

**PROBLEMS AND CHALLENGES FACED BY WORKERS ON SOLID
WASTE MANAGEMENT IN CHALAKUDY MUNICIPALITY**

Dissertation

*Submitted to the University of Calicut in partial fulfillment of the requirement
for the award of the Degree of Master of Arts in Economics*

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CONTENTS

CHAPTER NUMBER	TITLE	PAGE NUMBER
1	DESIGN OF THE STUDY	1 - 12
2	LITERATURE REVIEW	13 - 18
3	OVERVIEW OF THE STUDY	19 - 29
4	DATA ANALYSIS & INTERPRETATION	30 - 49
5	FINDINGS, SUGGESTIONS & CONCLUSION	50 - 54
	BIBLIOGRAPHY	
	APPENDIX	

LIST OF TABLES

TABLE NUMBER	TITLE	PAGE NUMBER
1.1	Source of solid waste	5
3.1	Demographic details of Chalakudy	28
4.1	Waste collection calendar of HKS in Chalakudy municipality	32
4.2	Details of municipality waste worker in Chalakudy	33
4.3	Description of sample respondents	34
4.4	Basic profile of respondents	35
4.5	Nature of duty of waste workers	36
4.6	Waste collection source of garbage pickers	37
4.7	Number of hours spent for waste collection	37
4.8	Types of vehicles used for waste collection	38
4.9	Days preferred for waste collection	39
4.10	Distance travelled for waste collection	39
4.11	Type and quantity of waste collected	40
4.12	Sale of collected waste	41
4.13	Observed morbidity prevalence	42
4.14	Reported morbidity prevalence	42
4.15	Musculoskeletal morbidity	43
4.16	Category wise observed morbidity prevalence	44
4.17	Observed morbidity group statistics	45

4.18	Category wise reported morbidity prevalence	46
4.19	Reported morbidity group statistics	47
4.20	Category wise musculoskeletal morbidity	48
4.21	Musculoskeletal morbidity group statistics	48

CHAPTER 1
DESIGN OF THE STUDY

INTRODUCTION

Every human activity creates waste in one form or another. Due to Population increase and unplanned urban development, unlike in the past, a Slight mismanagement of waste will invariably damage human health and Environment. The world over, accumulation of solid wastes is creating Numerous problems. Experts are yet to find out productive solutions to the Ever-growing solid waste issues. Most of the technological options put forward For waste treatment and disposal are either impracticable due to many reasons Or just transform waste in one form into another.

The quantum of waste generation in most of the countries is unmanageably huge and is increasing Constantly. Moreover, the waste composition is unpredictably changing, leaving The major portion non-biodegradable waste. In all walks of life, people are Speaking about sustainable development but, in Solid Waste Management, Sustainability remains as a distant dream. In urban areas, issues related to solid wastes are intensified due to high Density of population and unplanned development.

Especially in developing Countries, where resources are limited, waste problems are really burning Issues. In Kerala, Municipal Administrations do not have the required Technical support and resource backing; they fail miserably in managing Solid wastes in Municipal limits. In spite of highly educated population here, The efforts of Municipalities in managing waste often meet with failure. It Seems that the 'NIMBY Syndrome' (Not In My Backyard) is ruling the Municipal areas in the State, where the slogan 'waste generators are Responsible for waste treatment and disposal' has not yet reached the hearts Of the people. All success stories of Municipal Solid Waste Management may Be traced to public participation. But, in Kerala, people are escaping from Everything by just casting the whole responsibility of waste collection, Transportation, treatment and disposal upon the Municipal Administration. So, Solid Waste Management is a highly misunderstood subject in the State.

The Municipal Administrations are rightly expected to supervise the functions of Solid Waste Management and they should not be brought down to the status of Mere waste collectors, transporters or treaters. Amid serious discussions on Who has to manage solid wastes, the waste levels in Municipalities of Kerala Are growing like anything, contaminating fresh air, water and ecology. Municipalities account for a quarter of solid wastes generated in Kerala. Rapid urbanization, changing life styles, and scarcity of free space for waste treatment and disposal have made solid waste issues sky-high. Above all, a Highly sensitive population and unwanted

political interference propelled the Solid waste issues to alarmingly unmanageable levels. Rapid urbanization And increased population density, coupled with improper waste management, Make the State of Kerala a breeding place for a variety of life-threatening, Rare diseases. It is reasonably suspected that mismanaged solid wastes are Directly or indirectly responsible for this situation. Undoubtedly, these life-Threatening diseases will crumble the economic backbone of thousands of Poor people living in the State. A much talked-about subject, Integrated Solid Waste Management (ISWM) has to find out solutions to the manifold Problems of MSWM.

Management of Solid Waste (MSW) is one of the major problems Faced by the countries worldwide. In developing counties rapid increase Of solid waste is produced as a result of rapid population increases, Urbanization, rapid industrialization and economic sustainability. The Challenges in urban areas are diverse and enormous in a global point of view, But looking at the developing countries, particularly in the cities, an Inadequate waste collection and its inefficient management systems are The causes of serious urban pollution and risks to public health and Environment.

Waste is a complex mixture of different substances that are Discarded by households, individuals or organizations that are harmful to The environments and health. Waste management consists of collection, processing, transport and disposal of solid waste. Rapid populations cause Increases of municipal solid waste in developing countries, economy, Urbanization and high-level living standards of an individual or community. Municipal authorities are responsible for waste management in the Municipalities. They implement measures to ensure an effective and Efficient way to manage solid waste, facing challenges that are beyond Them to tackle.

The total amount of MSW generated globally is estimated at about 1.3 billion tones per year, which is expected to increase to approximately 2.2 billion tones by 2025. There is a strong positive correlation exists Between a nation's Gross Domestic Product (GDP) and the solid waste Generation by its citizens: as GDP increases, so does the per capita Generation of solid waste. The more wastes created, the more area is Required for disposal. This problem in turn affects the environment and The health of ecosystems and biodiversity.

The biodegradable portion of solid waste contributes approximately 5 percent of Green House Gas (GHG) emissions in the last decade. Electrical and electronic equipment waste, sometimes

called “e-waste”, Often contains complex, hazardous substances which may have deleterious Impacts on human health and the environment. Hospital and veterinary Waste can include substances with significant implications for ecological, Animal, and human health impacts. While there are differences in waste composition and per capita volumes between low-income countries and High-income countries, a common truth is that the appropriate management Of MSW is one of the most important considerations for any city.

Municipal Solid Waste Management (MSWM) has been undertaken With many drivers worldwide over the years. The principal objectives of MSWM were gradually developed to protect environmental issues, Health safety, and resource conservation, challenges of MSWM as a Result rapid generation of waste due to population growth, lifestyles of People, development and consumption of less biodegradable products. In developed or developing countries waste management has its Challenges, as developing countries waste management will be achieve Focusing on economic, population growth and environmental issues.

Waste Management in Europe is highly diverse. Main disposal technologies and Recycling and recovery rates are different. France, Netherlands, Germany, Denmark, Belgium, Luxembourg and Sweden traditionally rely on Incineration for waste management. UK, Portugal, Spain and Greece landfill Nearly all their MSW. Most newcomers in the EU also landfill their MSW. Latin American generates about 369,000 tones a day of municipal Solid waste, 56 percent of it in large urban centers, 21 percent in medium-Size ones, and 23 percent in small ones. The total per capita rate of waste Generation is about 0.8 kg/p, though it can exceed 2.4 kg/p during peak Tourism seasons in some municipalities.

In developing countries solid waste management has become an Issue of concern to health risk due to uncontrolled landfills causing Contamination to drinking water and soil. To improve the system of waste Management there should be legal framework guiding it, collection and Disposal are one main key principle. Infrastructure and detailed of waste Data must be put in place.

ASEAN countries have a combined population of approximately 625 million people, which account for 8.8 percent of the world’s Population. The population is projected to be increased to 650 million by 2020, more than half of this total population will be living in urban areas. The per capita Municipal Solid Waste (MSW) generation in ASEAN Is 1.14 kg/capita/day. In terms of total annual MSW generation, the order Is as follows: Indonesia generates the highest

quantity of municipal waste With 64 million tones/year, followed by Thailand (26.77 million Tones/year), Viet Nam (22 million tones), Philippines (14.66 million Tones), Malaysia (12.84 million tones), Singapore (7.5 million tones), Myanmar (0.84 million tones), and Lao PDR generating the lowest Quantity of MSW at 0.07 million tones/year.

The growing problem of SWM due to population growth is not Dealt with effectively as the municipal laws governing the urban local Bodies do not have efficient and competent provisions to handle this growth. Rapid urbanization is augmenting this problem, thus making it Critical. The average rates (0.5–0.99 kg per person per day) of waste Generation are higher in India as compared to those (0.1–0.49 kg per Person per day) in low-income countries worldwide and much lower than The developed economies (greater than 1.5 kg per day) of the world.

As per the estimation of The Energy and Resource Institute (TERI), New Delhi, the waste generation exceeds 260 million tones per year by 2047, which is more than five times the current level in India. Cities with A population over 100,000 are the major contributors (72.5 percent) of Total waste generated in the country as compared to the 3955 urban Centers which produce about 17.5 percent.

The 2011 Census of India estimated a population of 1.21 billion which Is 17.66 percent of the world population. In the context of growing Urbanization and the related rising personal income and standard of living, Volume of solid waste is also increasing in India. It has been estimated that About 1.45 lakh metric tone per day or 53 million metric tone per annum Of solid waste is generated across the country, out of which only about 34 Percent is being treated/processed scientifically, which is still quite low Compared to international standards. Sustained efforts under SBM have Yielded significant positive results.

The data report indicates that 366 cities in India, which represent 70 percent of India's urban population were generating 31.6 million tones of waste in 2001 and are currently generating 47.3 million tones (2011), A 50 percent increase in one decade. India has undertaken several waste Management programmes. In 1999, the Government of India restructured The Comprehensive Rural Sanitation Programme and launched the Total Sanitation Campaign (TSC) which was later (on 1 April 2012) renamed Nirmal Bharat Abhiyan (NBA).

In India, out of 84,358 wards, 67485(80%) now have 100 percent Door-to-door waste collection as on 2018 September. 88.4 megawatts (MW) of energy is generated from Waste-

To-Energy (WTE) projects in the country. The waste-to-compost production stands at 15,06,501 Metric tones. Notwithstanding the success of SBM, municipal solid Waste management continues to be a critical challenge for our cities, Especially managing its continuous and increasing flow on a daily Basis.

The challenge Is to convert the huge garbage hills or solid waste pyramids to inverted pyramids, so that landfill requirement is Minimized. The principle of 4R's- Reduce, Reuse, Recycle and Recover Will have to be at the Centre of any strategy on scientific disposal and Management of municipal solid waste. ULBs need to enforce SWM Rules 2016 effectively by using bio-remediation, bio mining and constructing Engineered landfills for scientific disposal of urban waste.

In the case of Kerala, about 8000 tones of garbage is being produced Everyday, of which 7 percent is plastic waste. Kerala has launched a Clean Kerala Mission in 2002, with the objective of creating garbage free Kerala. One of the initiatives of Kerala Government in 2016 was “Nava Kerala Mission”. Municipal Solid Waste (Management & Handling) Rule, 2016 Envisages segregated storage of waste at source, protected transportation To the treatment facility collection from source, safe disposal of inert Rejects and establishment environmentally safe treatment system and its Operation and maintenance.

In Kerala there has been significant importance Given to implement the MSW Rule 2016. Studies indicated that 70-80 percent of the total waste generated is biodegradable in nature and These putrescible waste needs to be managed within 24 hours. 23 percent By the 53 Municipalities, 13 percent of the waste is generated by the five City Corporations and the rest by the 999 Gram Panchayats. It is clear that General waste contributes a higher percentage among the other waste Materials.

Table 1.1 : Source of solid waste.

Household waste	49 %
Hostels/Marriage halls/Institutions	17 %
Shops & Markets	16 %
Street sweeping	9 %
Construction	6 %
Slaughter house/ Hospitals	3 %

(source: survey data)

Current waste generation rates and waste characterization details of Kerala as derived through the detailed studies and analysis by KSWMP is Given that the total solid waste generation in the State is around 8000 to 10000 tone per day. For the year 2020 the total waste generation for the 93 Urban Local Bodies (Municipalities plus Corporations) in the State is Estimated at around 3755 tone per day.

OBJECTIVES OF THE STUDY

- 1) To Enquire Into The Effectiveness Of Managing Solid Waste By Chalakudy Municipality.
- 2) To Study About Socio Economic Condition And Occupational Health Hazards Of Waste Workers In Chalakudy Municipality.
- 3) To Propose Practical Solutions And Strategies To Improve Solid Waste Management In The Chalakudy Municipality.

METHODOLOGY

The present study is based on both primary and secondary Sources of data.

1. PRIMARY DATA

Primary data were data that have not been previously published, i.e. The data is derived from a new or original research study and collected at the source. It is information that is obtained directly from first-hand Sources by means of surveys, observation or experimentation.

2. SECONDARY DATA

The data which were already collected by someone and is either published or unpublished report and/ or document used or obtained by third person without carrying any field work.

This study Mainly focused on the field enquiry conducted through well structured questionnaire with 150 randomly & conveniently selected samples from Chalakudy Municipality. In the context of studying problems and challenges of solid waste management (MSWM), utilizing a mixed method strategy is beneficial. This approach integrates both qualitative and quantitative methods within a single study.

This study examines the role of different groups in managing solid waste in Chalakudy municipality. The participants were divided into four groups: Nordic waste buyers,

Municipality workers, Haritha Karma Sena (HKS), and Landfill site workers. Data was collected from Municipality records and analyzed using the SPSS package of Version 21.

The study also asked about demographic characteristics, socioeconomic conditions, family income, sources of income, education level, and possession of domestic amenities. Simple statistical tools like mean value, standard deviation, and regression analysis were used to analyze the data.

SCOPE AND IMPORTANCE OF THE STUDY

Being a consumer state, Kerala is depending on the neighboring states For all its needs. Further, it is fast becoming a world tourist Centre because of Its natural beauty. It is assumed to have a developed modern society with Comparatively unique social development indices than other Indian states. The Fast-changing life styles of the people in Kerala make solid waste composition extremely vulnerable. Though ranked as a top layer State based on many indices, its solid waste efforts are far below the accepted standards. There is an Urban-rural continuum with even the rural areas displaying distinct urban Characteristics like high population densities and composite primary and Tertiary occupation structures (KSIDC).

The efforts of the Government for an organized MSWM are not hitting the target because of lack of commitment of People who are in the clutches of the ‘NIMBY Syndrome’ (Not in My Backyard),carelessly throwing away waste to streets and water bodies. In Kerala, Household sanitation level is very high but, environmental sanitation level is Surprisingly low. Unplanned disposal of solid waste seriously contaminates the Air and fresh-water sources in Municipal Limits. On the other hand, Municipal Authorities do not possess the required expertise and professionalism to tackle The ever-mounting waste issues.

A group of Government servants, called ‘Health Wing’ in each Municipality, is performing solid waste operations Without proper training and technical knowledge. The issues are too big to be Handled by them who try to resolve the problems with a weak resource base and technical support.

The State accounts for one per cent of the area of India but contains about Three per cent of the country’s population. The population density of the State is About 859 people per square kilometer, three times the national average. So, it is One of the densest States in the country. Hence, extreme scarcity of free space For landfilling waste adds fuel to the fire. Hence, some urgent steps are highly Needed from authorities as well as stakeholders to bring the waste

situation of Urban areas under control with proper collection, treatment and disposal, so that, In future, the urban centres of Kerala should be known for its cleanliness.

Now, In Kerala, the pace of urban growth is undergoing a rapid explosion on a scale Totally unpredictable. From 2001 to 2011 the State witnessed a decadal growth Of 92.72 per cent on urban population, whereas the rural population has declined By 25.96 per cent. The huge growth in urban population during the past decade Could be attributed squarely to the manifold increase in number of towns in the State between 2001 to 2011, from 159 to 520. Currently, 47.72 per cent of the Total population of Kerala dwells in urban areas (Census 2011). This is on a par With global figures.

Considering the current scale of migration from rural to Urban areas, within the coming fifty years, Keralites will become predominantly an urban species. Municipalities in Kerala account for almost one-fourth of the Total solid wastes generated. Official estimates indicate that Kerala generates 8338 tons of MSW every day (updated as on 31st July 2012) (CPCB). The Higher the urban population, the greater the amount of wastes generated. In the Context of these major issues, this study is conducted to throw some light on the MSWM operations and issues of Chalakudy municipality and to act as A torch-bearer for policy making.

The study attempts an evaluation of the awareness levels of the public Regarding the different aspects of SWM. It also studies the effectiveness of the Different methods used by Municipality workers and other agencies to collect, treat And dispose of solid waste in Municipal limits. Further, environmental degradation, air pollution, water pollution, noise pollution and health problems Created by mismanaged solid wastes are also evaluated. The major problems Faced by the public as well as Municipalities due to improper SWM are examined.

RELEVANCE OF THE STUDY

Any type of man-made development should be sustainable and should Not hinder the balance of the environment. Cautious efforts are highly demanded For making the fast-depleting resources available for the future generation also. Human activities essentially generate waste. Unprocessed waste creates immense Environmental damage and health problems. Sensing the potential problems Solid Waste Management can cause, developed countries evolved a variety of solutions to treat and dispose of waste with minimum harm to Mother Earth. In Kerala, Municipal Solid Waste Management is a much talked-about subject at present. People are slowly becoming increasingly concerned about the adverse effects solid

wastes can cause. It is becoming a very sensitive subject in the State for its high scale of vulnerability on environment and human health.

The issues have already become totally unmanageable and authorities are groping in darkness for an ultimate solution. Waste generators and waste managers are Blaming each other on their failure to manage a high altitude problem like MSWM. Official estimates indicate that Kerala generates 8338 tons of MSW Every day, but only 1739 tons are collected and treated (updated as on 31st July 2012) (CPCB). What is happening for the remaining 80 per cent of solid waste is a matter of big concern. So, the majority of MSW either remains uncollected or Untreated. Feeling the gravity of the solid waste menace and the potential health Threat it can exert on the inhabitants, the Government is coming forward with a lot Of corrective measures.

These positive changes will find result only if it is Supported by better awareness, participation of stakeholders, and active support From the public. Households, accounting for 49 per cent, are the major Contributors of the solid wastes generated in Kerala (KSIDC). Almost a quarter of the total waste generated in the State is contributed by the Municipalities. But, Waste Management is not yet considered as a high Priority area by Government, which extends only a handful of efforts to tackle The ever-mounting waste issues. This being an area which should be highly Prioritized by the Government, but currently receiving very little attention, a study based on the **PROBLEMS AND CHALLENGES FACED BY WORKERS ON SOLID WASTE MANAGEMENT IN CHALAKUDY MUNICIPALITY** is quite relevant.

STATEMENT OF THE PROBLEM

Waste Management is an essential service to be provided by municipal and local bodies. Failure of efficient delivery of solid waste services could be Disastrous. As far as Municipal solid waste is concerned, a major chunk of it emanates from households, hotels, schools, institutions, marriage parties, Slaughter houses and electronic sources. It is estimated that, on an average, over 8000 tons of Municipal Solid Waste is being generated across Kerala. The major Reasons for growing municipal waste generation are changing lifestyles and food Habits, changes in standards of living, fast economic development and Urbanization, and development of the tourism industry. Uncollected garbage Pileup and stinking waste all over the urban centres of Kerala is a normal sight today.

Uncontrolled waste accumulation and failure to adopt state-of-the-art Methods of waste management processes have serious consequences on the environment, public health and economy. Even though people are well aware About the problems and issues that improper

Solid Waste Management can create, They are highly reluctant to participate in the work for a Sustainable Solid Waste Management System.

In urban areas, as the commitment of people is too low, the Efforts of the State Government and Urban Local Bodies for an organized Solid Waste Management System are not hitting the target. Huge heaps of unsegregated wastes are quite common in the urban limits of Kerala. The slogan, Waste Generators are responsible for waste treatment and disposal has not yet reached The hearts of the people and they blame the Municipal Authorities for all issues Related with Solid Waste Management.

A complete and environmentally sound Solid Waste Management requires effective contribution from all those who are Involved in this problem. Everyone is part of the solid waste generation problem And everyone shall also be part of the solution of solid waste problem, that is, The solution depends upon collective human action and efforts. It is true that Municipalities lack professionalism and commitment in Solid Waste Management.

Besides, Municipalities in Kerala, which account for about 25 per cent of the total waste generated, are starving for funds and free space for Waste treatment and disposal. Hence, Municipal Solid Waste Management is Really a burning issue in a State like Kerala, where population density is Three times the national average.

It is a subject which needs the immediate Attention of the Government, different agencies and groups of people because Of the potential health threats and environmental damage it can cause. Sensing the heat of the problem, the State Government came forward with a Lot of campaigning and other measures to tackle the solid waste issues. But, These plans are not sufficient to address the issue of Solid Waste Management in the State. While general debates and experiments on Solid Waste Management continue, Kerala still stinks from village to village and from City to city.

Its water reservoirs and all spots of natural beauty are getting Affected as lack of organized Solid Waste Management system is causing Havoc to normal public life. Lack of proper service delivery in this essential Sector of Solid Waste Management results in the outbreak of epidemics like chickungunya , Dengue Fever, Malaria, Hepatitis and a series of other unknown life-threatening diseases in Chalakudy municipality.

The situation suggests the need to address the issue of waste management on a war-footing. Municipality are required to manage solid wastes generated in Municipal limits. According to the Municipal Solid Waste (Management and Handling) Rules 2000, all activities connected with management of collection, transfer, transportation, treatment and disposal of solid wastes in the respective Municipal limits are the responsibility of each Municipality. But, the

participation and support of public as well as various agencies like Residents' Associations, Self-Help Groups, NGOs, CBOs and Political Parties is essential, that is, collective efforts are fundamental to the success of MSWM System.

Hence, How effectively the Chalakudy Municipality are managing the collection, Transfer, transportation, treatment and disposal and to what extent they are Gaining support from public and other agencies are matters of major concern.

In this context, it is considered appropriate to conduct a study on the Effectiveness and on the problems of existing methods of Solid Waste Management of Chalakudy Municipality. The study also intends to gather Suggestions from the general public regarding the waste management Practices of various Chalakudy Municipality.

CONCEPTS

Waste is defined as any material that is generated by man, machine and nature by the day to day activities which do not have any immediate use and may or may not have any economic value. Depending on the physical state, wastes are categorized into solid, liquid and gaseous. This study looks only into the solid wastes which are generated from the areas under the urban local self government institutions. Chemical waste generated from industries and the medical wastes generated From hospitals are not considered for this study as it is not directly dealt by the urban local self government institutions.

Municipal Solid Wastes for this study is defined as the unwanted materials including both degradable and non-degradable objects generated from Households, markets, shops, restaurants, commercial establishments, Developmental activities and street sweeping in the urban centres of Kerala. These solid wastes include food wastes, paper, plastics, metals, glasses, leather Clothes, debris, plantain leaves, agro wastes, e-wastes etc.

The **Solid Waste Management** for this study is defined as a Systematic process of managing waste by the urban local self government Institutions starting from its generation, storage, segregation, collection, transportation, treatment and disposal. In addition to this, the management Indude implementation of innovative strategies for waste reduction, source Treatment and the recovery of wealth from it.

The study defines the **Waste Generators** as any person or institution or Commercial establishments, whose act or process produces waste. Here for the Purpose of the study, the waste generators are specifically identified as Households, shops, restaurants, hotels, markets, commercial establishments and Street sweeping.

LIMITATIONS OF THE STUDY

Limitation of the study is that the factors such as climate which affect the waste management differently especially during rainy season and the occasion like festival, strikes and public functions which generate huge quantity of waste in addition to normal Generation of wastes have not been dealt deeply in the study. Lot of unauthorized slums have sprang up in different parts of the city which al so are not recorded in the municipal corporations.

The study is restricted only to Chalakudy Municipality. It can be extended to other major municipalities. The information collected for the secondary data based study Carries all the limitations inherent with the secondary data. During the phase of data collection from experts, it is revealed that except a Few of them have very little knowledge regarding the financial, accounting And technological aspects of MSWM. This situation has limited the data Collection to a certain extent and affected the scope of the study.

CHAPTER 2
LITERATURE REVIEW

INTRODUCTION

Extensive literature exists in solid wastes management at institutions and household levels. These studies help us to understand the issue of solid waste management and its impacts on society and economy. Majority of the studies conducted in this area of waste management is in respect of developed countries As regards Kerala, the impact assessment studies have been carried out by researchers which highlight the seriousness of the issue. More micro level studies are needed to address the issue. A brief review of the available literature sheds light into this area of research.

- 1) **Raghavan Nambiar, K. (1992)** reveals that, Kochi city generates about 250 tons of waste per day. The study concludes that composting is the most suitable method for treatment of solid waste in Kochi as biodegradable waste is the major component of municipal solid waste there.
- 2) **Menon R. V. G. et al., (1994)** examine the existing system of waste Collection and recycling and suggest ways for its formalization/improvement. It is observed that no recycling facilities are available in Kerala. It is suggested That, in all the fifteen waste management circles in Trivandrum city, personnel can be appointed to collect waste. Remuneration can be paid to them by Collecting a nominal fee from the citizens. Degradable and non-degradable Waste should be separately collected and a formal committee can be appointed In each residential area to supervise the waste collection. Decentralized waste treatment facilities are suitable in the city because of shortage of free space. A clean Trivandrum city with people's participation is the ultimate aim.
- 3) **Dileep Kumar, M. (1995)** examines the composition and sources of Municipal solid waste in Thiruvananthapuram city. It is found that, the major Generators of municipal solid wastes in the city are markets, slaughter houses, Hospitals, hotels and houses. It is estimated that the quantity of MSW generated from the Corporation area comes to 264.5 tons per day. The study suggests that Composting is the most suitable waste treatment option for solid wastes since 70 Per cent of the wastes generated in the city consist of biodegradable matter.
- 4) **Geetha, C. (1995)** reports that to reduce the total cost of solid waste management in Thiruvananthapuram city mathematical models are helpful. An Optimization model and a simulation model are suggested and tested for the Purpose.

- 5) **Sosamma Oommen, K. (1998)** deals with the utilization and application Of local earth worms in the bioprocessing of different organic wastes, and the Efficacy of compost thus produced in plant growth. The study summarizes that vermitech can convert waste into wealth and this Technology is sustainable and ecofriendly compared to other disposal techniques Like landfilling and incineration.
- 6) **Gejo Anna Geevarghese et al. (1997)** examine the utilization of solid Waste for energy generation. It is concluded that vermin-composting is one of the most suitable options for domestic level management of biodegradable wastes, whereas, at the community level, both vermin-composting and biomethanation processes can be implemented.
- 7) **Babu Ambat (1999)** reveals the types and quality of wastes generated in each ward of Thiruvananthapuram Corporation. The present waste management System of the city is analyzed and a pilot scale model is developed for effective solid waste management. A more effective waste transportation system is Suggested in the study.
- 8) **Lynn Elisabeth Zender (1999)** points out that Solid Waste Management Practices and facilities on Indian Reservations are 20 to 40 years behind those of Conventional urban and suburban communities in the US. The purpose of the Study is to understand the obstacles tribes face in carrying out SWM, especially Conventional SWM. The conclusion of the study is that tribal sovereignty, with Its related issues of cultural integrity, legal authority and economic self-Determination, in the context of reservations are the fundamental forces driving tribal SWM decisions.
- 9) **Raj Mohan et al. (1999)** point out that Palakkad Municipality is one among those places which used an engineered Solid Waste Management System. The present conditions of waste generation, collection system, storage facilities and disposal methods are studied. Physical and chemical analysis of waste and population forecast for 20 years are made for good result. It is estimated that 20 to 30 trucks and around 75 carts are required for transportation Of the waste. Composting and incineration are suggested for waste disposal.
- 10) **Gajalakshmi, S. et al. (2000)** evaluates the potential of two epigeic species and two anecic species of earthworms in terms of efficiency and sustainability of vermi-composting water hyacinth. By using different vermireactors, the efficiency And sustainability was tested and it was found that in all the reactors the earthworms grew well, increasing their weights by more than 250 per cent.
- 11) **Jishi, R. (2000)** suggests decentralized collection and disposal of waste As the most suitable method of waste management for Thiruvananthapuram City. Composting is

highlighted as the suitable treatment option for the city Due to its eco-friendliness and its promotional role in agriculture.

- 12) **Mahadevan Pillai, P.R. (2000)** evaluates the existing system of solid Waste collection and disposal practices in Palakkad Municipality. There is a Proposal for modifying the existing system. It is estimated that daily collection Of waste is almost 30 tons. Almost half of the daily produced waste in Municipal limits remains uncollected and this indicates the inefficiency of the Waste collection system.
- 13) **Pillai et al. (2000)** identifies that Palakkad Municipality is following Open dumping of MSW without any scientific base. Composting method is Rarely used. The Municipality generates an estimated total of thirty tons of Solid waste per day.
- 14) **Patil and et al. (2001)** have carried out a detailed analysis on the existing Healthcare waste management in India, emphasized two important Components for healthcare waste management namely, appropriate technologies and effective institutional arrangements, they pointed out That health care waste management is not only a technical problem, but is Strongly influenced by economic conditions, that is, adequate provision Needs to be made.
- 15) **Holger Ecke (2001)** assesses the possibilities and limitations of Carbonation as stabilization method in fly ashes from MSW Incineration. Factors studied are the partial pressure of carbon dioxide, the addition of water, the temperature and the reaction time. It is found from the study that carbonization has a good prospect as a stabilization technique especially with Respect to the major pollutants, Lead and Zinc.
- 16) **Kerry L Hughes et al. (2001)** refers to Bio reactor Landfills, a technically Perfect landfilling system with provisions for leachate and gas collection. It explains the history of landfilling, meaning advantages and current status of Bio-reactor landfills in USA.
- 17) **Mathew, V. (2001)** found that daily around 52 tones of solid waste is Generated in Kottayam town. Depositing waste illogically in water bodies are very common and a meagre amount of non biodegradable waste is used for recycling.
- 18) **Rao et al. (2002)** have highlighted that the infrastructural requirement for Biomedical Waste Management the capital cost incurred by benchmarked Hospital of 1047 beds is 3 lakh 59 thousand excluding cost of incinerator and the hospital is incurring 656 per day as recurring expenditure. Plastic waste Is taken by rag pickers and sold to contractors at hospital waste dump itself. Pune city has common treatment facility for BMW final disposal. They are collecting infectious waste from 446 nursing homes and

hospitals all over The city. Approximately 1000 kg per day collection of waste is made with The help of two modified Tata 407 Trucks. They are charging ` 20/kg of waste.

- 19) **Pramod, B. (2002)** reports that improper routing and scheduling is The major problem in waste collection and disposal at Vilappilsala, Thiruvananthapuram. By using GIS the problem can be overcome. It will help To collect waste effectively from every point without irregularity and time delay.
- 20) **Ranjini (2002)** evaluates the inadequate facilities for the segregated collection of biodegradable and non biodegradable waste and for the transfer And disposal of waste in Thripunithura Municipality. The Municipality generates almost 7.93 tones of solid waste per day.
- 21) **Babu Ambat (2003)** points out that lack of waste segregation and Burning of household waste are the major problems in Thiruvananthapuram. The unsegregated waste are carelessly thrown away to streets.
- 22) **Balakrishna Moorthy (2005)** points out that sustainable development is the order of the day. A brief account of the solid waste generation levels of different Indian cities is given. Source reduction, reuse and recycling are the ways to overcome the growing solid waste problem.
- 23) **Michikazu Kojima (2005)** points out that the international trade in Recyclable resources like recyclable waste and second-hand goods is on the Rise in Asia. Japan is the largest exporter and China the largest importer. According to the Basel Convention, the movement of hazardous waste across International frontiers should be strictly regulated and controlled. The trans-boundary movement of unrecoverable waste to developing countries falsely Labelled as recyclable resources are common practice and should be controlled.
- 24) **Sukumari, P. (2005)** evaluates environmentally friendly tools for solid Waste management with optimum cost. Different types of composting techniques Are studied in detail and suggest them as best techniques in producing organic Fertilizers.
- 25) **Martin, M. et al. (2006)** have studied that household-recycling rate in the borough of Burnley, England in 2001/2002 was only half the national average of 12 percent. The Borough has a large Asian–British population concentrated in two deprived wards where recycling rates are particularly low, so special attention was given to ascertaining their attitudes towards recycling.
- 26) **Thomas George (2006)** examines the Solid Waste Management of Kollam Corporation. The study tries to verify the physical and chemical composition of

Household waste and the existing methods of collection, transportation and Disposal practices. It also examines the environmental challenges and health Hazards of surrounding locals.

- 27) **Rainer Bunge et al. (2016)** have observed that Switzerland plays a Pioneering role in waste management. About half of the annual municipal Waste is collected and recycled. The remaining half is disposed of in Modern municipal waste incineration plants, MSWIP, where much of the Energy content is recovered. Material recycling lies in the area of conflict Between economy and ecology. Materials that cannot be recycled must be substituted by primary raw materials such as ore and oil.
- 28) **Sasikumar, K. et al. (2009)** have examined that the existing Solid Waste Management System with respect to waste generation, collection, Transportation and disposal in the three Municipal Corporations of Kerala, thiruvananthapuram, Kochi and Kozhikode. The extent of public awareness and public involvement in Solid Waste Management of these Three Municipal Corporations is evaluated.
- 29) **Abu Qdais H. (2007)** has try to study the Environmental Impact Assessment (EIA) study for Al Ghabawy landfill site of the Jordanian capital City (Amman), so as to identify the significant adverse impacts And to recommend the necessary mitigation measures. Site visits, survey and scoping session revealed that the most serious issues that might have adverse impacts and required special attention were leachate and gaseous emissions from the landfill. The study analyzed the extent of the above impacts and the required measures to avoid or to minimize them were recommended. Furthermore, operational guidelines, monitoring, and post closure measures were suggested. The procedure followed and recommendations made by this study may serve as guidance for planners and decision makers to conduct EIA for landfills under similar conditions.
- 30) **Suchitwa Mission (2010)** indicates that the prime responsibility of Providing Solid Waste Management Services in the State is vested with Local self Government Institutions. The Municipal authorities are entrusted with the responsibility for the collection, segregation, storage, transportation, processing and disposal of municipal solid waste as per the Municipal Solid waste (Management and Handling) Rules, 2000. The provisions of solid waste management services in the Urban Local Bodies are detailed in the Kerala Municipality Act, 1994. A review of the Solid Waste Management in Urban Local Bodies (ULBs) reveals the failure of ULBs and the State pollution Control Board (SPCB) in discharging their responsibilities fixed by MSW Rules. Poor

record maintenance leads to inability to measure the Quantity and composition of waste generated....

RESEARCH GAP

From the review of available literature, it can be seen that, internationally, Solid Waste Management is a highly discussed subject. But, in Kerala – Chalakudy Municipality, no serious deliberation has been made regarding Municipal Solid Waste Management. All operational areas of MSWM require critical attention to its Potential for degrading environment and human health.

Most of the Municipalities In the State are currently unable to fulfil their duty to ensure environmentally Sound and sustainable ways of dealing with waste generation, and its Collection, transport, treatment, and disposal. The failure of MSWM can result In serious health problems and environmental degradation. Indiscriminate Dumping of uncollected waste in streets and in drains leads to flooding, Breeding of insects and vectors which, in turn, results in spreading of diseases.

Furthermore, even the collected waste is disposed of in uncontrolled dumpsites or burned openly, thus contributing to severe environmental impacts including Pollution of water resources, soil and air. In this context, it Is attempted to study all the operational areas of MSWM in Chalakudy Municipality including waste Collection, Storage, Transportation, Treatment and Disposal. In addition, The Planning, Controlling, Financial and Accounting aspects are also examined. The Awareness Levels of the public are also evaluated....

CHAPTER 3
OVERVIEW OF THE STUDY

GLOBAL SCENARIO

Solid waste management is a critical issue confronting the global community. With the rapid pace of urbanization and industrialization, managing the waste generated by human activities has become increasingly complex. This delves into the global scenario of problems and challenges associated with solid waste management, examining the multifaceted nature of this issue, its environmental and socio-economic implications, and potential strategies for improvement. **The Scale of the Problem** The world generates an estimated 2.01 billion tones of municipal solid waste annually, with this figure expected to rise to 3.40 billion tones by 2050. This surge is driven primarily by population growth, urban expansion, and changing consumption patterns.

While high-income countries generate more waste per capita, low- and middle-income countries are experiencing the most significant increases, exacerbating existing challenges in waste management infrastructure and capacity. One of the most pressing issues is the lack of adequate infrastructure and resources to handle the growing volumes of waste. Many cities, particularly in developing countries, lack the necessary facilities for waste collection, transportation, and disposal.

This results in improper waste disposal practices, such as open dumping and burning, which pose severe environmental and health risks. Solid waste management is an expensive endeavor, requiring significant investment in infrastructure, technology, and human resources. Many municipalities, especially in low-income regions, struggle to allocate sufficient funds for effective waste management.

This financial constraint leads to inefficient and inadequate services, perpetuating the cycle of poor waste management. Effective waste management requires robust policies and regulations that enforce proper waste segregation, recycling, and disposal practices. However, many countries lack comprehensive waste management policies, and enforcement is often weak.

This regulatory gap hampers efforts to implement sustainable waste management practices and incentivize private sector participation. Public awareness and participation are crucial for successful waste management. However, in many regions, there is a lack of awareness about the importance of waste segregation, recycling, and proper disposal. This is compounded by cultural attitudes and behaviors that do not prioritize environmental sustainability. Engaging communities and changing public perceptions remain significant challenges.

While advanced waste management technologies exist, their adoption is often limited by high costs and technical expertise requirements. Many developing countries lack access to modern technologies for waste treatment and recycling. This technological gap results in reliance on outdated and inefficient methods that contribute to environmental pollution. The mismanagement of solid waste has profound environmental and health impacts. Improper disposal methods, such as open dumping and burning, release harmful pollutants into the air, water, and soil.

These pollutants can cause respiratory diseases, waterborne illnesses, and other health problems among communities living near waste disposal sites. Additionally, waste pollution contributes to the degradation of ecosystems, affecting biodiversity and natural resources. Solid waste management also has significant socio-economic implications. Poor waste management can lead to decreased property values, reduced tourism, and adverse effects on local economies. Informal waste workers, who often operate without proper safety measures, are exposed to hazardous conditions, further exacerbating social inequalities. Addressing these socio-economic impacts requires a holistic approach that integrates waste management with broader development goals.

1. High-income countries, such as those in Europe and North America, have made considerable progress in waste management through stringent regulations, advanced technologies, and strong public participation. For example, Sweden has implemented a highly efficient waste-to-energy system, converting nearly 50% of its household waste into energy. Germany, with its robust recycling infrastructure, boasts one of the highest recycling rates globally. However, even in these countries, challenges remain, such as reducing plastic waste and addressing the environmental impact of waste exports.

2. Middle-income countries, such as Brazil and India, face a mix of advanced and traditional waste management practices. In Brazil, initiatives like the National Solid Waste Policy aim to improve waste management through regulatory frameworks and community involvement. However, informal waste picking remains prevalent, highlighting the need for inclusive policies that integrate informal workers into the formal waste management system. India faces immense challenges with its burgeoning urban population and inadequate infrastructure but has seen successes with programs promoting waste segregation and decentralized waste management solutions.

3. Low-income countries, such as those in sub-Saharan Africa, experience the most severe waste management challenges. Limited financial resources, infrastructure deficits, and weak regulatory frameworks result in widespread open dumping and burning of waste. However,

innovative community-driven solutions are emerging. For instance, in Kenya, the “Zero Waste” initiative focuses on empowering communities to reduce, reuse, and recycle waste, creating employment opportunities and improving local environments.

1. **Strengthening Infrastructure and Capacity** Investing in waste management infrastructure is crucial for improving collection, transportation, and disposal systems. This includes developing sanitary landfills, recycling facilities, and waste-to-energy plants. Capacity-building initiatives should focus on training waste management professionals and enhancing technical expertise in developing regions.

2. **Enhancing Financial Mechanisms** Innovative financial mechanisms, such as public-private partnerships, can mobilize resources for waste management. Governments can also explore funding options from international organizations and development banks to support infrastructure projects and capacity-building programs.

3. **Implementing Robust Policies and Regulations** Developing comprehensive waste management policies and enforcing regulations are vital for sustainable waste management. Policies should promote waste reduction, segregation, and recycling while discouraging harmful practices like open dumping and burning. Regulatory frameworks should also incentivize private sector participation and innovation in waste management.

4. **Promoting public awareness** about the importance of proper waste management and encouraging community participation is essential. Educational campaigns, community-based programs, and incentives for waste segregation can drive behavioral change and foster a culture of environmental responsibility.

5. **Leveraging Technology and Innovation** Adopting advanced waste management technologies can significantly improve efficiency and environmental outcomes. Governments and private sector entities should invest in research and development to explore innovative solutions, such as automated waste sorting systems, bioreactor landfills, and circular economy models that promote resource recovery and waste minimization.

INDIAN SCENARIO

Solid waste management (SWM) is a significant concern for India, a country experiencing rapid urbanization and population growth. The management of solid waste has become increasingly challenging due to the sheer volume of waste generated, coupled with inadequate infrastructure, financial constraints, and public awareness. India generates an estimated 62 million tones of municipal solid waste (MSW) annually, with this figure projected

to increase significantly due to urban expansion and rising consumption levels. The country's urban areas produce about 70-80% of the total waste, with metropolitan cities like Mumbai, Delhi, and Bangalore being major contributors. However, the current waste management systems are insufficient to handle the increasing volumes, leading to widespread issues.

1. The lack of adequate infrastructure is a major challenge in India's SWM. Many cities and towns lack proper waste collection, segregation, transportation, and disposal facilities. As a result, open dumping is a common practice, leading to environmental pollution and health hazards. The existing landfill sites are often unscientifically managed, resulting in groundwater contamination and air pollution from landfill fires.
2. Financial Constraints Municipalities in India face significant financial constraints, limiting their ability to invest in modern waste management systems. The cost of waste management, including collection, transportation, treatment, and disposal, is high. Limited budget allocations and financial mismanagement further exacerbate the problem, resulting in inefficient and inadequate waste management services.
3. Policy and Regulatory Gaps While India has established policies and regulations for SWM, such as the Solid Waste Management Rules, 2016, enforcement remains weak. There is a lack of coordination among different government agencies, and compliance with regulations is often poor. Additionally, the informal sector, which plays a crucial role in waste recycling, is not adequately integrated into the formal waste management system.
4. Public awareness about the importance of waste segregation, recycling, and proper disposal is generally low in India. Cultural attitudes and behaviors often do not prioritize environmental sustainability, leading to indiscriminate waste disposal. Engaging communities and fostering a sense of responsibility towards waste management is a significant challenge.
5. Technological Limitations Access to advanced waste management technologies is limited in India. Many municipalities rely on outdated and inefficient methods for waste treatment and disposal. The adoption of modern technologies, such as waste-to-energy plants and advanced recycling facilities, is hindered by high costs, lack of technical expertise, and regulatory hurdles.
6. Improper waste management in India has severe environmental and health impacts. Open dumping and burning of waste release toxic pollutants into the air, water, and soil, contributing to respiratory diseases, waterborne illnesses, and other health problems. Unmanaged landfills leach harmful chemicals into groundwater, posing risks to

drinking water sources. The degradation of natural ecosystems and loss of biodiversity are also significant environmental consequences.

7. The socio-economic implications of poor waste management are profound. Inefficient waste management practices lead to decreased property values, reduced tourism, and negative impacts on local economies. Informal waste workers, who constitute a significant portion of the workforce, operate under hazardous conditions without proper safety measures, perpetuating social inequalities and health risks. Addressing these issues requires inclusive policies that recognize and integrate the informal sector into the formal waste management system.
8. Large cities like Mumbai and Delhi face immense challenges in waste management due to their large populations and high waste generation rates. Mumbai generates approximately 9,400 tones of waste daily, while Delhi produces around 10,000 tones. Both cities struggle with inadequate infrastructure, resulting in overflowing landfills and environmental pollution. However, initiatives such as Mumbai's waste segregation campaigns and Delhi's waste-to-energy projects are steps towards addressing these challenges.
9. Mid-sized cities like Indore and Mysore have made notable progress in waste management. Indore, for example, has been recognized for its efforts in cleanliness and waste segregation, achieving significant improvements through community engagement, efficient collection systems, and waste processing facilities. Mysore has also implemented successful waste management practices, focusing on waste segregation, composting, and recycling.
10. Small towns and rural areas face distinct challenges in SWM due to limited resources and infrastructure. Open dumping and burning are common practices, posing serious environmental and health risks. However, community-driven initiatives, such as the Zero Waste Management model in Alappuzha, Kerala, demonstrate that sustainable waste management is achievable even in resource-constrained settings. These initiatives emphasize local solutions, community participation, and decentralized waste management systems.
11. Investing in waste management infrastructure is crucial for improving collection, transportation, and disposal systems. This includes developing sanitary landfills, recycling facilities, composting units, and waste-to-energy plants. Capacity-building initiatives should focus on training waste management professionals and enhancing technical expertise at the municipal level.

12. **Enhancing Financial Mechanisms** Innovative financial mechanisms, such as public-private partnerships, can mobilize resources for waste management. Municipalities can explore funding options from international organizations, development banks, and private investors to support infrastructure projects and capacity-building programs. Implementing user fees for waste services can also generate revenue to sustain waste management operations.
13. **Implementing Robust Policies and Regulations** Strengthening and enforcing SWM policies and regulations are vital for sustainable waste management. Policies should promote waste reduction, segregation, and recycling while discouraging harmful practices like open dumping and burning. Regulatory frameworks should also incentivize private sector participation, innovation, and integration of the informal sector into the formal waste management system.
14. **Raising public awareness** about the importance of proper waste management and encouraging community participation is essential. Educational campaigns, community-based programs, and incentives for waste segregation can drive behavioral change and foster a culture of environmental responsibility. Schools, colleges, and community organizations can play a pivotal role in spreading awareness and mobilizing action.
15. **Leveraging Technology and Innovation** Adopting advanced waste management technologies can significantly improve efficiency and environmental outcomes. Governments and private sector entities should invest in research and development to explore innovative solutions, such as automated waste sorting systems, bioreactor landfills, and circular economy models that promote resource recovery and waste minimization. Collaborating with international experts and organizations can also facilitate the transfer of technology and best practices.

KERALA SCENARIO

Kerala, known for its high literacy rates and progressive social policies, faces unique challenges in managing solid waste. Despite being one of the more developed states in India, Kerala struggles with increasing waste generation due to urbanization, tourism, and rising consumption patterns. This essay explores the problems and challenges associated with solid waste management in Kerala, examines their environmental and socio-economic impacts, and discusses potential strategies for improvement.

Kerala generates approximately 8,000 tones of solid waste daily, with urban areas like Thiruvananthapuram, Kochi, and Kozhikode being major contributors. The state's high population density and tourism influx exacerbate waste management issues, leading to environmental degradation and health risks. Effective waste management in Kerala is further complicated by the state's unique geographical and climatic conditions.

Kerala generates approximately 8,000 tones of solid waste daily, with urban areas like Thiruvananthapuram, Kochi, and Kozhikode being major contributors. The state's high population density and tourism influx exacerbate waste management issues, leading to environmental degradation and health risks. Effective waste management in Kerala is further complicated by the state's unique geographical and climatic conditions.

1. Inadequate Infrastructure and Resources Kerala faces significant infrastructure deficits in waste management. Many municipalities lack adequate facilities for waste collection, segregation, transportation, and disposal. Open dumping and burning of waste are prevalent, causing environmental pollution and health hazards. The existing landfill sites are often poorly managed, leading to groundwater contamination and air pollution from landfill fires.

2. Financial Constraints Municipalities in Kerala struggle with financial constraints, limiting their ability to invest in modern waste management systems. The cost of waste management, including collection, transportation, treatment, and disposal, is high. Limited budget allocations and financial mismanagement further exacerbate the problem, resulting in inefficient and inadequate waste management services.

3. Policy and Regulatory Gaps While Kerala has implemented various policies and regulations for waste management, enforcement remains weak. There is a lack of coordination among different government agencies, and compliance with regulations is often poor. Additionally, the informal sector, which plays a crucial role in waste recycling, is not adequately integrated into the formal waste management system.

4. Public Awareness and Participation Public awareness about the importance of waste segregation, recycling, and proper disposal is generally low in Kerala. Cultural attitudes and behaviors often do not prioritize environmental sustainability, leading to indiscriminate waste disposal. Engaging communities and fostering a sense of responsibility towards waste management is a significant challenge.

5. Technological Limitations Access to advanced waste management technologies is limited in Kerala. Many municipalities rely on outdated and inefficient methods for waste treatment and disposal. The adoption of modern technologies, such as waste-to-energy plants and advanced

recycling facilities, is hindered by high costs, lack of technical expertise, and regulatory hurdles.

Improper waste management in Kerala has severe environmental and health impacts. Open dumping and burning of waste release toxic pollutants into the air, water, and soil, contributing to respiratory diseases, waterborne illnesses, and other health problems. Unmanaged landfills leach harmful chemicals into groundwater, posing risks to drinking water sources. The degradation of natural ecosystems and loss of biodiversity are also significant environmental consequences. The socio-economic implications of poor waste management are profound. Inefficient waste management practices lead to decreased property values, reduced tourism, and negative impacts on local economies. Informal waste workers, who constitute a significant portion of the workforce, operate under hazardous conditions without proper safety measures, perpetuating social inequalities and health risks. Addressing these issues requires inclusive policies that recognize and integrate the informal sector into the formal waste management system.

1. Urban areas like Thiruvananthapuram and Kochi face immense challenges in waste management due to their large populations and high waste generation rates. Thiruvananthapuram generates approximately 300 tones of waste daily, while Kochi produces around 500 tones. Both cities struggle with inadequate infrastructure, resulting in overflowing landfills and environmental pollution. However, initiatives such as Thiruvananthapuram's decentralized waste management system and Kochi's efforts to promote waste segregation are steps towards addressing these challenges.

2. Mid-sized towns like Alappuzha and Thrissur have made notable progress in waste management. Alappuzha, for example, has implemented a successful Zero Waste Management model that focuses on decentralized waste management, community participation, and waste segregation. Thrissur has also achieved significant improvements through effective waste collection systems, composting units, and recycling facilities.

3. Rural areas in Kerala face distinct challenges in solid waste management due to limited resources and infrastructure. Open dumping and burning are common practices, posing serious environmental and health risks. However, community-driven initiatives, such as the Clean Kerala Mission, demonstrate that sustainable waste management is achievable even in resource-constrained settings. These initiatives emphasize local solutions, community participation, and decentralized waste management systems.

Strengthening Infrastructure and Capacity Investing in waste management infrastructure is crucial for improving collection, transportation, and disposal systems. This includes developing

sanitary landfills, recycling facilities, composting units, and waste-to-energy plants. Capacity-building initiatives should focus on training waste management professionals and enhancing technical expertise at the municipal level.

Enhancing Financial Mechanisms Innovative financial mechanisms, such as public-private partnerships, can mobilize resources for waste management. Municipalities can explore funding options from international organizations, development banks, and private investors to support infrastructure projects and capacity-building programs. Implementing user fees for waste services can also generate revenue to sustain waste management operations.

Implementing Robust Policies and Regulations Strengthening and enforcing waste management policies and regulations are vital for sustainable waste management. Policies should promote waste reduction, segregation, and recycling while discouraging harmful practices like open dumping and burning. Regulatory frameworks should also incentivize private sector participation, innovation, and integration of the informal sector into the formal waste management system.

Promoting Raising public awareness about the importance of proper waste management and encouraging community participation is essential. Educational campaigns, community-based programs, and incentives for waste segregation can drive behavioral change and foster a culture of environmental responsibility. Schools, colleges, and community organizations can play a pivotal role in spreading awareness and mobilizing action.

Leveraging Technology and Innovation Adopting advanced waste management technologies can significantly improve efficiency and environmental outcomes. Governments and private sector entities should invest in research and development to explore innovative solutions, such as automated waste sorting systems, bioreactor landfills, and circular economy models that promote resource recovery and waste minimization. Collaborating with international experts and organizations can also facilitate the transfer of technology and best practices.

THRISSUR DISTRICT

Thrissur is known as the cultural capital of Kerala, and the land of Poorams. Thrissur is a revenue district of Kerala situated in the central part of that state. Spanning an area of about 3,032 km², Thrissur district is home to over 10% of Kerala's population. Thrissur district is bordered by the districts of Palakkad and Malappuram to the north, and the districts of Ernakulam and Idukki to the south.

The Arabian Sea lies to the west and Western Ghats stretches towards the east. It is situated in southwestern India (10.52°N 76.21°E) and is in the central part of Kerala. According to the 2011 census Thrissur district has a population of 3,110,327. This gives it a ranking of 113th in India (out of a total of 640). The district has a population density of 1,026 inhabitants per square kilometer (2,660/sq. mi) . Its population growth rate over the decade 2001–2011 was 4.58%. Thrissur has a sex ratio of 1109 females for every 1000 males, and a literacy rate of 95.32%.

CHALAKUDY MUNICIPALITY AT A GLANCE

Table 3.1 : Demographic details of Chalakudy.

Name of Municipality	Chalakudy
District	Thrissur
Taluk	Chalakudy
Area	25.23 km sq/11597 in KM2
No. of wards	36
Population	49525(as per 2011 census)
Male	23744
Female	25781
No. of Households	12567
Density of population	1963 /sq km
SC Population	3401
ST Population	77
Male Female Ratio	1086
Literacy Rate	97.03%
No. of BPL families	4014
No. of identified slum	1

CHALAKUDY is a municipal town situated on the banks of Chalakudy River in Thrissur District of the Kerala State in India. The name ‘Chalakudy’ might have come from two words, ‘yagashala’ (which means temporary settlement for conducting sacrifice) and ‘kody’ (which means flag). Once Chalakudy was famous all over India as a place for conducting sacrifice. Many rishis used to come over here as it was considered as a sacred land. In order to identify these settlements; they hoisted flags next to it.

Thus those entire area got its name ‘yagashalakody’, this however evolved in to “shalakody” and finally in to today’s Chalakudy. Chalakudy was the head quarters of Kodassery nadu. Sakthan Thampuran the ruler of kingdom of Cochin formed Kodassery (Chalakudy) taluk in the 1790 by adding Kuzhurnadu, Ayyanezhinadu, Korattynadu, Malayattur, and Kanjur-chowara (now in Aluva taluk) to Kodassery nadu. According to Brahminical tradition, Chalakudy was part of Adur (Annamanada) grama and Potta in Chalakudy municipality was part of Irinjalakuda grama.

There was also an old seminary at Sampalur (Ampzhakkad) on the banks of Chalakudy River. Chalakudy is a place of historical importance as its nearby places like Thazhekkad property of Mukundhapuram nadu was the base of operations of Mysore invader Tipu sultan during his attack on the Travancore lines. He kept the nearby places of Chalakudy as a southern army base for attacking Travancore and other southern province.

Chalakudy municipality came into existence in the year 1970. The municipality covering an area of 25.23sqkmis divided into 36 electoral wards. The municipality has a total population of 45,069 with a density of 1786 per sqkm. Chalakudy is a Grade II municipality. Chalakudy is a Midland region.

The Chalakudy river flows through the southern part of the town. The Kodakara, Kossery, Pariyaram, Meloor, Kallur, Vadakkummuri and Aloor grama panchayaths lie adjacent to Chalakkudy Municipality. Chalakkudy is at a distance of 35 km from Thrissur. The nearest airport is Nedumbassery, which is 22 km away.

Chalakudy River: It has one of the highest fish diversities in Kerala. The river is known for its diversity, as it contains 85 species of fresh water fishes out of the 152 species known from Kerala. Among these, 35 are endemic species of the Western Ghats and nine are considered to be endangered.

Chalakudy Municipality has implemented innovative strategies for solid waste management, including door-to-door collection of segregated waste. The municipality has established biogas plants to convert organic waste into energy and composting units for processing biodegradable waste. Chalakudy Municipality also collaborates with local NGOs and community groups to promote sustainable waste management practices.

CHAPTER 4

DATA ANALYSIS & INTERPRETATION

INTRODUCTION

Waste collection is a low-paying occupation in the urban informal sector, primarily undertaken by weaker sections of society as a means of livelihood. It involves collecting waste materials such as paper, plastic, rags, bottles, tins, metal pieces, and broken containers from roadside dustbins, streets, or other sources and selling them to nearby dealers. Waste collectors manually recover reusable and non-reusable materials from solid waste, while nomadic buyers collect recyclable materials from residential areas, commercial establishments, or generating sources. They purchase waste materials by estimating the price of each separated material and sometimes exchange low-quality finished products. The waste collectors and nomadic buyers are considered the lowest link in the recycling industry and the first strata of informal solid waste management system. The waste collection process is crucial for the sustainability of the urban informal sector.

ROLE OF WASTE COLLECTORS IN CHALAKUDY MUNICIPALITY

Chalaky Municipality has a formal and informal system for recycling solid waste. The municipal authority controls the formal system, which involves collection, transportation, and processing of waste. This system primarily manages organic and biodegradable kitchen and food waste. The informal sector, on the other hand, focuses on recovering recyclable materials from non-biodegradable products like metal, glass, leather, paper, and plastics. This sector provides employment to thousands of citizens, including waste pickers, petty traders, entrepreneurs, and workers involved in manufacturing new products from recycled materials. Waste collectors are often the primary agents of salvaging recyclable waste, collecting waste from residential and public areas of Chalaky city.

Waste collectors retrieve valuable materials from municipal waste before formal sector work, reducing solid waste volume and content. They manage 40-60% of the total waste in the municipality, with informal waste collection mainly undertaken by waste pickers and nomadic buyers. Waste pickers collect market-value items like paper, plastic, metal, and glass. Nomadic buyers purchase scrap from residential and commercial establishments, accessing small amounts of capital and bartering finished products. Housewives play a crucial role in the informal waste management system by sorting and keeping recyclable goods for sale. After rudimentary sorting, waste collectors sell the collected waste to retailers, who then use it in their production processes.

The informal waste management system attracts residual people like agricultural migrants, environmental refugees, and cobblers, whose traditional skills have become outdated in the rapidly changing economic activity. Chalakudy Municipality has both formal and informal waste management systems, with 60% of the total solid waste managed by municipal authority. Nearly 40% of non-biodegradable parts, including paper, plastic, metal, and glass scrap, are handled by informal waste management. This informal system reduces the burden on the municipal system and provides employment and income to a large number of people.

The rise of plastics, metal cans, and advanced packaging materials has significantly impacted the informal waste management system. This system is considered environmentally friendly and helps conserve natural resources and reduce pollution from solid waste. It is becoming popular among waste collectors like rag pickers and Nordic buyers, reducing the burden on the municipal system and providing employment and income to many people. It is crucial to integrate this informal system into the overall solid waste management scheme.

ROLE OF HARITHA KARMA SENA (HKS) IN CHALAKUDY MUNICIPALITY

The Haritha Karma Sena project in Kerala began on July 15, 2017, and is a collaborative effort between various organizations, including Kudumbasree, Haritha Kerala Mission, Suchitwa Mission, Pollution Control Board, and Clean Kerala Company. The project focuses on the collection and management of non-biodegradable wastes, with each member assigned specific tasks such as collection, transportation, processing, recycling, disposal, and management. The selection process involves LSGI and Haritha Kerala Mission, with Kudumbasree members receiving the highest priority. Each Haritha Karma Sena member receives three days of training on waste collection, segregation, and management activities. The project aims to improve waste management facilities in the region. The Kerala Government has provided funds for the initial level training of the Haritha Karma Sena, with Kudumbasree proposing a 3.6 Crore rupees grant. The Haritha Kerala Mission is responsible for overall coordination, while the Suchitwa mission provides financial and technical support. Kudumbasree provides manpower and enterprise formation assistance. Clean Kerala Company is assisting in the discharge of non-biodegradable waste from Material Collection Facility (MCF) to Resource Recovery Facility (RRF). In Chalakudy Municipality, 56 women members from Kudumbasree unit collect segregated clean waste from houses and shops, which are then transported to RRF. The company also shredded waste plastics using a plastic shredding machine at RRF, which are

then used for road tarring. The shredded plastics are sold to PWD and similar institutions, generating profit.

Table 4.1 Waste collection Calendar of HKS in Chalakudy Municipality

Sl no.	Types of waste	Collecting month
1	Paper, Plastics, Plastic covers	All months
2	Rubber and leather items (chappals, bags etc)	January, April, July, October
3	Glass, Bottles, etc	February, May, August, November
4	E-wastes (Tube lights, CFL etc.)	March, June, December
5	Medicine stripes	January, March, June, September, December
6	Cloths and garments wastes	April, September

Source: Chalakudy Municipality

Haritha Karma Sena is getting user fee from home and shops along with a 6 months Viability Gap Fund (VGF) from government. For collecting the waste from households HKS were getting 60 from each houses and 150 from shops and stalls. 2000 rupees were received by the HKS members as 6 months Viability Gap Fund from Chalakudy Municipality.

MUNICIPALITY WASTE WORKERS

There are 23 workers engaged in waste collection from collection point in the city and transporting to dumping site. 15 employees are permanent and 8 workers are on contract basis. In permanent workers 6 male and 9 female working and on contract basis there are only male workers.

Table 4.2 Details of Municipality waste workers in Chalakudy

Sl No.	Category	Males	Females	Total	Percent
1	Municipality sanitation workers (Permanent)	6	9	15	66
2	Municipality sanitation workers including street sweepers (Temporary)	8	Nil	8	34
Total				23	100

Source: Primary data

WASTE SEGREGATING WOMEN WORKERS

The Municipal Solid Waste facility in Chalakudy processes around 10 tonnes of waste daily, with 43 women workers working 27 days a month, earning a daily wage of 500 rupees. The facility houses a processing shed, waste grinding machine, plastic shredding unit, and plastic cover moulding unit. However, there are no scientific landfills or disposal facilities, and plastic wastes are disposed of all over the facility. Manual segregation of salvageable waste is done, and inert materials are disposed in nearby fields. Reclaimed old waste dumps are observed inside the facility. The plastic covers compression moulding method is used, where preheated moulding material is placed in an open, heated cavity, closed with a top force, and pressure applied until the material has cured.

SOCIO ECONOMIC CONDITION OF WASTE WORKERS

In Chalakudy Municipality, there are approximately 93 waste collectors, who rummage and wander in waste yards, dumpsites and urban pavements to collect recyclable materials. In this study 80 waste collectors from the Panchayath area are surveyed. They are classified in to four categories as Nordic buyers, HKS members, Municipal sanitary workers and Waste segregators.

There are 42 Haritha Karma Sena members, 13 waste segregators, 12 Municipal sanitary workers engaged in waste collection, segregation and processing activities in Chalakudy Municipality. And there are approximately 26 Nordic collectors were engaged in Chalakudy Municipal area.

Table 4.3 Description of sample respondents.

Sl No.	Category	Males	Females	Total	Percent
1	Nordic buyers	9	6	15	16
2	HKS members	-	40	40	44
3	Municipality sanitation workers (Permanent and Temporary)	14	9	23	25
4	Land fill site workers (Segregators)	-	13	13	15
	Total	23	68	91	100

Source: Sample survey

The table 4.3 depicts the description of category wise classification of respondents. Out of the total respondents 25 percent are males and 75 percent are females. There are no male workers engaged in the segregation and shredding works at Panamanna dumping yard. All the members in HKS are women.

Out of 42 members of Haritha Karma Sena, two members were not ready to respond due to Covid positive. There are approximately 26 Nordic buyers were identified in Chalakudy area and out of them, 15 were responded to the questions asked by the observer.

Table 4.4 Basic Profile of respondents.

	Particulars	Male	Female	Total	Percentage
1	Number of respondents	23	68	91	100
2	Educational Qualification				
a.	Primary School- High School	1	2	3	3
b.	High School- Degree	16	53	69	76
c.	Above Degree	6	13	19	21

3	Age				
a. Less than 30		2	6	8	9
b. 30-50		18	43	61	67
c. More than 50		3	19	22	24
4	Land area owned				
a. Below 10 cents		7	14	21	23
b. 10 cents – 1 acre		16	54	70	77
c. Above 1 acres		0	0	0	0
5	House ownership				
a. Owned house		17	47	64	70
		6	21	27	30
b. Rented house					
6	Monthly Income				
a. Up to 5000		0	9	12	29
b. 5000-10000				12	38
c. above 10000		14	27	41	45
7	Monthly expenditure				
a. Up to 5000		0	0	0	0
b. 5000-10000		0	3	3	3
c. above 10000		23	65	88	97

Source: Primary data

Table 4.4 shows that The majority of waste collectors (67%) are aged 30-50, with 24% above 50 and 9% below 30. Only 21% have a degree, and only 3% have graduated. These individuals choose this occupation due to lack of other employment opportunities. Out of 91 respondents, 70 own land between 10 cents to 1 acre, and 64 live at home. About 45% receive monthly incomes over Rs 10,000, while 42% receive incomes between Rs 5000 to Rs 10,000, and 97% have more than Rs 10,000 monthly expenditure.

OCCUPATIONAL CONDITION & HEALTH STATUS OF WASTE WORKERS

In Chalakudy Municipality, there are 42 women members from Kudumbasree unit (Haritha Karma Sena), 23 Municipality sanitation workers and 13 Nordic buyers collecting the waste mainly from houses and shops and malls. Around 23 percent of respondents were engaged in segregation practices. A number of waste workers doing the both work of collection and segregation activities at the same time and handled to the collection center or land fill site.

Table 4.5 Nature of duty of waste workers

Nature of works	No of workers	Percentage
Waste collection	78	86
Segregation	21	23
Transportation	8	9
Composting	2	2
Plastic shredding	7	7
Plastic covers compression molding	6	7
Other practices	12	13

Source: Primary data

There are 13 women workers engaged in segregation process of waste at the land fill area near West Chalakudy. Plastic wastes collected by the HKS members were segregated mainly by these women workers. After that bottles were kept separately and hand over to the medicine manufacturing companies. Some of them were also engaged in plastic shredding and Plastic cover compression molding practices.

COLLECTION OF WASTE

The quantification study of solid waste in Chalakudy Municipality revealed that around 40 percent of total solid waste generated in the city is coming from residential area. Then the garbage pickers collected the materials mainly from houses and residential area in the town. And it is also identified that around 45 percent of workers collecting the waste materials from hotels and restaurants and 69 percent of respondents collecting from shops and malls.

Table 4.6 Waste collection sources of garbage pickers

Source	Number of workers	Percentage
1. Houses and residential areas	80	88
2. Shops and malls	63	69
3. Hotels and restaurants	41	45
4. Vegetable, meat and fish markets	53	58
5. Marriage and community halls	15	16
6. Institutions and offices	8	9
7. Hospitals and health care institutions	12	14
8. Street sweeping and drain cleaning	16	18
9. Construction and demolition	4	4

Source: Primary data

TIME SPENT FOR COLLECTION & MANAGEMENT OF WASTE

Nordic buyers and Haritha Karma Sena members work without fixed hours for waste collection, starting at 8 am and continuing until 6 pm. They visit residential areas, streets, and market places, making multiple rounds on foot, walking 3 to 5 kilometers per day. Rag pickers usually start their work before municipal authorities clean streets. Some have specific beats and establish territorial rights over bins and dumping sites. Some Nordic buyers also establish friendly relations with households or establishments.

Table 4.7 Number of hours spent for waste collection and management in a day

Number of hours in a day	Number of peoples	Percentage
Less than 5 hours	12	14
5 -8 hours	75	82
More than 8 hours	4	4

Source: Primary data

The table 4.7 reveals that 82 percent of the respondents work for 5 to 8 hours in a day and 4 percent of them have to work for more than 8 hours. It is quite understandable that

respondents, who have taken this occupation as part time work for less than 5 hours, since it is not their sole source of income.

TYPES OF VEHICLE USED FOR COLLECTION OF WASTE

Rag pickers in the study area use various vehicles for waste collection, with 23 respondents not using any vehicles. Municipality sanitation workers primarily use heavy trucks, while around 42 carrier rickshaws are used by waste collectors. The narrow roads in residential areas and passages make it easy to collect waste using hand carts, carrier rickshaws, and motor cycles.

Table 4.8 Types of vehicle used for collection of waste

Types of vehicles	Self owned	Contract basis
Truck	2	1
LMV carrier	2	2
Tractor	2	1
Hand cart	1	0
Carrier rickshaw	0	42
Motor cycle	9	0
No vehicle	23	

Source: Primary data

DAYS PREFERRED FOR WASTE COLLECTION

Table shows that most rag pickers, including HKS members and municipal workers, collect waste on all days except Sundays and holidays. A minor group, around 3%, prefers week-end collection. 3% prefer all days, while 36% collect twice a week. The majority of rag pickers follow these schedules.

Table 4.9 Days preferred for waste collection

	Number of respondents	Percentage
All day including holydays	3	3
Working days only	39	43
Once in a week	13	15
Twice in a week	32	36
Week end only	3	3

Source: Primary data

DISTANCES TRAVELLED FOR WASTE COLLECTION

Rag pickers usually traveled a distance of 15 km for collection of waste. In the present study it was noted that majority of the rag pickers (73 percent) travelled a distance between 5 to 10 kilo meters and 18 percent of rag pickers travelled above 10 kilometers daily.

Table 4.10 Distances travelled for waste collection

Distance of travelling (In kilometers)	Number of respondents	Percentage
1-5 km	9	9
5-10 km	66	73
Above 10 km	16	18

Source: Primary data

QUANTITY OF WASTE COLLECTED

The survey revealed that around 55 waste workers in Chalakudy Municipality collect over 10 kg of paper daily, while 32 people collect 5-10 kg of news papers and magazines daily. 43 respondents collect 5-10 kg of plastic waste daily. Cloths and garments are mainly collected by Haritha Karma Sena members and Nordic buyers, with 69 respondents collecting garments and cloths daily from the Municipal area. The amount of waste collected depends on the number of houses covered and the time spent for collection.

Table 4.11 Types and quantity of waste collected by the waste collectors

Parameters	Quantity	Number of people
	Below 5 Kg	4
Paper (News papers, magazines)	5 -10 kg	32
	Above 10 kg	55
	Below 5 Kg	19 43
Plastic (Recyclables, Plastic covers)	5 -10 kg	
	Above 10 kg	29
	Below 5 Kg	52 28
Metals (including Machines parts)	5 -10 kg	
	Above 10 kg	11
	20 numbers	8
Glass (Bottles, vases etc.)	20-50	61
	More than 50	22
	20 numbers	91
Rubber items (chappals, tyres etc.)	20-50	5
	More than 50	0
	Below 5 Kg	69 20
Cloths and garments	5 -10 kg	
	Above 10 kg	2

Source: Primary data

SEGREGATION OF COLLECTED WASTES

The survey revealed that 18% of rag pickers collected waste materials without segregation from the site, while 82% segregated them at the collection center. Proper waste segregation can improve recycling and reuse opportunities. This highlights the importance of proper waste management in waste collection and management.

SALE OF COLLECTED MATERIALS

Nordic buyers often sell collected materials the same day, with waste collectors not having fixed work hours. Haritha Karma Sena collects waste and segregates it before moving it to Material Collection Facility (MCF). Clean Kerala Company assists in disposing of non-biodegradable waste from MCF and transports it to Resource Recovery Facility (RRF), ensuring proper disposal and recycling.

Table 4.12 Sale of collected waste

Time schedule	Number of respondents	Percentage
At the same day of collection	11	12
Twice in a week	1	1
On the week end	0	0
Once in a month	40	44
No timing	3	3

Source: Primary data

DURATION OF PAYMENT

Nordic buyers sell waste on a payment basis, with some rag pickers receiving money on the same day, while street sweepers receive wages on a daily basis. The study reveals 23 municipal workers, both permanent and contract-based, receive monthly salaries. Haritha Karma Sena members receive payments after selling recyclable materials and transporting shredded plastics to Clean Kerala Company.

OCCUPATIONAL HEALTH PROBLEMS OF WASTE WORKERS IN CHALAKUDY MUNICIPALITY

Waste collectors face numerous health hazards when rummaging through putrefying garbage, including toxic medical waste and metal scraps. They are prone to cuts, injuries, and back problems due to constant bending over. They also suffer from bites from rats, snakes, dogs, and insects. Exposure to garbage and hospital wastes can lead to various diseases such as skin diseases, tuberculosis, anemia, scabies, lice, oozing ears, sore eyes, leprosy, distended stomach, wounds, and respiratory infections. Many waste pickers report back pain, coughs, headaches, stomach aches, sore muscles, and itchy skin/rashes. Most have suffered cuts to their hands, feet, and limbs, and have been bitten by mosquitoes.

Table 4.13 Observed Morbidity Prevalence (N =91)

Morbidity	Number	Percentage
Respiratory diseases	9	9.90
Eye problems	14	15.38
Skin problems	50	55.00
Nail infections	46	50.10

Source: Primary data

Around 50% of waste workers have nail infections, 55% have skin problems, and 15.38% have skin problems. Most of these issues are due to fungal infections and secondary bacterial infections, worsened by frequent wetting due to direct contact with waste. Less washing facilities are provided, and containers, vehicles, temporary storage points, and treatment yards need daily washing. Respiratory diseases are reported by 9% of respondents, with most reported problems being those who have worked at landfill sites for over five years. The relationship between exposure to solid waste and increased health risk is strongest where contact between workers and waste is greatest and protection is least. Most respondents complain about unsegregated mixed wastes, pathogens, toxic substances, and chemicals from waste and its decomposition.

Table 4.14 Reported Morbidity Prevalence (N =91)

Events	Number	Percentage
Hospitalization	7	7.69
Road accidents	4	4.39
Falls	56	62.0
Injury with sharps objects	41	45
Animal bites	8	8.79
Fire burns	4	4.39
Injury from chemicals like acids	9	9.89
Water borne diseases	17	18.68
Mosquito borne diseases	59	64.83

Source: Primary data

Waste workers often face minor accidents, cuts, and wounds due to sharp objects, which can lead to infection and inflammation of exposed skin. This can result in tetanus. Some workers use shaped rods to pick up recyclables, while others suffer burns from latent fires and flammable substances. Wastes also provide breeding sites for insects and rodents, increasing the risk of contracting leptospirosis. Work-related injuries are a major health concern, with around 65% of respondents experiencing mosquito-borne diseases.

Table 4.15 Musculoskeletal morbidity (N =91)

Affected joints	Number	Percentage
Low back	52	57.14
Neck	46	50.54
Shoulder	62	68.13
Elbow	61	67.03
Wrist	59	64.83
Knee	47	51.64
Ankle	61	67.03

Source: Primary data

The study highlights the harsh working conditions faced by waste pickers, who often suffer from back, shoulder, and joint pains due to their long-distance work. Despite the dangers of landfill sites, these workers continue to work daily to generate earnings for their families and pay for daily expenses and education. The socio-economic conditions of these workers highlight the need for improved safety measures.

Waste pickers face health risks due to daily travel and potential illness transmission from landfill sites. Public authorities should address waste management challenges, promote policies improving workers' conditions, and adopt a holistic approach to solid waste management. Local governments should also consider the economic and environmental benefits of including informal waste pickers in waste management and planning.

TESTING OF HYPOTHESIS

The study has hypothesized that

- 1) There is significant difference between Observed Morbidity Prevalence among four category waste workers in Chalakudy Municipality
- 2) There is significant difference between Reported Morbidity Prevalence among four category waste workers in Chalakudy Municipality
- 3) There is significant difference between Musculoskeletal Morbidity among four category waste workers in Chalakudy Municipality

Testing of Hypothesis No 1

There is significant difference between Observed Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

H0 There is no significant difference between Observed Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

H1 There is significant difference between Observed Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

Table 4.16 Category wise Observed Morbidity Prevalence

Morbidity	Municipality workers	HKS	Land fill site workers	Nordic buyers
Respiratory diseases	1(4.34)	1 (2.5)	6 (46.15)	1 (6.66)
Eye problems	1(4.34)	1 (2.5)	12 (92.30)	0 (0)
Skin problems	20(86.95)	10 (25)	13 (100)	7 (46.66)
Nail infections	21(91.30)	7 (17.5)	13 (100)	5 (33.33)

*Numbers in brackets represents percentage ,Source: Primary data

The analysis reveals that most waste workers in South Panama, including landfill site workers, suffer from skin diseases and nail infections. In Haritha Karma Sena, respiratory diseases and eye problems are less prevalent, with only 4% experiencing these issues.

Municipality workers also face skin diseases and nail infections, with nail infections and skin problems being prevalent at 92% and 87%, respectively.

Table 4.17 Observed Morbidity Group statistics

Observed Morbidity Prevalence		N	Mean	Std Deviation	T value	p value	Remarks
	Municipality workers	23	1.30	2.78690	2.245	0.035	
	HKS	40	43	0.89170	13.136	0.00	Significant
	Land fill site workers	13	1.8293	8.16968	2.614	.023	
	Nordic buyers	15	5.9231	.77460	14.00	.00	

Source: Primary data

From the above analysis it is found that the observed morbidity for the four selected category is show significantly different according to the p values. Hence, the null hypothesis is rejected.

H1 There is significant difference between Observed Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

Testing of Hypothesis No 2

There is significant difference between Reported Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

H0 There is no significant difference between Reported Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

H1 There is significant difference between Reported Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

Table 4.18 Category wise Reported Morbidity Prevalence

Events	Municipality workers	HKS	Land fill site workers	Nordic buyers
Hospitalization	4 (17.39)	1 (2.5)	2 (15.3)	0 (0)
Road accidents	2 (8.69)	0 (0)	0 (0)	2 (13.33)
Falls	16 (69.56)	12 (30)	13 (100)	15 (100)
Injury with sharps objects	6 (26.08)	7 (17.5)	13 (100)	15 (100)
Animal bites	0 (0)	0 (0)	6 (46.15)	2 (13.33)
Fire burns	1 (4.34)	0 (0)	2 (15.38)	1 (6.66)
Injury from chemicals like acids	3 (13.04)	0 (0)	5 (38.46)	1 (6.66)
Water borne diseases	2 (8.69)	2 (5)	7 (53.84)	6 (40)
Mosquito borne diseases	18 (78.26)	13 (32.5)	13 (100)	15 (100)

*Number in brackets represents percentage ,Source: Primary data

Landfill workers and Nordic buyers report high rates of injury due to sharp objects, slipping accidents, and falls. Waste materials can be contaminated with hazardous substances, leading to mosquito-borne diseases. Hungry animals, rodents, snakes, dogs, and vermin bite waste pickers, causing infections. However, the prevalence of animal bites, fire burns, and road accidents is low. Haritha Karma Sena workers, who use protective gear, report low reported morbidity among members, indicating that they are protected by occupational health and safety measures.

Table 4.19 Reported Morbidity Group statistics

Reported Morbidity Prevalence	N	Mean	Std	T	p	Remarks
			Deviation	value	value	
Municipality workers	23	5.667	6.68954	2.54	.03	Significant
HKS	40	3.889	5.37225	1	5	Not
Land fill site workers	13	6.778	5.14242	2	.06	Significant
				3.95	.00	Significant
				4	4	
Nordic buyers	15	6.3333	6.70820	2.83	.02	Significant
				2	2	

Source: Primary data

From the above analysis it is found that the reported morbidity for the three categories is shows significantly different except HKS (Haritha Karma Sena) according to the p values. Hence, the null hypothesis is rejected.

H1 There is significant difference between Reported Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

Testing of Hypothesis No 3

There is significant difference between Musculoskeletal Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

H0 There is no significant difference between Musculoskeletal Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

H1 There is significant difference between Musculoskeletal Morbidity Prevalence among four category waste workers in Chalakudy Municipality.

Table 4.20 Category wise Musculoskeletal Morbidity

Affected joints	Municipality workers	HKS	Land fill site workers	Nordic buyers
Low back	16 (69.56)	8 (20)	13 (100)	15 (100)
Neck	18 (78.26)	6 (15)	13 (100)	9 (60)
Shoulder	20 (86.95)	14 (35)	13 (100)	15 (100)
Elbow	18 (78.26)	15 (37.5)	13 (100)	15 (100)
Wrist	16 (69.56)	15 (37.5)	13 (100)	15 (100)
Knee	12 (52.7)	10 (25)	10 (76.92)	15 (100)
Ankle	15 (65.21)	18 (45)	13 (100)	15 (100)

*Number in brackets represents percentage ,Source: Primary data

Musculoskeletal morbidity is prevalent among landfill site workers and Nordic buyers due to their hard labor involving sharp heavy metal equipment. 100% of respondents suffer from this condition. Haritha Karma Sena members report low morbidity prevalence due to their well-coordinated work method, formal working relations, and understanding of waste collection by area, with some territorial boundaries.

Table 4.21 Musculoskeletal Morbidity Group statistics

Musculoskeletal morbidity	N	Mean	Std	T	p	Remarks
			Deviation	value	value	
Municipality workers	23	16.4286	2.57275	16.895	.000	
HKS	40	12.2857	4.34796	7.476	.000	
Land fill site workers	13	12.5714	1.13389	29.333	.000	Significant
Nordic buyers	15	14.1429	2.26779	16.500	.000	

Source: Primary data

From the above analysis it is found that the reported morbidity for the all categories is shows significantly different according to the p values. Hence, the null hypothesis is rejected

H1 There is significant difference between Musculoskeletal Morbidity prevalence among four category waste workers in Chalakudy Municipality.

CHAPTER 5
FINDINGS,SUGGESTIONS &
CONCLUSION

INTRODUCTION

Municipal solid waste management is crucial for sustainable, healthy, and inclusive cities and communities. In low-income countries, municipalities spend 20% of their budgets on waste management, but over 90% of waste is dumped or burned. As cities and countries grow, they need systems to manage waste and pay for essential services. As countries develop from low-income to middle- and high-income levels, waste generation, prosperity, and urbanization increase, making waste collection and land procurement more difficult.

Around 2.01 billion tonnes of municipal solid waste are generated globally annually, with 33% not being scientifically managed. Global waste is expected to grow to 3.40 billion tonnes by 2050. There is a positive correlation between waste generation and income level, with daily per capita waste generation in high-income countries projected to increase by 19% by 2050. In contrast, low- and middle-income countries are expected to see a 40% or more increase in waste generation. Waste generation is expected to increase faster for incremental income changes at lower income levels. By 2050, the total quantity of waste generated in low-income countries is expected to increase by more than three times.

In 2016, 1.6 billion tonnes of CO₂ equivalent emissions were generated from solid waste treatment and disposal sites, accounting for 5% of global emissions. By 2025, emissions are expected to increase to around 2.6 billion tonnes. India's rapid urbanization, lifestyle changes, and income rise have led to increased municipal solid waste volumes, with a projected volume of 125 million tonnes by 2030. Untreated legacy waste from cities remains at dumping sites, causing waste to remain in landfills for months. Kerala, a state with only 3% of India's population, generates 3.7 million tonnes of municipal solid waste annually, with 14% generated by city corporations, 45% by municipalities, and 41% by Grama Panchayaths.

FINDINGS

1. A waste or rag collector earns a higher livelihood by collecting waste from various sources, such as roadside dustbins, streets, or other sources, and selling it to nearby dealers.

2. Chalakudy Municipality's informal waste collection primarily involves two groups: waste pickers who collect market-value items like paper, plastic, metal, and glass, and nomadic buyers who purchase scrap from residential and commercial areas.
3. Chalakudy Municipality has both formal and informal waste management systems. The formal system manages 60% of the total solid waste, while the informal system handles 40% of non-biodegradable parts like paper, plastic, metal, and glass scrap, which are raw materials for the reprocessing industry.
4. Chalakudy Municipality has 48 Kudumbasree women members collecting segregated clean waste from houses and shops. These items are stored at MCF after final segregation. Clean Kerala Company or similar institutions manage the waste with the Municipality's assistance, ensuring proper disposal.
5. Haritha Karma Sena collects waste from households and shops, receiving 50 rupees per house and 150 rupees from shops and stalls. The government provides a 6 months Viability Gap Fund, while Chalakudy Municipality provides 2000 rupees to HKS members.
6. 23 municipal waste workers are involved in waste collection and transportation to a dumping site, with 15 permanent and 8 contract-based employees. The permanent workers are male and female, while the contract-based workers are male.
7. 13 women workers in Chalakudy Municipal area segregate waste transported by Municipality workers and HKS members, working 27 days a month from 8:30 am to 5 pm, earning 500 rupees daily. Additionally, approximately 26 Nordic collectors are employed in the area.
8. The study reveals that 67% of waste collectors are aged 30-50, 24% are above 50, and 9% are below 30. 21% have a degree, and only 3% have graduated. These individuals choose this occupation due to lack of other employment opportunities. Of the 91 respondents, 70 own land between 10 cents to 1 acre, and 64 live at home. Only 3% have graduated above graduation.
9. A study in Chalakudy Municipality revealed that 45% of respondents earn more than Rs 10,000 monthly, while 42% earn between Rs 5000 and Rs 10,000, and 97% have more than Rs 10,000 monthly expenditure. The study also found that 40% of the city's solid waste comes from residential areas, with garbage pickers mainly collecting materials from houses and residential areas. Additionally, 45% of workers collect waste materials from hotels and restaurants, while 69% of respondents collect from shops and malls.

10. Nordic buyers and Haritha Karma Sena members work without fixed hours for waste collection, starting at 8 am and continuing until 6 pm. They collect waste from residential areas, streets, and markets, mostly on foot, walking 3 to 5 kilo meters per day. Rag pickers use various vehicles, with 23 respondents not using any vehicles.
11. Municipality sanitation workers mainly use heavy vehicles like trucks, while around 42 carrier rickshaws are used by waste collectors in the municipal area. It is easy to move and collect waste through narrow roads in residential areas and passages using hand carts, carrier rickshaws, and motor cycles.
12. The study revealed that most rag pickers, including HKS members and Municipality workers, prefer to collect waste on all days except Sundays and holidays. A small group prefers week-end collection, while 33% prefer all days and 36% collect twice a week. The majority of rag pickers travel 15 km, with 73% traveling 5-10 kilo meters and 18% traveling above 10 kilometers daily. A minor group prefers week-end collection, while 36% prefer all days and 36% collect twice a week.
13. The survey revealed that around 55 waste workers in Chalakudy municipality collect over 10 kg of paper daily, while 32 people collect 5-10 kg of news papers and magazines daily. 43 respondents collect 5-10 kg of plastic waste daily. Cloths and garments are mainly collected by Haritha Karma Sena members and Nordic buyers, with 69 respondents collecting garments and cloths daily from the Municipal area. The amount of waste collected depends on the number of houses covered and the time spent for collection.
14. Nordic buyers do not have fixed work hours for waste collectors, and most sell collected materials on the same day. Haritha Karma Sena collects waste and segregates it first before moving it to Material Collection Facility (MCF). Clean Kerala Company assists in disposing of non-biodegradable waste from MCF and transporting it to Resource Recovery Facility (RRF). Many waste pickers report back pain, coughs, headaches, stomach aches, sore muscles, and itchy skin/rashes.
15. The survey revealed that 50% of waste workers had nail infections, 55% had skin problems, and 15.38% had skin problems. Fewer washing facilities were provided at work intervals or at the end of the day. 9% had respiratory diseases, while 65% had mosquito-borne diseases. Long-term bending, carrying heavy items, and walking for long distances caused backache, shoulder, and joint pains in the arms and legs. Most respondents reported joint and back pain.

SUGGESTIONS

School-level training for children to manage waste effectively is crucial for fostering a waste management culture. In Kerala, an organized waste collection system is absent, resulting in inefficiency. A door-to-door collection system should be implemented to minimize health threats and maintain cleanliness. Government facilities for training Solid Waste Management staff are insufficient, and consistent training programs are not being conducted

. Municipalities and stakeholders should collect measurable waste amounts to provide quality waste management services. Municipalities should measure key determinants of solid waste, such as moisture content, calorific value, and water pH, to determine their complexity and water contamination levels. Segregation of waste at source and separate collection of hazardous and electronic waste for treatment and recycling are also necessary.

Poor planning and accounting for Solid Waste Management (SWM) are major problems in Kerala. Full Cost Accounting is the most suitable accounting system for MSWM. Well-executed campaigning programs can eradicate ignorance about SWM among the public.

Waste generators should be responsible for waste treatment and disposal, rather than relying solely on municipalities. Kerala's municipalities lack advanced waste treatment options like Refuse-Derived Fuel (RDF) and recycling facilities, relying on neighboring states for recycling. Urban centers should establish recycling facilities for non-biodegradable waste. Unsegregated waste is often dumped into landfills, while biodegradable waste should be composted or biogasified to reduce carbon emissions.

Biogasification helps capture methane gas, which is 21 times more potent than carbon dioxide and a greenhouse gas. Only a few municipalities have biogas and composting plants, and no municipality has enough plants to treat all biodegradable waste.

CONCLUDING REMARKS

Waste collection and cleaning of drains and sewers are professions which have an adverse social perception, possibly due to the inherent nature of the work. The level of hygiene and health status of such workers is a concern that is widely debated. Garbage

collecting may not seem extremely hazardous at first glance but in reality it comprises of many health problems.

The Chalakudy city is growing rapidly and therefore a strategic planning is needed to address the MSW management. Considering the importance of the city as tourist and cinema site a good city sanitation plan is necessary in near future. The city sanitation plan should address the key issues identified above and consider the recently revamped MSW Management Rules (SWM Rules 2016) by Ministry of Environment, Forest and Climate Change, Government of India.

Hence the study recommends that health education programs should be conducted on a regular basis for all the workers who engaged in garbage collection, segregation and activities related to waste management and the relevant authorities regarding occupational health diseases and health hazards, and their prevention with emphasis on the advantage of prevention over cure. Workers should be provided with and encouraged to use safety equipment such as nose-and-mouth masks to prevent respiratory problems, slip-resistant footwear to prevent falls, and heavy gloves and PPE kit during work in the field...

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APPENDIX

PROBLEMS AND CHALLENGES FACED BY WORKERS ON SOLID WASTE MANAGEMENT IN CHALAKUDY MUNICIPALITY

QUESTIONNAIRE PREPARED IN CONNECTION WITH DATA COLLECTION FROM MUNICIPAL CLEANING WORKERS

1. Name :
2. Post :
3. The present waste collection centers

Name the road side waste collection centers

Waste collection areas in Bins				Road side waste collection area			
Places	Arrangement of removal of waste		Collection satisfactory	Collection insufficient	Places	Arrangement of removal of waste	
Daily waste removing places	Lorry/ Tractors	Hand craft			Waste removed on daily basis	Lorry/ Tractors	Hand craft
Waste removing places twice in a week	Lorry/ Tractors	Hand craft			Waste removed twice in a week	Lorry/ Tractors	Hand craft
Waste removing places once in a week	Lorry/ Tractors	Hand craft			Waste removed once in a week		

4. Whether people throw away the waste in the open : Yes/ No
5. Whether the bins overflows and scatter around : Yes/ No
6. Whether enough bins are placed in all places : Yes/ No
7. If not, which are the places requiring new waste bins :

8. Any suggestion in the shape and designs of waste bins :

9. Whether Bio-medical waste deposited in Bins : Yes/ No If yes, name the hospitals
10. If yes, whether the municipal authorities have given any suggestion to hospital : Yes/ No
11. Whether waste from slaughter houses deposited in the waste bin :
Yes/ No
12. Whether factory chemical wastes are deposited in the waste bin :
Yes/ No If yes, name the places
13. Whether you burn the waste, including plastic waste as apart of waste processing
14. The drawbacks of the present system of waste collection
15. Suggestion if any to improve the present system of waste collection

**SOCIO ECONOMIC CONDITION AND OCCUPATIONAL HEALTH PROBLEMS
OF WASTE COLLECTORS IN CHALAKUDY MUNICIPALITY**

QUESTIONNAIRE

1. House No. :
2. Name of the Head of the Family :
3. Address :
4. No of members in the Family :
Age 1-4 4-18 18-65 Above 65
5. Monthly income :
< 5000 5000-10000 Above 10000
6. Area of Land
< 3 Cent 3-5 cent 5-10 cent > 10 cent
7. Monthly expenditure :
< 5000 5000-10000 Above 10000

8. Educational qualification

Primary school Degree above Degree

9. Nature of work doing now

Waste collection Segregation Transportation Composting

Plastic shredding Plastic covers moulding Other practices

10. Waste collection sources

Houses and residential areas Shops and malls Hotels and restaurants

Vegetable, meat and fish markets Marriage and community halls

Institutions and offices Hospitals and health care institutions

Street sweeping and drain cleaning Construction and demolition

Other sources

11. Number of hours spent for waste collection

Less than 5 hours 5 -8 hours More than 8 hours

12. Types of vehicles used for waste collection

Truck LMV carrier Tractor Hand cart

Carrier rickshaw Motor cycle No vehicle

13. Days preferred for waste collection

All day including holydays Working days only Once in a week

Twice in a week Week end only

14. Distance travelled for garbage collection

1-5 km 5-10 km above 10 km

15. Types and quantity of waste collected

Paper (News papers, magazines) Below 5 Kg 5 -10 kg Above 10 kg

Plastic (Recyclables, Plastic cove Below 5 Kg 5 -10 kg Above 10 kg

Metals (including Machines part Below 5 Kg 5 -10 kg Above 10 kg

Glass (Bottles, vases etc.) Below 5 Kg 5 -10 kg Above 10 kg

Rubber items (chappals, tyres etc) Below 5 Kg 5 -10 kg Above 10 kg

Cloths and garments Below 5 Kg 5 -10 kg Above 10 kg

16. Selling of collected waste

At the same day of collection Twice in a week On the week end

Once in a month No timing

17. Details of occupational health problems suffered by the respondents

Morbidity Respiratory diseases Eye problems Skin problems Nail infections

18. Details of injuries and accidents during the time of works

Hospitalization Road accidents Falls Injury with sharps objects Animal bites

Fire burns Injury from chemicals like acids Water borne diseases Mosquito borne diseases

19. Details of Musculoskeletal problems faced by waste workers (affected joints)

Low back Neck Shoulder Elbow

Wrist Knee Ankle