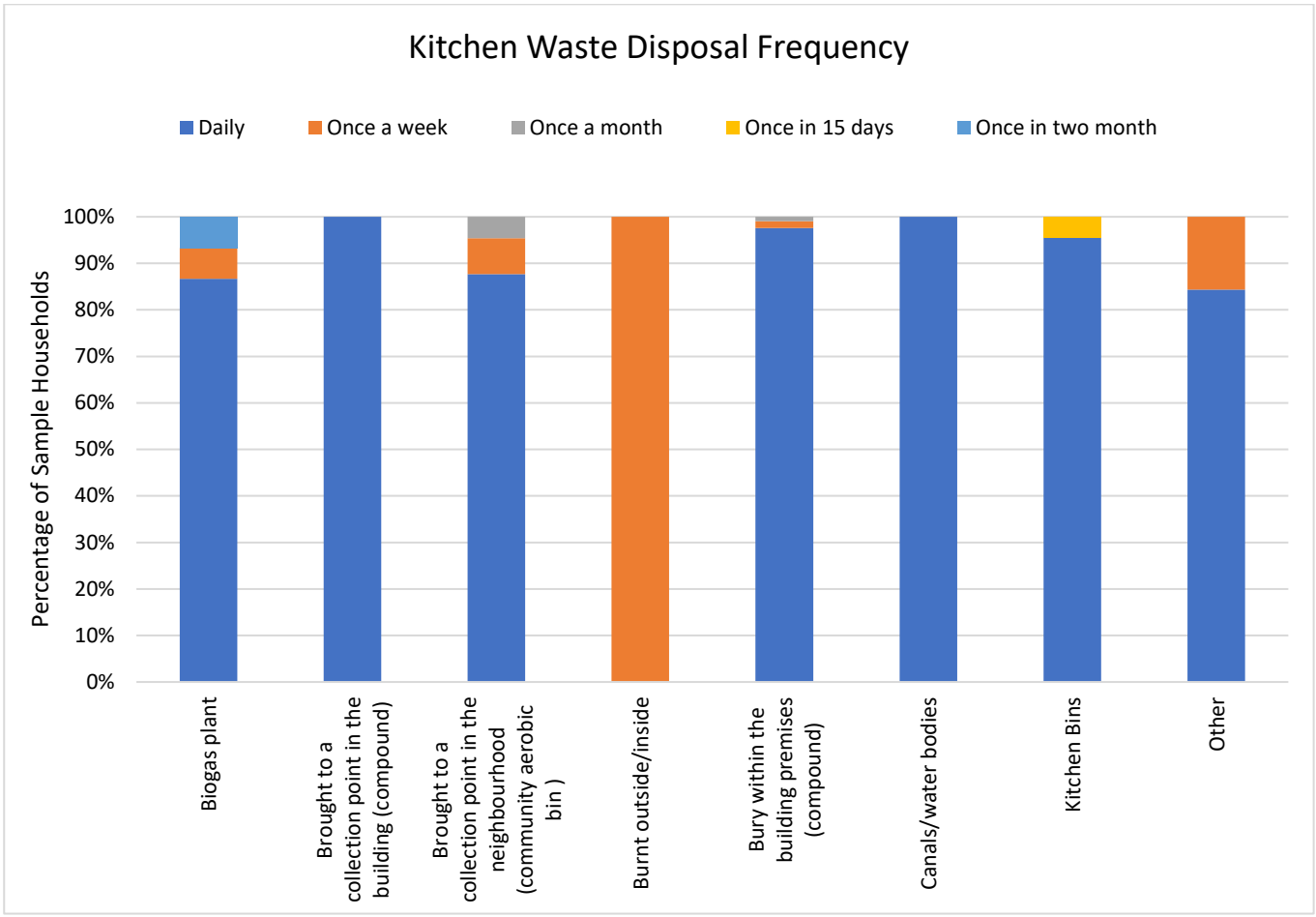

Figure 26: Kitchen Waste Disposal Frequency for Different Methods

Only 2 out of 37 households, using kitchen bins and biogas plants, complained about operations and maintenance issues. Rest of the 35 households find kitchen bin and biogas plants useful for odorless way of disposing waste, fertilizer, and cooking gas. 20 out of 22 households received kitchen-bins from government/local municipality. 9 out of 15 households received bio-gas plants from government/local municipality.

The average monthly O&M expenditure on biogas plants and kitchen-bins was reported to be 100 INR and 112 INR respectively. Box plot in figure 27 shows the spread of the O&M expenditure for both technologies. 50% of the households having kitchen bins incur 112 INR as O&M expenditure on kitchen-bin. 50% of the households having biogas plant reported to have no O&M expenses. The O&M frequency for kitchen bins reported to be varying between once in 3 to once in 6 months.

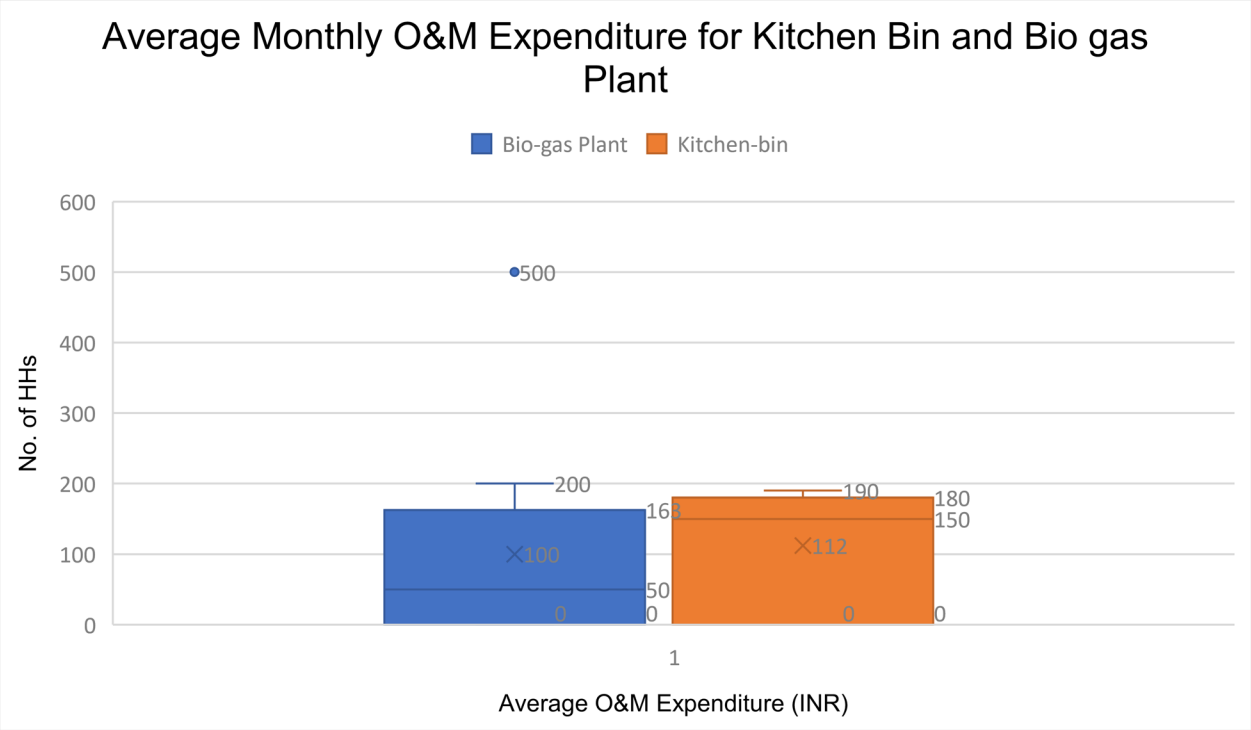

Figure 27: Average Monthly O&M Expenditure for Kitchen Bins and Bio-gas Plants

Kitchen Waste Disposal Method and Class, Caste, Religion

Table 5 provides summary of primary method of kitchen waste disposal for different Class, caste, and religion households. It can be seen that biogas plants and kitchen bins usage are higher for the non-priority homes (APL and non-priority homes). None of the priority homes reported to be using biogas plants. The usage of community aerobic bins is highest for the non-priority homes, and comparable for APL and BPL homes.

64% of the priority home resort to burying kitchen waste within the building premises (compound) as compared to 54% of the non-priority homes. Burying as a method of disposal is highest among priority homes (BPL and most economically backward). This could be because of the lack of or limited access to kitchen and biogas plants. Among different caste households, the usage of biogas plants is higher for the General category homes. Usage of kitchen bins is comparable between three categories. The usage of community aerobic bins is highest for the SC and General category homes. Burying as a method of disposal is highest among OBC homes as compared to General and SC homes. This could be because of the limited access to kitchen and biogas plants, and limited usage of community aerobic bin. Among different religion category households, the usage of kitchen bins is comparable for Hindu, Christian and Muslim HHs. The usage of bio-gas plants and kitchen bins is lowest for Christian households. However, community aerobic bin usage is highest for Christian households. Burying as a method of disposal is highest for Hindu HHs.

Table 5: Primary Method of Kitchen Waste Disposal for Different Class, Caste, and Religion Homes

	Religion			Class				Caste		
Disposal Methods	Christian	Hindu	Muslim	Non – Priority Homes	Non – Priority/ APL	Priority-Most economically backward	Priority/ BPL	General	OBC	SC
Biogas plant	2.40%	6.25%	3.13%	6.67%	8.33%	0.00%	0.00%	5.70%	2.88%	0.00%
Kitchen Bins	5.99%	6.25%	6.25%	8.57%	7.29%	4.35%	3.79%	6.74%	5.04%	7.69%
Brought to community aerobic bin	25.75%	12.50%	15.63%	22.86%	18.75%	8.70%	18.18%	21.24%	15.11%	46.15%
Bury within building premises	53.29%	61.25%	59.38%	53.33%	52.08%	78.26%	61.36%	55.44%	61.15%	23.08%
Brought to a collection point in the building	2.99%	0.63%	0.00%	0.00%	3.13%	4.35%	1.52%	2.07%	0.72%	7.69%
Burnt outside/inside	0.60%	0.00%	0.00%	0.00%	0.00%	0.00%	0.76%	0.00%	0.72%	0.00%
Canals/water bodies	3.59%	0.00%	0.00%	1.90%	1.04%	0.00%	2.27%	2.59%	0.00%	0.00%
Other	5.39%	11.88%	3.13%	6.67%	8.33%	4.35%	10.61%	6.22%	12.95%	7.69%
Littered	0.00%	1.25%	12.50%	0.00%	1.04%	0.00%	1.52%	0.00%	1.44%	7.69%

Figure 28: Primary Method of Kitchen Waste Disposal in Different Class Homes

Kitchen waste disposal methods and household level vacant area

In order to understand the relationship between the choice of disposal methods and vacant space available in households, we drew a box plot of available vacant area (cents) against different disposal methods. We found that, both category of HHs that bury their kitchen waste within the compound and HHs that use kitchen bins seem to have an average empty-space of 5.3 and 6.2 cents respectively. HHs that use community aerobic bins for disposing off their kitchen waste seem to have average empty-space of around 4.6 Cents. Biogas using HHs have an average empty-space of around 7.1 Cents. HHs disposing of their kitchen waste into canals/ water-bodies seem to have an empty-space of around 10.1 Cents and the littering HHs have an average empty-space of around 5.4 Cents. These values show that there seems to be no definitive relation of kitchen waste-disposal with having empty-space in their house-plots. Majority HHs dispose- off their kitchen waste using 'bury within compound' and 'community aerobic bins' despite them seemingly having average empty-space of around 5 Cents.

5.2.4 Plastic Waste Management

The questions related to plastic waste management focused on wastes like plastic covers, packaging material, and plastic bottles. Out of 359 households who practice waste segregation, 347 households have door-to-door collection of plastic waste by the third party, 10 households deposit waste to the community aerobic bin units and the remaining 2 burn their waste (figure 29). Burning as a method of plastic waste disposal seems to be more prevalent in non-residential properties according to our field observations. The door-to-door collection in 341 households out of 347 involve HKS women workers i.e., 98% of the households practicing waste segregation have door-to-door collection

services by the HKS members. Whereas 6 households give their waste to scrap dealers[8]. The collection by HKS happens once a month at monthly payment of 60 INR per household. This collected user fee directly goes to the HKS account and is equally distributed by the end of each month among the members. The selling of plastic waste to scrap dealer can fetch up to 20 INR/Kilogram. 335 out of 347 households reported to be having no issues with the plastic waste management services and the same number of households reported to have no issues with the HKS workers providing the services. Unsatisfaction with the frequency of waste collection and user fee was expressed by few respondents.

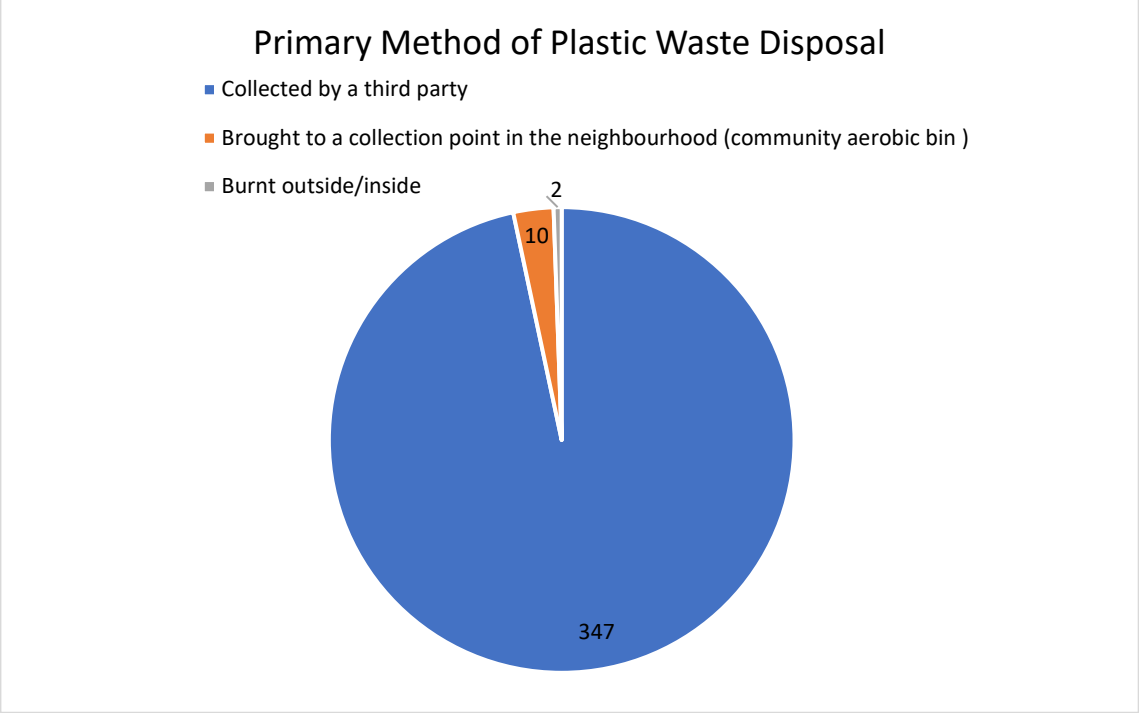

Figure 29: Primary Method of Plastic Waste Disposal

Plastic Waste Disposal Practices across different Class, Caste, Religion

As shown in figure 30, the door-to-door collection services are highest and lowest for the most economically backward and APL category homes respectively. The unsafe practice of burning plastic waste is highest for the APL and BPL category homes, negligible though. Community bin usage is highest among APL and non-priority homes.

[8] In Kerala context, scrap dealers usually are small to medium shop owners to deal (sell and buy) with scrap materials such as plastic, paper, newspaper, metal, cardboard, glass etc.

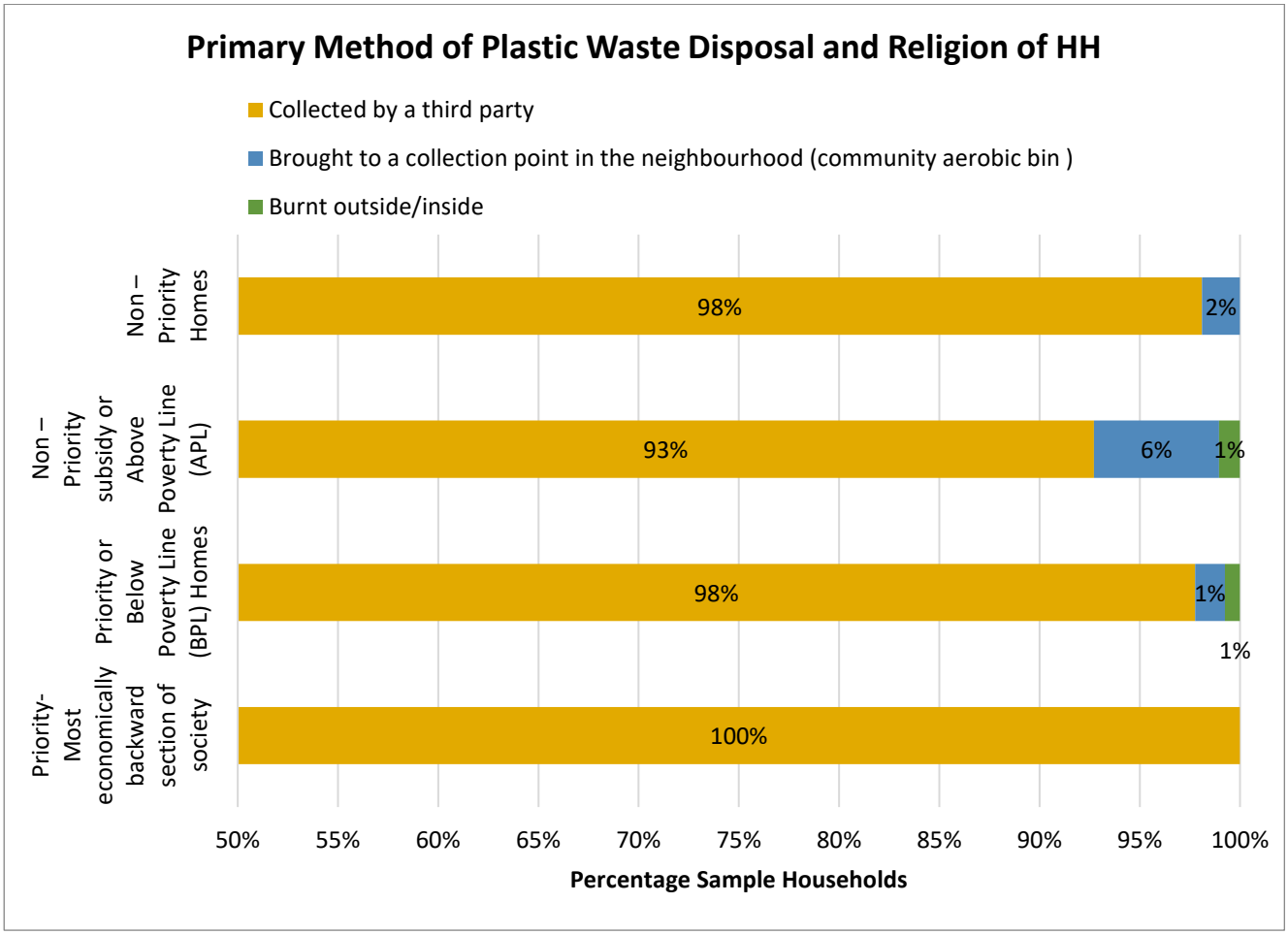

Figure 30: Primary Method of Plastic Waste Disposal for Different Class Households

Among different caste households, the door-to-door collection is higher for the ST and OBC households as compared to General households (figure 31). In turn, the usage of community aerobic bins is highest for the General households. None of the SC households reported to be using community aerobic bins. The unsanitary practice of burning waste is highest among SC households.

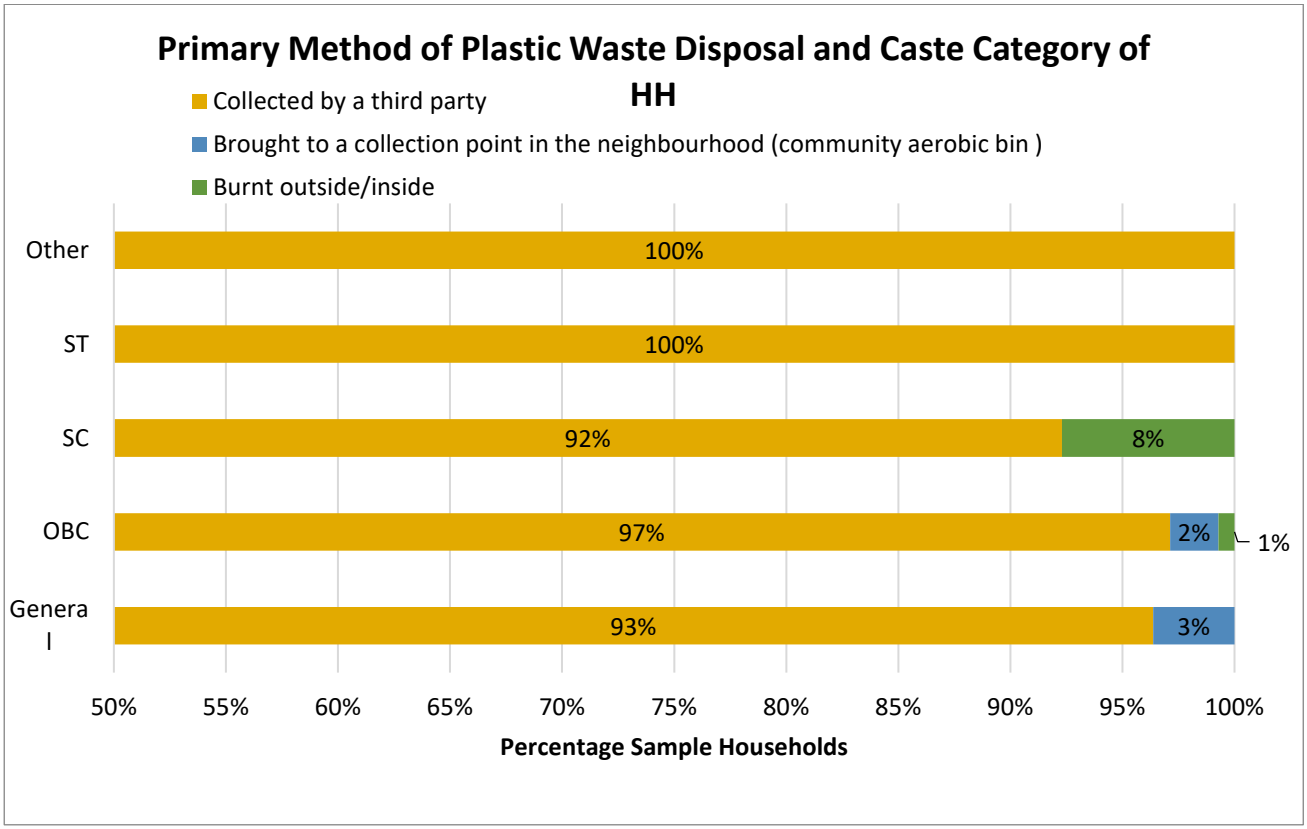

Figure 31: Primary Method of Plastic Waste Disposal for Different Caste Households

As shown in figure 32, among different religion category households, door-to-door collection is highest among Muslim households, followed by Hindu and Christian households. Community aerobic bin usage is comparable for Christian and Hindu households. The unsanitary practice of burning plastic waste is highest among Christian households.

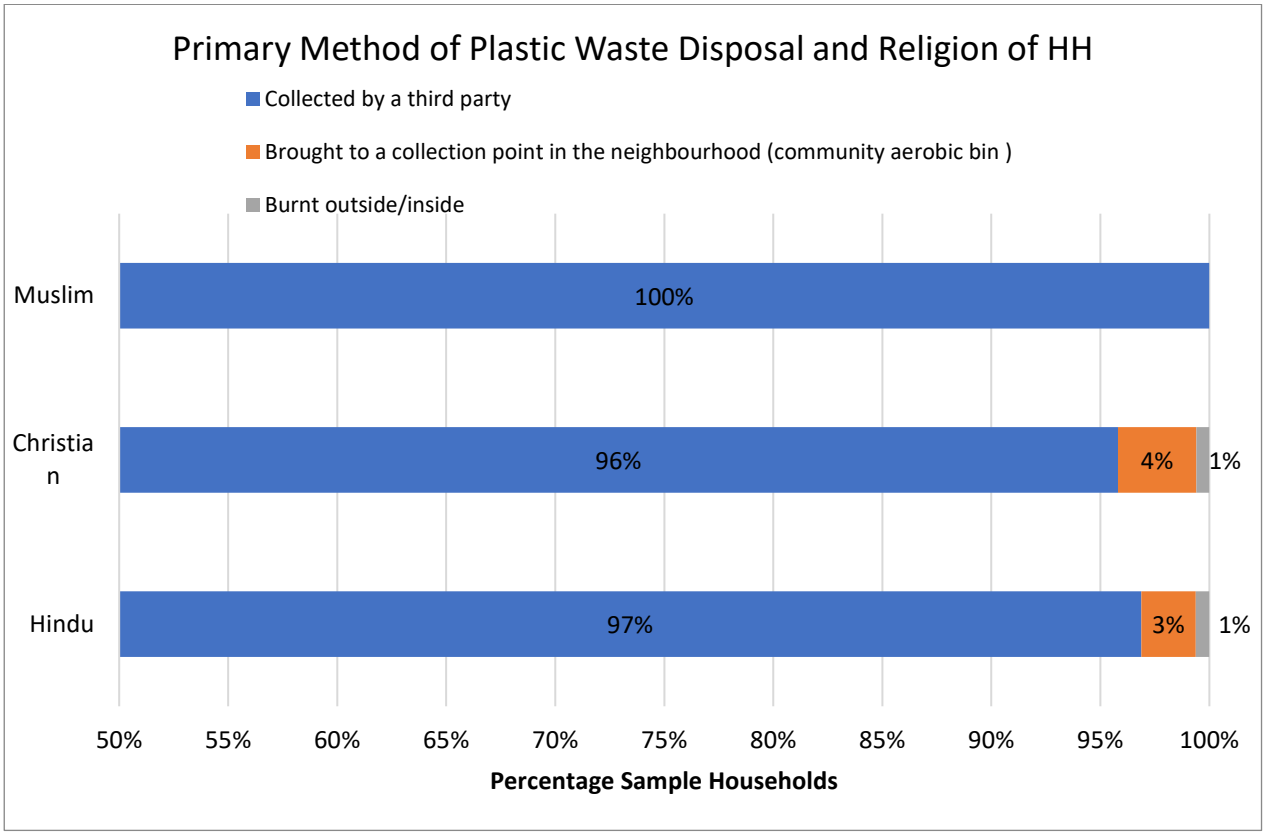

Figure 32: Primary Method of Plastic Waste Disposal for Different Religion Households

5.2.5 Polythene Waste Management

The primary method of disposing polythene waste (plastic buckets, and containers) is illustrated in figure 33. Out of 380 total respondents, 74 either didn't respond or were not practicing waste segregation. Data obtained is for 306 households, 75% of which give their waste to a third party, 4% deposit waste to community aerobic bins, and 20% did not know what happens to the polythene waste, which is worrisome. The higher percentage of 'don't know' responses could be either such households are engaged in malpractices or the respondents were not aware of the polythene disposal practices.

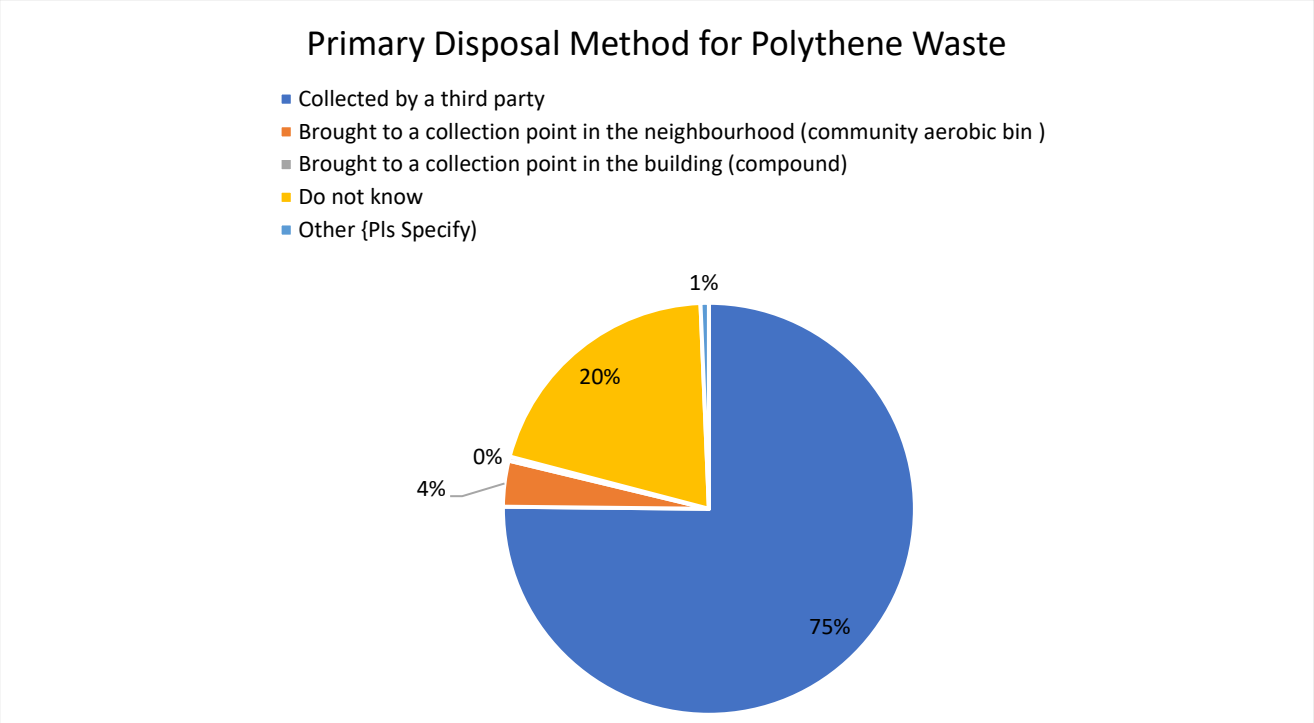

Figure 33: Primary Disposal Method for Polythene Waste

As shown in figure 34, 93.8% of the households that use third party services for waste disposal rely on HKS/municipal personnel i.e., 213 out of 230 households. About 5 % rely on scarp dealers whereas presence of informal collector is minimal[9]. Majority of the municipal worker are females – these could be HKS workers. For majority of the households that rely on HKS, the door-to-door collection happens once a month at 60 INR/household user fee. For some it is twice a month. Majority of the households using services of third party do not have any issues with either their services or the workers themselves. A few respondents complained about user fee being on the higher side especially on days when not enough plastic waste is generated and HKS members not showing up regularly.

[9] As oppose to scrap dealers, the informal waste collectors are individuals typically collecting and gathering scraps from door-to-door, or from landfills and waste dumps and then sell these to scrap dealers. They buy household scraps.

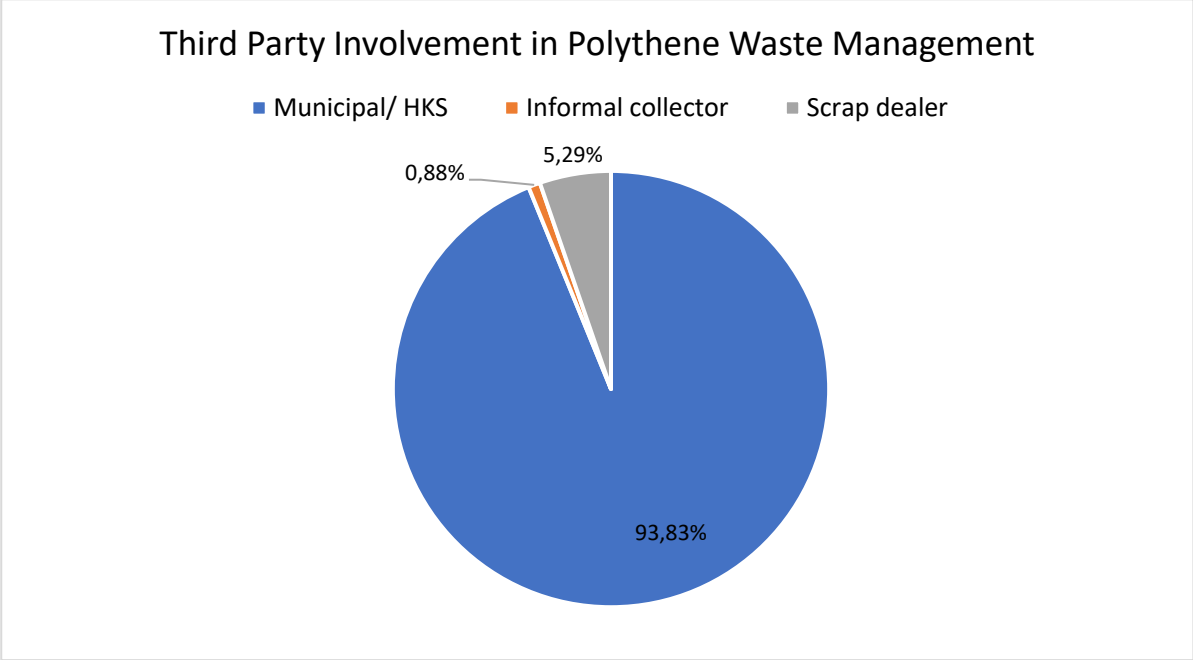

Figure 34: Third Party Involvement in Polythene Waste Management

Polythene Waste Disposal Practices Across Different Class, Caste, Religion

Reliance on third party for door-to-door collection is highest among priority homes i.e., most economically backward and BPL homes (figure 35). The community being usage is highest among APL, which might be related to the fact that door-to-door collection is lowest among these homes. The unsanitary practices like collecting waste within building compound is also highest among APL homes.

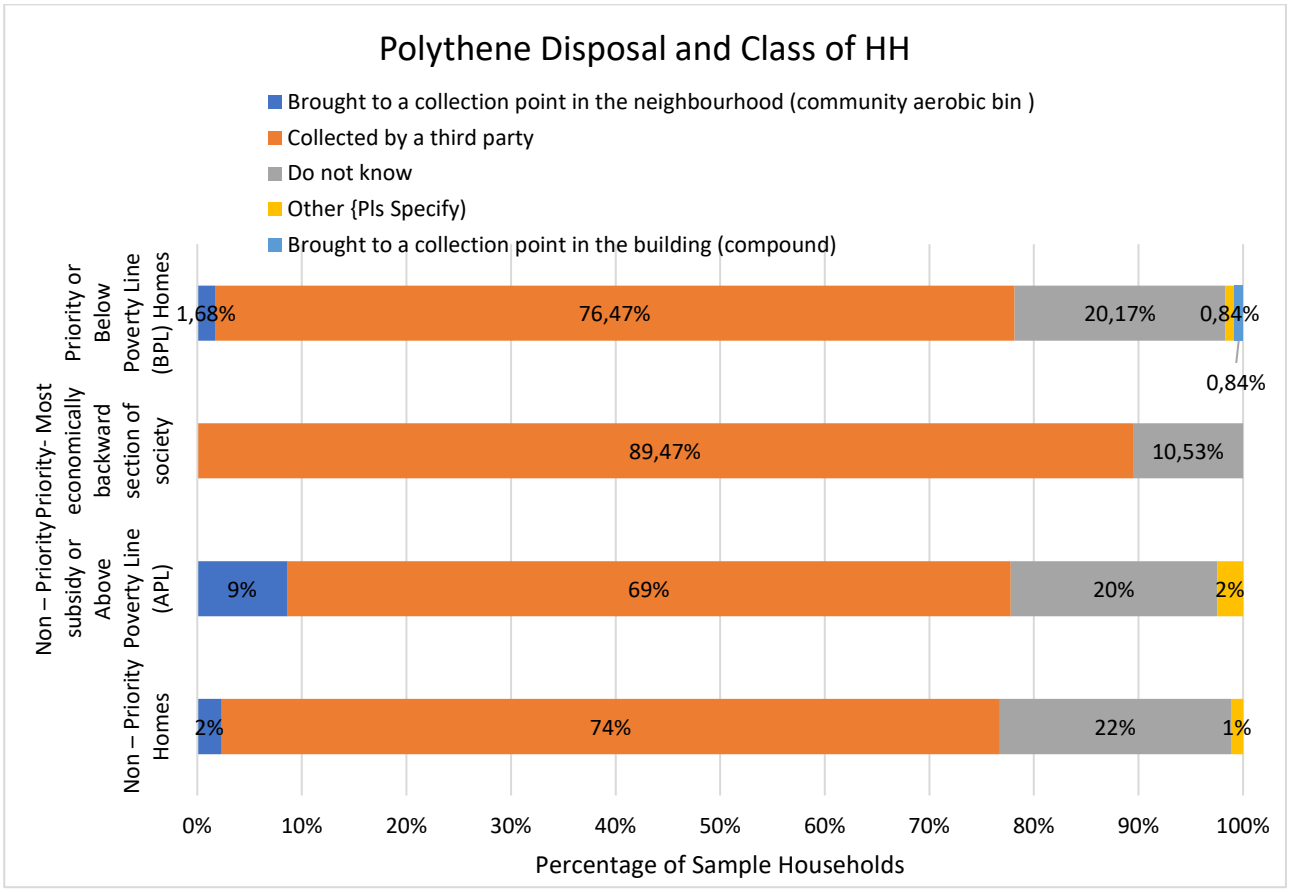

Figure 35: Primary Disposal Method for Polythene Waste for Different Class Category Homes

As shown in figure 36, collection by third party is highest for Christian households followed by Hindu households. The door-to-door collection was lowest for Muslim households. Majority of the Muslim households were unaware of the disposal methods. Among different category homes the usage of community aerobic bins for disposing polythene waste is same for Hindu and Christian category households. Considering majority of the sample Muslim households are relatively nearer to the community aerobic bin (A), the usage of community aerobic bins was not reported by any of the Muslim households -see figure 2 for geographical spread of sample households.

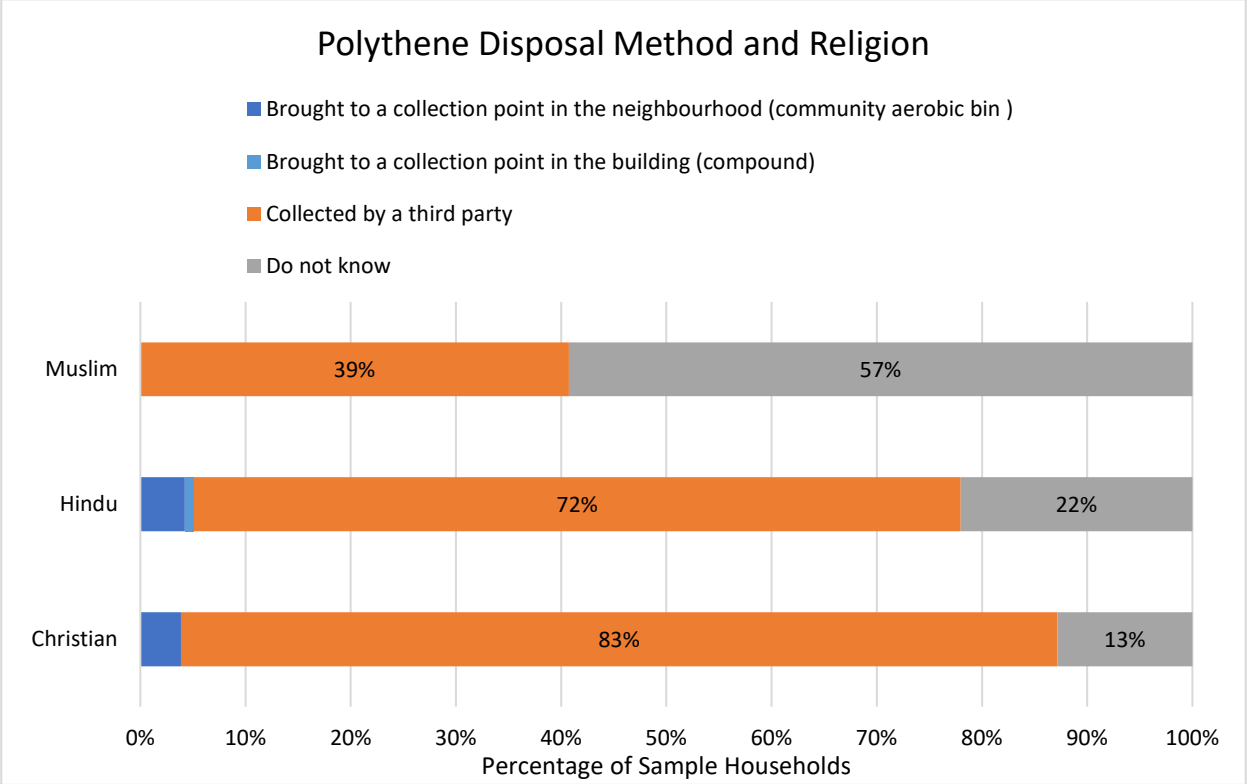

Figure 36: Primary Disposal Method for Polythene Waste for Different Religion Category Homes

As shown in figure 37, collection by third party is highest for the ST and General households followed by SC households. The usage of community aerobic bins for disposing polythene waste is highest for others category homes followed by General households. Malpractices like bringing (littering in) of polythene waste within the building compound is highest for SC category households. Considerable percentage of households in all four categories were not aware of the waste disposal practices of their homes – highest among OBC households.

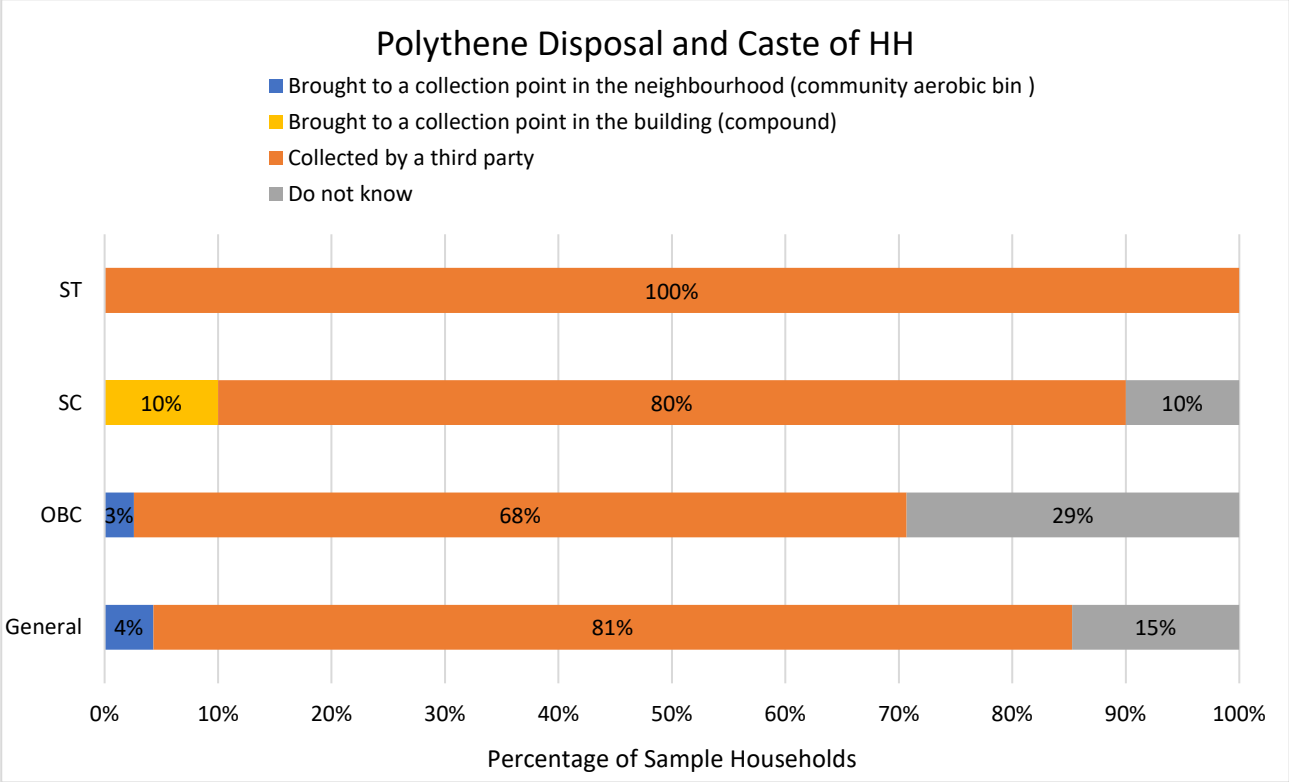

Figure 37: Primary Disposal Method for Polythene Waste for Different Caste Category Homes

5.2.6 Paper Waste Management

Out of 380 sample households, responses were received for 354 households i.e., 21 do not practice waste segregation and for 5 households no response was recorded.

There is no provision of door-to-door collection services for paper waste by the municipality, and hence no collection services fee. Perhaps this explains the high percentage of households (48%) relaying upon malpractices like burning and burying of paper waste (figure 38). The second largest method of paper waste disposal involves third party i.e., 41 % of households (146/354). Out of this 89% of the households depend upon scrap dealers, 5% on informal collectors, 1% on private companies and 3% give their waste to HKS or municipal personal. Only 7% rely upon the community aerobic units for disposal. Some of the community aerobic bins have facility to collect paper, plastic and glass waste. For the majority, the frequency of paper waste disposal to scrap dealer is once a month or once in two months. All scrap dealers, according to respondents, are male. None of the households reported any issues with this third-party arrangement and the scrap dealers. The disposal frequency through burning varies between daily to once in a week to once in a month – the majority however burns the waste daily.

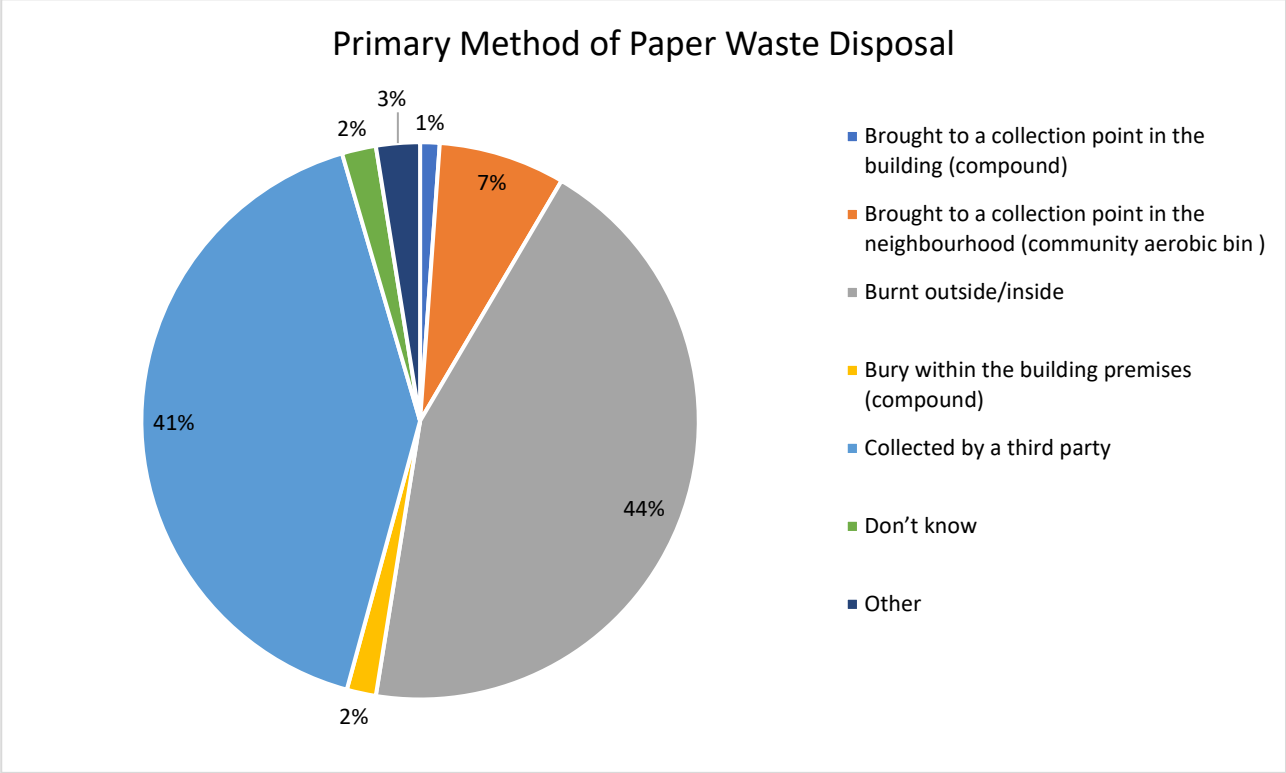

Figure 38: Primary Method of Paper Waste Disposal

Figure 39 shows box plot of the money received by selling paper waste to scrap dealer. Minimum selling price is 4 INR/kg paper waste and maximum is 24 INR/kg. Average selling price is seen to be 14.28 INR/kg and median is 20 INR/kg as well. Segregating and selling household waste like glass, metal, newspaper has been practiced in most of the Indian households for generations, with or without much economic incentive.

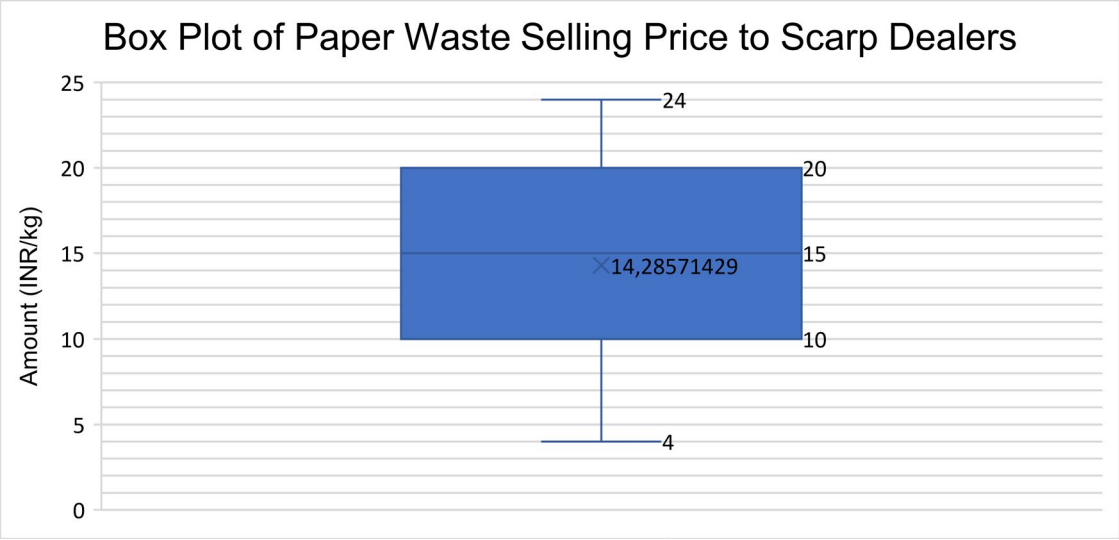

Figure 39: Box Plot of Paper Selling Price

Paper Waste Disposal Practices Across Different Class, Caste, Religion

As shown in figure 40, malpractice of burning and burying paper waste is highest among APL and BPL households. Reliance on third party for door-to-door collection is highest among non-priority homes followed by most economically backward homes. This might explain highest usage of community aerobic bins by APL homes.

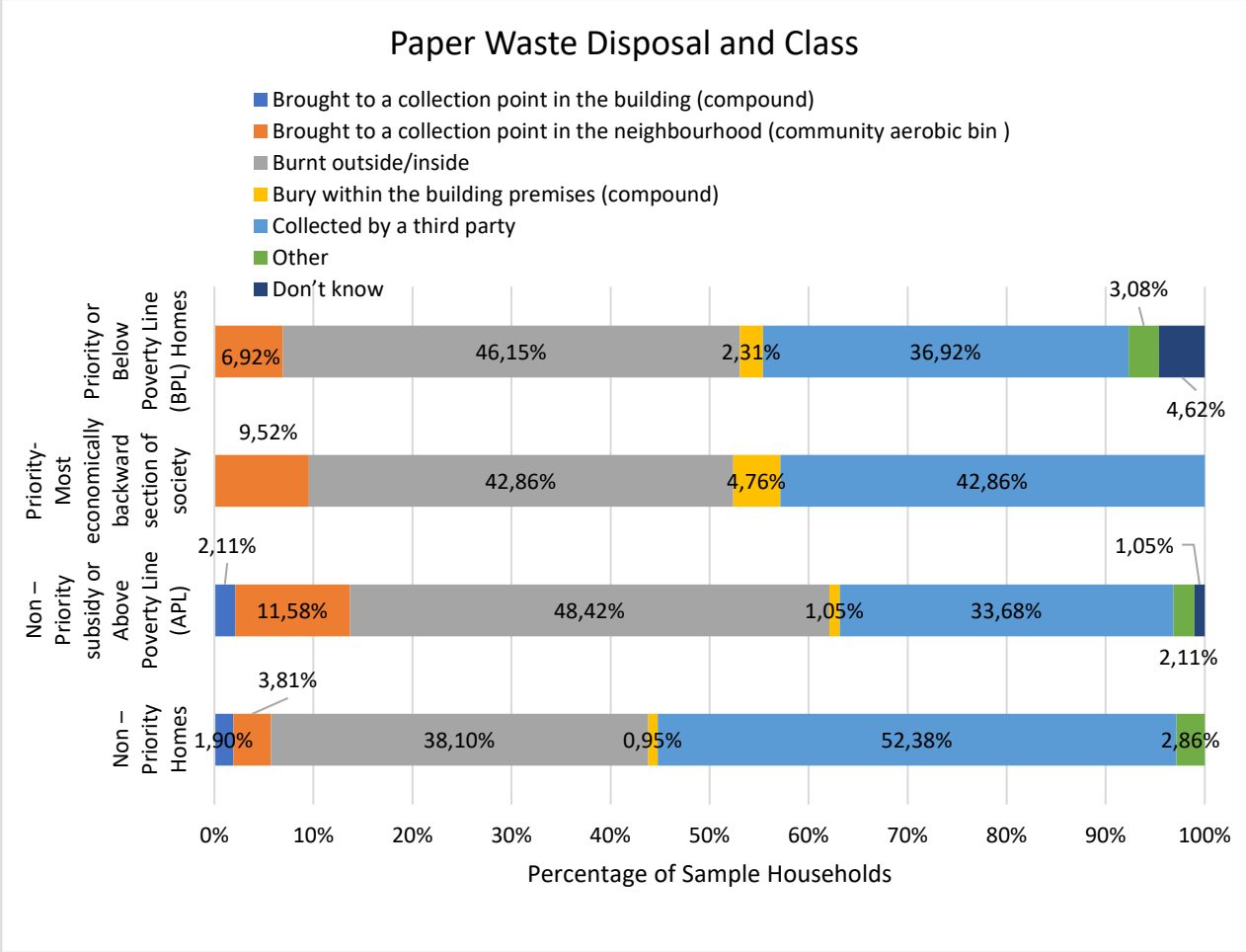

Figure 40: Primary Method of Paper Waste Disposal in Different Class Homes

Malpractices such as burning and burying of waste is highest for SC and General category homes. Usage of community aerobic bin is highest among OBC households. Usage of third party as primary method of paper waste disposal is highest among OBC households and lowest among General category households (figure 41).

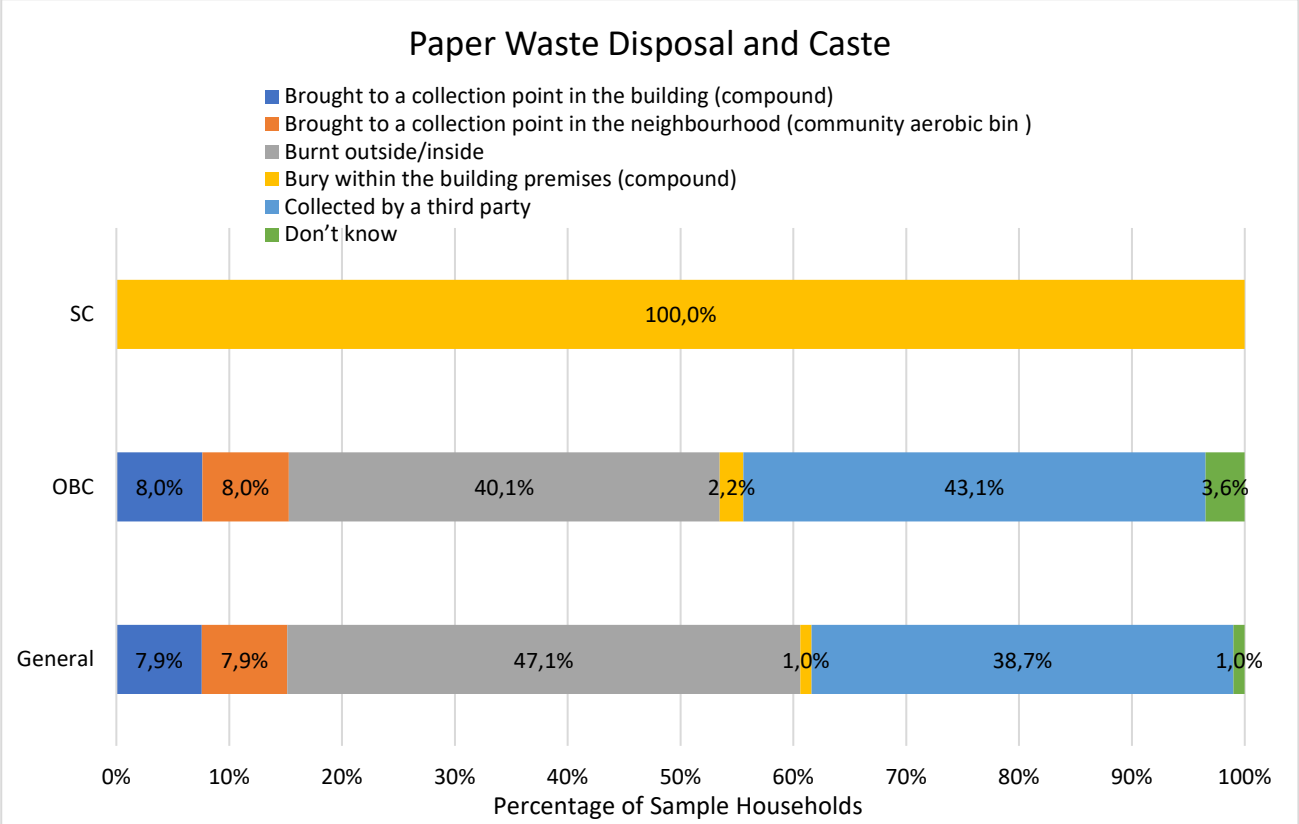

Figure 41: Primary Method of Paper Waste Disposal Among Different Caste Households

Malpractices such as burning and burying of waste is highest for Muslim households followed by Christian households. Usage of community aerobic bin is highest among Hindu and Christian households. Usage of third party as primary method of paper waste disposal is highest among Hindu households and lowest among Muslim category households (figure 42).

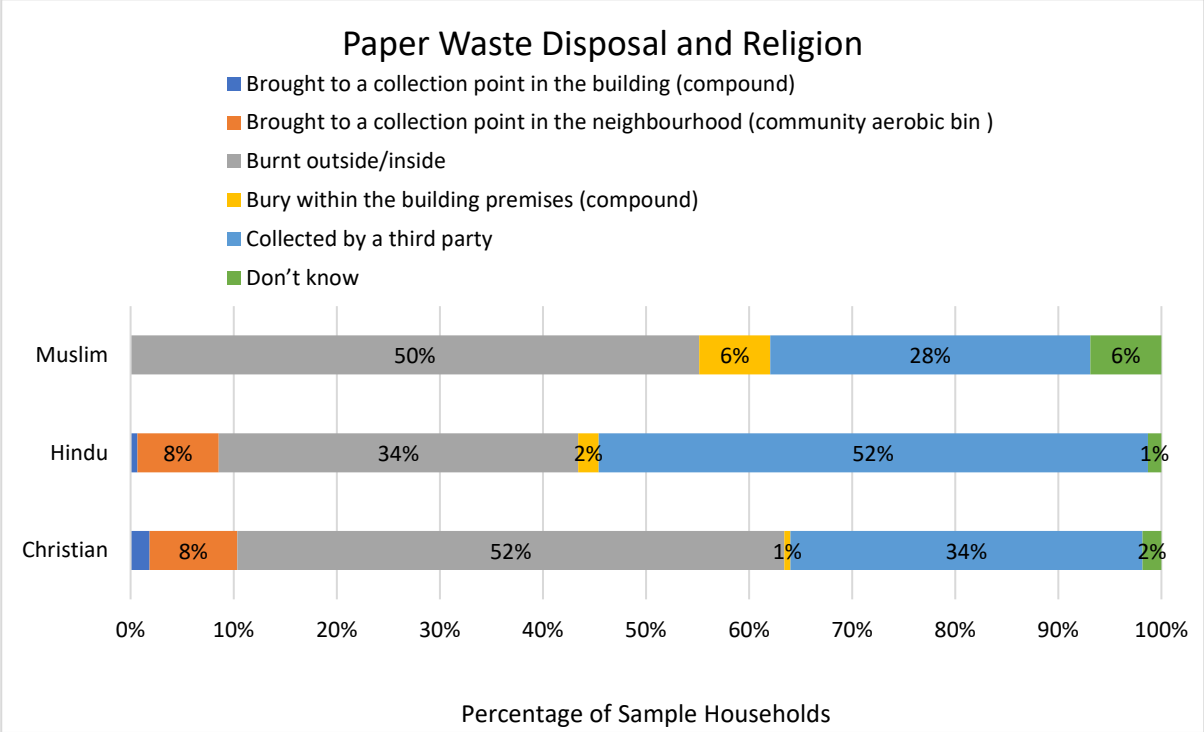

Figure 42: Primary Method of Paper Waste Disposal in Different Religion Households

5.2.7 Cardboard Waste Management

Out of 380 sample households, responses were recorded for 318 households i.e., 21 do not practice waste segregation and 41 households did not respond. About 51% of the households (162/318) dispose of their cardboard waste through third parties (figure 43). 90% of these households rely upon scrap dealers for disposal whereas 4% rely upon HKS and informal collectors each. Second most common method after third party collection is disposal to community aerobic bins - 20.4% of households (65/318). Malpractices such as burning and burying is reported to be practiced in 14% of the households (44/318).

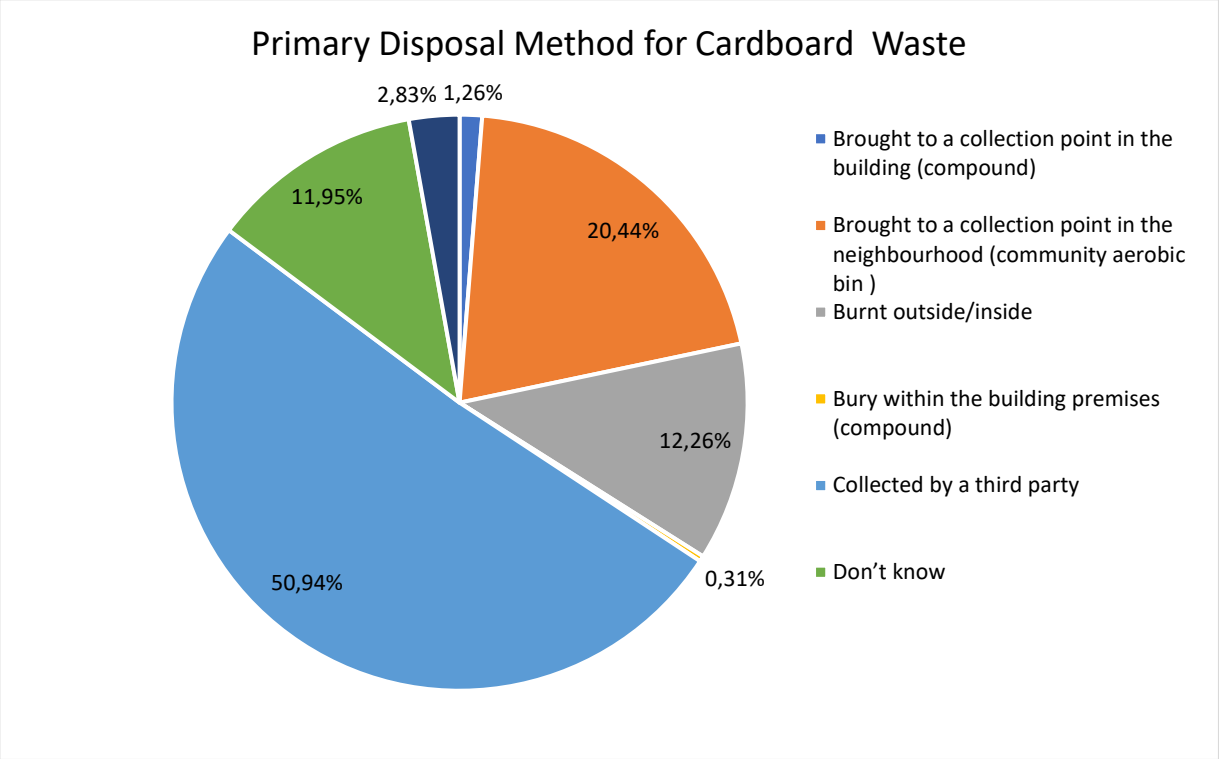

Figure 43: Primary Method of Cardboard Waste Disposal

The disposal frequency varies between once a month to once in two months. As per the respondents, all scrap dealers are males. None of the households using services of third party (scrap dealers and HKS) have any issues with either their services or the workers themselves.

Figure 44 shows that average amount received is 15.8 INR/kg. However, 50% of the values (Q2) fall within the 20 INR/kg mark. Minimum selling price is 4 INR/kg waste and maximum is 50 INR/kg.

Figure 44: Selling Price of Cardboard Box

Cardboard Waste Disposal Practices Across Different Class, Caste, Religion

As shown in figure 45, reliance on third party for door-to-door collection is highest among non-priority homes followed by BPL homes, and least for APL homes. This might explain the prevalence of malpractices of burning and burying cardboard waste in APL households then others. This might also explain heavy reliance of APL homes on the community aerobic bins.

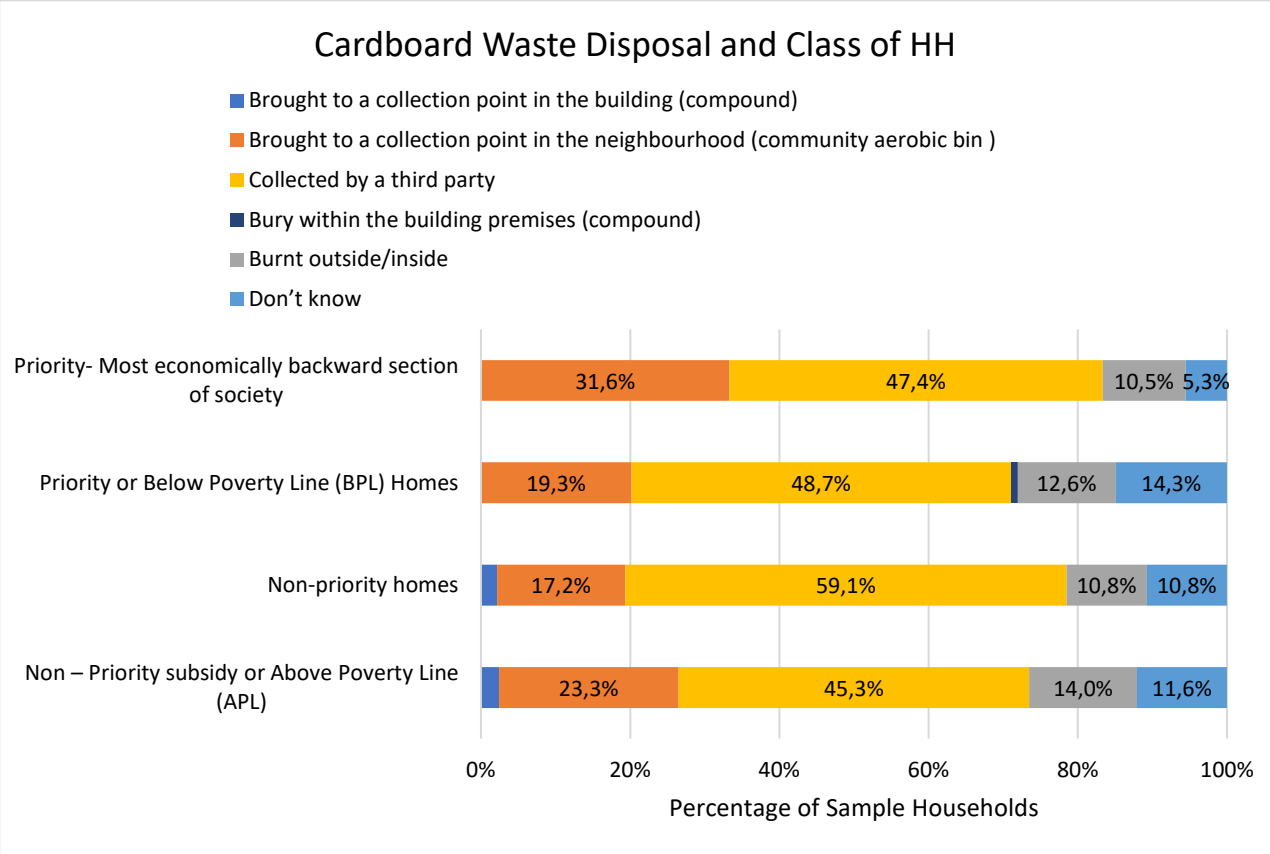

Figure 45: Primary Disposal Method for Cardboard in Different Class Homes

As shown in figure 46, reliance on third party for door-to-door collection is comparable for Hindu and Christian. It is lowest for Muslim households. This might explain the prevalence of malpractices of burning and burying carboard waste in Muslim households i.e., 20% of the Muslim households. The community bin usage is highest among Christian households followed by Hindu households and nothing among Muslim households. This could be due to lower education levels in Muslim households (section 5.1.6) or distance from the two of three closest community aerobic bins (figure7).

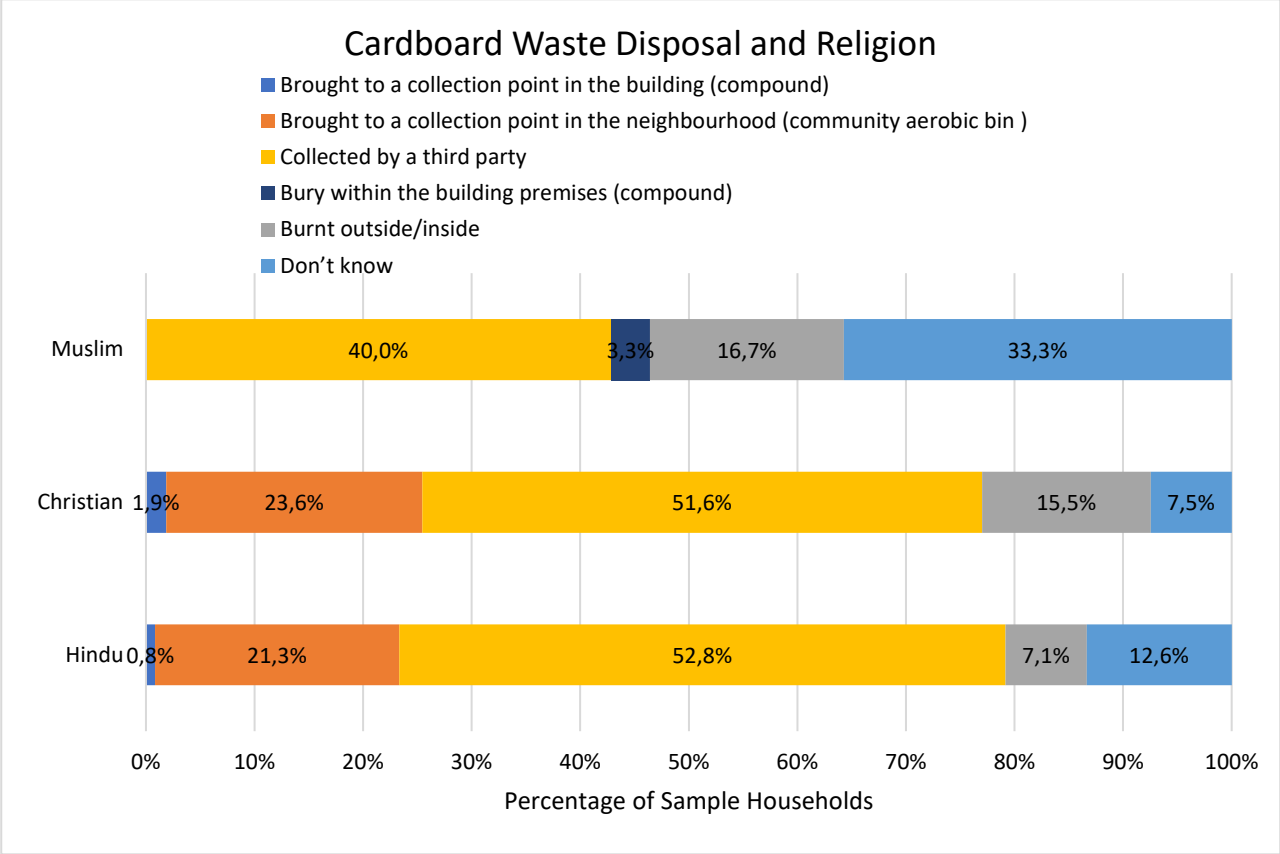

Figure 46: Primary Disposal Method for Cardboard Waste in Different Religion Homes

As shown in figure 47, reliance on third party for door-to-door collection is highest for SC households followed by Hindu households. It is lowest for OBC households. This might explain heavy reliance of OBC households on community bins i.e., 22% of the OBC households. Also, relatively a greater number of OBC households are clustered closer to the community aerobic bin A. The malpractice of burning and burying carboard waste is highest among other and General category homes.

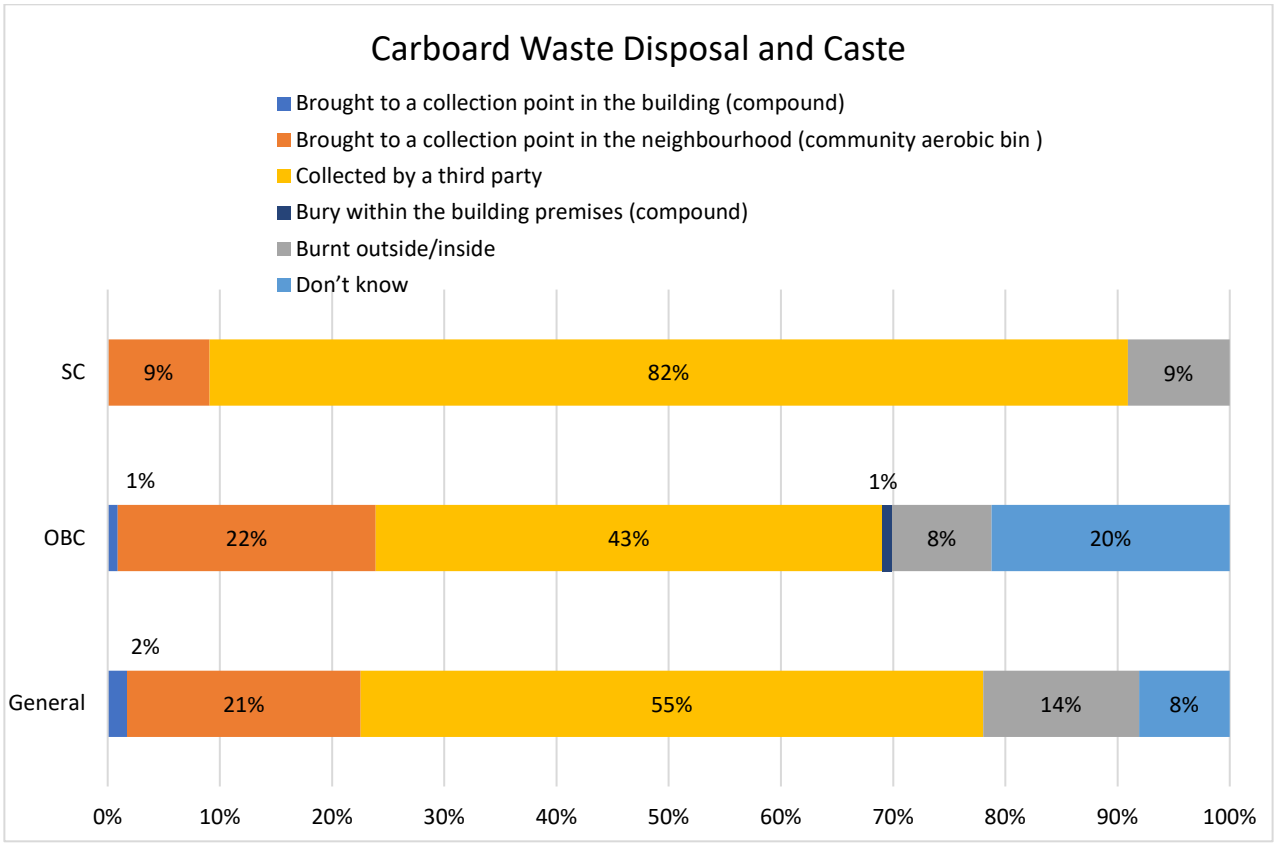

Figure 47: Primary Method of Medical Waste Disposal in Different Caste Category Homes

5.2.8 Medical Waste Management

Out of 380 sample households, responses were obtained for 311 households i.e., 21 do not practice waste segregation and remaining households did not/refused to respond.

As shown in figure 48, majority of the households i.e., 44.3% (110/311) reported to be depositing their medical waste to community aerobic bin units. The second most common disposal method is third party collection with 65 out of 311 households practicing this method. Out of this, 71% households (46/65) rely upon scarp dealers, 26% on HKS/municipality and 2% on informal collectors. None of the households using services of scrap dealers have any issues with either their services or the workers themselves. However, few reported to have issues with the HKS not coming regularly to collect the waste. Malpractices such as burning and burying is reported to be practiced in 22 % of the households (68/311). 20% of the respondents were not aware of the disposal methods practiced at their home, which is worrisome. There are no door-to-door collection services provision by the municipality, and hence no collection services fee.

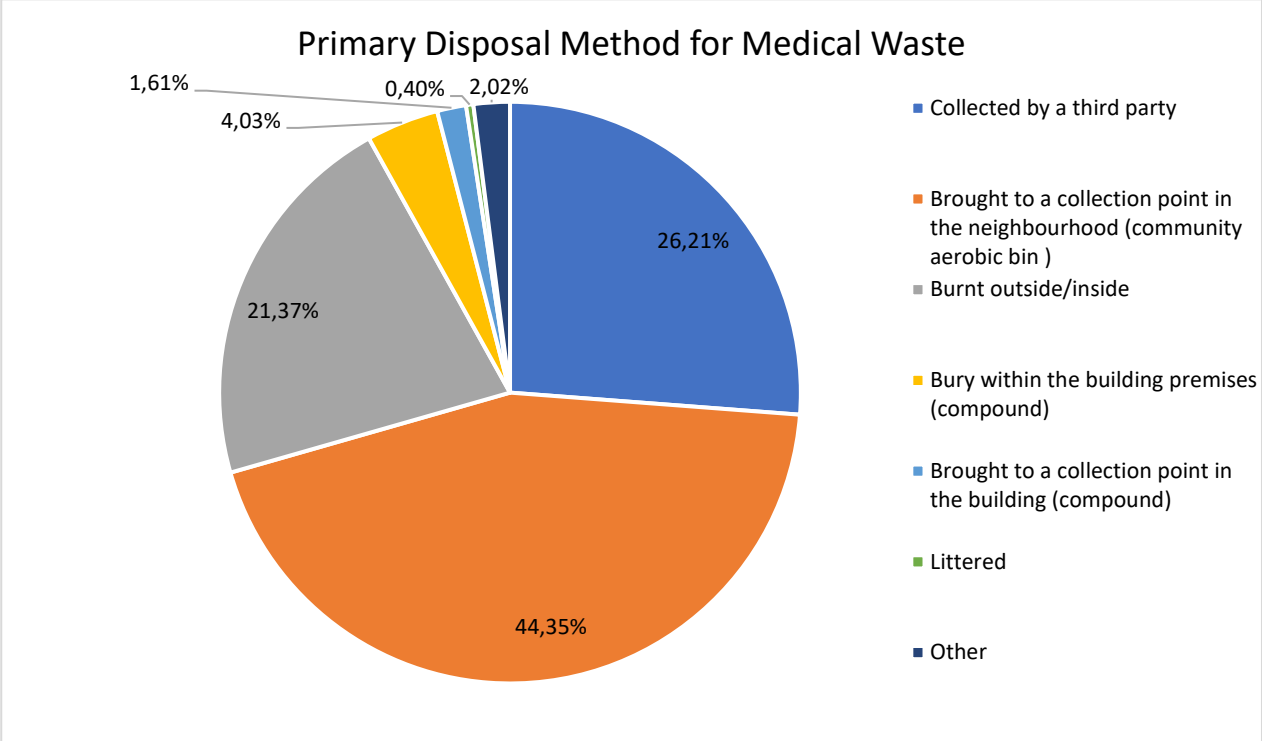

Figure 48: Primary Method of Medical Waste Disposal

The frequency of waste disposal to scrap dealer is primarily once a month whereas 20% of households have once in two months disposal frequency. The average amount received is 20 INR/kg from scarp dealers. Scrap dealers are males.

Medical Waste Disposal Practices by Different Class, Caste, Religion

As shown in figure 49, malpractice of burning and burying medical waste is highest among non-priority and BPL households. For these category households the reliance on third party for door-to-door collection is highest. The third-party collection is lowest among most economically backward households which might also explain highest usage of community aerobic bins by these.

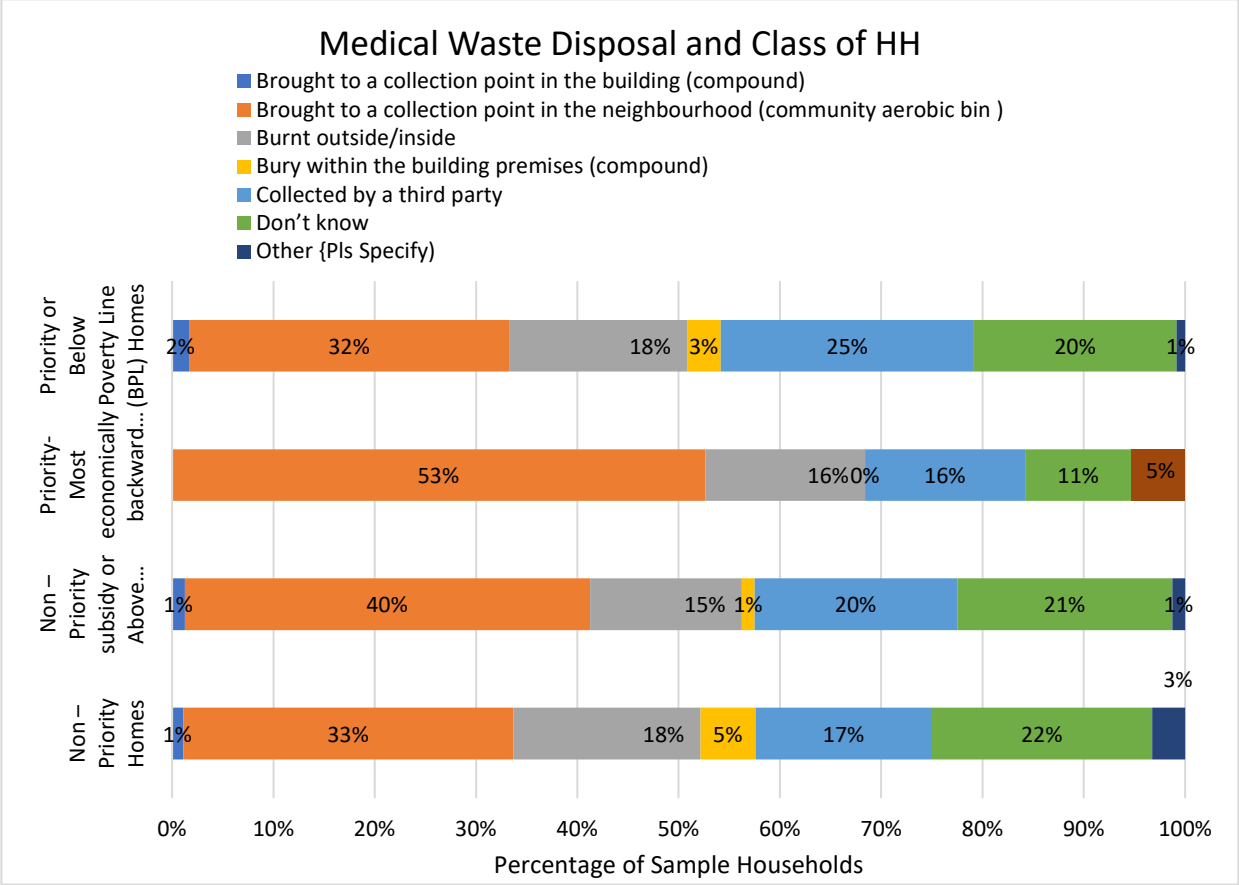

Figure 49: Primary Method of Medical Waste Disposal in Different Class Category Homes

The usage of community aerobic bins and third party is lowest for SC households (figure 50). No doubt that the malpractice of waste burning/burying is noticeable for SC category households. Usage of third party as primary method of medical waste disposal is highest among others category households followed by general and OBC.

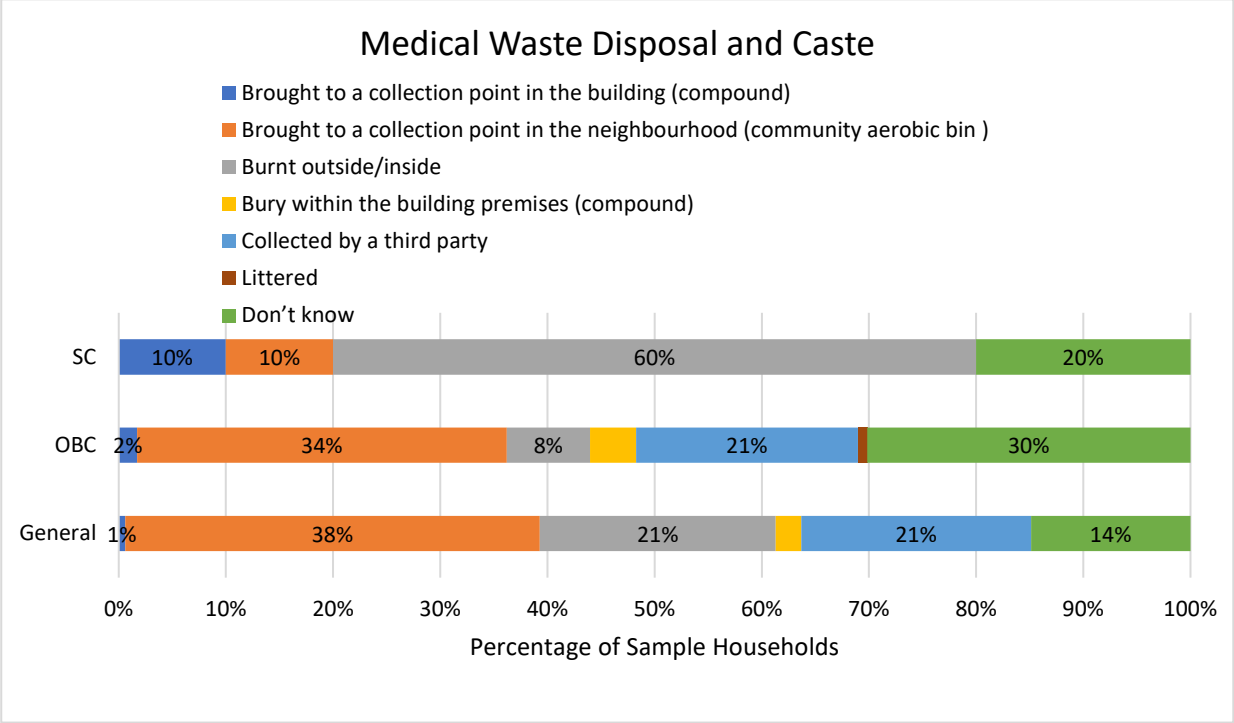

Figure 50: Primary Method of Medical Waste Disposal in Different Caste Households

As shown in figure 51, the usage of community aerobic bins is lowest for Muslim households and highest for Christian households. Accordingly, the reliance on third party is lowest for Christian households. lowest for SC households. The malpractice of waste burning/burying is reported to be highest for Muslim households followed by Christian households.

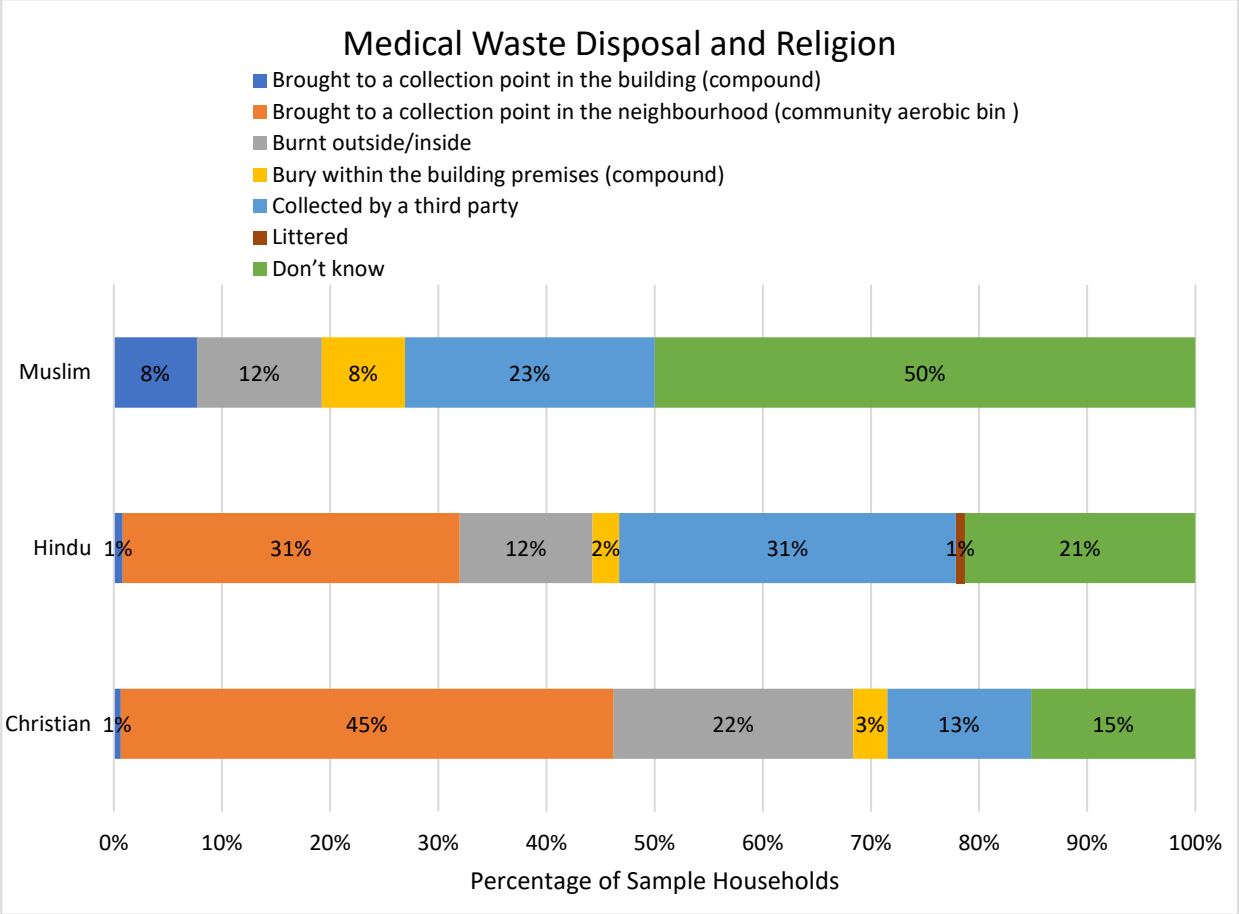

Figure 51: Primary Method of Medical Waste Disposal in Different Religion Homes

5.2.9 Glass Waste Management

Out of 380 sample households, responses were recorded for 317 households i.e., 21 do not practice waste segregation and remaining households did not respond. There are no door-to-door collection services provision by the municipality. 59% of the households (186/317) reported to be engaged in malpractices like burying (throwing or disposal to the land) and littering of glass waste (Figure 52). The findings are contrary to the common understanding that glass waste gets sold to the scrap dealers or informal waste collectors. The second most common method is disposal to collection units at the community aerobic bins – 19% of the households. Disposal through third parties is happening in merely 4% of the households. Most of these households rely upon scrap dealers for once-a-month disposal and sometimes once in two months disposal. For this, households get average 20 INR/kg. None of the households reported to have any issues with the services or management of glass waste.

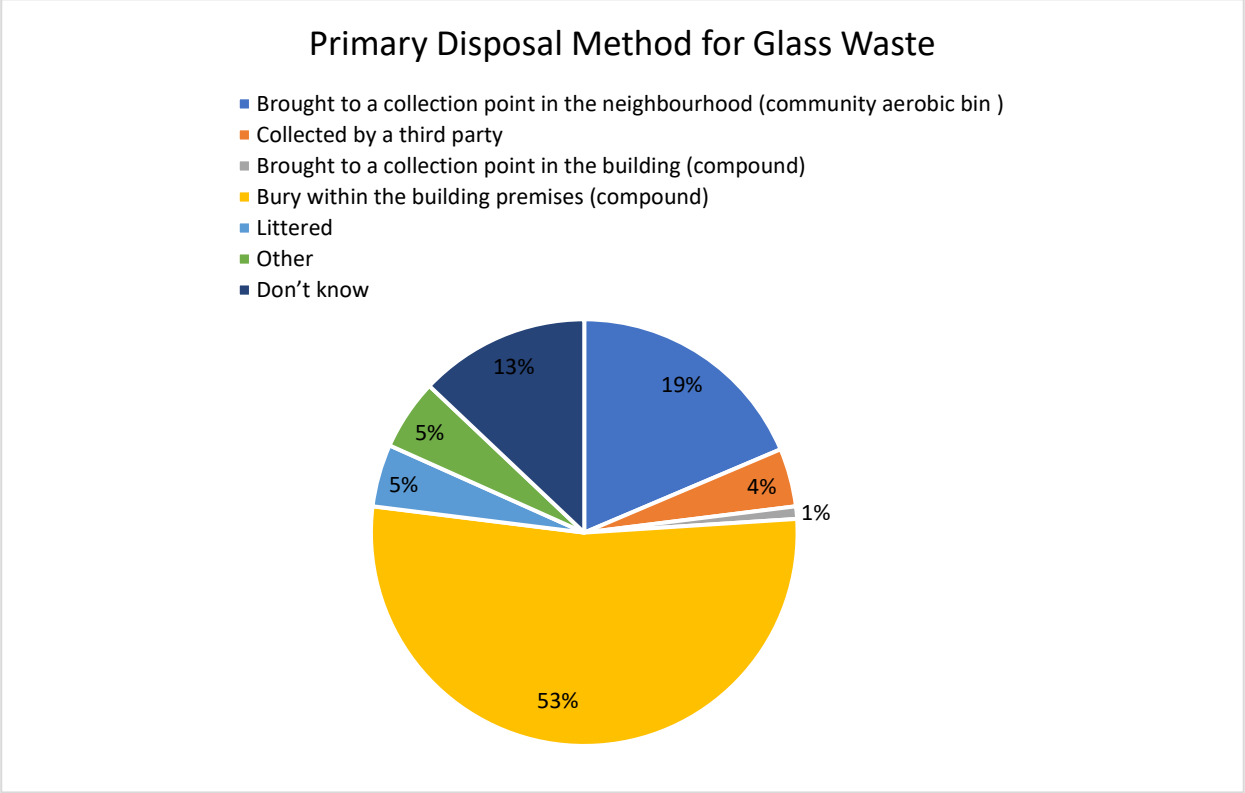

Figure 52: Primary Disposal Method for Glass Waste

Glass Waste Disposal Practices Across Different Class, Caste, Religion

As shown in figure 53, malpractices like burying of waste and littering of glass waste is reported to be highest for non-priority homes followed by most economically weaker section. For these categories, the reliance on community bins is highest. Least number of most economically weaker homes rely upon third party collection. The third-party collection is highest for non-priority homes.

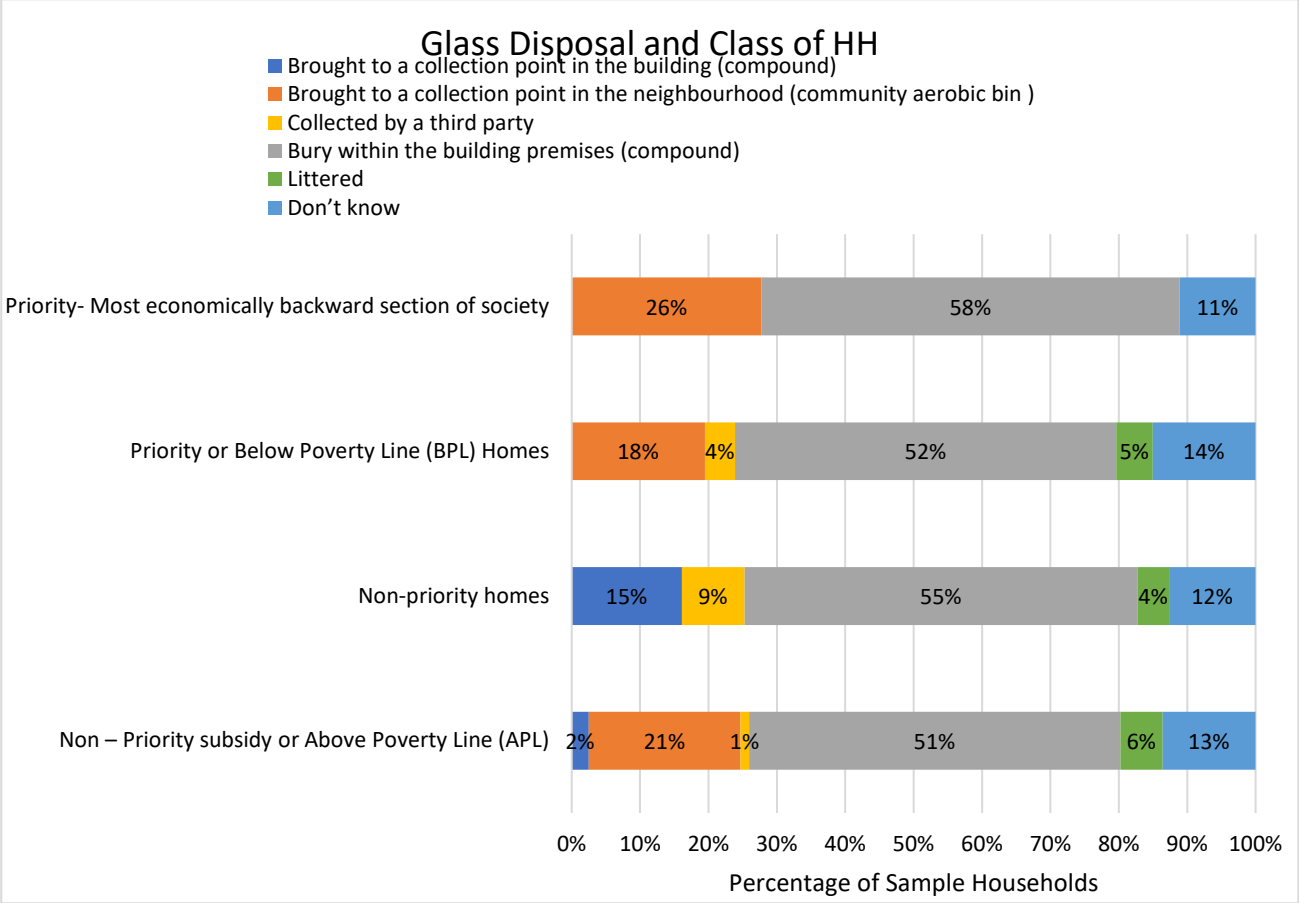

Figure 53: Primary Method of Glass Waste Disposal in Different Class Category Homes

As shown in figure 54, the usage of community aerobic bins and third party is lowest for SC households. No doubt that the malpractice of waste burning/burying is reported to be highest for SC category households. Usage of third party as primary method of glass waste disposal is highest among others category households. Usage of community bins is highest among OBC and general category households.

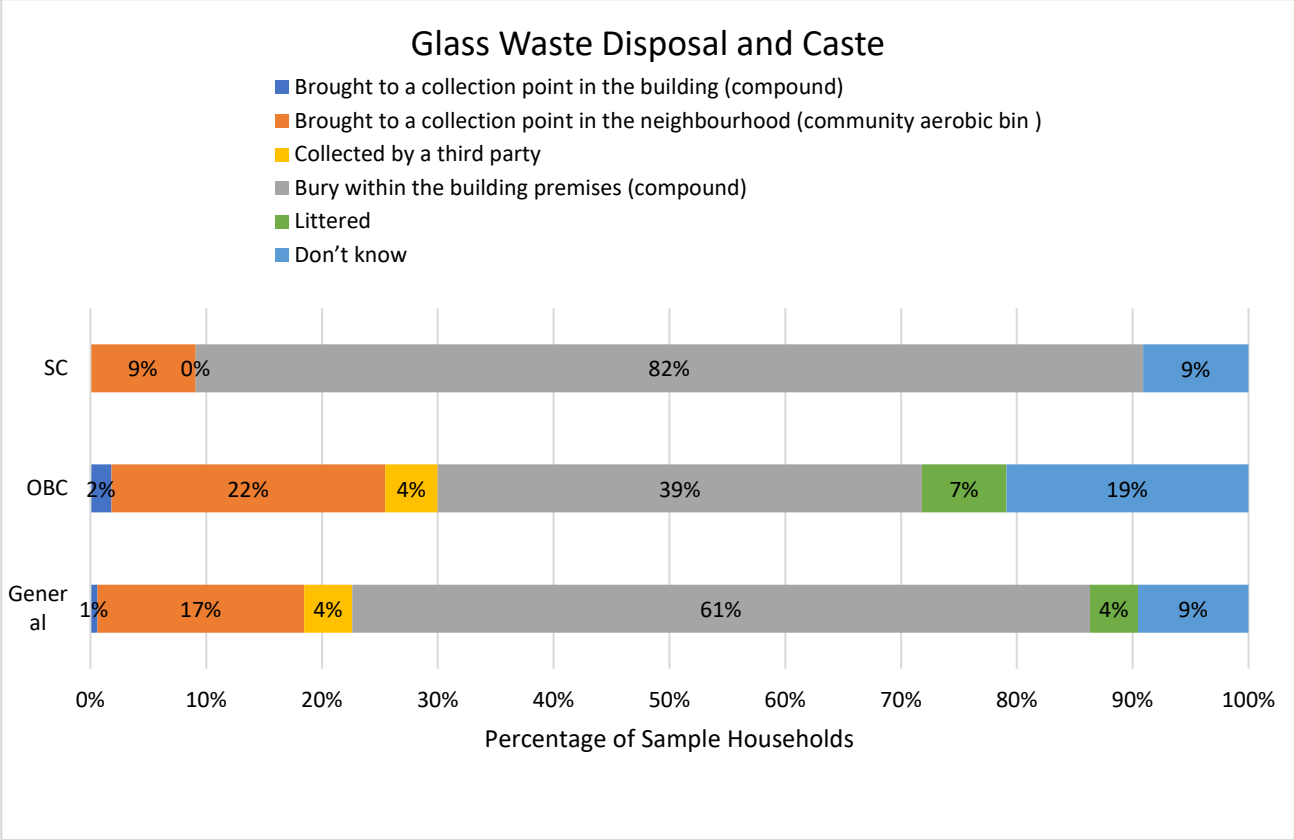

Figure 54: Primary Disposal Method for Glass Waste in Different Caste Homes

As shown in figure 55, the usage of community aerobic bins is lowest for Muslim households and comparable for Hindu and Christian households. The malpractice of waste burning/burying is reported to be highest for Christian category households. Usage of third party as primary method of glass waste disposal is highest among Hindu category households.

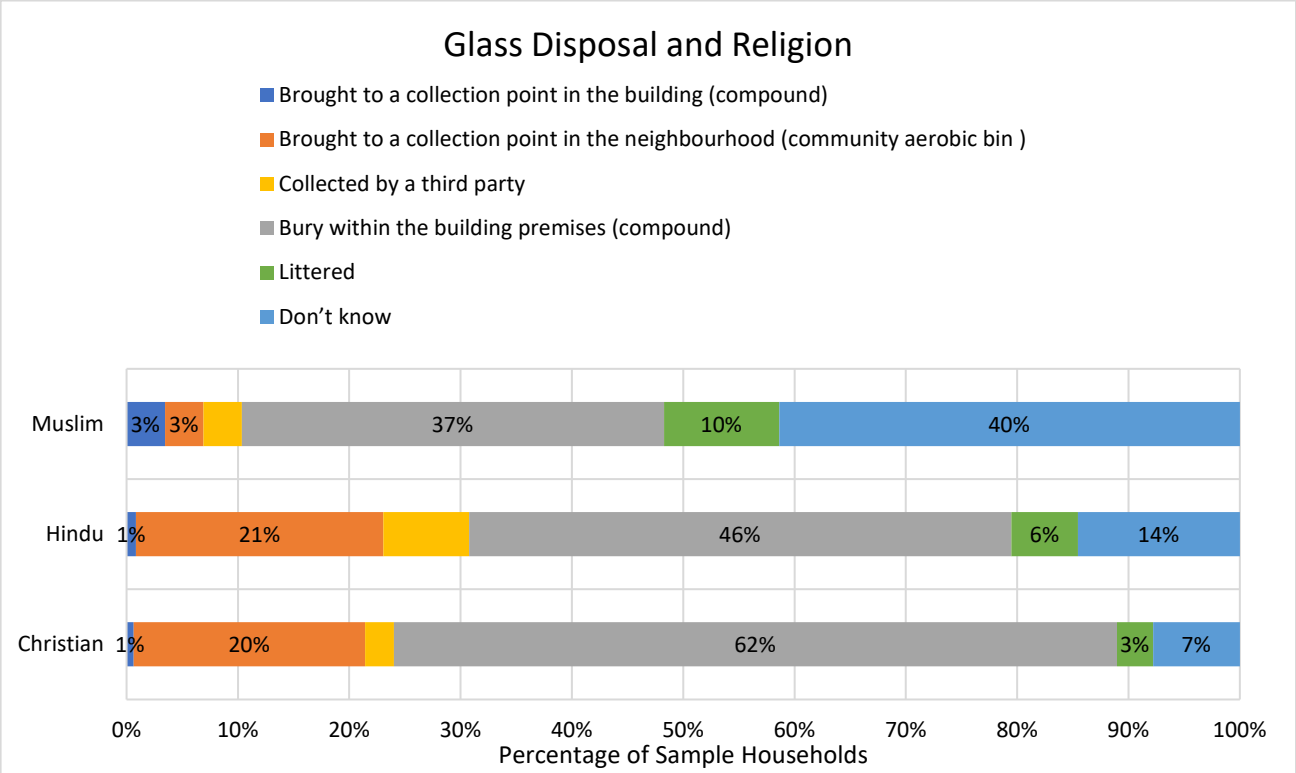

Figure 55: Primary Method of Glass Waste Disposal in Different Religion Households

5.2.10 Metal Waste Management

Out of 380 sample households, responses were recorded for 300 households i.e., 21 do not practice waste segregation and remaining households did not respond.

There are no door-to-door collection services by the municipality. The most common method of disposal is reported to be community aerobic bins i.e., 116 out of 300 households (figure 57). Disposal through third party comes second with 112 households out of 300 resorting to this method. Of this, 101 households rely upon scrap dealers, and 4 on HKS/municipality and 5 on informal collectors. Significant percentage of respondents (19%) were not aware of the disposal methods practiced at their homes. Malpractices like burning (burning of all waste together) and burying of metal waste is reported to be followed by few households.

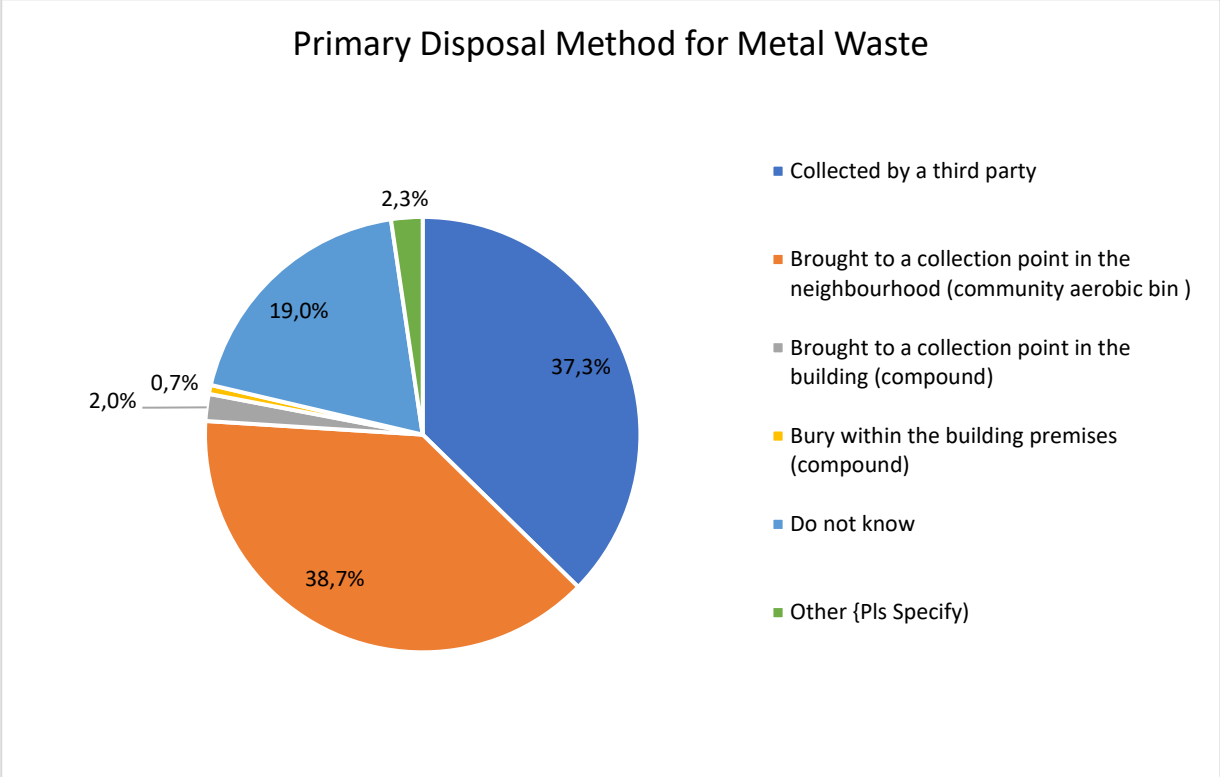

Figure 56: Primary Disposal Method for Metal Waste

The disposal frequency varies between once a month to once in two months. Scrap dealers, as per respondents, are males. None of the households using services of third party have any issues with either their services or the workers themselves.

Figure 57 shows that average amount received by selling metal waste to scrap dealer is 28 INR/kg. However, 50% of the values (Q2) fall within the 20 INR/kg mark. Minimum selling price is 10 INR/kg waste and maximum is 150 INR/kg. The standard deviation is high in this case i.e., average money earned by selling waste varies by 24.3 INR in both directions, which may be because different types of metal fetch different prices.

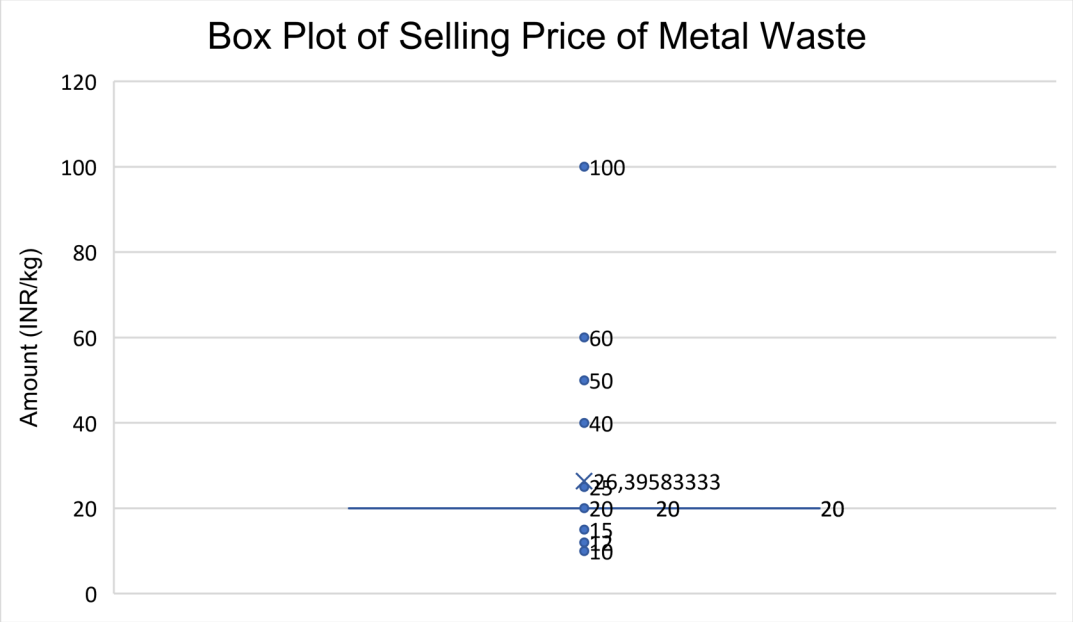

Figure 57: Box plot of Selling Price of Metal Waste

Metal Waste Disposal Practices Across Different Class, Caste, Religion

As shown in figure 58, among different classes, the usage of community aerobic bins is highest for most-economical backward households, and comparable for APL and non-priority homes. Among BPL homes the reliance on community aerobic bins is lowest. However, disposal through third party is highest among BPL families. Malpractices like burying of metal waste within the building compound is highest for most economically backward class and lowest for non-priority homes.

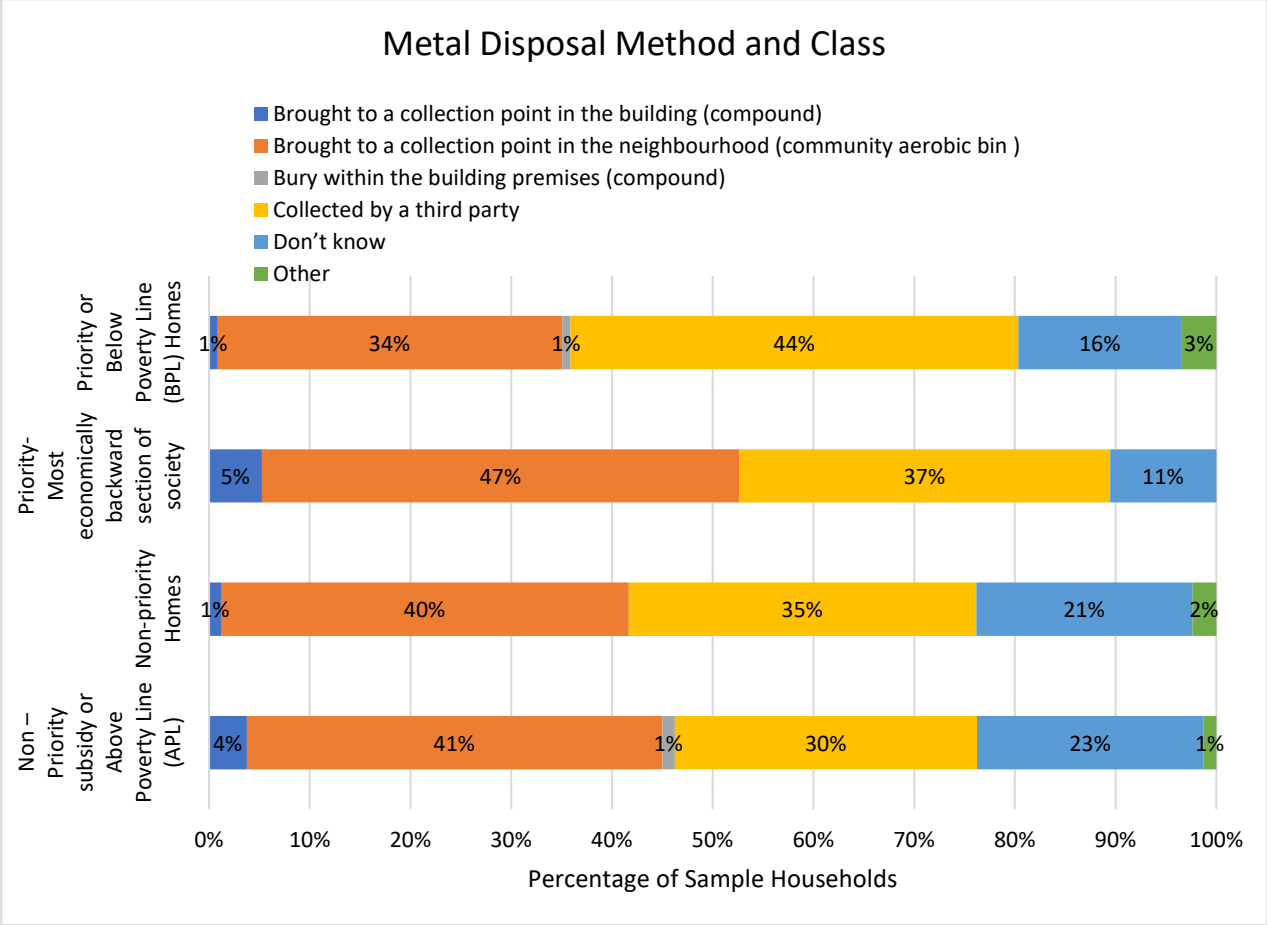

Figure 58: Primary Disposal Method of Metal Waste in Different Class Category Homes

Among different classes, the usage of community aerobic bins is highest and comparable for General and SC category homes, and lowest for OBC category homes (figure 59). However, disposal through third party is highest for other and SC families. Malpractices like burying of metal waste within the building compound is 3% for OBC households. No such reports from SC households. Higher number of OBC households followed by General households were not aware of the disposal practices.

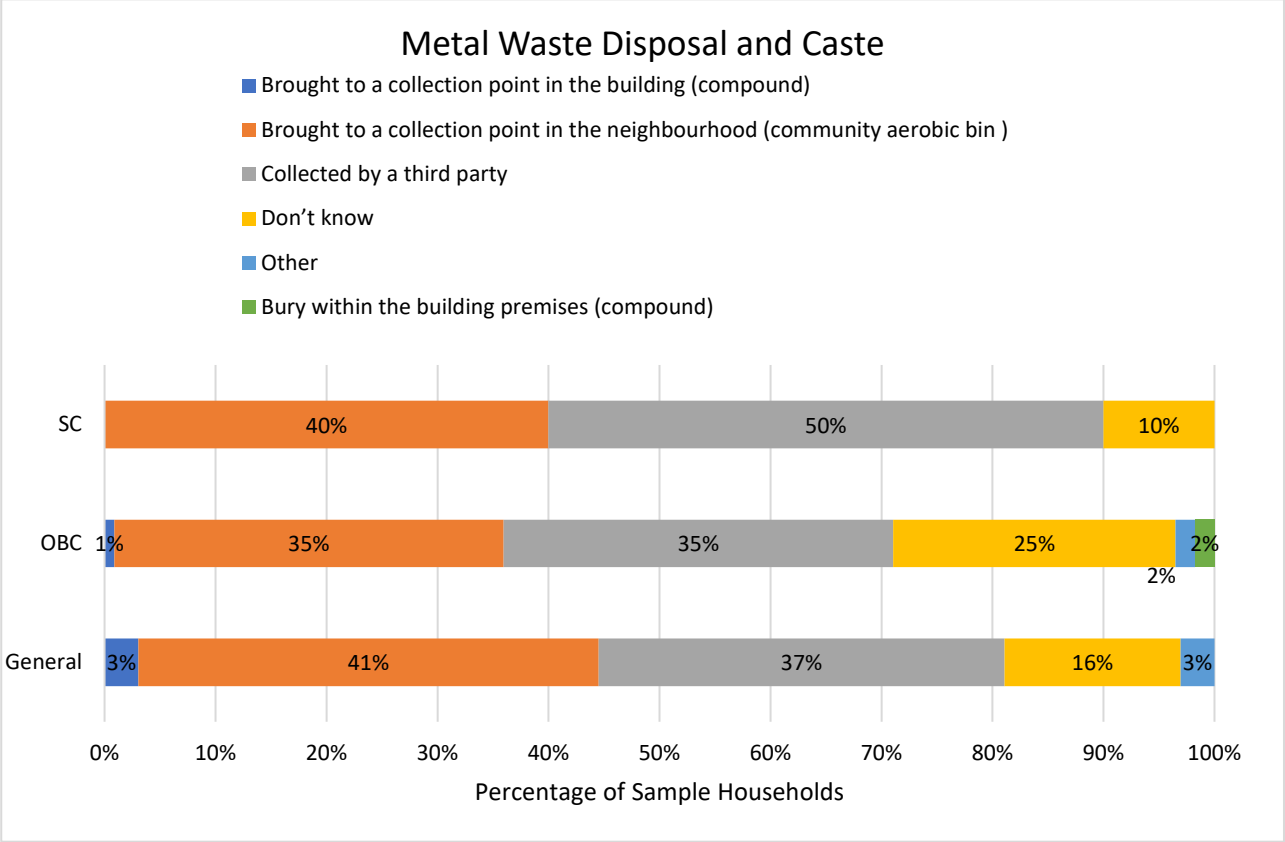

Figure 59: Primary Disposal Method of Metal Waste in Different Caste Category Homes

Among different category homes the usage of community aerobic bins is highest for Christian category households and negligible among Muslim category homes (figure 60). However, collection by third party is highest for Muslim households followed by Hindu households. Malpractices like burying of metal waste within the building compound are equally practiced in Hindu and Christian households. No such reports from Muslim households. However, higher percentage of Muslims respondents were not aware of the disposal practices.

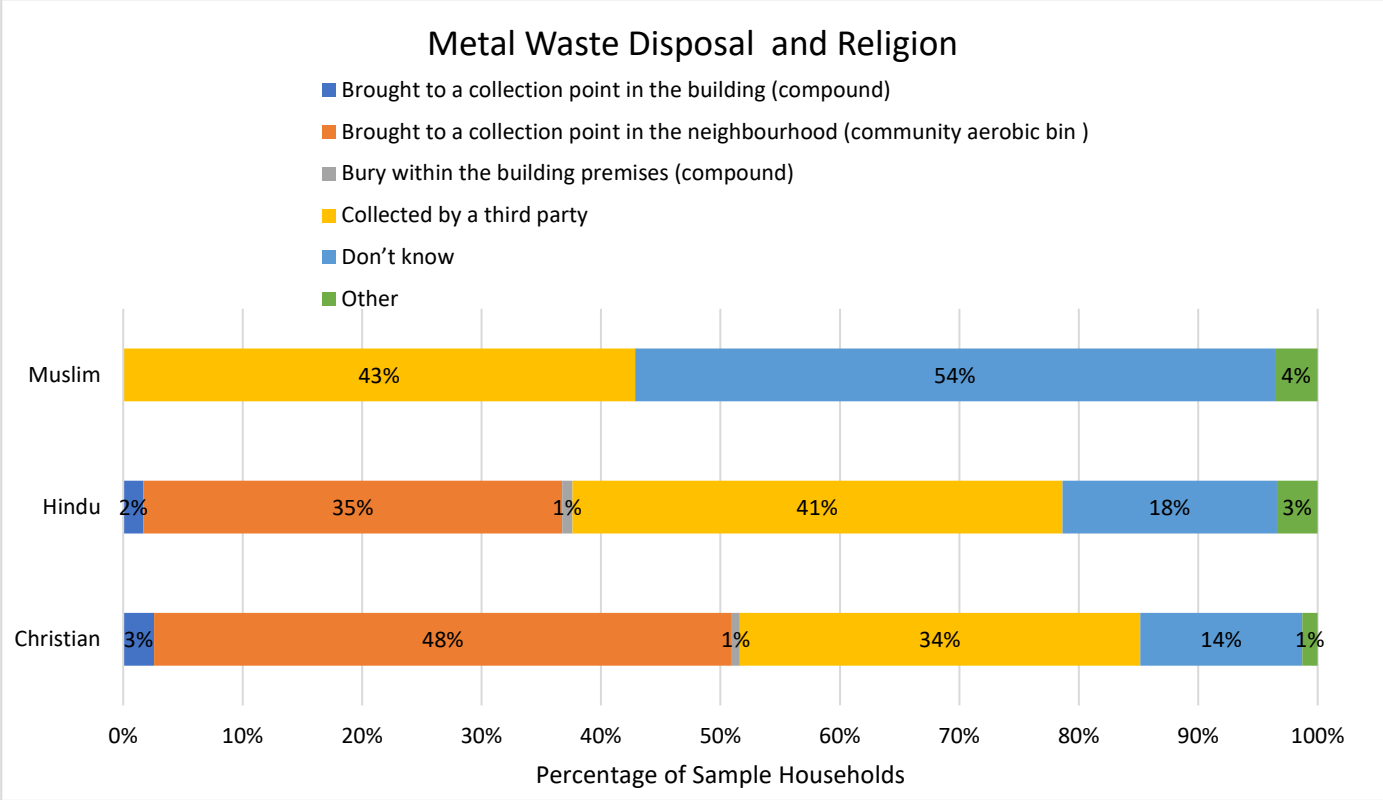

Figure 60: Primary Disposal Method of Metal Waste in Different Religion Homes

5.2.11 Electronic Waste Management

Out of 380 sample households, responses were recorded for 304 households i.e., 21 do not practice waste segregation and remaining households did not respond.

There are no door-to-door collection services by the municipality. The most common method for disposing electronic waste is community aerobic bins with 38% of the households (116/304) relying upon this method (Figure 61). Disposal through third party comes second with 26% of the households (79/304) resorting to this method. Of this, 73 households rely upon scrap dealers, and 1 on HKS/municipality, 3 on private company, and 2 on informal collectors. Malpractices like burning and burying of electronic waste is reported to be existed merely for 4% households. However, there could be potential leakages in the electronic waste chain since 29% of the households were not aware of the disposal practices at their homes.

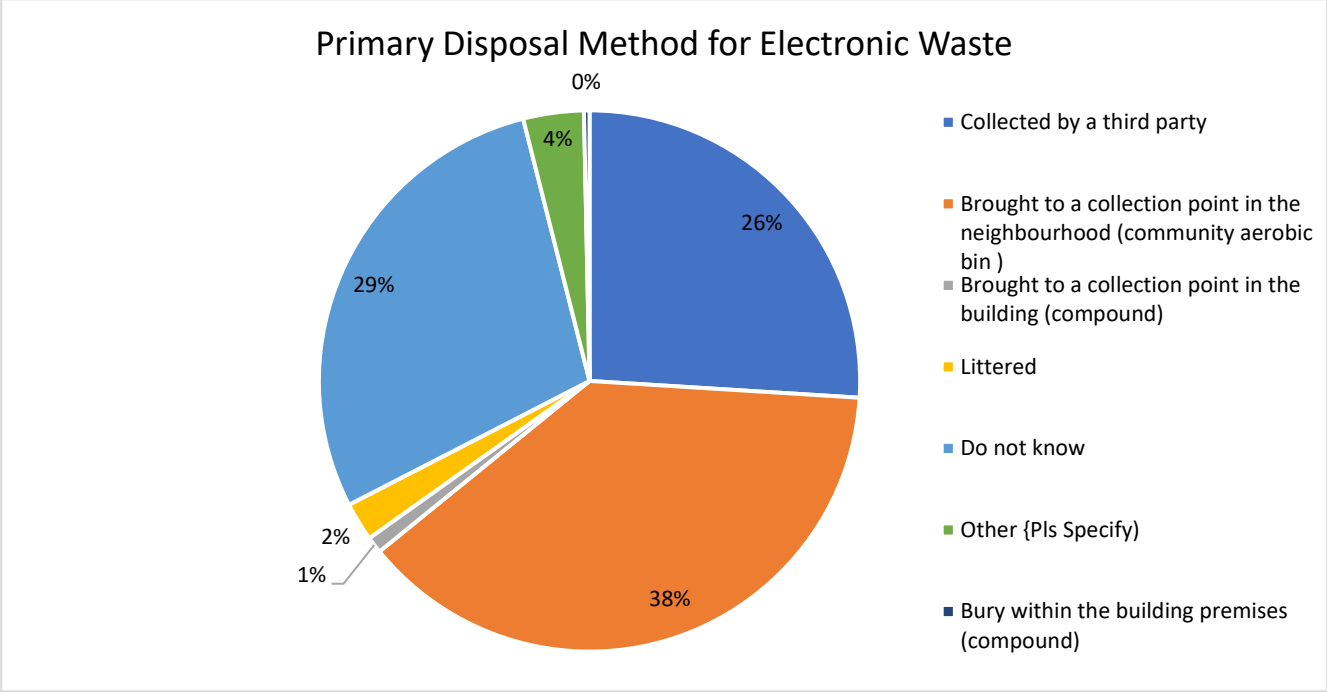

Figure 61: Primary Disposal Method for Electronic Waste

The disposal frequency varies between once a month to once in two months. Scrap dealers are males. None of the households using services of third party have any issues with either their services or the workers themselves.

Figure 62 shows that average selling price of electronic waste to scrap dealer is 63.1 INR/kg. However, 50% of the values (Q2) fall within the 20 INR/kg mark. Minimum selling price is 15 INR/kg waste and maximum is 500 INR/kg. The standard deviation is high in this case i.e., average money earned by selling waste varies by 112.3 INR/kg in both directions, which may be because different types of electronic fetch different prices or wrong reporting of the prices by the respondents.

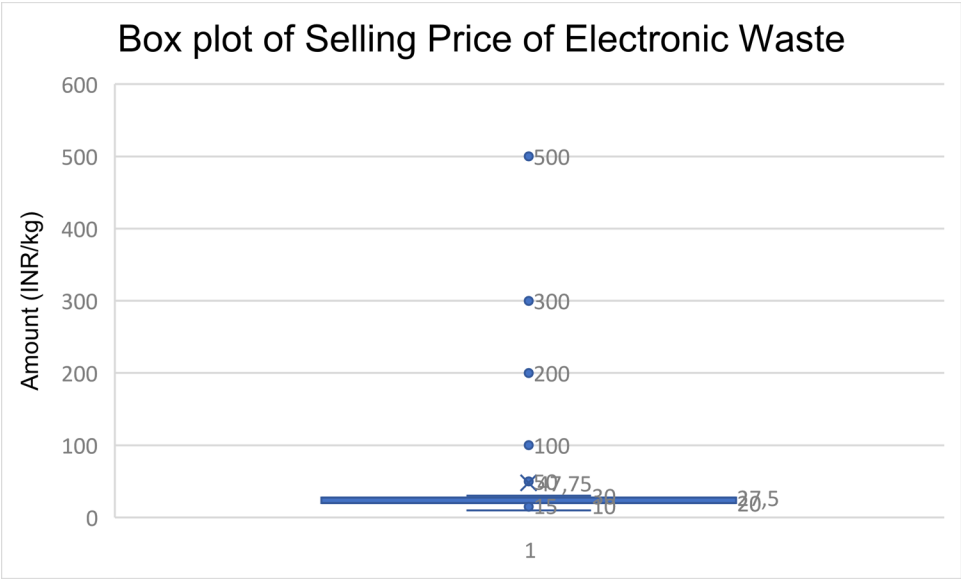

Figure 62: Box plot of Selling Price of Electronic Waste

Electronic Waste Disposal Practices Across Different Class, Caste, Religion

As shown in figure 63, among different classes, the usage of community aerobic bins is highest for most-economical backward households, and APL homes. Among BPL homes the reliance on community aerobic bins is lowest. Accordingly, disposal through third party is highest among BPL and most-economically backward families. Malpractices like burying of metal waste within the building compound is highest for most economically backward class and lowest for APL homes. The ignorance about disposal methods at household level is highest among non-priority homes.

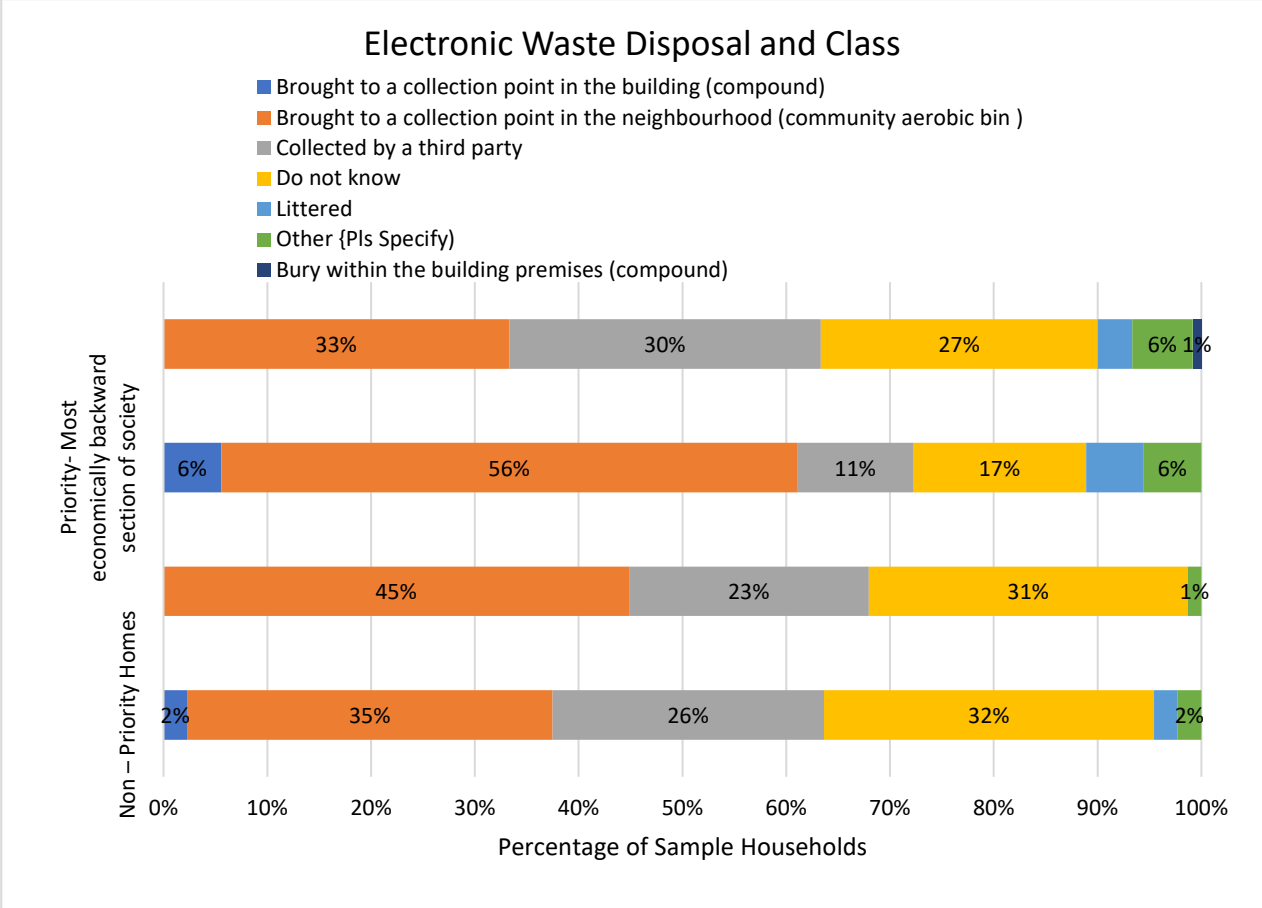

Figure 63: Primary Disposal Method for Electronic Waste for Different Class Category Homes

As shown in figure 64, among different category homes the usage of community aerobic bins for disposing electronic waste is higher for Christian category households. Negligible Muslim households reported to be using community aerobic bins. Collection by third party is comparable for Hindu and Muslim households. Significant percentage i.e., 54 % of respondents from Muslim households were not aware of the disposal method practiced at their home. Malpractices are highest among Hindu households and least in Christian households

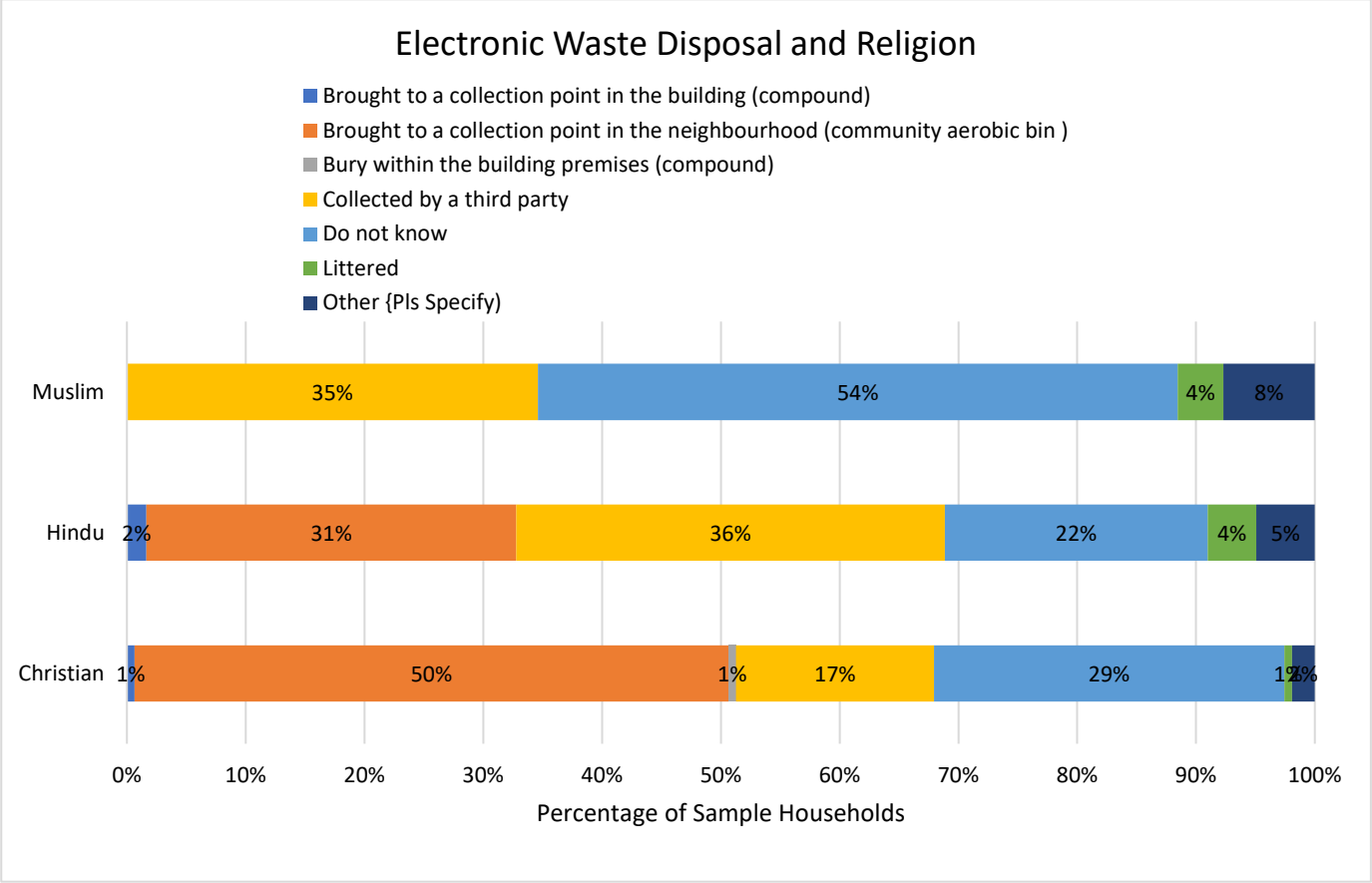

Figure 64: Primary Disposal Method for Electronic Waste for Different Religion Homes

As shown in figure 65, among different category homes the usage of community aerobic bins for disposing electronic waste is highest for General households followed by OBC category homes. It is lowest for SC Category households. Waste collection by third party is highest for the OBC households, and lowest for General category households. Malpractices like burying of electronic waste within the building compound and littering is highest for SC and other category households.

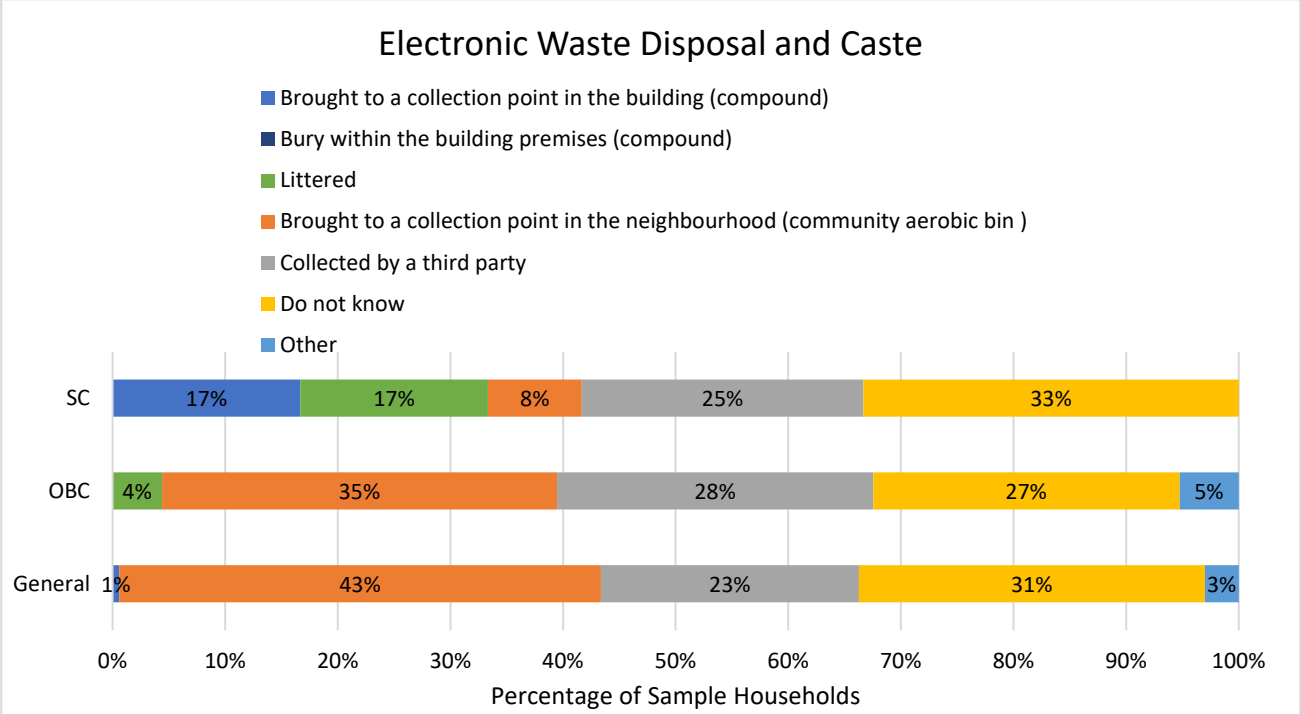

Figure 65: Primary Disposal Method for Electronic Waste for Different Caste Category Homes

5.2.12 Electric Waste Management

Out of 380 sample households, responses were recorded for 307 households i.e., 21 do not practice waste segregation and remaining households did not respond. There are no door-to-door collection services provision by the municipality. 37% of the households (113/307) bring their electric waste to the community aerobic bin (figure 66). Majority of these households bring their electric waste to community aerobic unit once a month. About 23% of the households (72/307) sell their electric waste to a third party. Of this, 94% rely upon scrap dealers rest on informal collectors or private companies. Prevalence of malpractices is reported in 8% of the households. A significant percentage of households i.e., 28% wasn't aware of the disposal methods practiced at their home.

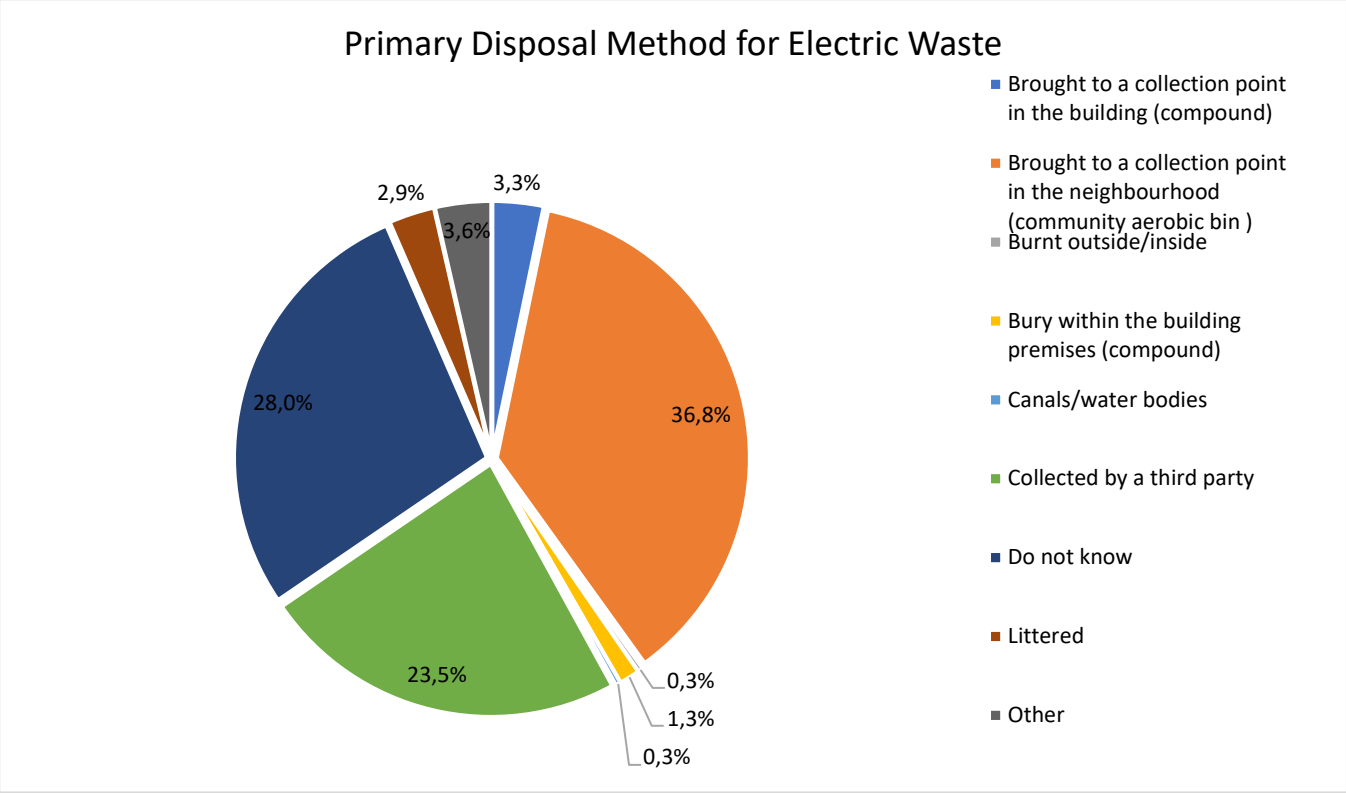

Figure 66: Primary Disposal Method for Electric Waste

The disposal frequency varies between once a month to once in two months. Scrap dealers are males. None of the households using services of third party have any issues with either their services or the workers themselves.

The average amount received by selling electric waste to scrap dealer is 23.4 INR/kg (figure 67). However, 50% of the values (Q2) fall within the 20 INR/kg mark. Minimum selling price is 8 INR/kg waste and maximum price is 100 INR/kg. The standard deviation is high i.e., average money earned by selling waste varies by 16.38 INR/kg in both directions, which may be because different types of electronic fetch different prices or wrong reporting of the prices by the respondents.

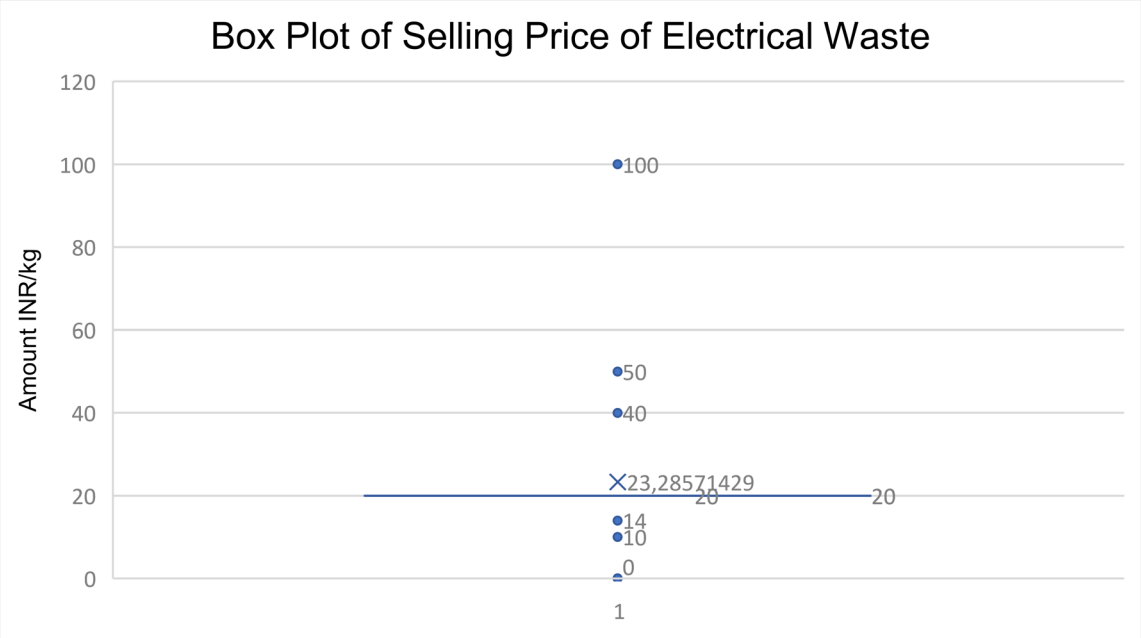

Figure 67: Box plot of Selling Price of Electric Waste

Electric Waste Disposal Practices Across Different Class, Caste, Religion

As shown in figure 68, among different category homes the usage of community aerobic bins for disposing electric waste is highest for Christian category households and negligible for Muslim homes. According, third party collection is reported to be highest in case of Muslim households and lowest for Christian households. Malpractices were found to be comparable for all three category households. Significant percentage i.e., 48% of respondents from Muslim households were not aware of the disposal method practiced at their home.

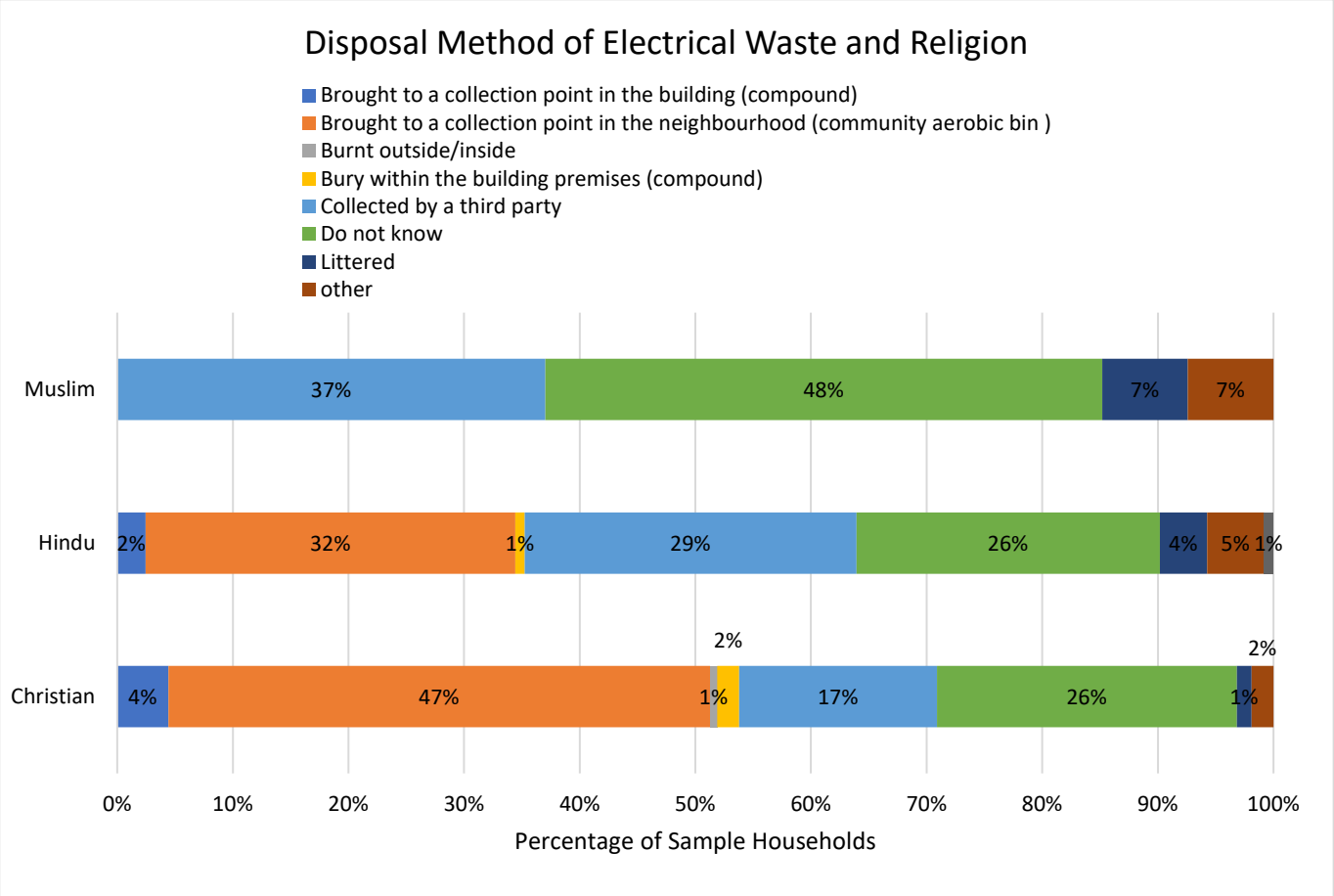

Figure 68: Primary Disposal Method for Electric Waste for Different Religion Homes

As shown in figure 69, among different category homes the usage of community aerobic bins for disposing electric waste is highest for General category homes followed by OBC and SC households. Collection by third party is comparable for General and OBC. No usage of third party is reported by the SC households. Malpractices like burying of electric waste within the building compound and littering is highest for SC category households. The ignorance of respondents of electric disposal method practices at their homes is also highest for SC households.

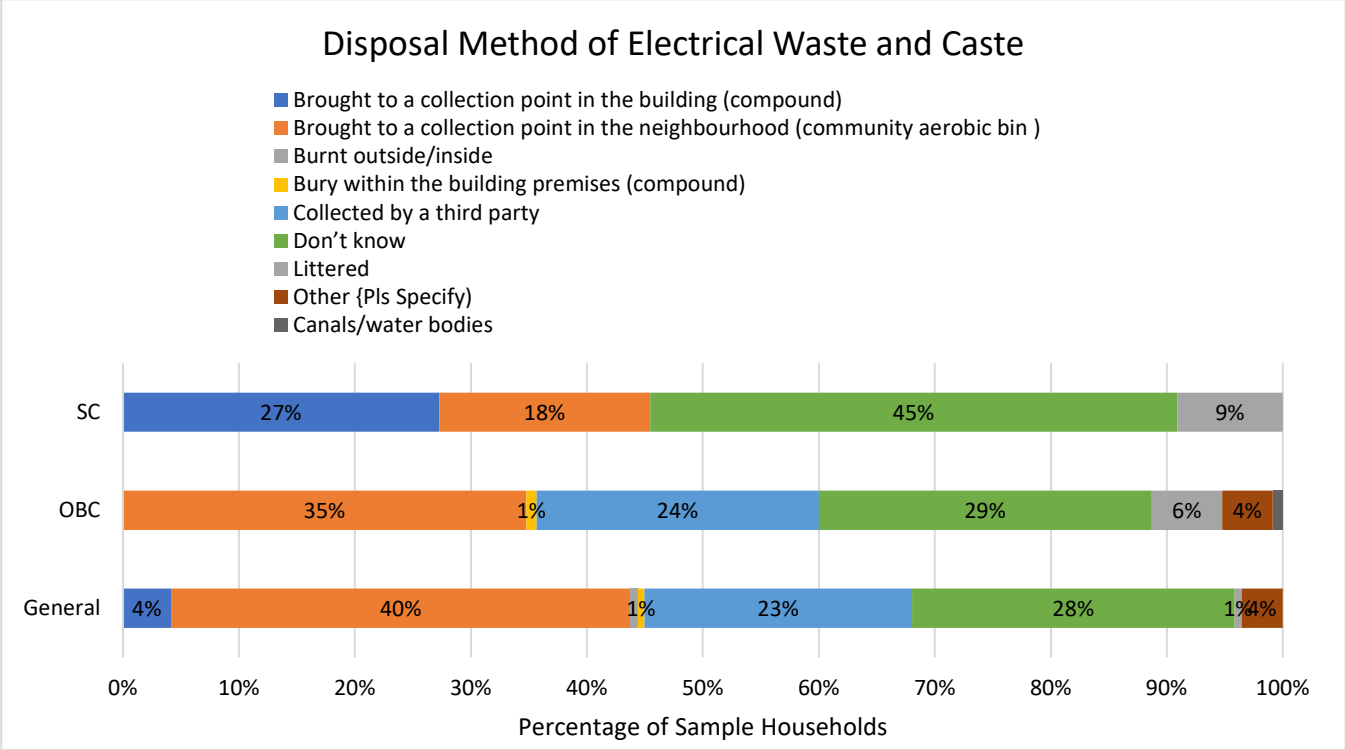

Figure 69: Primary Disposal Method for Electric Waste for Different Caste Category Homes

As shown in figure 70, among different classes, the usage of community aerobic bins is highest in most economically backward followed by APL homes. The disposal of electric waste via third party is highest for BPL and comparable for non-priority and APL homes. The collection is lowest for most-economically backwards homes. No doubt that the malpractices are more prevalence in most-economically backward homes. The ignorance regarding electric waste household practices is also highest among most- economically backward homes.

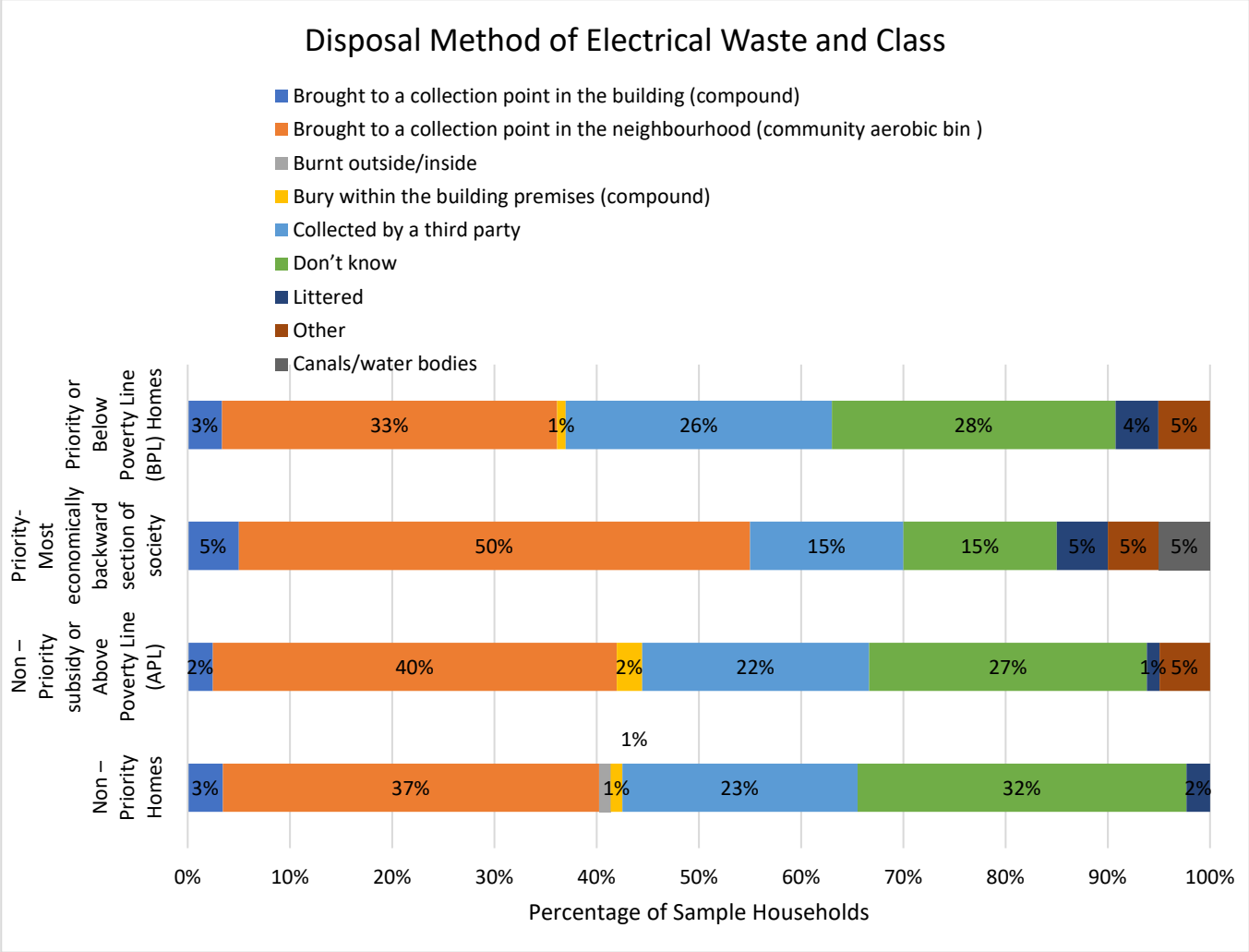

Figure 70: Primary Disposal Method for Electric Waste for Different Class Category Homes

5.2.13 Mixed Waste Management

21 households out of 380 sampled households reported to be not practicing waste segregation. These households were asked questions related to mixed waste management. Out of 21, we got response from 15 households. Majority of households (13/15) deposit their waste to the community aerobic bins whereas 2 households bury mixed waste within their building premises (compound) on daily and monthly basis.

5.2.14 Usage of Community Aerobic Bins and Third Party for Different Types of Waste

The wards have one community aerobic bin unit. Figure 71 shows usage of community aerobic bins and third party (HKS, informal collector, scrap dealer, private company) for disposing different types of wastes. The community aerobic bins and scrap dealers combined are responsible for majority of the dry waste disposal from households in the two wards. Management of household paper, glass and medical waste has a huge service gap though.

It shows households use community aerobic bins majorly for disposing metal, electronic, electrical, and medical waste. The reliance on third party is majority for depositing plastic and polythene waste whereas it is lowest for kitchen and glass waste.

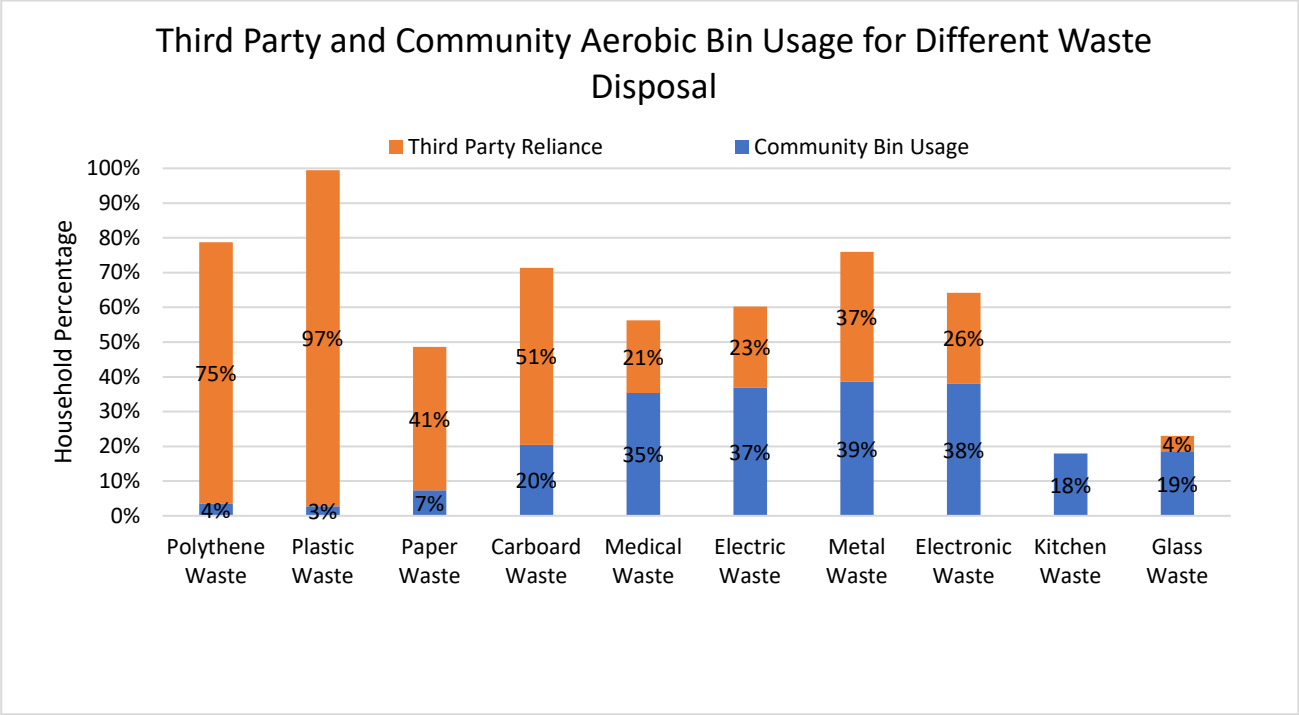

Figure 71: Community Aerobic Bin and Third-Party Reliance for SWM

Reliance on HKS is maximum for plastic waste and polythene waste management. For valuable waste like paper, cardboard, metals, electronic, electric, medical the households primarily depend upon the scrap dealers (Figure 72). For cardboard waste management, some households rely upon informal collectors and private company.

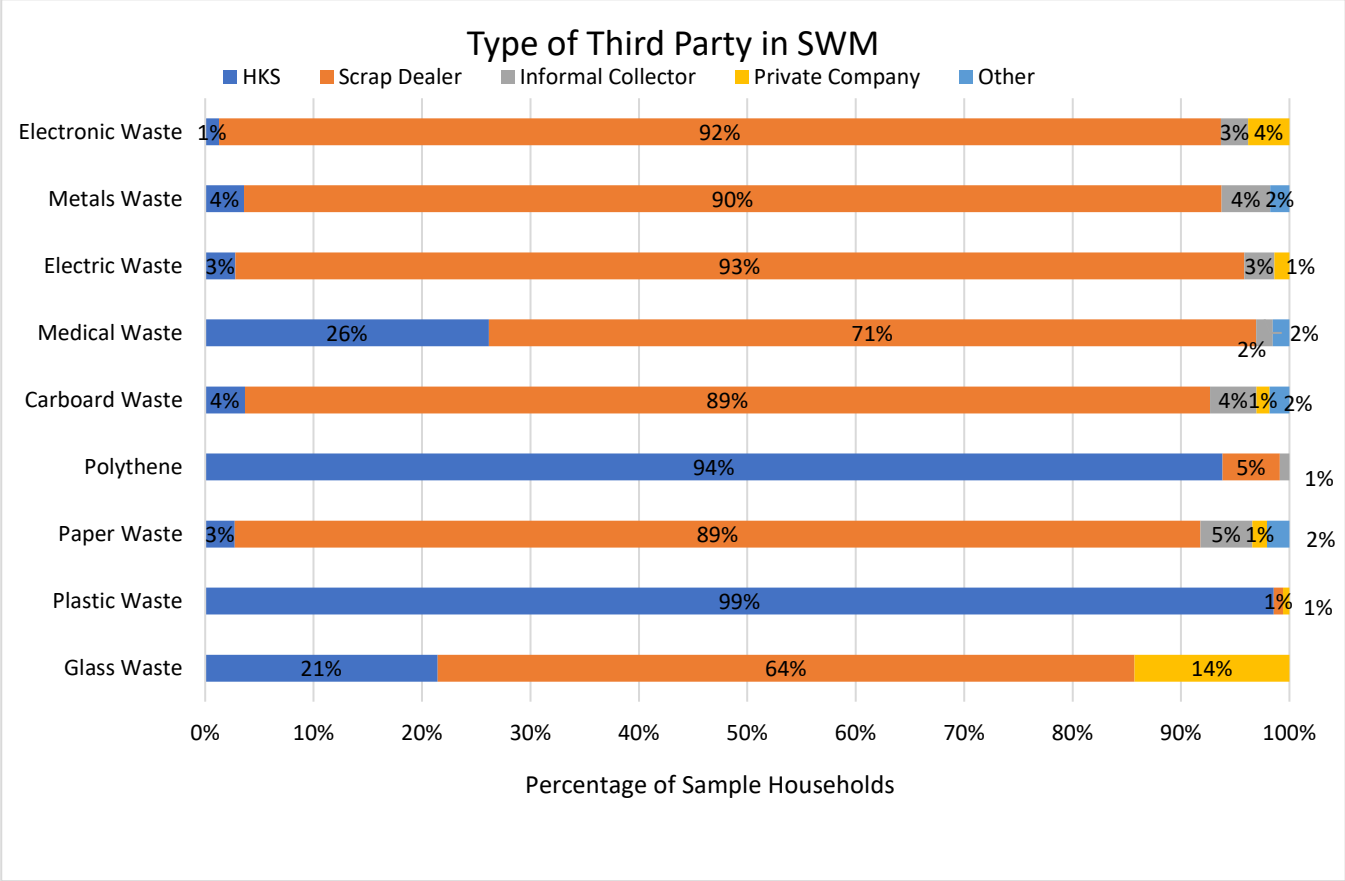

Figure 72: Third Party Involvement in Solid Waste Management

5.3 Perceptions

Perception of respondents were recorded for quality of services in the area and impact on services during the COVID lockdown. Respondents were asked to elaborate their responses.

5.3.1 Existing Waste Management System

Respondents were asked if they are "satisfied with the waste collection nowadays". We received 376 responses out of 380 sample households. 91.49 % of the respondents responded with the "Yes", and 6.38% as 'somewhat yes'. Only 2 % of the respondents responded with a 'No' or 'Somewhat No' – figure 73.

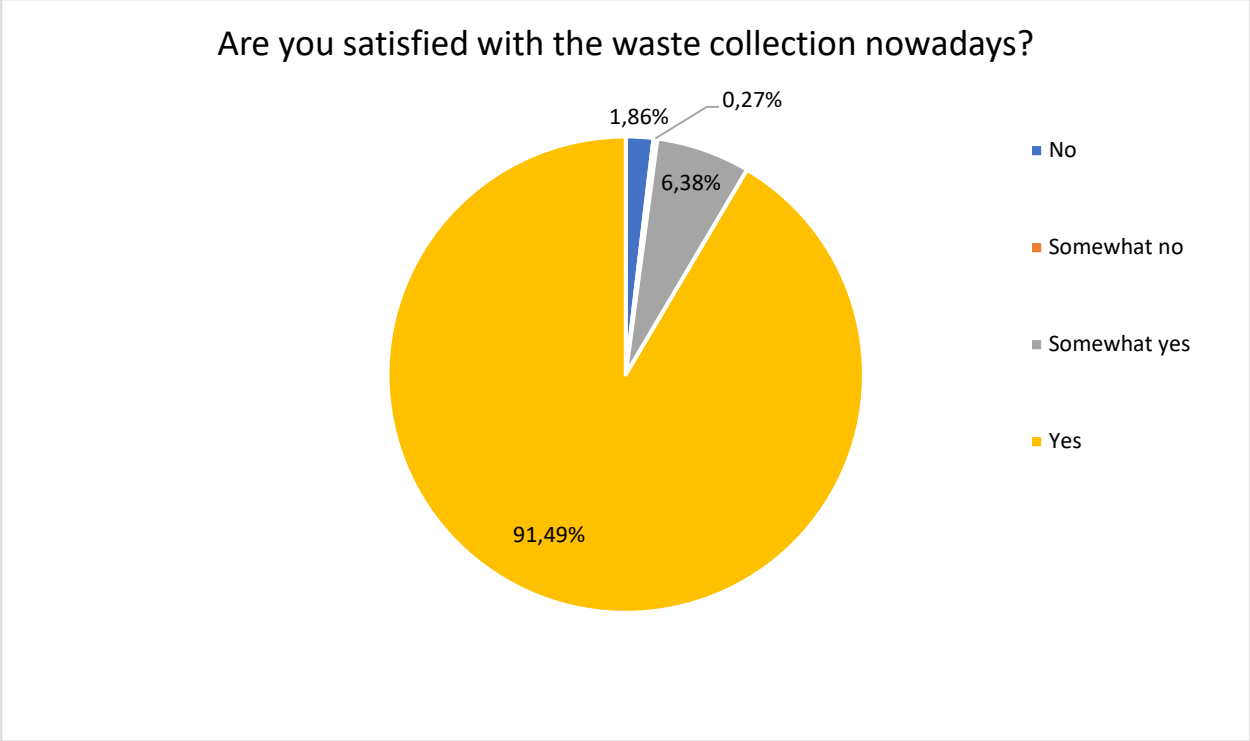

Figure 73: Responses to 'Are you satisfied with Waste Collection Nowadays?'

The above findings were compared with class, caste, religion.

As shown in figure 74, among different caste category homes, relatively higher percentage of OBC and General category households were 'satisfied' or 'somewhat satisfied' with the current waste collection services. Less percentage of SC category households were 'satisfied' or 'somewhat satisfied' with the current waste collection services. Among different class categories, relatively higher percentage of BPL and non-priority were 'satisfied' or 'somewhat satisfied' with the current waste collection services. Less percentage of most-economically backward households were 'satisfied' or 'somewhat satisfied' with the current waste collection services. Among different religion categories, relatively higher percentage of Hindu category households were 'satisfied' or 'somewhat satisfied' with the current waste collection services. Relatively higher percentage of Muslim and Christian were not satisfied with the current waste collection services households found no changes in the services post blockade/garbage strike. Generally, inter-group differences were not that significant.

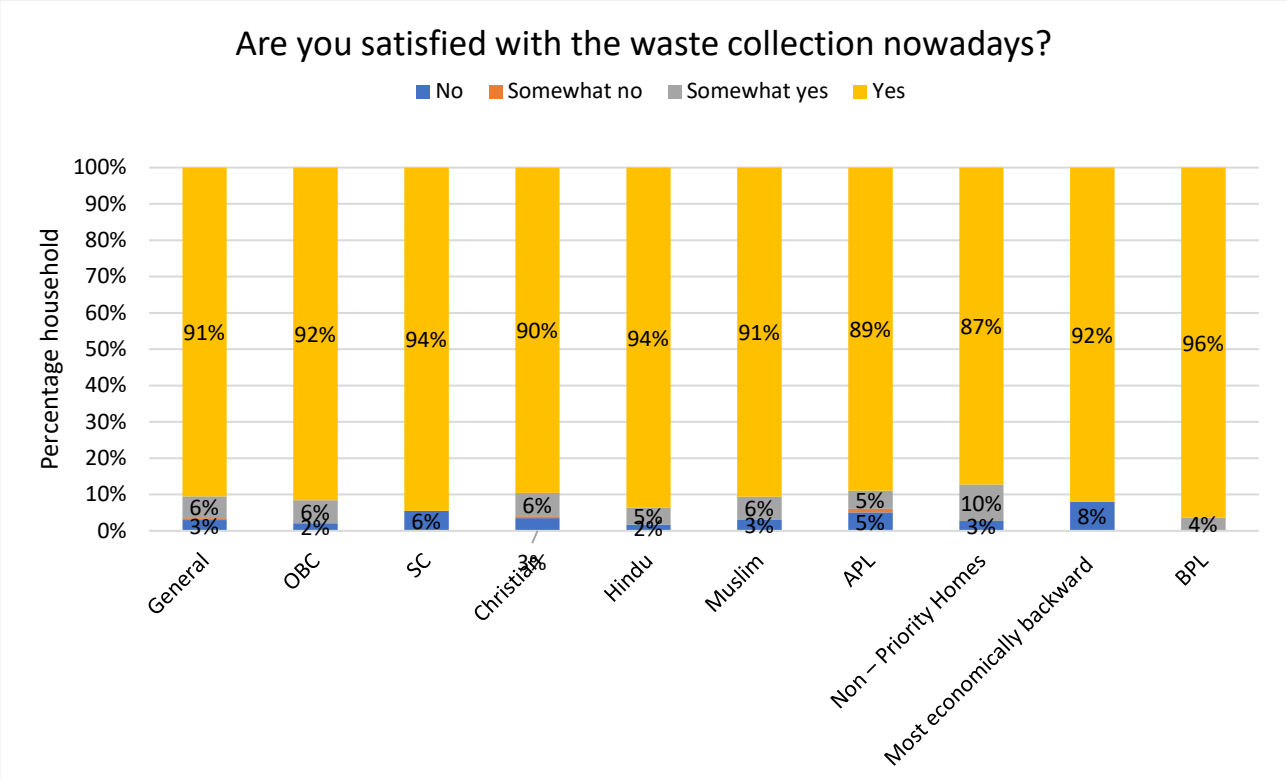

Figure 74: Level of Satisfaction for Waste Collection Services Across Class, Caste, Religion

Respondents were asked to elaborate their responses to the previous question. The 'No' responses were concerned with the delay in waste collection by HKS, littering especially plastic on the road, lack of collection for other waste types. The 'Somewhat Yes' responses wanted HKS to collect kitchen waste along with the plastic waste. The respondents wanted door-door collection of glass waste, e-waste, and sanitary waste as well. Concerns with delays in collection by HKS were expressed here too. One of the respondents wanted "trolly" to collect and pick-up the waste from homes – as it was during "Sarvodayapuram period". The majority of the 'Yes' responses talked about effective monthly door-to-door waste collection system specially appreciating HKS members and their punctual, polite, and cooperative behaviour. Few of the respondents talked about contribution of community aerobic bins. Respondents also mentioned how waste is not seen piling up on the road.

Upon asking how would they like to improve the current waste management system/services; 34% of the respondents did not want to change anything particular and another 32% were "okay" / "satisfied" with the current system (figure 75). About 11% showed interest in installing bio-bins and biogas plants, and 7% wanted more community aerobic bins. 5% of the respondents wanted to make fertilizers form composters available for agriculture. 2% of the respondents also brought attention to glass waste management – which corresponds to poor status of glass waste management as discussed in previous sections.

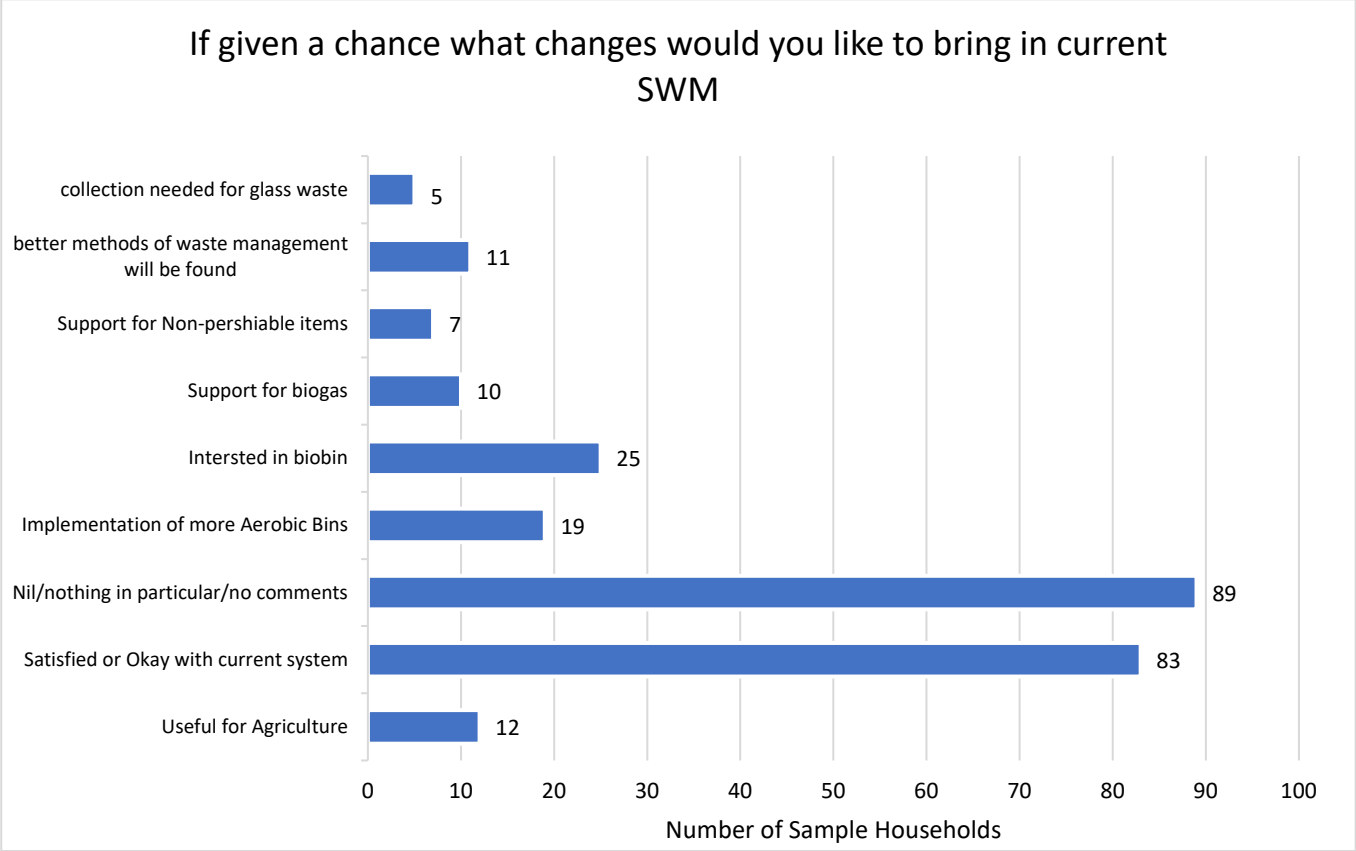

Figure 75: Suggestions to improve the current waste management system/services

5.3.2 Cleanliness of Neighbourhood

Upon asking what do they "think about the cleanliness of their neighbourhood", 84% of the responders said 'clean' (figure 76). This was primarily attributed to HKS and their punctuality in waste collection. 2% of the respondents said their neighbourhood is "dirty", which was primarily attributed to indiscriminate dumping of the both inorganic and kitchen waste on the road side by their neighbours.

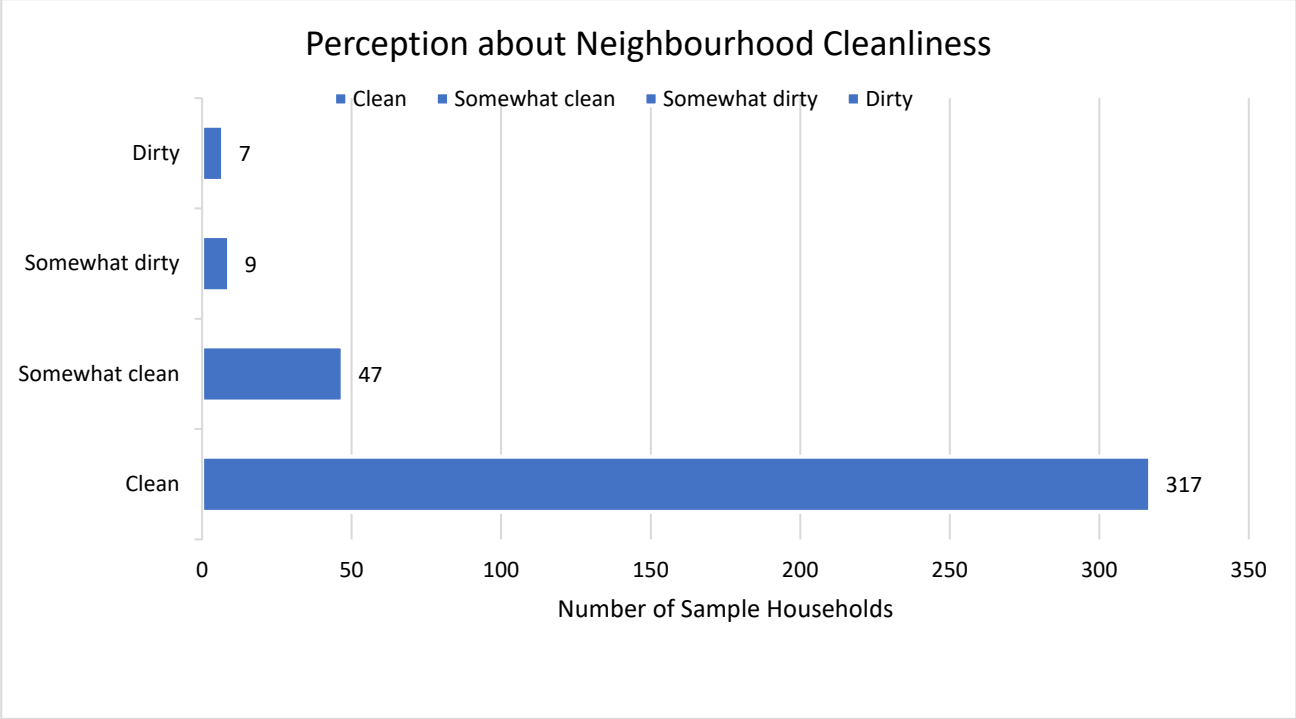

Figure 76: Response to Cleanliness of Neighbourhood

As shown in figure 77, about 88% of the Christian and 84% of the Hindu households found neighborhood to be "clean". Relatively low percentage (53%) of Muslim households found their neighborhood to be "clean". The results are corresponding with the results on questions 'if respondents are satisfied with the current collection system' – where Muslims were least 'satisfied' with the current waste collection services. This is understandable considering relatively a greater percentage of Muslim households has a low reliance on community aerobic bins and third-party collection for all waste types disposal, hence, higher occurrence of malpractices – as discusses in the previous sections.

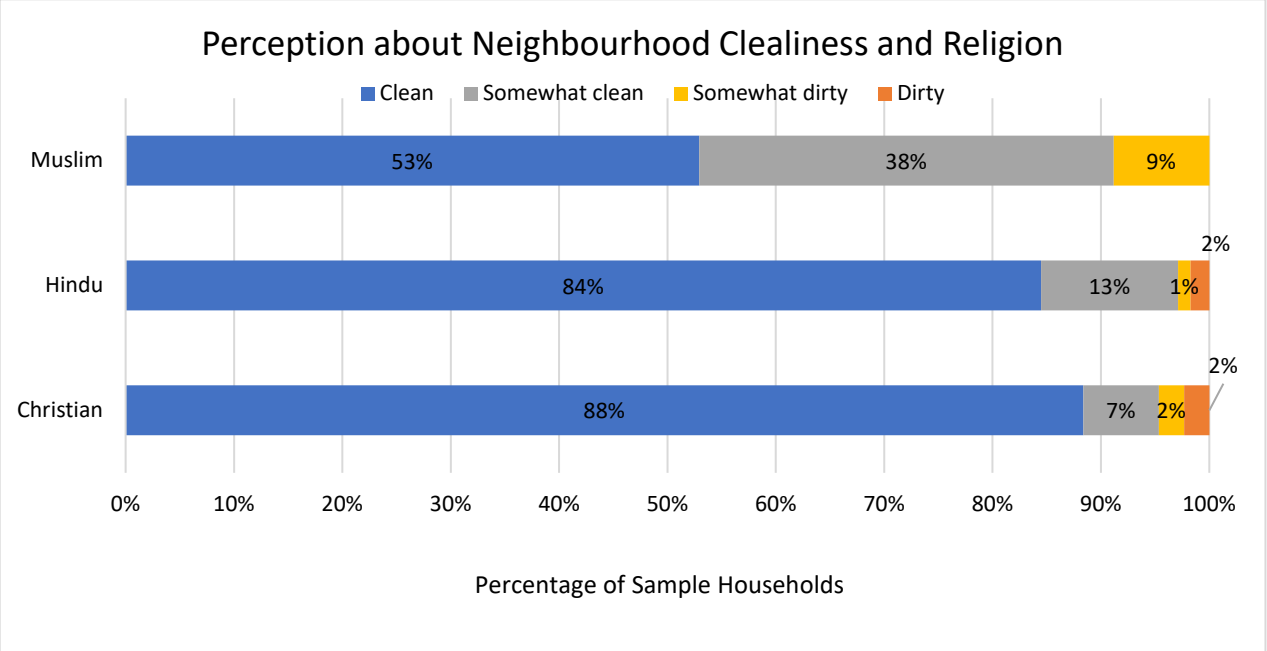

Figure 77: Perception about Neighbourhood Cleanliness and Religion

As shown in figure 78, about 96% of the most-economically weaker households found their neighborhood to be “clean”. Among different category homes, the respondents from non-priority and BPL homes seem to be more dissatisfied with the neighborhood cleanliness. The view of respondents from BPL homes is understandable considering relatively a higher percentage of BPL homes has a low reliance on community aerobic bins and third-party collection for different waste types (paper waste, cardboard, medical, electronic, electric, metal) disposal. This has led to higher occurrence of malpractices in BPL homes. However, for non-priority homes conclusion is difficult to draw.

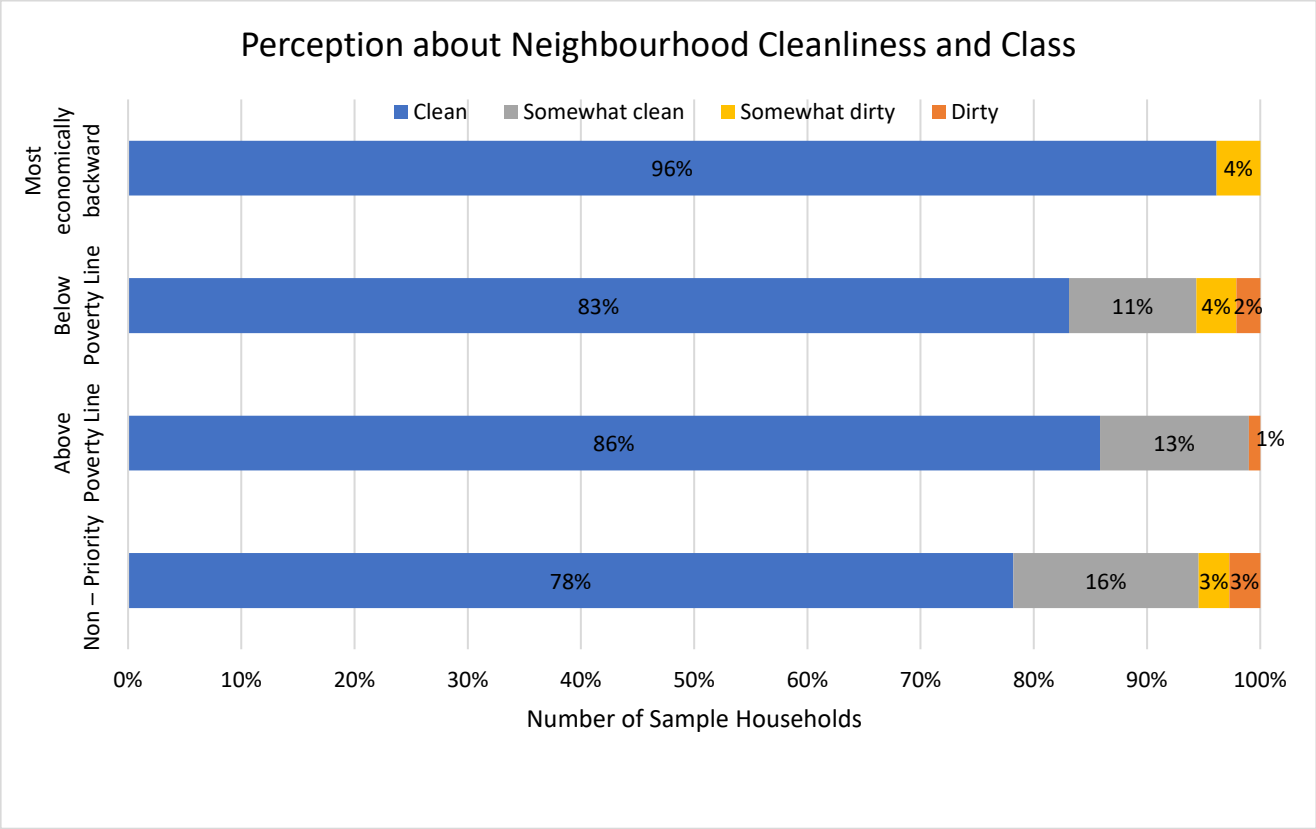

Figure 78: Perception about Neighbourhood Cleanliness and Class

As shown in figure79, about 88% of the General households found their neighborhood to be “clean”. Among different category homes, the respondents from SC category seem to be most dissatisfied with the neighborhood cleanliness. The results are corresponding with the results on questions ‘if respondents are satisfied with the current collection system’ – where SC households were least ‘satisfied’ with the current waste collection services. The view of respondents from SC category homes is comprehensible considering higher percentage of SC homes has a low reliance on community aerobic bins and third-party collection for different waste types (plastic, low access to biogas plants, medical waste, glass waste) disposal. This has led to higher occurrence of malpractices in SC homes.

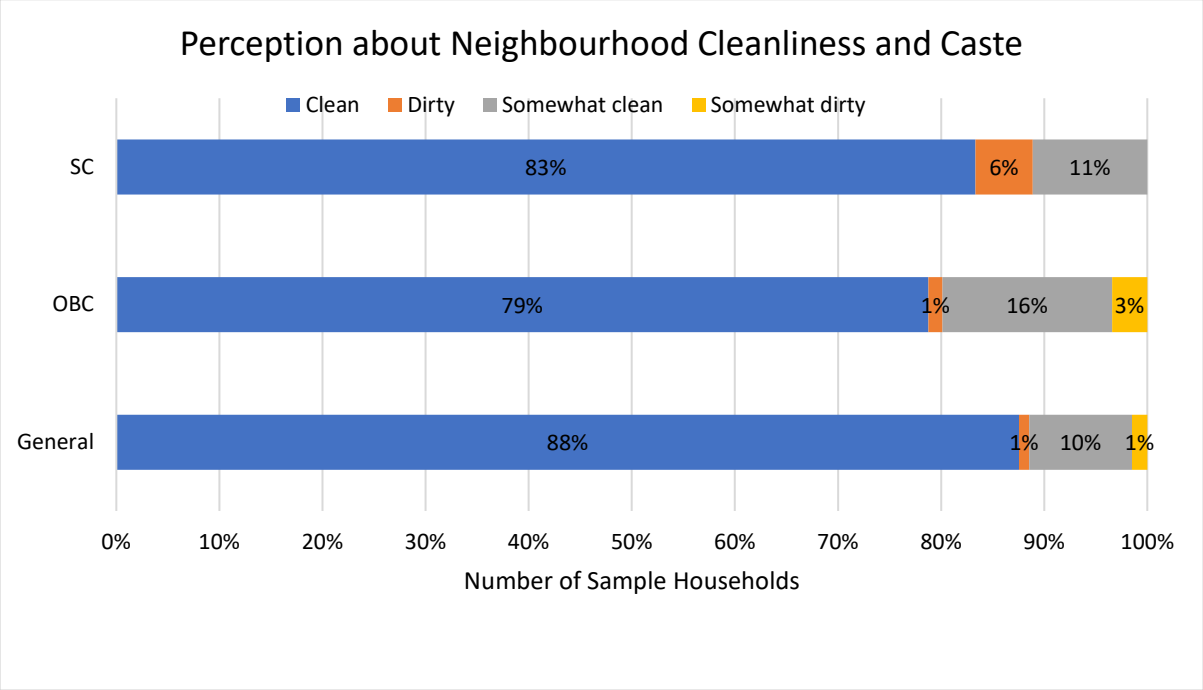

Figure 79: Perception about Neighbourhood Cleanliness and Caste

Majority of the respondents attributed clean neighborhood to their own efforts in taking care of their waste (figure 80).

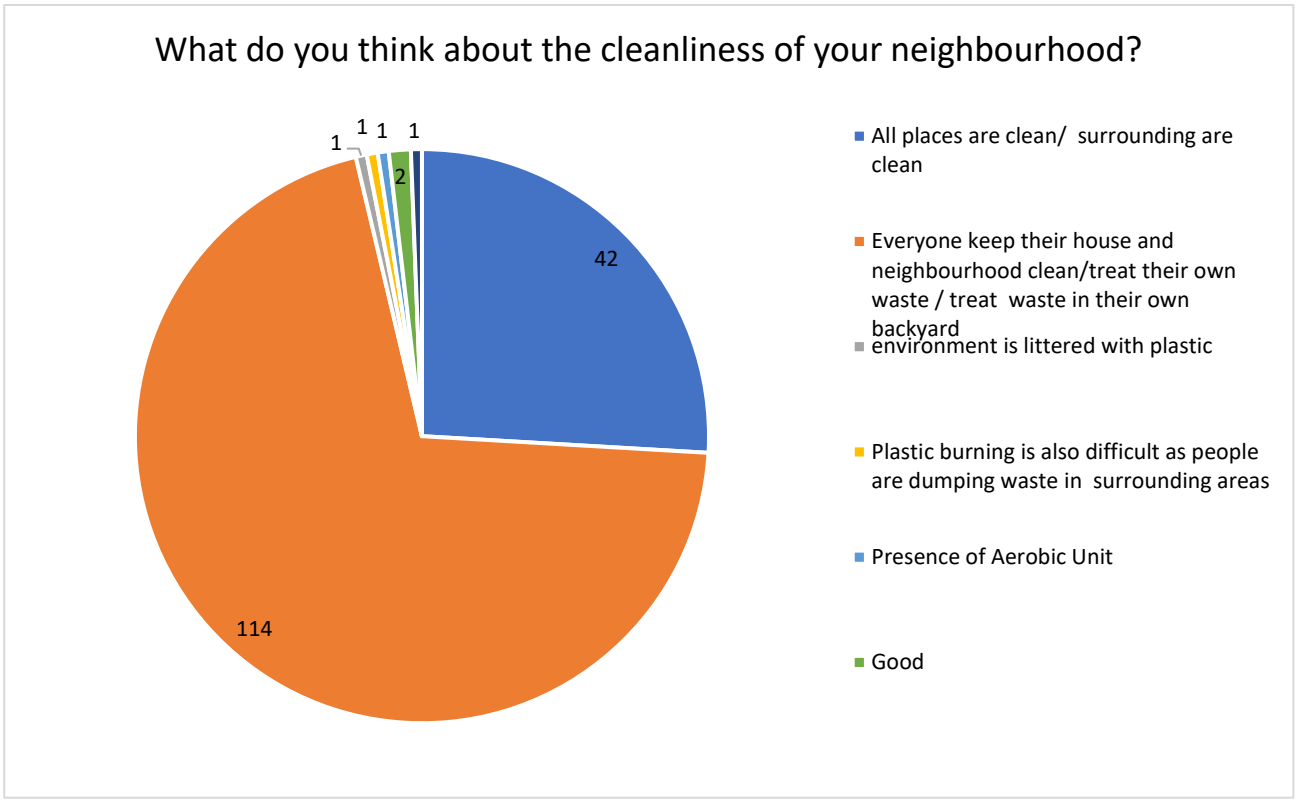

Figure 80: Qualitative Responses to Cleanliness of Neighbourhood

Majority of the 'dirty' and 'somewhat dirty' responses were with respect to waste dumping on roadside (by neighbors). The second most common response was with respect to poor wastewater management from households into canals. Few respondents also expressed concerns related to mosquitoes and poorly maintained grass curb.

5.3.3 Improvement in Waste Collection in last 5 Years

Respondents were asked to respond, in Yes or No, to question: "Do you think the waste collection has improved compared to 5 years ago?" We got 374 responses, and 79% of these found improvement in the waste collection when compared to last 5 years. The responses were compared with respondents' religion, class, and caste, as shown in figure 81).

Relatively higher percentage of SC and General Households as compared to OBC households found improvement in the waste collection system in last 5 years. About 26% of the OBC homes did not find improvement in waste collection services in last 5 years. Relatively higher percentage of Muslim households as compared to Christian and Hindu households found improvement in the waste collection system in last 5 years. Among different class category homes, relatively higher percentage of most-economically backward homes followed by APL homes found improvement in the waste collection system in last 5 years. These results are not corresponding to the responses recorded for the question on neighborhood cleanliness nor with the level of services for different class, religion, and caste category homes.

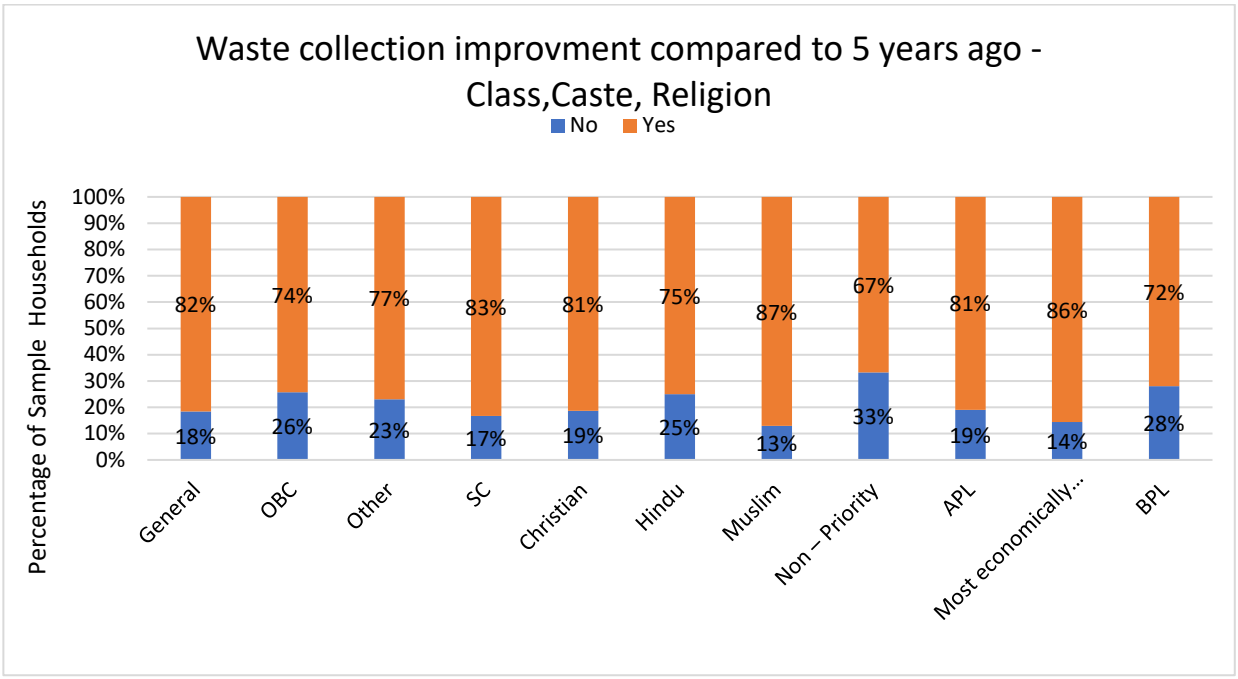

Figure 81: Responses to "if waste collection improved compared to 5 years ago" Across Religion, Caste, Class

Respondents were asked to elaborate their responses. Respondents that reported no change in the waste collection (33/37) elaborated their responses with "nothing in particular" – refer figure 82.

Respondents that reported improvements in the waste collection, 24% of these attributed the improvement to presence of aerobic bins followed by respondents that attributed the improvement to nothing in particular. 19% attributed improvements to overall changes in the waste processing/management. 15% of the respondents attributed improvements to HKS and their services in collecting plastic waste. 8% of the respondents gave credit to both community aerobic units and HKS services.

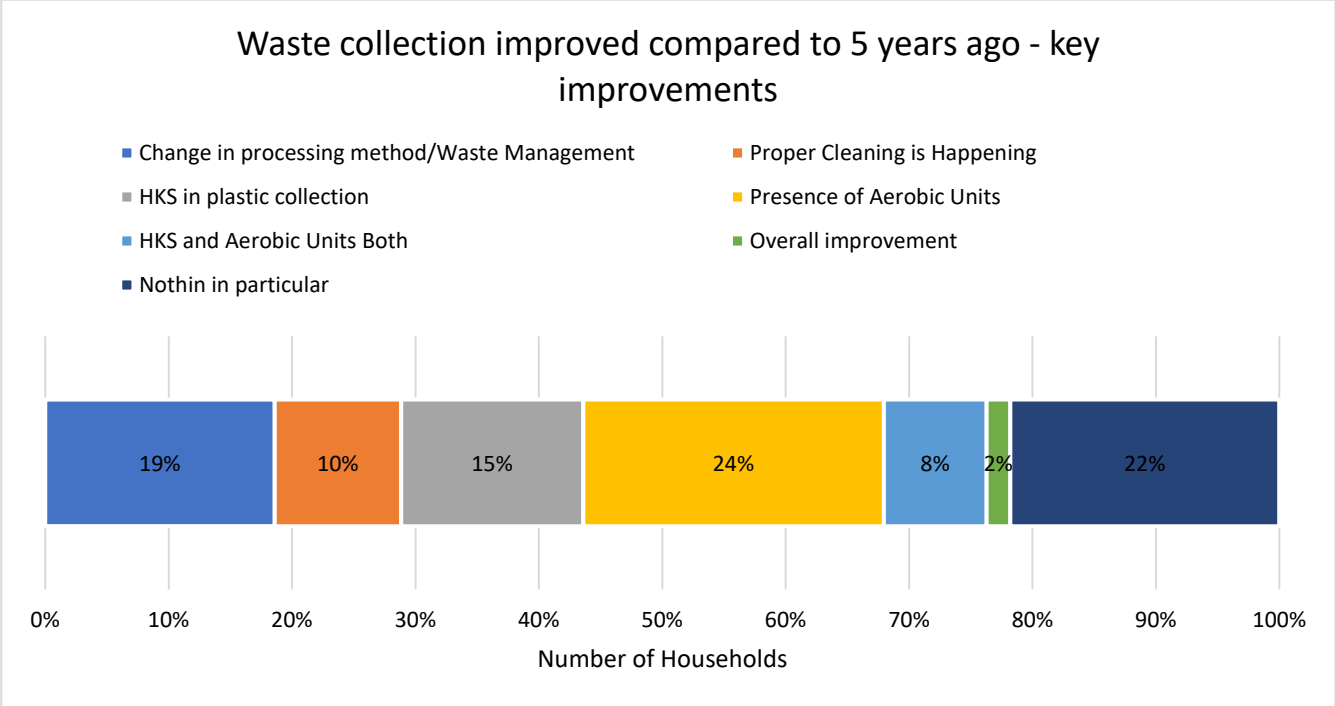

Figure 82: Responses to "what improvements in waste collection compared to 5 years ago"

5.3.4 Garbage Crisis in Sarvodayapuram

The Sarvodayapuram garbage crisis brought lot of changes in SW management and related practiced at the town, community, and household level. This mainly includes introduction of community aerobic bins, and distribution of kitchen bins to households expecting households to segregate waste and treat kitchen waste at home. A set of questions were asked to capture respondents' perception about these changes. We got responses from 370 households out of 380 sample households.

Upon asking if waste management services have changed after the blockade/garbage strike in Sarvodayapuram/Alappuzha, 65% of the respondents were not aware of any such changes. About 22% found changes in the waste management services after the blockade/garbage strike. 13% of the respondents found no changes.

These responses were compared with respondents' religion, class, and caste (figure 83). To specifically understand why majority is unaware of this, we compared the findings with the house ownership status and respondent's sex.

Among different caste category homes, relatively higher percentage of SC and General category households found changes in the waste management services have changed post blockade/garbage

strike. The ignorance about such changes was found to be highest among OBC households. Among different class categories, relatively higher percentage of non-priority and most economically backward category households found changes in the waste management services post blockade/garbage strike. The ignorance about such changes was found to be highest among APL households. Among different religion categories, relatively higher percentage of Christian category households found changes in the waste management services post blockade/garbage strike. Relatively higher percentage of Muslim households found no changes in the services post blockade/garbage crisis . Because Muslim community does not benefit from community bins (as discussed in previous sections), hence no change in services is perceived.

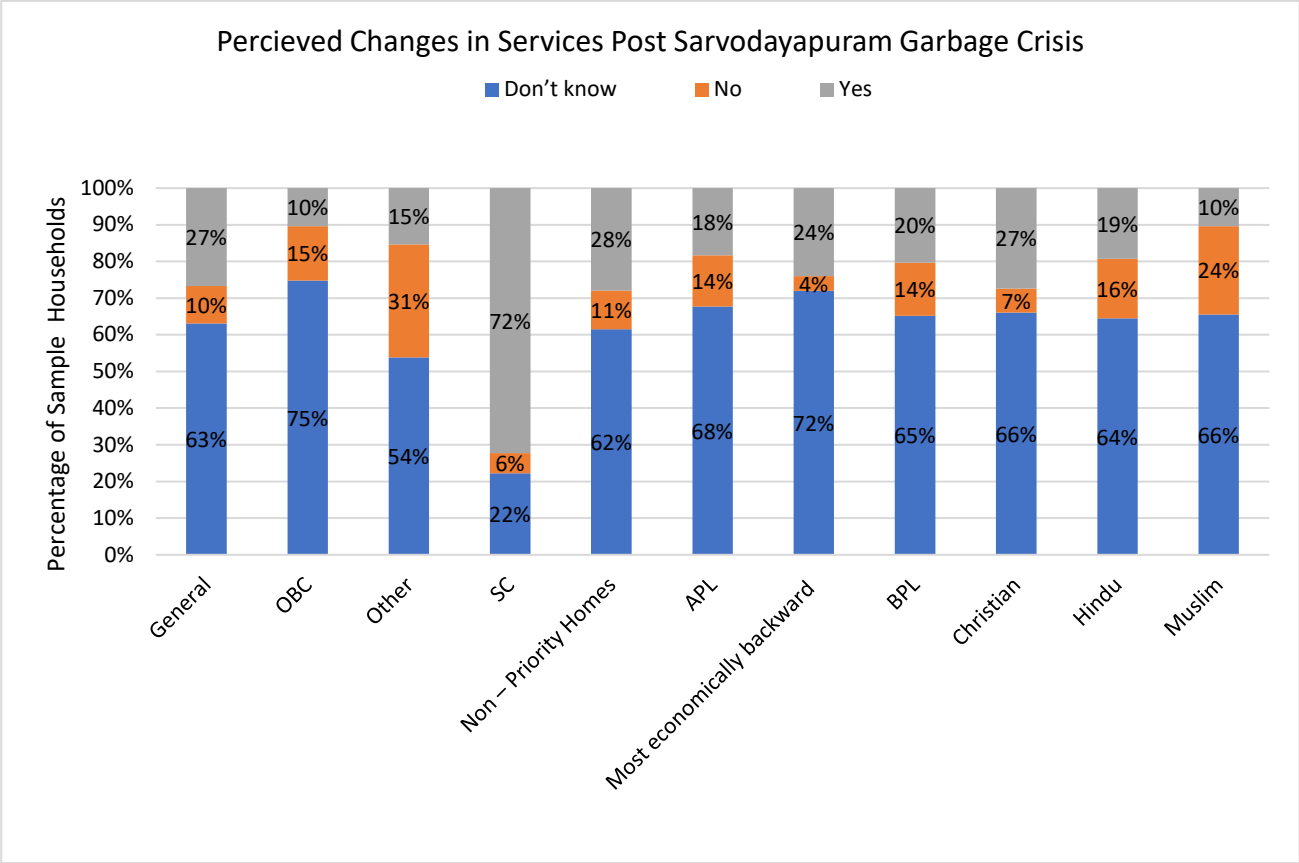

Figure 83: Perceived Changes in Waste Management Services Post Sarvodayapuram Garbage Crisis and Class, Caste, Religion Variation

To specifically understand why majority is unaware of changes, we compared the findings with the house ownership status and respondent's sex. For house ownership status, we received 371 responses out of 380 sampled household (figure 84). As expected, higher percentage of respondents having rented housing were not aware of the changes post garbage crisis. These respondents and their families may have inhabited Alappuzha much after the crisis.

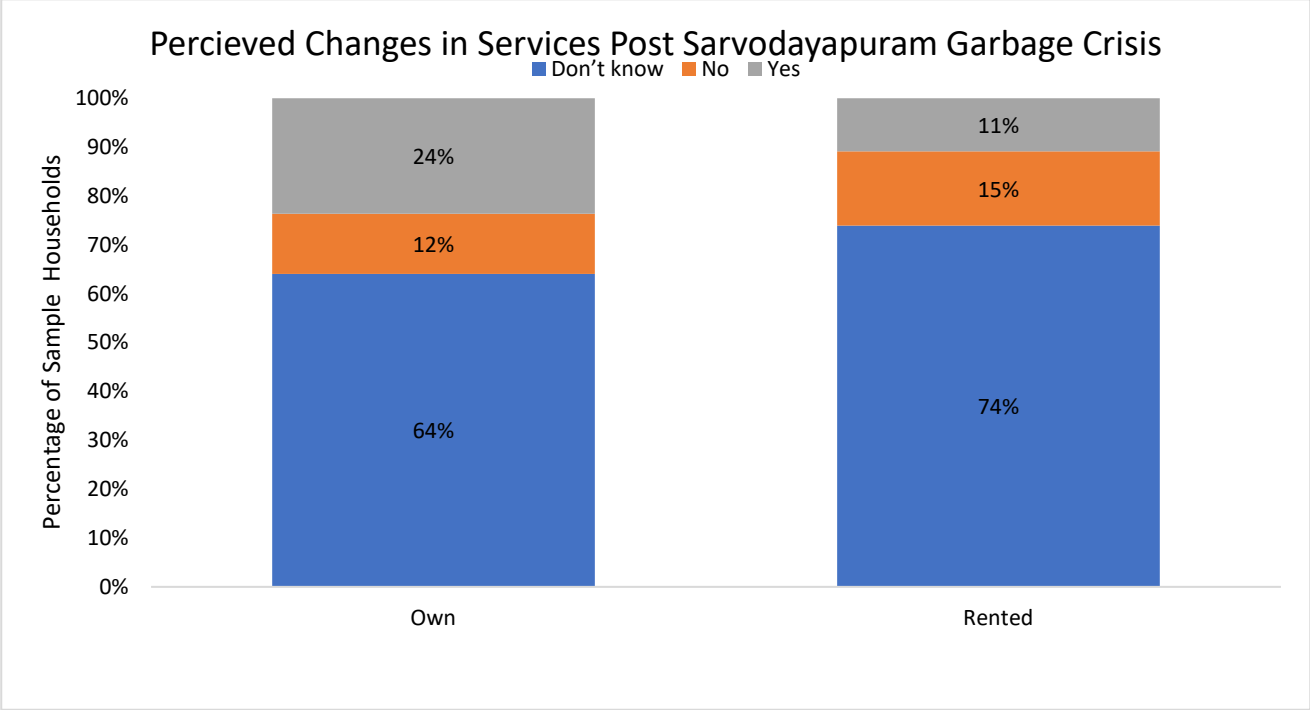

Figure 84: Perceived Changes in Waste Management Services Post Sarvodayapuram Garbage Crisis and Home Ownership Variation

Upon comparing responses to the question 'if waste management services have changed after the blockade/garbage strike in Sarvodayapuram/Alappuzha' with the sex of the respondents, we found that significantly large percentage of female respondents were not aware of this (Figure 85).

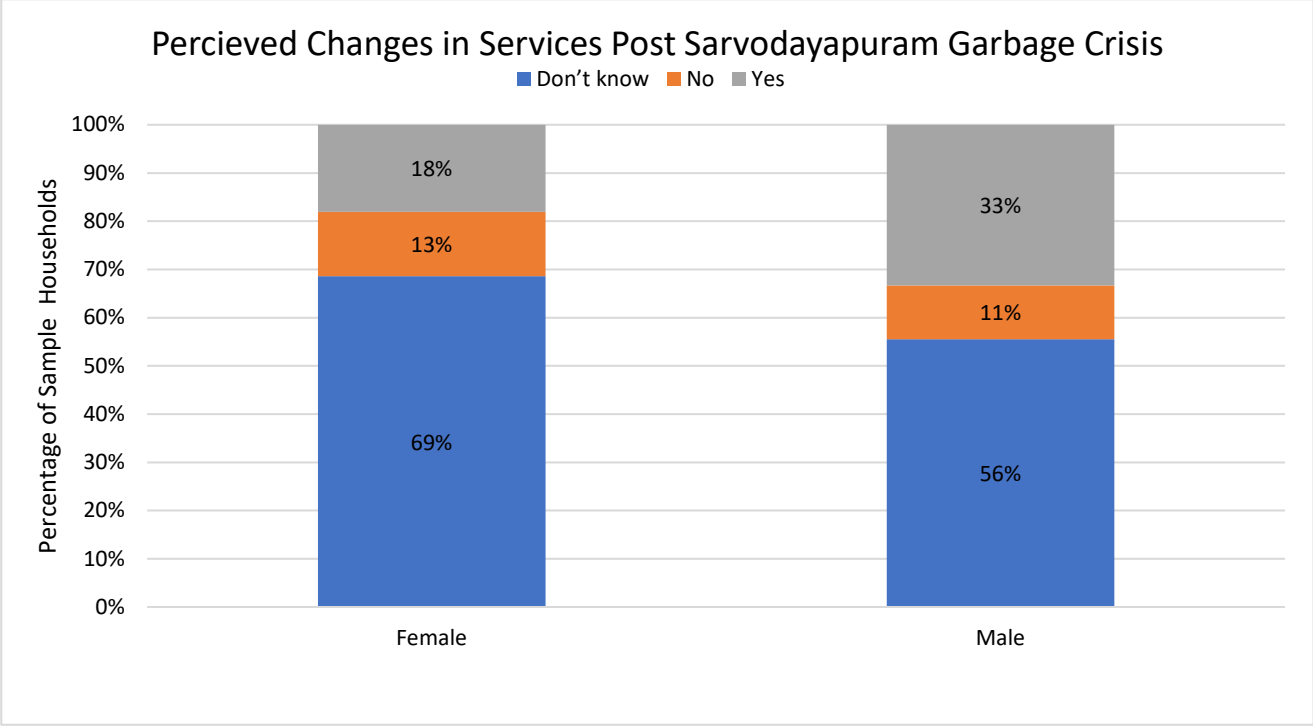

Figure 85: Perceived Changes in Waste Management Services Post Sarvod3ayapuram Garbage Crisis and Respondent's Sex

Respondents who found changes in the waste management, a majority reported changes in the plastic collection by HKS members (figure 86). Few respondents reported that areas are not clean and garbage is littered.

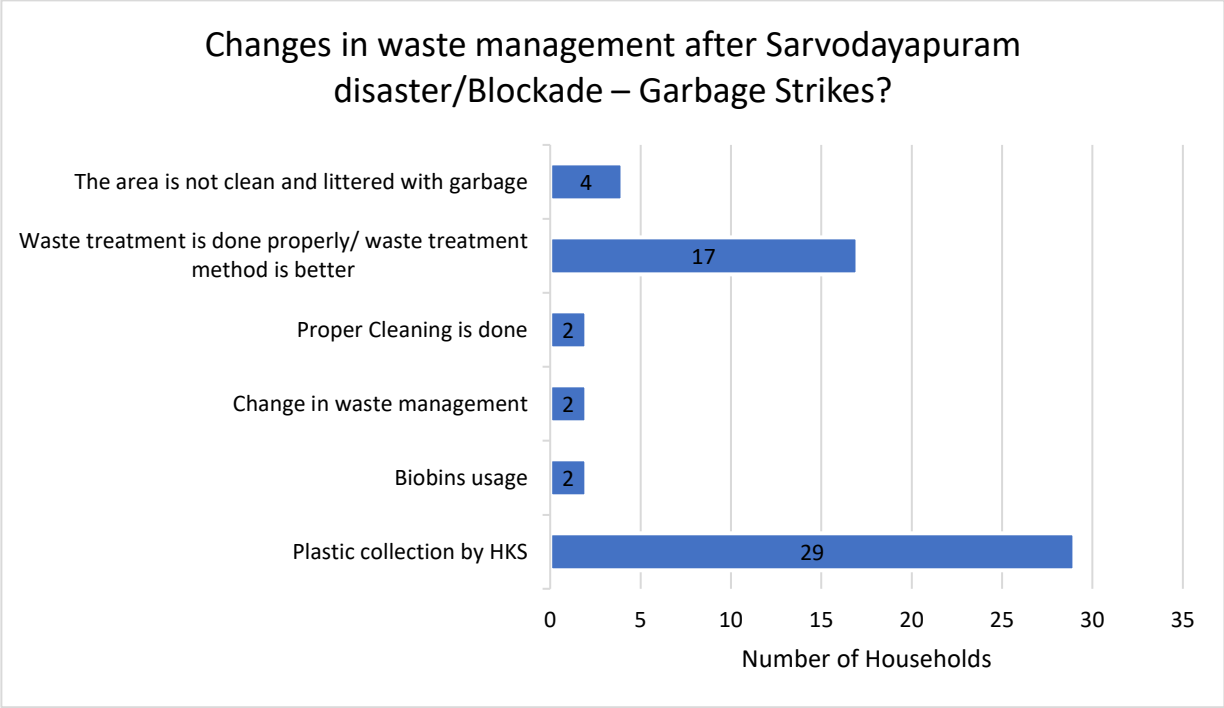

Figure 86: Type of change in SW management services post garbage crisis in Sarvodayapuram

Respondents were asked if they (households) had to change their household level solid waste management practices after the blockade/garbage strike in Sarvodayapuram. For this, 359 responses out of 380 sample size were recorded. As shown in figure 87, merely 12% responded with an 'yes' whereas majority of the respondents (59%) were not aware of any such changes.

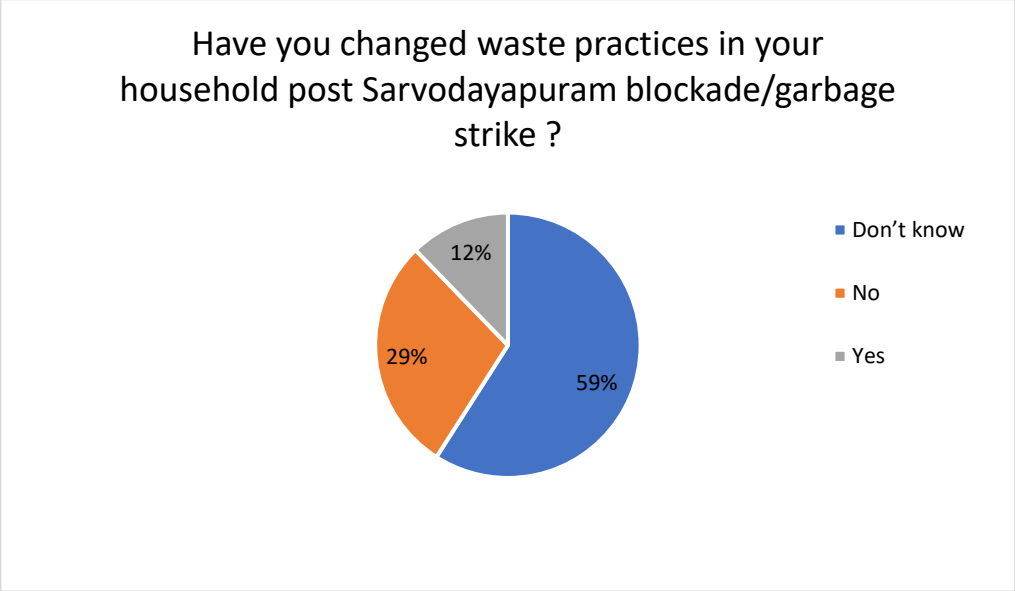

Figure 87: Change in SW household practices post garbage crisis in Sarvodayapuram

We compared the perceived changes in SW household practices post blockade/garbage strike with the house ownership, and class, caste, and religion. For house ownership status, we received 359 responses out of 380 sampled household. As expected, higher percentage of respondents having rented housing were not aware of the changes in household level SWM practices post garbage crisis (figure 88). These respondents and their families may have moved to Alappuzha after the crisis.

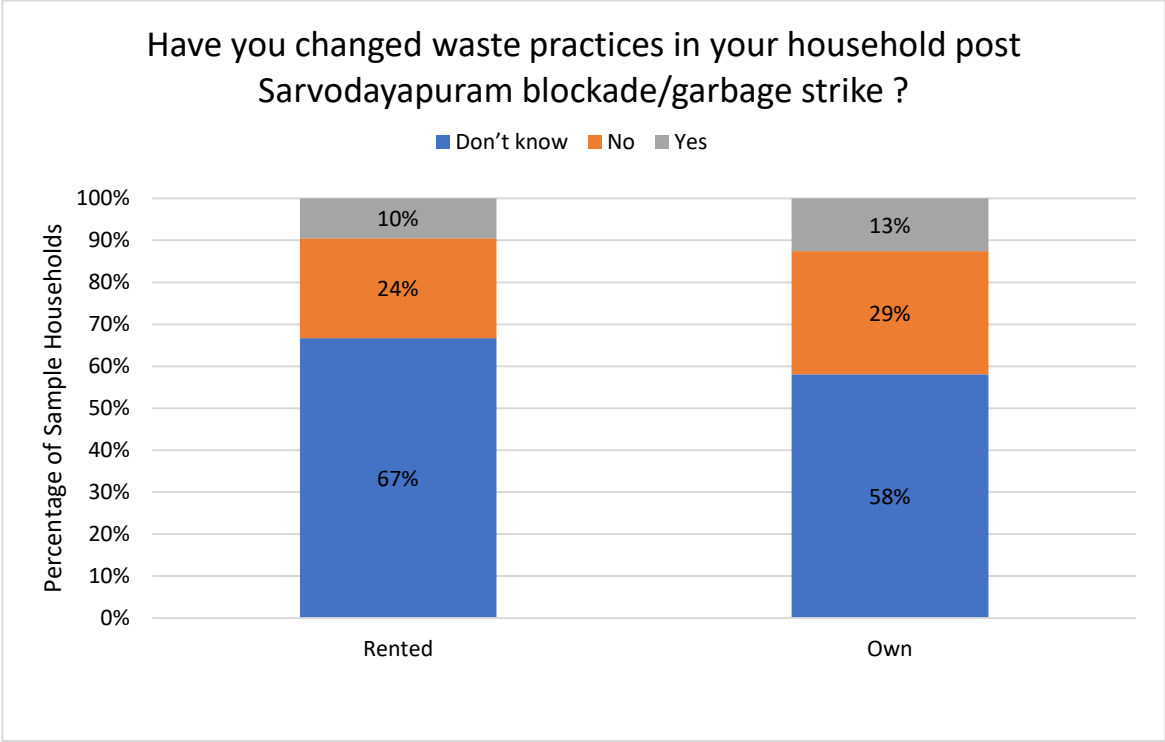

Figure 88: Changes in Household Practices post Garbage Crisis and House ownership

We compared the perceived changes in SW household practices post blockade/garbage strike with the respondent's sex considering majority of the respondents identified as females and in majority of the households the female family members primarily perform SW related work.

As shown in figure 89, a higher percentage of the female respondents were unaware of household level SW practices post crisis. A higher percentage of male respondents reported to have changes in the household practices post crisis. Upon asking to elaborate their response "Yes", majority of the female respondents as compared to the male respondents talked about plastic waste being given to HKS members.

The higher percentage of the female respondent not noticing any change could be related to the types of changes in the household practices that were introduced post garbage crisis by the government. Those who noticed some change referred mainly to the introduction of kitchen bins and community aerobic bins. This needed segregation at source and depositing of segregated waste to the community units. However, typically Kerala households especially female members were already practicing waste segregation before the introduction of segregation practices and technologies. Since male members were expected to deposit waste to community aerobic bins, the changes in practices post crisis perhaps were felt more by the male family members than the female members.

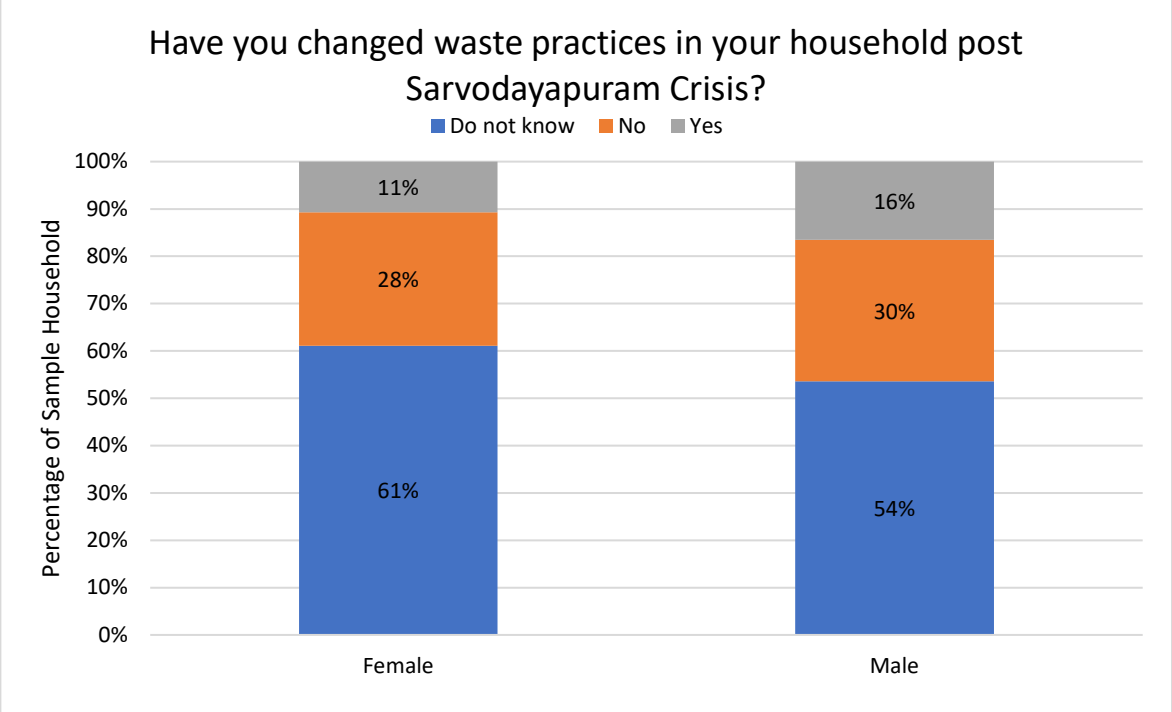

Figure 89: Change in SW household practices post garbage crisis in Sarvodayapuram and Respondent's Sex

5.3.5 Effect of COVID-19 Lockdown

The Covid-19 lockdown led to a disruption of many of the public services including solid waste collection. Respondents were asked questions to capture their experience during the period.

We obtained 376 responses out of 380 sample households. 70% of the respondents did not find any changes in the waste collection services during the COVID- 19 lockdown whereas 10 % of the

respondents were not able to respond to this question. 23% of the respondents did find changes in the waste collection services; the majority of them reported the failure of the collection system as HKS did not visit houses.

Upon asking if there were any changes in household waste management activities change in the SARS COV19 Virus lockdown period, 89% responded with 'No' and 7% with 'don't know'.

We compared these results with respondent's sex, and class, caste, religion.

The results show that 27% percentage of male respondents as compared to 22% of female respondents noticed an impact of the COVID lockdown on SWM services (figure 90). However, opposite results were obtained when asked to respond to 'if there were changes in the household SWM practices' (figure 91). Relatively higher percentage of female respondents (5%) as compared to their male counterparts (1%) were aware of the impact of lockdown on the household level SWM practices.

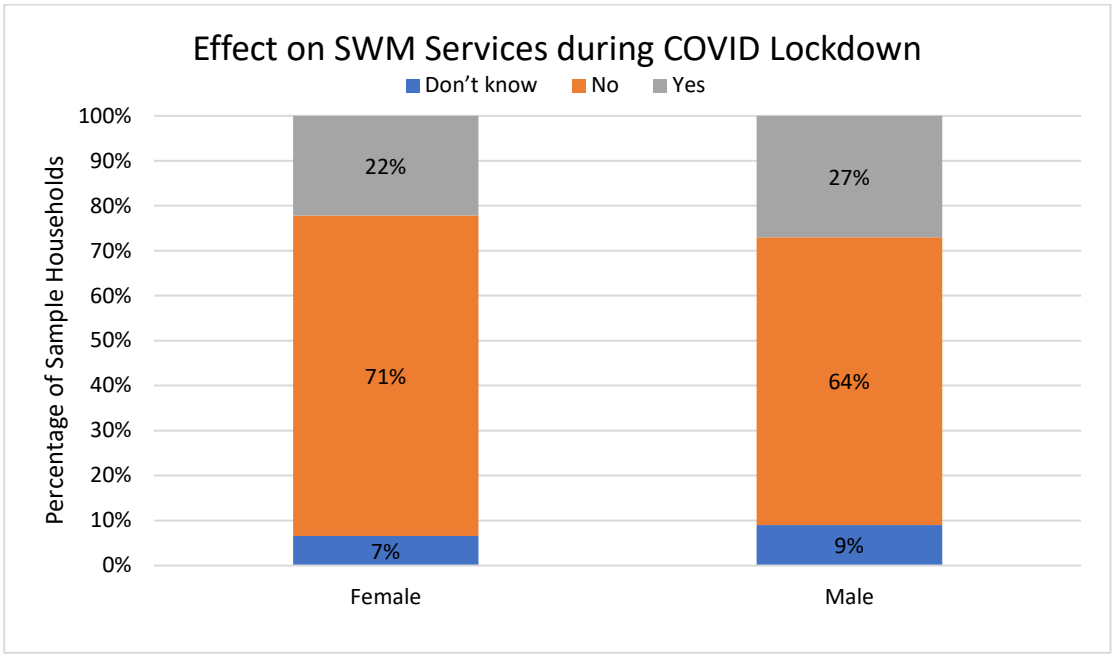

Figure 90: Effect on SWM Services During COVID Lockdown and Respondent's Sex

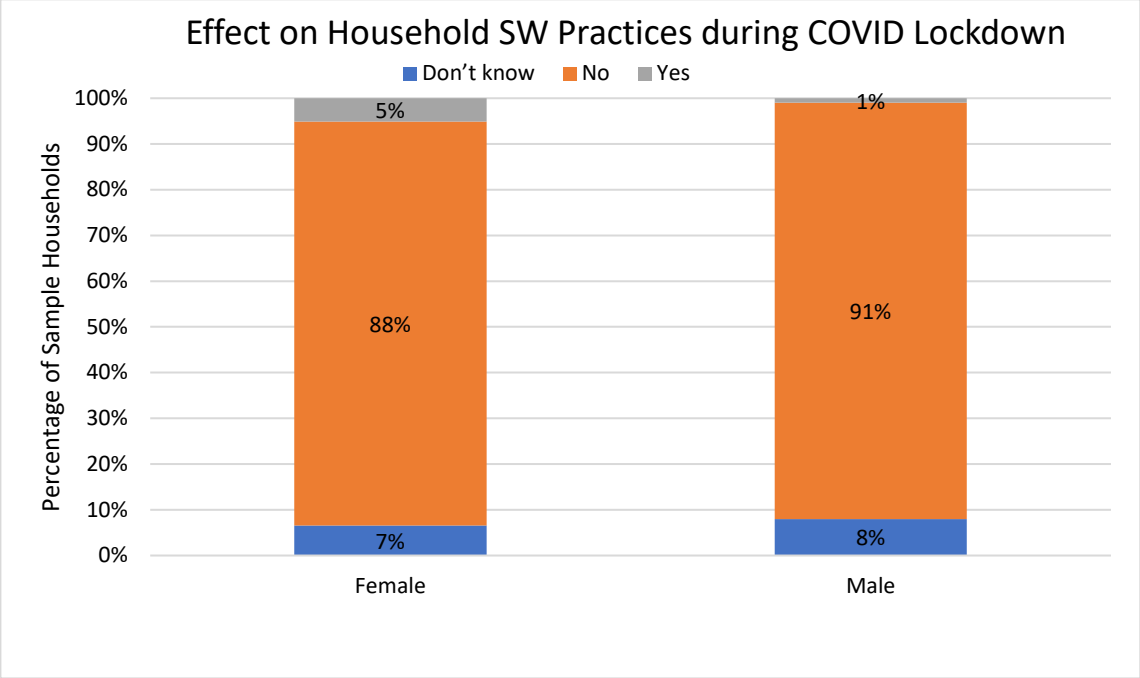

Figure 91: Effect on Household Level SWM Practices During COVID Lockdown and Respondent's Sex

As shown in figure 92, among different category homes, higher percentage of SC, Muslim and non-priority homes felt the change on SWM services during COVID lockdown. Prior to the lockdown, SC and Muslim categories households were having relatively poor services in terms of door-to-door collection, third party involvement and usage of community aerobic bins, the lockdown related changes in the services may have affected them the most.

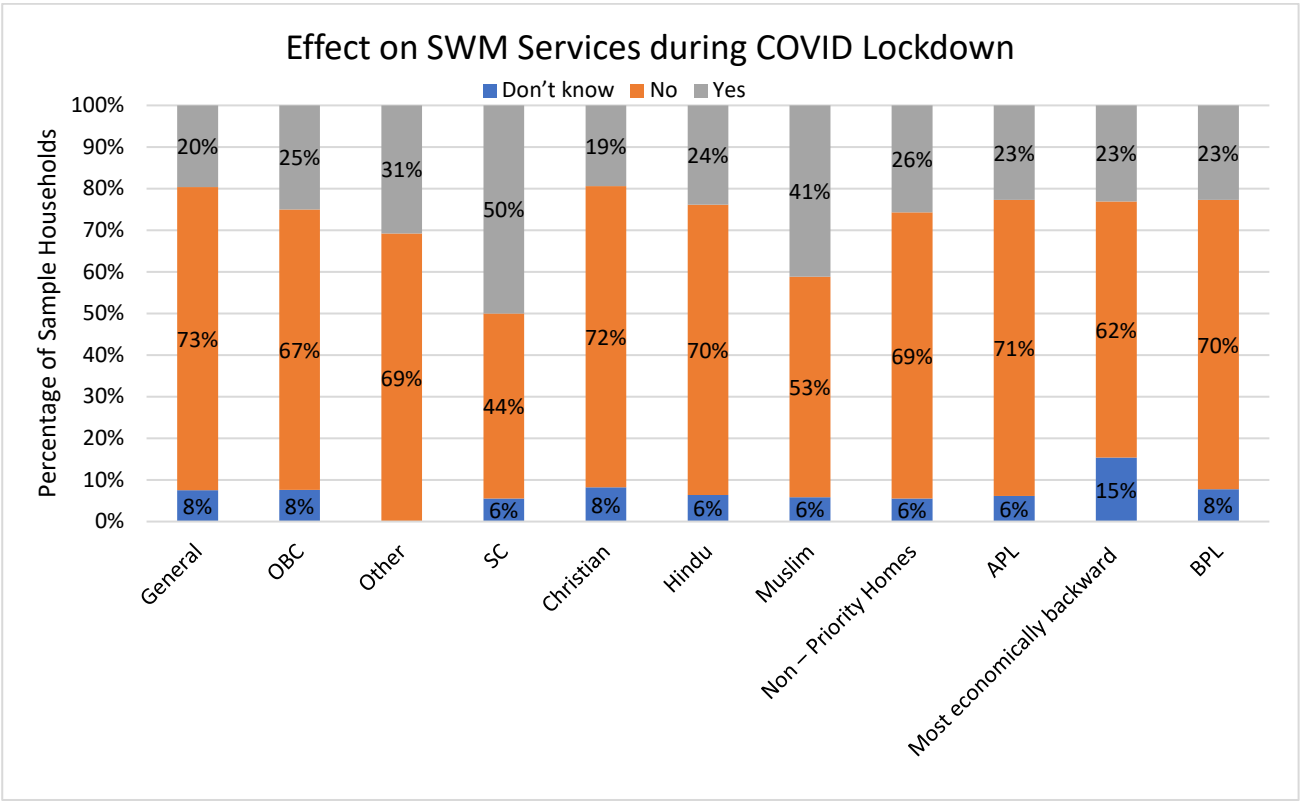

Figure 92: Effect on SWM Services During COVID Lockdown – Class, Caste and Religion

Change in household level services during COVID lockdown services was felt by higher percentage of OBC, Muslim and APL, non-priority homes (figure 93).

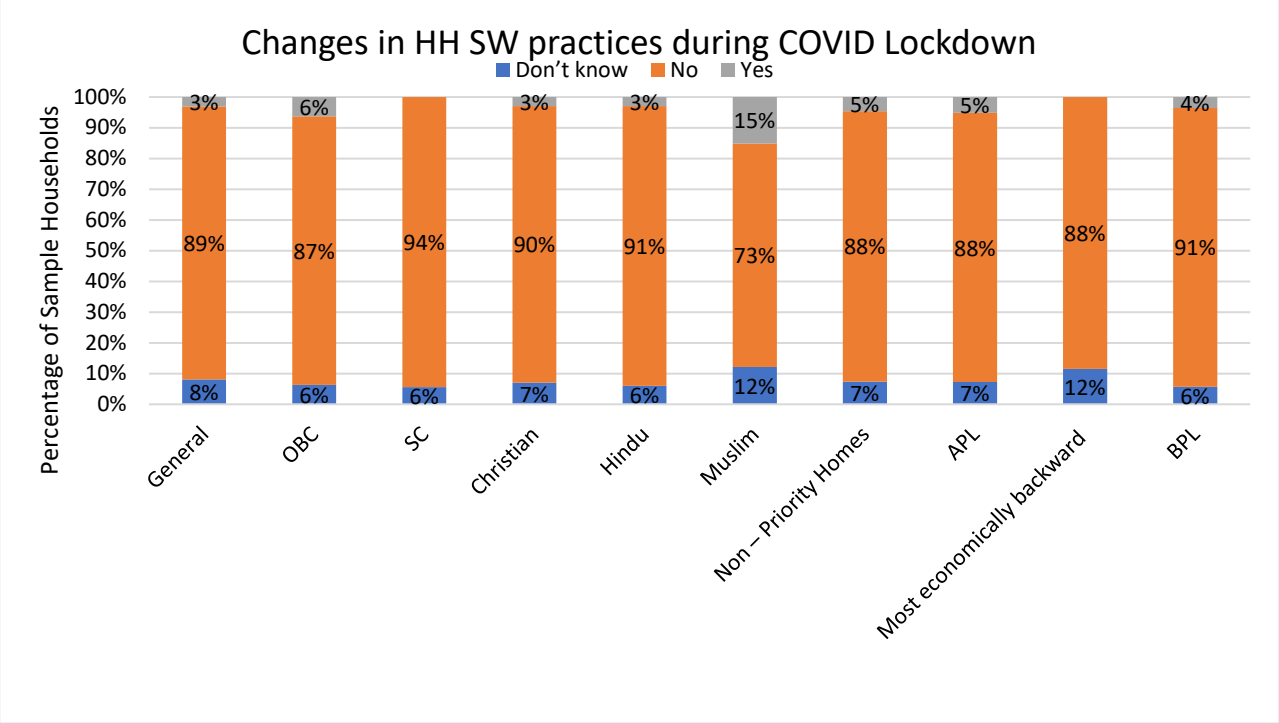

Figure 93: Effect on Household Level SWM Practices During COVID Lockdown – Class, Caste and Religion

6. Discussion

A household survey (n=380) was conducted in two wards of Alappuzha municipality to capture household level solid waste management practices in relation to socio-economic status (class, caste and religion). Respondents' perceptions regrading level of services post Sarvodayapuram garbage crisis and during COVID lockdown were also recorded. The current section discusses key findings.

Starting with the very first component of the waste value chain i.e., waste segregation, 94% of the households reported to be following this practice. Regarding the wet (kitchen) waste management practices, although many do not have easy access to community aerobic bins, the survey households seem to be performing rather well. 90% of the households manage their kitchen waste through number of ways. The higher reliance on 'disposal within building premises' method is perhaps due to cultural practices and/or prevalence of independent housing units having enough open land in Alappuzha town. Furthermore, sampled households have less reliance on the decentralized technology options such as biogas, and kitchen bins which seems to be more of an access issue and then preference. The low reliance on biogas plants as a disposal method is also not related to the vacant land available required to setup such units. Comparing different kitchen waste disposal methods with empty land available at household level revealed non-conclusive relation between the

two variables. These findings make a case for not needing technical solutions for managing segregated household kitchen waste when the same can be managed at negligible cost and expertise specifically in context of small towns with individual independent housing system, and when the aim is not to produce market quality compost/manure. The mixed waste is primarily taken to or deposited to the community aerobic bins. Some burn their mixed waste.

The plastic waste management in comparison to management of other dry wastes, both households and the municipality are relatively performing well. The door-to-door collection is available for 96% of the sampled households, and rest of the households deposit their waste to the community aerobic bins. Except for few households who reported delays in collection and demanded decrease in the user fee, most of the households reported to be having no issues with either HKS workers or their services. Malpractices are reported to be lowest for metal waste perhaps as it fetches better selling prices. The occurrence of malpractices is highest for medical waste, electronic, electric, and glass waste. We also noticed worrisome trend of large number of households not knowing how glass and medical waste is being managed.

For almost all types of dry waste, we found possible relationship between the higher occurrence of malpractices, limited or no door-to-door collection services, and higher dependency on the community aerobic bins. Further, for management of dry waste heavy reliance on the third party (HKS, scrap dealers, informal collectors, private company) by households is observed. Reliance on HKS is maximum for plastic waste and polythene waste management whereas for valuable waste like paper, cardboard, metals, electronic, electric, the households primarily depend upon the scrap dealers.

The study throws interesting insights between solid waste management practices and social structure - caste, class, religion, house ownership, education, and gender.

Among different socio-economic categories, study could identify Below Poverty Line, most-economically backward (ration card types), Other Backward Classes, SC/ST (caste categories), and Muslim households (religion categories) having lowest education levels, relaying upon uncertain occupation like daily wage employment, and lack of home ownership. These sections were also found to be on the margins with respect to many of the solid waste management practices and services. For example, less prevalence of waste segregation practices, poor management of most of the dry waste types is found in households belonging to these categories. In terms of services, lower door-to-door collection, lower access to kitchen bin and biogas, and limited usage of community aerobic bins was found in households belonging to these categories. While poor practices at household level could be due to lower education levels, the poor services could be due to exclusion or the fact that majority of the respondents belonging to these categories stay in rented home. The distance to community aerobic bin(s) seems to be playing little role in deciding its usage. For example, Muslim households seem to be clustered nearer to a community aerobic bin but its usage is low. The poor or lack of services for these category households is reflected in their response to questions on quality of services in general and during COVID lockdown. Majority of households belonging to these categories were relatively less satisfied with both waste collection services and neighbourhood cleanliness. Similarly, higher percentage of these category households found no or limited changes

in the services post Sarvodyapuram waste crisis. As expected, higher percentage of respondents having rented housing were not aware of the changes post waste crisis.

Analysis of gender dimension in waste management practices led to some interesting revelations. As expected, 86% of the sample households practicing waste segregation have female members as the primary responsible person for the waste management. The role of females does not stop at the household level. The Harith Karma Sena (women-led local government initiative), new institutional innovation post waste crisis, clearly forms the backbone of the municipal services such as plastic waste management. Understandably, majority of the households who reported to be satisfied with the current waste management services and improvement post waste crisis credited it all to either to HKS or their own efforts.

Interestingly, gender analysis proved to be critical in explaining households' response to government's waste management innovations like kitchen bin and community aerobic bins that were introduced post Sarvodyapuram crisis. Majority of the female respondents did not feel any changes in the waste practices after introduction of these innovations. This could be due to two reasons. As mentioned previously, it's the female members that are primarily responsible for household level waste management, by extension kitchen bin became their responsibility. However, female members in a typical Kerala household were already practice waste segregation, thus may have not felt any change in the waste practices after introduction of segregation practices and kitchen bins. On the other hand, in a typical Indian household anything that requires visit outside of the house or travelling to a distance, as in the case of community aerobic bins, it becomes male members' responsibility. Hence, the changes in practices after introduction of innovations perhaps was felt more by the male respondents than the female respondents.

Furthermore, male and female respondents perceived COVID lockdown and its impact on household practices differently. Higher percentage of female respondents as compared to male respondents felt changes in the household practices during COVID lockdown. This could be because COVID lockdown led to limited or no municipal services which placed additional burden on the female members of the house. Further, during lockdown people were home, which would perhaps lead to more cooking and more waste generation.

Despite how important women are in waste management, they work for wages lower than their male counterparts (observed in case of HKS) and are primary decision makers in only 24% of the sample households.

Based on the above discussion, we suggest government interventions ensuring better door-to-door collection services and access to decentralized technologies for Muslim, and priority category homes. Awareness generation campaign on waste segregation targeting above category homes can be planned. Authorities need to devise processes and solutions for safe disposal of medical waste, glass waste and medical waste.

7. CONCLUSIONS

Alappuzha witnessed a change in waste management and governance regime change from centralized to decentralized to tackle the Sarvodayapuram garbage crisis. The new approach warranted innovations in technology, institutions, new form of labour and behavioural practices. Our household survey shows that technical innovations like kitchen bin and biogas plants at household level were relatively irrelevant in case of Alappuzha as majority of the households had already been engaged in primary level of composting or manuring. This seems to be related more with the prevalent culture practices and less with the available vacant land. However, lack of access to these technologies to priority and Muslim settlements is an issue of exclusion. Community aerobic bin usage for wet waste is lowest indicating that perhaps these are more useful for public places rather residential settlements for households are already engaged in some level of wet waste management. Institutional innovations specifically creation of new form of labour i.e., HKS seems to be instrumental in plastic waste value chain. In other kind of wastes, scrap dealers play critical role. The third parties (HKS, scrap dealers, informal workers, private companies) currently managing (collection) major chunk of the dry waste. Along with these, the women of the households are also key actors in the waste chain. The three actors are like extended human (people) infrastructure who despite working in precarious conditions make-up for the lack of infrastructure in the town.

REFERENCES

- Department of Economic and Social Affairs. (2005). Designing Household Survey Samples: Practical Guidelines. New York: United Nations.
- Government of Kerala. (2012). Housing Condition and Amenities in Kerala, July2008-June2009.
- IIT Mumbai. (2022, July 22). 'Appropriate technology' to tackle the crisis of solid waste: Challenges in aerobic bins, Alappuzha. Waste of(F) Life. Retrieved from https://lifeofwaste.com/2022/07/27/appropriate-technology-to-tackle-the-crisis-of-solid-waste-challenges-in-aerobic-bins-alappuzha/

ANNEXURE I : KERALA RATION CARD TYPES

Kerala ration cards spot four different colours. Types of ration card in Kerala are tabulated below:

Ration Card Colour	Beneficiaries	Subsidy On Foods and Commodities
Yellow Card	Most economically backward section of society. Antyodaya Anna Yojana Beneficiaries	35 kg of Food Grains completely free of cost • Rice – 28Kg • Wheat – 75 kg
Pink Card	Priority or Below Poverty Line (BPL)	5 kg of Food Grains completely free for each member of the family. • Rice – 4Kg • Wheat – 1Kg
Blue Card	Non – Priority subsidy or Above Poverty Line (APL)	2 kg rice at Rs. 2 per kg per person
White Card	Non – Priority	• Rice – 8.90 Kg • Wheat – 6.70 Kg