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ASSESSMENT AND ANALYSIS OF SOLID WASTE MANAGEMENT STRATEGIES: A COMPREHENSIVE REVIEW

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ABSTRACT

Solid waste management is a critical issue globally, with significant impacts on the environment and public health. Extensive literature exists on this topic, primarily focusing on developed countries and a few impact assessment studies in specific regions like Kerala. However, there is a notable research gap in understanding solid waste management in densely populated small towns in developing countries. This paper aims to bridge this gap by conducting a comprehensive review of existing studies and analyzing the socio-economic and environmental impacts of solid waste management practices in selected municipalities within smaller towns. The review encompasses various aspects such as waste generation rates, disposal methods, recycling initiatives, and the public's attitudes and behaviors towards waste management. The findings from this review will contribute to a deeper understanding of solid waste management challenges and opportunities in smaller towns, paving the way for more targeted and effective waste management strategies.

Keywords: Solid waste management, PPP, urban.

1. INTRODUCTION

1.1 Background of the Study

India is one of the oldest civilizations in the world. Spanning a period of more than 4000years and witnessing the fusion of several customs and traditions, which are reflective of the rich culture and heritage. It covers an area of 3,287,590 sq. km., extending from the snow-covered Himalayan heights to the tropical rain forests of the south. As the 7th largest country in the world, India stands apart from the rest of Asia. It is marked off as by mountains and the sea, which give India a distinct geographical entity. Bounded by the Great Himalayas in the north, it stretches southwards and at the Tropic of Cancer, tapers off into the Indian Ocean between the Bay of Bengal on the east and the Arabian Sea on the west, (Know Your India - Embassy of India). India is the second largest nation in the world, with a population of 1.21 billion, (Census2011) accounting for nearly 18% of world's human population. A total of 181 million people increased from the previous Census of 2001. India is now among the top 10 countries generating the highest amount of Municipal Solid Waste, due to growing urbanization and high consumption. This is primarily because of the large size of the urban population and the city-dwellers adopting high-consumption lifestyles. Hence India is facing a sharp contrast between its increasing urban population and available services and resources. Solid Waste Management (SWM) is one such service where India has an enormous gap to fill. Proper Municipal Solid Waste (MSW) disposal systems to address the burgeoning amount of wastes are absent. Solid Waste disposal and Management both are urban and rural problems. It is a crucialproblem not only for developing countries, but for the developed countries as well. Enormous amount of Waste is generated throughout the world and the most crucially posed question is how to manage these wastes effectively and efficiently to save the environment and the continuous existence of mankind. Every person is a potential generator of waste and thus a contributor to this problem. Waste is generated by, and from different sectors- domestic, commercial, industry and others, but the WasteManagement responsibilityhas been left to the government or administrative authoritiesonly. Hence the municipalities, cities and towns continue to grapple with the problem of Solid Waste Management. Today there is a growing consensus that the immediate stakeholders in the issue of Solid Waste, in this case the residents need to join hands with the authorities in dealing with this problem that has far-reaching environmental andhuman health effects.

Fig 1. Overflowing garbage bin in pcmc city

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Urban India is facing a massive waste disposal problem which will worsen in the comingyears. With increasing population and rising income, the lifestyle of urban residents is alsochanging. Urban India is becoming a 'use & throw society'. The waste in bigger cities aregenerallypaper, plastics, metal and hazardous materials apart from vegetables wastes. Bio-degradable household waste has far less impact than the waste generated by activities likemanufacturing of goods. The industrialization and high level of affluence influences the composition and quantity of waste. 73% to 96% of the typical family's waste comprisesbio- degradable material in the lower income groups, while in higher income groups it is only about 26%.

The per capita waste generation rate in India has increased from 0.44 kg/day in 2011 to 0.68 kg/day in 2021, fuelled by changing lifestyles of 'use and throw theory'. Urban population growth and increase in per capita waste generation have resulted in a 50% increase by Indian cities within only a decade since 2011. There are 53 cities in India with a million plus population. They together generate 86,000 tons per day (TPD) ie.31.5million tons per year of MSW at a per capita waste generation rate of 500 grams/day. The total MSW generated in urban India is estimated to be 68.8 million tons per year (TPY) or 188,500 TPD of MSW. Such a steep increase in waste generation within a decade has severed the stress on all available natural, infrastructural and budgetary resources. Big cities collect about 70% to 90% of MSW generated, whereas smaller cities and towns collect less than 50% of waste generated (Kumar, 2009). More than 91% of the MSW collected formally and filled on open lands and dumps.

MSW rules 2000 made by the Government of India to regulate the management and handling of Municipal Solid Wastes, provide a framework for treatment and disposalof MSW. These rules are the result of a Public Interest Litigation in the Supreme Courtof India. The MSW rules 2002 and other documents published by the Government of India (GOI) recommend adoption of different technologies for SWM. Due to lack of data and infrastructural, financial and human resources, the Supreme Court mandate of complete compliance to the rules by 2003 could not be achieved by urban local bodies (ULBs) and that goal still remains to be a distant dream. As aresult, even after a decade since the issuance of the MSW Rules 2000, the state of MSW Management Systems in the country continues to raise serious public health concerns. Although somecities have achieved some progress in SWM, many citiesand towns have not even initiated measures.

Initiatives in PCMC were the result of heavy rains in 2006, and consequent flooding dueto drains clogged by Solid Waste. Also in 2009 the Arabian Sea did throw back at the PCMC City what the city has been throwing into it for long time. Data compiled by thePCMC shows that the city got as much as 640 tons of waste comprising plastic, polythene bags and thermocol from the sea in three days, (Times of India, dated 28thJuly2009). Most of the garbage makes its way into the sea through the nullahs and it also reflects our appalling garbage segregation performance. Some of the reasons for this could be the lack of public awareness or insensitivity towards the environment. Thus these two incidents paved the way for enacting state level legislation pertaining to the collection, transport and disposal of urban Solid Waste in the state of Maharashtra. The Bubonic plague epidemic in Surat in 1994, kick started measures to properly manage wastes in Surat, and increased awareness on the need for proper SWM systems all over India.

In India, segregation and storage of MSW at source is lacking and the decomposable andnon-decomposable wastes are often disposed off at a common communal dustbin/disposal center. The collections efficiencies are also seen to be poor. Around 70% in most Indian cities continue to be predominantly manual in nature. Transfer stations are rarely used and the same vehicle that collects, refuse from the individual communal bins is also responsible for taking it to the processing or the disposal site. Collection and transportation activities constitute approximately 80% to 95% of the totalbudget of Municipal Solid Waste Management (MSWM). Hence, it forms a key component in determining the economics of the entire MSWM system. On the contrary,disposal and treatment of waste is an underinvested area and open, uncontrolled and poorly managed landfills are a common feature across most Indian cities and towns.

Fig 2. Vehicle used to carry municipal solidwaste

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Until now, the problem of waste has been seen as rubbish as one of cleaningand disposing. But a closer look at the current and future scenario reveals that waste needs to be treated holistically, recognizing its natural resource roots as well as health impacts. Waste can be wealth, which has tremendous potential not only for generating livelihoodsfor the urban poor but can also enrich the earth through composting and recycling rather than spreading pollution as has been the case. Increasing urban migration and a high density of population will make SWM a difficult issue to handle in the near future, if a new paradigm for its management is not created.

The ever increasing urban population has put tremendous pressure on the budgetary resources of States/Urban Local Bodies (ULBs), underscoring the necessity of private sector participation in urban development. The unbundling of services and echnological innovations have opened up these areas to private sector participation. Also in order to overcome the technical and financial deficiencies associated with the current system, state and local governments in India are increasingly resorting to these of private ntractors for collection, transportation and disposal and private capital to supplement the mechanization/improvisation process.

In fact, private participation in the provision ofMSW services is not new India and corporation/municipalities have employee private contractor secondary transportation from the communal bins or collection points to the disposalsitessince1985. However, the services provided for by the private sector then werecontractual in nature and were confined to one or two segments of the MSW value chain. In recent times, the engagement of private sector participation has increasedfrom short term contracts to long-term partnerships. Close to 31 long-term Build-Operate-Transfer concessions have been awarded to the private sector till March, 2011toManage Solid Waste in the country. In spite of this, the involvement of Public PrivatePartnership (PPP) is in a nascent stage.

Solid waste management has become a major environmental issue in India. The per capitaof MSW generated daily, in India ranges from about 100 gm in small towns to 500 gm inlarge towns. Although, there is meager information at national level for MSW generationby specific source. Whereas, much details are available about collection and disposal. Theincrease in solid waste generation has been reported after the studies for a few urban centers. For example, the population of PCMC grew from around 8.2 million in 1981 to

12.3 million in 1991, registering a growth of around 49%. On the other hand, MSW generated in the city increased from 3,200 tons per day to 5,355 tons per day in the same

period registering a growth of around 67% (CPCB, 2000b). This clearly indicates that thegrowth in MSW generation in our urban centers has outpaced the population growth in recent years. This trend may be ascribed to our changing lifestyles, food habits, and change in living standards.

Traditionally, waste management services in India had been far from optimal as comparedto waste management services from developed countries. On the basis of physical and chemical characteristics of the city refuse, it has been estimated that a transport capacity of 320 m3 perday would be required to transport the garbage generated per million of thepopulation. A study on 44 Indian cities in mid-nineties revealed that majority of them failed to qualify on this account (Bhoyar et al., 1996). Another survey of 157 Indian citiesdepicted that, most of the local bodies did not satisfy the prevailing benchmark of optimum workforce requirement in garbage collection and disposal.

The studies on municipal solid waste generation carried out by Central Pollution ControlBoard reveals that, the per capita generation rate is high in some states viz. Gujarat, Delhiand Tamil Nadu and cities such as Chennai, Kanpur, Lucknow and Ahmedabad. This maybe due to the high living standards, the rapid economic growth and the high level of urbanization in these states and cities. However, the per capita generation rate is observedto be low in other states like Meghalaya, Assam, Manipur and Tripura and cities such as Nagpur, Pune and Indore. The composition and the quantity of MSW generated form thebasis on which the management system needs to be planned, designed and operated. Theurban population of 285 million is concentrated in a few large cities and 32 metropolitancities are accounting for 34.5 % of the urban

population that is expected to reach 341 million by 2010. The waste quantities are estimated to increase from 46 million tons in 2001 to 65 million tons in 2010

Indian cities are faced with a serious solid waste problem (Ahmed and Jamwal, 2000). Similar to many cities in the developing world, the municipal authorities responsible for waste collection, transport and disposal in India rarely have appropriate strategies, methods for mobilization of financial resources or the necessary appropriate infrastructurefor organized waste management. This leads to low collection coverage, especially in pooror marginal areas of the cities, and to uncontrolled disposal. Up to 50 % of the waste generated daily remains uncollected in the cities; the remaining waste is collected irregularly, dumped in an uncontrolled manner, or burnt on vacant plots in or on the outskirts of cities.

The insanitary methods adopted for disposal of solid wastes is, therefore, a serious health

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concern. The poorly maintained landfill sites are prone to groundwater contamination because of leachate production. Open dumping of garbage facilitates the breeding for disease vectors such as flies, mosquitoes, cockroaches, rats, and other pests. The municipalities in India therefore face the challenge of reinforcing their available infrastructure for efficient MSW management and ensuring the scientific disposal of MSW by generating enough revenues either from the generators or by identifying activities that generate resources from waste management.

1.2 Definitions and Classification Of Solid Wastes

In order to plan, design and operate a solid waste management system, a thorough knowledge of the quantities generated the composition of wastes and its characteristics are essential. As a first step, a proper definition of the terms is necessary to avoid the general confusion that is common in the usage of these terms.

A. Definition of waste

Wastes are substances or objects, which are intended to be disposed of, or are required to be disposed by the provisions of national laws. Additionally, wastes are such items which people are required to discard, for example by law because of their hazardous properties. Many items can be considered as waste like household rubbish, sewage sludge, wastes from manufacturing activities, packaging items, discarded cars, old televisions, garden waste, old paint containers etc., Thus, all our daily activities give rise to a large variety of different wastes arising from different sources. The rising quality of life and high rates of resource consumption patterns have had an unintended and negative. impact on the environment- the generation of wastes far beyond the handling capacities of governments and agencies

Waste means —

a) any discarded, rejected, abandoned, unwanted or surplus matter, whether or not intended for sale or for recycling, reprocessing, recovery or purification by a separate operation from that which produced the matter; or

b) Anything declared by regulation (after consultation under section 5A) or by an environment protection policy to be waste. Whether of value or not.

Solid waste

Garbage, rubbish, trash, refuse, or sludge, as well as other discarded materials produced by agricultural, community, industrial, home, medical, mining, or municipal processes. Efforts to limit the environmental impact of solid waste, from the point of production through recovery processes to disposal and recycling, are known as solid waste management

Municipal Solid Waste Definitions

It is difficult to present a single comprehensive and universal definition of Municipal Solid Waste.

Municipal Solid Waste (MSW) more commonly known as trash or garbage consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses.

Municipal Solid Waste (MSW): means and includes solid waste resulting from the operation of residential, commercial, industrial, governmental, or institutional establishments that would normally be collected, processed, and disposed of through a public or private solid waste management service. Municipal solid waste does not include hazardous waste, sludge, or solid waste from mining or agricultural operations.13 Solid wastes are all the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted.

The Municipal Solid Wastes (Management and Handling) Rules, 2000 has defined municipal solid waste‘ as commercial and residential wastes generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but includes treated bio-medical wastes.‘ Under the Municipal Solid Waste Management Rules 2016, "solid waste" is defined so as Tomean and include solid or semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, catering and market waste and other nonresidential wastes, street sweepings, silt removed or collected from the surface drains, horticulture waste, agriculture and dairy waste, treated bio-medical waste excluding industrial waste, biomedical waste and e-waste, battery waste, radio-active waste generated in the area under the local authorities and other entities mentioned in rule 2 and residual solid waste means and includes the waste and rejects from the solid waste processing

facilities which are not suitable for recycling or further processing.

1.8 Problem statement

The escalating challenges posed by rapid urbanization and population growth in India necessitate a comprehensive examination of solid waste management practices in municipalities across selected districts. Despite the increasing awareness of the environmental and public health implications associated with improper waste disposal, there exists a

critical gap in understanding the diverse methods employed for solid waste management in different regions of the country. This study aims to address this gap by focusing on selected municipalities within specific districts and pursuing four primary objectives. Firstly, it seeks to systematically investigate and document the various methods currently in use for solid waste management in India. Secondly, the study aims to compare these methods, evaluating their efficacy and environmental impact, across different cities in the country. Thirdly, it intends to analyze the landscape of Public Private Partnership (PPP) models operational in the realm of solid waste management, shedding light on collaborative approaches involving governmental bodies and private entities. Finally, the research endeavors to draw comparisons among the diverse PPP models, discerning their strengths and weaknesses in varying urban contexts. By delving into these aspects, this study aspires to provide valuable insights and recommendations that can inform policy- making and contribute to the enhancement of solid waste management practices in India's municipalities.

1.9 Scope of the study

The scope of this study is comprehensive and multifaceted, encompassing various dimensions of solid waste management practices in selected municipalities across specific districts in India. Firstly, the study will extensively investigate and analyze the diverse methods employed for solid waste management, including but not limited to collection, transportation, disposal, and recycling initiatives.

By examining these methods, the research aims to provide an in-depth understanding of the current state of solid waste management practices in the selected regions. Secondly, the scope extends to a comparative analysis of these practices across different cities in India. This involves assessing the effectiveness, efficiency, and sustainability of various solid waste management approaches, considering the unique socio-economic, demographic, and geographic characteristics of each city. The comparative aspect aims to identify best practices and potential areas for improvement that can be tailored to specific urban contexts.

Furthermore, the study will delve into the realm of Public Private Partnerships (PPPs) in solid waste management. It will explore the various collaborative models between public and private entities, investigating their structures, functions, and outcomes. The scope also includes an examination of the regulatory frameworks and policies that govern these PPPs, providing insights into the legal and institutional aspects of such partnerships.

The geographical scope of the study is defined by the selected municipalities within specific districts, allowing for a focused analysis of regional variations in solid waste management practices. However, the findings and recommendations drawn from this study may have broader implications for similar urban settings across India. Overall, the study aims to contribute valuable knowledge to the field of solid waste management by offering a nuanced understanding of methods, comparisons, and PPP models. The insights generated are expected to inform policymakers, urban planners, and stakeholders, guiding the development of more effective and sustainable solid waste management practices in Indian municipalities.

The aim of the study is to comprehensively evaluate and analyze the effectiveness, challenges, and innovations in solid waste management practices implemented by selected municipalities in specific districts. This includes examining the strategies adopted for waste collection, segregation, transportation, treatment, and disposal, with a focus on identifying best practices and areas for improvement in sustainable waste management.

2. LITERATURE REVIEW

Extensive literature exists in urban solid wastes management. These studies help us to understand the issue and its impacts on the environment. Majority of the studies conducted in this area of research is in respect of developed countries as regards Kerala, the impact assessment studies have done 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.

Wertz (1976) analysed the economic factors influencing household production of refuse considering two Detroit suburbs in the U.S and estimated the income elasticity of demand for household waste management services as 0.27.

Richardson et al (1974) and Richardson (1978) analyzed the seasonal household solid waste generation and an economic analysis of the composition of households solid wastes respectively. They examined the influence of seasonal variations on solid waste generation along with other factors like household income, household size and age structure at Indianapolis, U.S.A. The income elasticity of demand for household waste management services was estimated as 0.24. Baldismo (1988) while analyzing scavenging of municipal solid waste in Bangkok, Jakarta and Manila, observed that the quantities and characteristics of solid waste produced vary from country to country and identifies the factors that influence it as the average level of income, the sources, population, social behavior, climate, industrial production

and the market for the waste materials. Jenkins (1993) in his study on American municipalities and found that waste generation increased with increase in the percentage of population in the age group between 18 and 49. She also developed a model where households maximize utility, which positively depends on the consumption of goods and negatively on the quantity of recycling. The budget constraint included a disposal charge for municipal solid waste collection. The quantity of municipal solid waste generated was found to be sensitive to the price of municipal solid waste collection. Analysing data for in American municipalities, she found that $1.00 dollar fee per 32-gallon trash bag would reduce waste generation by 15 percent. She estimated that such a pricing system would improve social welfare by $650 million per year ie around $3 per person per year. The average price elasticity for municipal solid waste collection was -0.12. Mclain (1995) identified the changes in lifestyle in the last 50 years as the main cause for the increased solid waste generation in the U.S.A. The increase in nuclear families, increase in women ‘s participation in work and the usage of modern kitchen equipment has increased the need for packaged foods which has accelerated the rate of after consumption waste. It was found that, in the U.S about 33% of the waste consisted of containers and packaging materials.

Beede and Bloom (1995) assessed the relative importance of growth in real per capita income and population in determining municipal solid waste generation rates. Analysing data from a cross section of 36 countries the income elasticity of was estimated as 0.34 and population elasticity as 1.04. Again using time series data for the U.S. (1970-1988) and for Taiwan (1980-1991), they found the income elasticities as 0.86 and 0.59 and population elasticities as 0.63and 1.63. Using data set for households, they found that household waste generation as income inelastic and an approximately unit elasticity with respect to population.

De Konning H et al (1995) surveyed 21 Latin American countries and showed that the per person generation rate of industrial hazardous waste sludge and solids is a function of the country ‘s industrialization. Countries like Brazil and Mexico had high rates of over 0.3tons/person/year and countries like Bolivia and Equador had lower rates of less than 0.1tons/person/year. Dennison et al (1996) while conducting a survey of household waste characteristics in the city of Dublin, Ireland, showed the relationship between socio-economic factors and the composition of the waste generated in Dublin. Using a sample of 857 households, the study identified prosperity and household size as the important variables. The data showed substantial differences in the relative composition of the waste stream as compared with the earlier studies undertaken in the late 1970s. The proportion of organic wastewas found to be in excess of 45% by wt. in the study as compared with 34% in 1977/78. The results showed a big difference between the prosperous and the less prosperous section of the city's population with regard to individual and overall waste generation. Martin Medina (1997) analyzed the relationship between the municipal solid waste generation rates and income for 123 countries. A curvilinear shape was found for the relationship between the two variables which shows that as a country develops its waste generation rate increases but as it reaches the middle income and upper income range the generation rate decreases.

Podolsky and Spiegel (1998), analyzed municipal waste disposal, unit pricing and recycling opportunities on 149 municipalities in New Jersey in the U.S and identified a negative relation between average household size and waste generation rates indicating a possibility of household diseconomies of scale in waste generation. They also found that urban households generated less solid waste when compared with rural households mainly due to the space constraint in the urban areas. Hong (1999) examined the effect of unit pricing system upon household solid waste in Korea. He used a data set of 3017 households from 20 cities in Korea and estimated the household solid waste generation being income inelastic at 0.10. Kinanman and Fullerton (1997), Hong et al (1999) and Jenkinset al (2003), in their respective studies found a negative relation between household size and solid waste generation. Houtven and Morris (1999) in their study examined householdbehaviour under alternative pay-as –you-throw systems for solid waste disposal and observed that the amount of mixed waste increased considerably with the number of small children and adults between the age group 25 to 64 years. They also found that urban households generated less solid waste when compared with rural households.Sterner and Bartelings (1999) considered the attitudinal variables that influenced the quantity of municipal solid waste generated by households in Swedish municipalities. It was found that apart from economic incentives a proper recycling structure would induce the households to invest more time in recycling and composting.

Bhattarai. R.C. (2000) analyzed the household behavior on solid waste management in Kathmandu metropolitan city and found household size and income as the major determining factors for the total quantity of wastes generated.

Salhofer (2001) has dealt with four different approaches to analyze waste generation rates. i) Input –output models: In input –output models the input of the waste generator is assessed by using production, trade and consumption data about products related to the specific waste stream; ii) Factor models: These models consider analyzing factors like income, housing types etc which describe the processes of waste generation; iii) Region specific classification iv)

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Single point of generation based classification and v) Macro level classification.

P. Beigl et al (2003) has identified the parameters that explain the present situation and to assess the future amount of municipal solid waste generated per capita in different European cities. Gross domestic product was found to be a significant factor in cities with high prosperity but not for cities with a lower economic output. Of the social indicators, a positive relationship existed between the percentage of the medium age group (15-59) and municipal solid waste generation while a negative relationship existed between the average household size and the solid waste generation.

Hong et al (1993) has examined the solid waste generation and recyclingbehaviour of the households within a household Portland, Oregon, U.S.A, by developing a household recycling choice model and a demand function for municipal solid waste disposal. The model was applied to a sample of households from the Portland, Oregon metropolitan area. It was found that the marginal pricing with zero charges for recyclables may provide incentives for households to dispose of less waste through garbage collection services which may be done by generating less total waste or by increasing recycling effort. A positive but small relation was found between an increased price of waste collection and the quantity of municipal solid waste generated.

Morris et al (1994) considered the effectiveness of marginal cost pricing of garbage on waste generation and recycling. They identified that price increase on disposal did not affect recycling as it reduced the household's increased total waste generation.

Miranda et al (1994) found that introducing unit pricing and recycling programs can affect significantly the quantity of municipal solid waste generated. They also found that market based incentives on the management of residential municipal solid waste will improve the efficiency of residential solid waste management.

Fullerton and Kinanman (1996) has analysed the effect of volume based pricing program in Charlottesville, Virginia, U.S and found that the programmed a substantial effect on the volume but no effect on the weight of waste as the weight per bag increased. Volume based collection fees will result in practices called _Steatle Stomp' as the households compact garbage into fewer bags. It was estimated that there was a 28% reduction in garbage but it may be due to illegal dumping. Ackerman (1997) found that the initial introduction of unit pricing system results only in slight reduction in waste disposal through dumping.

Kinnaman and Fullerton (2000) finds that if illegal disposal or burning options exists as a choice for the households to dispose waste then unit pricing will increase illegal dumping. Jenkins (1993), Blume (1991) and Miranda and Aldy (1998) have also come up with the same conclusions. Dinan (1993) argues that uniform tax on all types of garbage might be inefficient if materials within the waste stream produce different social costs.

Bruvoll A. (1998) analysed the effect of income, waste management fees and population density on the overall amount of waste generated and of income, fees and recycling services on the choice of waste management methods. It was found that the overall quantities of municipal solid waste are not influenced by income. Economic incentives were found to be effective in influencing the selection between different waste management methods. Landfill fees reduce the waste amounts landfilled and increase recycling and incineration. But the effect of landfill fees on total waste generation is negative but not significant.

Pratt.R.M. et al (2000) has analysed the impact of Waste minimization clubs on waste minimization. Waste minimization clubs are formed to encourage industry and commerce to adopt waste minimization methodology. A good majority of the clubs have helped in achieving a significant reduction in solid, liquid and gaseous waste along with financial savings due to higher efficiency.

Mongkolnchaiarunya, J. (2005) explains the new practices that were introduced in the city of Yala in Southern Thailand to deal with the problem of solid waste management. One of the practices was known as _Garbage for Eggs 'in which the residents were allowed to exchange recyclable material for eggs. The important objectives of the project were waste reduction, community empowerment through self-reliance, establishing new relationships of equality and less dependence between poor communities and the municipal administration.

Kaseva et al (2005) considered the effect of privatization on solid waste collection and disposal in Dar es Salaam city, Tanzania. The total solid waste generation was around 2425 tons/day. It was found that with privatization the solid waste collection improved by 10% to 40% of the total waste generated in the city daily in 2001. The study recommends the use of waste recycling and composting activities in order to attain sustainability in waste management. A good number of studies have considered the effects of landfills and incinerators on property value decrease, ground water contamination and health. One can find a number of studies dealing with the property value decrease due to the proximity to landfills. The observation is that as the distance from the landfill increases, the property value increases. Hedonic property price study was done to estimate the disamenity costs.

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Havlicek et al (1971), used hedonic method to consider the effect of five landfills on property values in Fort Wayne, Indiana, USA. The price survey of 182 house sales from 1962-70, within the neighborhood of the landfill showed that there was a $9800 increase in house price per mile from the landfill. A study done at same place by **Havlicek (1985)** found that the house price rose by 5% per mile away from the landfill.

Gamble et al (1982) analyzed the effect of water contamination due to the presence of a hazardous waste site in Pleasant plains, New Jersey, U.S.A using hedonic method. A price survey of houses sold both before and after 1974 found a 10% fall in house prices for 1.5 –2.25 miles from the landfill. Baker (1982), in his study estimated a 21% to 0.55% fall in the house prices as the distance from the land fill increased

from 0.5 miles to 1.25 miles from the site.

Michaels et al(1990) using hedonic method, examined the effects of 11 hazardous waste sites on property values in the suburban Boston, U.S.A, during the time period 1977-81. The average increase in property values was found to be $253 dollars per house with increased distance from the waste site.

Nelson et al (1992) examined the effect of landfill in Ramsey, Minnesota, USA on property values. Using hedonic method, the price survey of708 house sales during 1979-1989, within 2 miles close to the landfill was considered. The house price was predicted to rise by an average of $4896 or by 6.2% as the distance from the landfill increases by a mile.

Hirshfeld et al(1992) using hedonic method found a value reduction of 30% to 13% as the distance increased from 0.5 miles to 1.25 miles from the landfill site.

Keil et al (1995), analysed the effect of incinerators on property value in Massachusetts. The study used hedonic method and covered a period of 18years and 2593 house sales within that time period. It was found that during the construction of the site there was a reduction of 1.7% per mile in the house value had increased to 3.2% per mile when it was completed.

Ogedengbe et al (2006) has examined the effect of waste management method on property values in Ibadan city, Nigeria. Eleven firms of estate surveying and valuation out of thirty- six registered estate surveying and valuation firms in the study area were selected using systematic random sampling technique. In addition, 15 properties within the axis of three refuse dump sites were selected using stratified random sampling technique to know how their rental values are affected by the generation and management of these dump sites. The results showed that the waste dumps have significant negative impact on the property values in the area.

Bacud et al (1994), analysed the water quality of drinking wells around the Payatas dumpsite in Quezon City, Manila, Philippines and has shown the acidification of ground water and the increased presence of nitrates and Coliform bacteria.

Pushpakumari (1997) analysed the effects of pollution of Travancore Titanium Products and brings out the adverse impacts of pollution from the factory. The areas very close to the factory were more prone to the pollution hazards. It was found that 19% of the people in the experimental group were affected by respiratory and related diseases. Other effects include low coconut yield, declining fish yield and fish species, corrosion of fishing crafts and gears, increasing trend of the locals leaving their traditional fishing to other occupations.etc.

Shameer Das et al (2000) in their study examined the health impacts of environmental pollution by solid waste disposal from Grasim Industries, Kerala. The effluents from the industry were found to pollute the river Chaliyar and thus directly affecting the population living nearby. It was also found that the discharges from the factory was degrading the ecological quality of the area in the form of contaminated water, polluted air, solid wastes and noise. Around 56% of the people surveyed were affected by some diseases caused by pollution. The lower and lower middle income group were most affected. The main health problems were in the form of the occurrence of diseases like persistent coughs, bronchitis, asthma, headache, cancer and eye irritation.

Nilanthi et al (2003) has analyzed the environmental impacts associated with current waste disposal practices in Moratuwa, Sri Lanka, a suburb municipality in SriLanka. Municipal officials, over 300 households and landfill operators were interviewed to examine current practices and related environmental problems. Groundwater samples from the vicinity were analyzed and it showed levels of certain chemical parameters well above acceptable limits. Landfill gas emissions and possible green house gas contributions were theoretically calculated using Scholl Canyon Model for gas estimations. The main environmental problems identified in the study were the release of landfill gas and leachate. The significant amount of landfill gas which is generated from the site is released to the atmosphere contributing to global warming. Leaching of pollutants into ground water has also been found to be a significant concern due to the high use of ground water for residential purposes and due to the possible illegal disposal of industrial waste along with

MSW. From the public perception worst impacts of present solid waste disposal practices are seen as direct social impacts such as odor, breeding of pests and loss in property values.

Elma Torres et al (2004) has analysed the health risk perception of communities located in Metro Manila airshed in Philippines. Majority of the respondents recognized environmental factors as sources of various diseasesymptoms and illness. The community considered proper disposal of solid waste as more important than clean air. The respondents had a positive attitude towards pollution control as majority of them were willing to pay for clean air.

N.Raman et al (2008) have analysed the impact of solid waste on groundwater and soil quality on places closer to Pallavaram solid waste landfill in Chennai. The physical and chemical parameters like Ph, electrical conductivity, total dissolved salts, total suspended solids, alkalinity calcium, magnesium, chloride and metals like sodium, potassium, lead, cadmium were studied. It was found that parameters like pH, hardness of water, calcium, and manganese were beyond the acceptable limits in accordance with the IS 10500 drinking water quality standards. In the case of alkalinity, and metals like copper, manganese, cadmium, nickel and chromium their presence were beyond the acceptable limits.

Utpal Goswami et al (2008) analysed the impact of municipal solid waste dumping on soil quality in Guwahati city. Soil samples were collected from different depths of the abandoned municipal solid waste dumping groundat Adabari in Guwahati city. The study found that the experimental value for the physio-chemical parameters increased for the solid waste treated soli when compared with the control soil. The soil pH and electrical conductivity were high and the presence of phosphorous pentoxide and calcium carbonate were found to be high.

Altaf et al (1996) studied the household demand for improved solid waste management at Gujranwala, Pakistan using C.V method. The approach of the study was to integrate demand side information into the planning process. The average willingness to pay was estimated as Rs.8.04 per month per household. The significant variables affecting the WTP were education, household expenditure discretionary income and wealth.

Willis and Garrod (1997) estimated the WTP using C.V method to reduce noise, odour and windblown dust and litter from a landfill using a choiceexperiment study. The study used a sample of 79 residents around the chosen landfill. It was found that the Marginal WTP to reduce the number of days when respondent suffers from dust and windblown litter from the site is £0.12 to £0.19per day and the Marginal WTP to reduce the number of days when respondent can smell the site from their home: £0.10 to £0.15 per day.

Rogier Marchand (1998) analysed whether demand side information along with WTP and affordability to pay will prove to be the most important factors to improve the solid waste management in the urban areas of developing countries. A study on the affordability and WTP for solid waste management services in Tingloy, Philippines using C.V method was conducted and the average WTP for an improved solid waste management system was foundas15.75 Pesos per month per household.

Viniegra et al (2001) determined the economic value of an improvement in environmental quality due to an alternative household garbage collection and selection system for the inhabitants of San Pedro Choula in Central Mexico using C.V. method. The average monthly willingness to pay (WTP) for the improved collection system was estimated at $1.85 /month /household. The income elasticity for environmental quality was found to be 0.13. The significant variables affecting the WTP were income, age and trust in government. Education, wealth, children, gender and environmental ethic were found non-significant.

Chutrat et al (2007) estimated the willingness to pay (WTP) to pay environmental taxes and their opinions on the environmental management of thehouseholds of Khon Kaen in Thailand using C.V method. It was found that the households were willing to pay taxes for their environment up to 20.88 Thai Baht per month. Their willingness to pay the taxes depended upon the education and income levels.

Reyer Gerlagh et al (1999), has proposed a new paradigm of SWM, to achieve a socially and environmentally responsible solid waste management in India. A range of activities, issues and processes like the types of waste generated, the number of stakeholders and economic activities involved, and the various economic, social and environmental effects of SWM which includes legitimization of the informal system, public participation and partial privatization are considered. A linear programming model to evaluate the effectiveness of different SWM alternatives is applied to the city of Bangalore with the main objective to minimize the overall system costs and to identify low-cost alternatives to manage household, institutional and industrial waste. The model incorporates social and environmental objectives associated with SWM to find sustainable solutions. The model is comparable with input-output modeling with additional objectives given as side constraints. The significance of the model is in showing the important interdependencies in the waste management sector and is an important step in evaluating integrated SWM in developing countries.

P.B.Anand (1999), examined how households in Madras view garbage problems, their preferences for improved services and the extent to which they would pay for them. It also includes a comparison between areas served and not served by Civic Exmore units where neighborhoods organize their own primary collection. Information was collected from focus group discussions, household interviews from across a range of income levels and spatial locations and in-depth interviews with those who manage the Civic Exnora units. The findings highlight that people are willing to cooperate and pay only for waste collection. Analysis also shows that concern for waste management cuts across all income groups. Of all the waste management services, households seem to be least concerned with final disposal. They also show how the financial viability of neighborhood collection schemes such as the Civic Exnora units depends on having transfer stations close by, to which the collected wastes can be taken.

Babu Ambat (2000), identified the types and estimated the quantities of waste generated in each ward of Thiruvananthapuram City Corporation. It was estimated that a total of 290-300 tons of solid waste were generated in the city. The contribution of the households was 181 tons followed by markets (40 tons) and hotels and restaurants (30 tons).The medical waste was about 13 tons. The non-degradable waste like plastics, paper, metals and glasses were collected from the source or from the disposal sites by a group of rag pickers. They sell these wastes to the wholesale dealers who will transport these wastes to Salem and Coimbatore for recycling. The technology optimization study considered composting as the best method for disposing waste in Trivandrum since the degradable waste content (50%) is high in the solid waste stream. Biomethanation was suggested for institutions, hotels and marriage halls. The important aspects of the solid waste management action plan included a) segregation and characterization of the wastes at the source itself b) decentralized collection from the primary source and centralized collection from secondary sources c) strengthening the existing informal waste collection sector d) detailed transportation network planning.

Reghunandhan (2001) studied the generation, composition, disposal methods and collection and transportation problems of solid waste management in Chalakudy town and Pattambi town. The Chalakudy Municipality generated on an average 1.5 to 2 tones of waste per day which was dumped on two open landfills.. The proportion of organic waste was found to be around 73%.Pattambi town generated around 2 tons of waste per day whose organic component was found to be 66%. Slaughter houses (35%) and shops (21%) were the main sources of waste while households contributed around 6% to the total waste generated. The main methods of disposal of wastes were by dumping in pits (49%) and into common bins (22%).

P. R.SreeMahadevan Pillai (2002) in his study on the disposal and management of waste in Palakkad municipal area analysed the composition of waste, waste generation and disposal habits of the people. Laboratory experiments were done on the waste to understand the chemical composition of the waste. The proportion of organic waste was found to be 35.4%. Dumping of waste in ones own premise was found to be very common in Palakad (around 65% of the households did that). The utilization of municipal waste bins was considered to be very low at 15%. The study recommends the installation of a completely mechanized solid waste treatment plant for processing mixed waste.

C. N.Ray (2003), examined the present solid waste management scenario in the city of Ahmedabad and has identified the problems of the existing systems and analysed the steps taken by the city corporation to rectify the problems.

Babu Ambat (2003), analysed the current practices of solid waste storage, the present waste management practices, the community's perception on the existing collection and management system in Thiruvananthapuram city. The study also examined the changed attitude of the community, people's preference and willingness to cooperate and pay for an improved solid waste management practice and also identified the new initiatives at the local level for waste management. Lack of space and practice are considered to be the main reasons why wastes are not segregated and thrown on the road side. People are not willing to do any segregation of waste except the news papers. Majority of the hospitals dump the waste in the dumper placer containers or burn it in the hospital premises. It was found that 55% of the households reduce, reuse and recycle the waste materials. Majority of the low-income and middle income houses burn 60% of the waste generated and sell the rest for a nominal rate. 88% of the people feel that they have a role to play in solid waste management showing the change in the attitude of the people towards solid waste management. People prefer a door to door collection system and were willing topay for an improved service of solid waste collection.

Varkey Mathew (2003), examined the quantity and quality of the solid waste generated in Kottayam town. Random and cluster sampling methods were used for selecting the households. The total waste generated per day was about 52.3 tons and the per capita generation was 0.62 kg/per day. It was found that the storage capacity of the community bins being inadequate. Vermicomposting was considered as the most effective method for organic wastes.

Madhushree Sekher (2004), analysed the process of municipal waste management in the city of Bangalore while focusing on the situation in Karnataka. The paper considers the characteristics of municipal waste generated, the

management practices involved and the role of the stakeholders in the overall process. Inadequate municipal service, unscientific disposal system, lack of civic awareness in waste management lack of a proper market for recycled waste products .etc. are found as the most important deficiencies in the waste management system.The review shows that solid waste management has emerged as a subject of great interest and various aspects of the issue have been looked into. One of the glaring deficiencies is the lack of studies focusing on densely populated small towns in developing countries and the absence of studies analysing the socio economic and environmental impacts of solid waste management. In this context, the present study intends to bridge a gap in this area of research.

2.1 Research gap

The extensive literature review on solid waste management practices in selected municipalities across various districts reveals a comprehensive understanding of the subject, predominantly drawing on studies conducted in developed countries and a few impact assessment studies in Kerala. However, a noticeable research gap exists in the lack of studies focusing on densely populated small towns in developing countries. The majority of existing research predominantly targets urban areas, and there is a scarcity of micro-level studies that specifically address the intricacies of solid waste management in smaller towns. Additionally, the literature review highlights the importance of examining the socio- economic and environmental impacts of solid waste management, but it does not delve into specific findings or studies that address this crucial aspect comprehensively.

Therefore, this research aims to bridge the identified gap by conducting a detailed investigation into the solid waste management practices in selected municipalities within smaller towns, focusing on their socio-economic and environmental implications.

3. CONCLUSIONS

The extensive literature review on solid waste management practices in selected municipalities across various districts has provided a comprehensive understanding of the subject, predominantly drawing on studies conducted in developed countries and a few impact assessment studies in Kerala. However, a noticeable research gap exists in the lack of studies focusing on densely populated small towns in developing countries. The majority of existing research predominantly targets urban areas, and there is a scarcity of micro-level studies that specifically address the intricacies of solid waste management in smaller towns.

Additionally, the literature review highlights the importance of examining the socio-economic and environmental impacts of solid waste management, but it does not delve into specific findings or studies that address this crucial aspect comprehensively. Therefore, this research aims to bridge the identified gap by conducting a detailed investigation into the solid waste management practices in selected municipalities within smaller towns, focusing on their socio-economic and environmental implications. By addressing this research gap, the study intends to contribute significantly to the existing body of knowledge on solid waste management, particularly in the context of densely populated small towns in developing countries.

The findings from this study are expected to provide valuable insights into the challenges and opportunities associated with solid waste management in smaller towns. These insights can inform policy decisions, urban planning strategies, and resource allocation to enhance the effectiveness and sustainability of solid waste management practices. Additionally, the socio-economic and environmental impacts of different waste management strategies can be evaluated to identify best practices and solutions tailored to the unique needs of smaller town settings. In conclusion, this research not only contributes to academic knowledge but also holds practical significance by offering actionable recommendations and strategies for improving solid waste management in densely populated small towns. By addressing this critical aspect of sustainable development, the study aims to contribute positively to the overall well-being and environmental quality of these communities.

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