EXPLORING SOLID WASTE GENERATION DYNAMICS: A COMPREHENSIVE STUDY OF SELECTED INDIAN STATES WITH A SPOTLIGHT ON MENSTRUAL WASTE MANAGEMENT IN PONDA-GOA

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I hereby declare that the data presented in this dissertation report entitled. "Exploring Solid Waste Generation Dynamics: A Comprehensive Study Of Selected Indian States With A Spotlight On Menstrual Waste Management In Ponda-Goa" is based on the results of investigation carried out by me in the Economics Discipline at the Goa Business School/ Economics Dept, Goa university/ Goa Business School under the Supervision of Ms. Sumita Datta and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities/ Goa Business School will not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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PREFACE

The challenge of Solid waste management is one of the most pressing issues faced in India. As populations grow and urbanization accelerates, the volume and complexity of solid waste generated pose significant effects. Against this backdrop, the need for comprehensive research to understand the solid waste generation dynamics and also looked into one of the crucial aspects of waste management, that is menstrual waste management, a pressing need. The genesis of this project lies in the recognition of understanding solid waste generation dynamics of selected Indian states with a special spotlight on examining the menstrual waste management in Ponda-Goa, which is often overlooked. Yet, it is a significant aspect of the waste stream.

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ABBREVIATIONS USED

Entity	Abbreviations
GSDP	Gross State Domestic Product
PMC	Ponda Municipal Council
SWM	Solid Waste Management
MHM	Menstrual Hygiene Management
MWM	Municipal Waste Management
CPCB	Central Pollution Control Board
WTP	Willingness to Pay
S.E	Standard Error

ABSTRACT

The relationship between Solid Waste Generation and economic indicators is complex and important. On the other hand, menstrual waste management is often overlooked but a crucial aspect of waste management. This research study aims to explore the dynamics of solid waste generation in selected Indian states, with a focus on menstrual waste management in Ponda-Goa. This study comprises of two main components. Firstly, an analysis of solid waste generation in relation with economic indicators such as Gross State Domestic Product (GSDP), Urbanization rate and Industrial activity which reveals a positive correlation between these factors and solid waste generation across the chosen states. Secondly, a comprehensive examination of menstrual waste management in Ponda-Goa highlights the current inadequacies in disposal facilities. A primary survey explores women's willingness to pay in improved menstrual waste disposal methods, alongside an assessment of existing practices and disposal habits adopted by Ponda Municipality. Findings indicate a pressing need for enhanced menstrual waste management facilities in Ponda, coupled with demonstrated willingness among women to support such improvements, where there's a clear need for better management of menstrual waste.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Waste generation and Waste management is a major issue that every country faces. It is indeed a universal challenge. Any Item that is neither liquid nor gaseous that is thrown away is referred to as solid waste. Understanding the various waste categories and their attributes is crucial for solid waste management, it encompasses various types of waste such as municipal solid waste which is one of the main categories of solid waste. Other wastes include industrial waste, sanitary waste, e-waste, biomedical waste and hazardous waste, and several others. The Goals of solid waste management methods are to reduce the amount of garbage generated, stimulate resource recovery, reduce environmental impact, promote recycling and composting, and make sure that leftover waste is disposed of appropriately. India's legal and policy framework, which consists of state and federal laws and regulations, enables efficient handling of solid waste. The Solid Waste Management Rules (SWM), 2016, which were adopted under the Environment (Protection) Act, 1986, are the primary laws regulating solid waste management in the nation. These rules provide a comprehensive framework for waste management practices, which every state, region, and district of the nation is required to follow. Despite the existence of a foundation of policies and laws, solid waste management rules in India encounter challenges in being implemented and keeping effective.

Undoubtedly, India is among the world's fastest-developing nations. It is the fifth-largest economy in the world. Despite economic growth, India faces significant challenges in effective Solid waste management. It generates around 62 million tonnes of waste each year. About 43 million tonnes (70%) are collected, of which about 12 million tonnes are treated, and 31 million tonnes are dumped in landfill sites ("Waste Management in India," 2024). With its rapidly growing population, urbanization, and industrial activity, the amount of waste generated has increased substantially. Waste generation in urban areas of India will be 0.7kg per person per day in 2025, approximately four to six times higher than in 1999 (*Waste to Wealth Mission* |

Invest India, n.d.). India's Solid waste management practices have evolved. In the past, disposing of waste required open dumping and burning, which posed serious health risks and environmental damage. An array of environmental issues have been caused by the ineffective management of solid waste. Inadequate waste treatment and improper disposal methods lead to air pollution, water pollution, and soil contamination, which is destructive to ecosystems and to the health of humans. The accumulation of waste in dumping grounds and landfills causes environmental degradation by emitting greenhouse gasses and polluting groundwater. Furthermore, inappropriate waste disposal promotes the spread of respiratory and vector-borne diseases. The effects impact not solely the environment but also the society, the economy, and individuals' well-being and their standard of living.

In India, Municipal solid waste (MSW) is typically in low-lying locations without the necessary operational controls and safety measures. Solid waste management involves activities that are associated with generation, storage and collection, transfer and transport, treatment, and proper disposal of solid waste. However, the generation, collection, transportation, and disposal of waste are the only four functions that make up the MSWM system in the majority of Indian states. Municipal solid waste builds up in every corner.

It has been constantly observed that waste production rises yearly in direct proportion to Population growth, Economic growth, Urbanization, and Industrial activity. In 2022, India overtook China as the country with the largest population in the world. The growing population exerts pressure on urban infrastructure and services, including waste management systems. As more people migrate to urban centers in search of better opportunities, the demand for goods and services rises, consequently leading to increased solid waste generation. Therefore, as the population increases there has been a notable increase in the per capita generation of solid waste. This is also due to the improvement in people's standard of living conditions. Economic growth influences consumption patterns and lifestyle choices, directly impacting waste

generation rates. Also, when we look at urbanization, it not only accelerates the pace of infrastructure development but also leads to concentrated waste generation in urban centers. The rate of urbanization directly correlates with the increased generation of solid waste and also the demand for efficient waste management systems. On the other hand, industrial activity or industrialization plays a crucial role in the composition and volume of solid waste generated. Understanding the influence of industrial activity on solid waste is essential for exploring the overall status of solid waste generation.

Hence numerous studies have examined the impact of increased solid waste generation on environmental and public health. Limited research has been conducted to understand and explore the economic factors that are contributing to solid waste generation. Economic factors such as urbanization rate, industrial activity, and economic growth influence the volume and composition of solid waste. Thus, the link between economic growth, urbanization rate, industrial activity, and solid waste generation underscores the importance of adopting an integrated approach to address the overall complex solid waste generation status in India.

Hence, the purpose of this research study is to comprehend the dynamic relationship that exists between solid waste generation and economic growth (as reflected in the gross state domestic product) industrial activity, and urbanization rate in randomly chosen Indian states which are, Haryana, Punjab, Goa, Madhya Pradesh, Himachal Pradesh, Odisha, Manipur, Tripura and Meghalaya. One of the aims of this research project is to add to the body of knowledge on the management and generation of solid waste and provide an overview of these selected Indian states.

Among the various components of solid waste, menstrual waste presents a unique and often overlooked concern. Menstrual waste comprising of sanitary pads, tampons, and related

materials, poses significant challenges due to its non-biodegradable nature. Hence the other part of this research study focuses on menstrual waste management with respect to goa.

Menstruation is a natural fact of life or a natural biological process that occurs monthly for 1.8 billion girls, and women of reproductive age. According to the World Bank, around 300 million women menstruate daily. Women who menstruate are in need to maintain proper menstrual health and hygiene. Menstrual hygiene management (MHM) is the creation of an ecosystem that allows women and girls to experience menstruation in a safe and dignified manner. This would often begin with easy as well as affordable access to menstrual hygiene products such as sanitary napkins, disposable pads, menstrual cups, and tampons. Also having appropriate access to facilities for disposing the menstrual waste or used products in a safe hygienic and sustainable manner. Menstrual health hygiene is essential for the well-being and empowerment of women and adolescent girls. Adequate menstrual hygiene management is essential for ensuring uninterrupted access to education for girls and also enables women and girls to participate fully in economic activities. Eventually reducing economic barriers for them. Hence, the government as well as non-governmental organizations in India have taken significant steps to promote the importance and necessity of maintaining menstrual health hygiene. Continued efforts and investments in this area are made to ensure that all women and girls in India can manage menstruation with better hygiene facilities and safety. The current discourse of MHM practices in India primarily focuses on generating awareness and creating access to menstrual products for women and girls in rural and urban areas. But the menstrual waste disposable system is an equally important thing that needs urgent attention. India has one of the largest numbers of menstruating women. As the usage of menstrual products is increasing, the amount of menstrual waste generated every day is also increasing. Approximately 200 tonnes of sanitary waste are generated every day. Disposing of menstrual waste is a critical concern that needs addressing. If such waste is not handled properly, it can

be harmful to the environment as well as public health. Handling this kind of waste brings several kinds of challenges. Like, many places lack adequate infrastructure for the disposal of sanitary waste. The disposal of menstrual products like sanitary pads, tampons, and menstrual cups contributes to environmental pollution. Improper disposal of menstrual waste can lead to health risks such as the spread of infections and diseases. In areas with inadequate waste disposal facilities, women may resort to unsafe methods of disposal, increasing the risk of contamination. Several women have now developed their strategies to handle this period. These strategies vary greatly based on their personal preferences, availability of resources, economic status, cultural traditions and beliefs, education status, and brief knowledge about menstruation as well as the environment. While India has made progress in addressing menstrual hygiene through policies and initiatives in several states, there is often a very limited focus on menstrual waste management. Around 12.3 billion sanitary napkins are accumulated in India's landfills. When it comes to disposing of this menstrual waste many women lack adequate knowledge and menstrual waste disposal facilities. Hence, prioritizing menstrual waste management is a pressing need.

The other part of this research study aims to understand the menstrual waste management in Goa specifically in Ponda. Menstrual waste management remains an issue that needs more investigation and focus in Goa, a state known for its unique culture and beautiful landscape. The complex nature of the menstrual waste disposal system in Ponda-goa must be understood in the light of disposing of sanitary waste habits of women living in Ponda, also assessing the existing menstrual waste disposal system or practices and procedures that Ponda Municipal Council follows, methods of collection, segregation, transportation, and disposal of menstrual waste. This study also addresses the willingness of women to pay for safe menstrual waste disposal and the factors influencing their decisions, by taking into account their economic consideration and preferences of managing the menstrual waste.

1.2 BACKGROUND

India, due to its rapid urbanization and population growth, faces significant challenges in managing solid waste generation effectively. The country generates around 150,000 metric tons of solid waste per day, with urban areas contributing a significant amount of this waste. (Ministry of Environment, Forest and Climate Change). However, inadequate infrastructure, limited resources and inefficient waste management practices aggravate various issues because of improper waste disposal. Many studies focus on the environmental and health impacts associated with Solid waste generation but very limited studies solely take into account how the growth in economic indicators of the country also plays a significant in increasing the generation of solid waste day by day. Effective solid waste management is essential for maintaining environmental sustainability, public health, and most importantly overall quality of life.

However, managing certain types of waste like, Menstrual waste is a challenging task. Menstrual waste management is a multifaceted approach that involves tackling the issues related to safe or appropriate disposal methods, establishing effective waste management systems, ensuring proper disposal facilities in public toilets, and in households, or establishing robust waste management infrastructure to facilitate responsible handling of menstrual waste. Comprehensive efforts include public awareness campaigns and promoting environmentally friendly products. The Solid Waste Management rules provide for a process of segregation of waste at source into various categories and identify a disposal method for each kind of waste. The biomedical rules identify and categorize bio-medical waste including sanitary waste, and prescribe incineration to destroy pathogens in such waste. On the other hand, MHM (Menstrual Hygiene Management) guidelines discuss incineration, composting, and deep burial as some of the ways of treating and disposing of menstrual waste. Therefore, there is a need to understand and examine the appropriate disposal and treatment of menstrual waste in a city.

However, like many Indian cities, Goa also struggles with Solid waste management issues, including proper menstrual waste disposal. Therefore, there is a pressing need to examine and understand the existing menstrual waste management and disposal and treatment of menstrual waste in the city of Ponda-goa. Hence, by conducting a comprehensive study on solid waste generation by linking it to economic factors in selected Indian states, and examining the menstrual waste management status of a city, this study aims to fill the existing gap in the literature and provide insights that there is a need to improve menstrual waste management practices in the region.

1.3 RESEARCH OBJECTIVES

This study consists of the following objectives.

1. To provide an overview of solid waste generation status of selected states of India in relation with economic growth, industrial activity and urbanization rate.
2. To investigate the disposal of menstrual waste in Ponda Taluka.
3. To examine the existing practices of menstrual waste disposal management adopted by Ponda Municipal council.
4. To study women's willingness to pay for the safe disposal of the menstrual waste.

1.4 RESEARCH QUESTIONS

1. What is the effect of urbanization rate, population density and GSDP on the overall waste generation?

H0: Waste generation does not positively depend on the level of urbanization rate, industrial activity and GSDP (gross state domestic product)

H1: Waste generation positively depends on the level of urbanization rate, industrial activity and GSDP (gross state domestic product)

2. How do women manage menstrual waste in Ponda?

H0: Women do not dispose menstrual waste in an appropriate manner.

H1: Women Dispose menstrual waste in an appropriate manner.

3. What are the methods followed by Ponda Municipal Council to dispose the menstrual waste?

H0: There are no special measures undertaken to safely dispose menstrual waste in Ponda.

H1: There are special measures undertaken to safely dispose menstrual waste in Ponda.

4. How much an individual is willing to pay to dispose the menstrual waste in an appropriate way?

H0: Women are not willing to pay extra for the safe disposal of menstrual waste in Ponda.

H1: Women are willing to pay extra for the safe disposal of menstrual waste in Ponda.

1.5 SCOPE OF THE STUDY

This research study aims to investigate the landscape of solid waste generation across a few selected Indian states, to examine how economic growth (GSDP), population density, and urbanization rate of these states affect their overall solid waste generation over a period of 4 years. With a special reference to menstrual waste management in Ponda-Goa, this study also seeks to examine how adolescent girls and women residing in Ponda manage menstrual waste at home as well as at their workplace. It aims to understand the procedure Ponda municipal council follows to collect, segregate, and dispose of such waste. Also looking at women's

willingness to pay to dispose of menstrual waste more safely. By examining both general solid waste generation and the specific issue of menstrual waste this study focuses to shed light that economic indicators also play a significant role in increasing the amount of generation of solid waste. Also, to provide insights on the challenges associated with menstrual waste management in Ponda. Offer recommendations for better infrastructure, improved menstrual waste disposal facilities, and community engagement practices to promote sustainable waste disposal practices.

1.6 LIMITATIONS

There are three possible limitations in this study. Challenges in accessing or obtaining accurate information or data. Specifically, on solid waste management, secondary data was collected from CPCB (Central Pollution Control Board). Only a few Indian states were selected due to the accuracy level of the data which was much reliable as compared to other states that are not included in this study. Regarding menstrual waste management in Ponda, as it focuses only on working women and adolescent girls to know how they manage and dispose of such waste, it sets a limitation to generalizing it to the majority of the women and girls in Goa. So, there is a sort of inability to generalize these results to other parts of Goa. The methods adopted in Ponda-goa to dispose of menstrual waste may not be sustainable enough to be adopted in other cities of Goa due to its environment, cultural norms, and personal preferences.

CHAPTER 2

REVIEW OF LITERATURE

2. LITERATURE REVIEW

(Sk et al., 2023) Conducted a comprehensive study on solid waste management in Indian perspectives. Solid waste management is a critical global concern. In general, it is difficult to overestimate the importance of efficient waste management for maintaining the environment and safeguarding public health. This study aimed to provide in-depth understanding of the current state of solid waste management in India, also identify key issues, challenges and explore potential solutions for attaining sustainable waste management practices. The methodology adopted in this paper was a comprehensive search strategy, it collected primary and secondary data through various online databases like CPCB. Qualitative as well as quantitative analysis was conducted to assess trends, challenges, waste generation rates, composition over time. Their findings suggest that a progress has been made in managing the solid waste but there still exist significant gaps and obstacles that hinder effective and efficient waste management in the nation. Challenges are faced in terms of efficiency, coverage, and infrastructure and increased investment in waste management system. This study also provides scope for further research which can focus on evaluating the effectiveness of waste management interventions, studying socio-economic impacts and their implication on solid waste management, and a need for longitudinal study to assess the long-term effects of waste management policies and government interventions in terms of sustainability and people's health.

(Tahir, Hussain, Behaylu, & Tilahun, 2015) The generation of solid waste is frequently regarded as an urban issue. It is strongly linked to the rate of economic expansion, the degree of industrialization, consumer trends, and lavish lifestyle of city dwellers. The development and management of solid waste is a major issue. This research study aimed to quantify the current generation of Solid Waste and project the generation in future by projecting population growth and increasing urbanization in Metro Cities and find out the causative factors for the

same. Secondary data was collected from the published reports of the city administration and also from Central pollution control board. To analyze the data, statistical techniques were adopted. The findings showed that, there exist a positive correlation between a population's income and the amount of solid wastes generated. Increased earnings and economic expansion frequently have an effect on waste composition. Rich people use more packaged products which in turn increases the proportion of inorganic materials in the waste stream. This would have a severe impact on public health and environment. Also due to changes in dietary habits of the metro cities, not only the quantity of waste generation increases but the quality as well as composition of the waste also changes. As the country gets richer, the organic share decreases and paper and plastic increases. In conclusion, this paper highlights on active participation and awareness of the Public in effective and fruitful Municipal Solid Waste Management. This study limits its views only towards the metro cities, instead of taking into consideration the whole of Indian states for a better picture regarding its present waste generation.

(Gour & Singh, 2022) this state-of-the-art review typically examines the literature on management, framework, awareness, generation, collection, segregation, characterization, minimization, storage, transport, treatment, recycling, disposal, impact, GHG emission, COVID-19, and waste-to-energy aspects of solid waste management**.** the industrial revolution and economic development have led to changes in the consumption patterns. This study aims to address the state art view on more current matters in solid waste management in contrast to other combined retrospective and contemporary literature along with new perspectives on SWM, which will benefit developing and low-income countries. This study also provided a summary on recent solid waste management studies, their objectives, key findings, issues addressed in various countries. It presented the amount of solid waste generation trend in India, waste composition, status of waste processing, collection storage and segregation of waste,

transport and transfer, treatment and disposal, waste to energy conversion, key challenges faced which includes – greenhouse gas emissions, health issues, and also provided solutions to these challenges. The source of data collected is CPCB. The findings overall show that achieving a superior level of awareness among citizens needs to be the emphasize.

(Vij, 2012) Solid waste generation is directly influenced by urbanization, and improper trash management degrades the urban environment and creates health risks. In this light, the focus of this research paper was to see the upcoming trends of urbanization in India and linked waste generation. This research study examined the current practices prevalent in India to deal with this solid waste and problems associated with it. It also provided the measures to deal with solid waste in healthy and environment friendly manner to prove it as a resource instead of waste. Secondary data was collected from various census reports, FICCI Survey, NEERI Report. The findings showed that urbanization directly contributes to waste generation, unscientific waste handling which causes health hazards and urban environment degradation. Lack of proper planning in relation to the solid waste status of Indian cities and the need for including treatment and disposal facilities for urban solid waste management should be a part of a cities master plan. It also highlighted the status of waste generation and disposal and sanitary landfills across Indian cities. It also highlighted the current practices of solid waste management and also the challenges faced. Later the strategies suggested by the author, which includes – encouraging door to door collection system with optimum frequency so that waste should not be accumulated or thrown here and there by the residents or waste collectors. Initiating proper provisions of waste disposal and treatment, so that its waste should be treated at its source level itself. Starting of new charge based on 'Polluters Pay Principle' can be levied on people for the whole waste management activity, and lastly awareness and equal participation from public plays a vital role. Further suggestions were made where in India there is a strong case of private sector participation in this area and private sector can come up with

its expertise, technology, capital, improved and efficiently managed service for efficient waste management.

(Banerjee, et al., 2019) Solid waste management is a major concern in the twenty first century. Solid waste generation and its management depends on national income and legal policies of the nation. Also, safeguarding the environment and addressing human health should be of the utmost importance. In this light, this study focused on reviewing generation of different Solid wastes and corresponding techniques of SWM starting from conventional tools to modern technique. Its objective was to deal with different methods for safe disposal of the vast amount of solid waste in India. Different Solid wastes and their generation were discussed together with the safe disposal method starting from conventional method to modern. More emphasis was put on the possible use of solid waste as efficient energy resources. The findings showed the different classification or categories of solid waste that required more attention. Discussion aimed at Municipal solid waste and its corresponding sources, Radioactive solid waste, E-waste and their life cycle, agricultural solid waste, Hospital or Biomedical wastes and its various categories. This study also highlights the pre-treatment technologies for any waste treatment such as, landfilling, composting and many other. It also provided the importance of thermal treatment - to minimize the release of toxic waste and treatment of residual part, and principle technologies are incineration, gasification and pyrolysis. These solutions and strategies would help in safe disposal of solid waste. Also, proper system of waste management and most significantly public awareness plays an important role in preventing increased amount of Solid waste and also safeguarding environment and public health.

(Chakrabarti & Sarkhel, 2003) Significant solid waste output has been brought about by the rapid increase in per capita income and population growth, affecting both human health and the environment. This is more so in the case of developing countries where large quantities of solid waste are dumped. This research paper made an attempt to summarise the economic

literature devoted to solid waste management in both developed and developing countries. Dealt with the estimation of MSW and possible explanation of its trends and pattern, the various waste management options and their viability to environmentalist vis-à-vis economists, describes the general theoretical framework of the market-based instruments and the impact of optimal policy instruments as in theory and practice. Also focused on the problem of MSW management in the context of developing countries and policy options for developing countries. Findings showed that, there are three ways in which the flow of material wastes to the environment could be reduced – waste minimization, reuse and recycling. It also mentioned about economic instruments that could help in reduction of solid waste impact, like, taxes and subsidies, unit pricing for garbage collection, advance disposal fees and deposit. This study also highlighted the valuation of solid waste externality. It also specifies that currently, solid waste management system in developing countries has not largely incorporated market-based instruments. Further research scope provided by this research paper was that to find out the appropriateness of disposal tax and / or deposit- refund system as waste management policy.

(Das, et al., 2019) A crucial component of an environmental management system is solid waste management. In order to develop sustainability, SWM techniques have been updated into a more workable and efficient approach based on 3R principles. (reduce, reuse and recycle). This study provides an overview on wide range of existing SWM strategies and also focuses on the geographical positions and economic status of nations that are important to dictate waste characteristics. Its objective includes, to comprehensively describe current technologies, strategic innovations, and monitoring tools, to provide an overview of prevailing waste management scenarios across different countries, to identify the roles of life cycle assessment (LCA) and other modeling tools in SWM, and to showcase feasible approaches for sustainable recycling and utilization of solid wastes. Secondary data was used and an extensive literature survey was done. The findings showed the global scenario of the SWM in under developed,

developing and developed countries. India is identified as highest producer of MSW among all developing countries. Countries like Nigeria, Bangladesh, Sudan, and Ethiopia are the major contributors to solid waste production among underdeveloped countries. The management of waste were intimately related with the economic status of the countries. The under-developed and developing countries face the issue of improper waste management due to the lack of infrastructure and proper waste processing channels. Looking at environment aspect, solid waste landfills are responsible for about 14% of the global methane emissions. Solutions include, shift from open dumps to eco-friendly waste recycling technologies, to minimize odour, leachate from landfills with scientific and traditional methods, to devise proper pathways for plastic waste management, to formulate proper legal instruments and other, to offer rewards for citizens/organizations who resist non-scientific waste disposal (for encouraging sustainability) to support the tenability of the legal instruments and also adopting low cost techniques. Approaches for solid waste monitoring and strategic innovations required tools and technologies were also discussed in this paper. Also, an improved approach to integrate social, economic, institutional, legal, technical, and environmental aspects is essential for sustainable management of solid wastes. Involvement of common citizens and awareness generation and participatory approach which plays a very important role and should be adopted by the Governments across the world.

(**Sultan, 2017)** In an effort to solve the issue of Municipal solid waste management, the Indian government has recently changed a number of institutions, rules and management techniques. However, the outcomes were below expectations. This study provided an overview of the existing municipal solid waste management practices from the global to national and national to local level perspectives in reference to the Indian cities. Also laid emphasis to assess the overall solid waste generation and management services practiced by the Indian municipalities, legal, institutional and policy issues relating to urban solid waste management were also

discussed. The findings show the SWM status at global level, similarly the status, type and composition of solid waste generation in india, also looked at collection, segregation and disposal methods adopted. Highlights the financing system of municipal solid waste management in India and policies, legal and Institutional frameworks for MSWM in India. A number of initiatives were proposed that can be taken to address the challenges of solid waste management in urban India.

(Kumar & Agrawal, 2020) the increase in population, economic growth, diversity of cultures, changing dietary habits and the changing lifestyle have led to the problem of municipal solid waste management in India. This study has provided a comprehensive review summarising the present SWM status, identifying the associated challenges and deriving potential solutions for the MSWM in the Indian context. The unsorted solid waste at source, social taboo, citizen's attitude, poor assessment, inadequate potential strategies unorganised informal sector of waste, unplanned fiscal, and poor implementation government policies. Secondary data from Central Pollution Control Board and Census 2011 has been used in this study. The findings show that the idea of effective and efficient solid waste management is a long-term goal for municipalities to achieve in India. Hence, adopting centralised and decentralised strategies for managing solid waste at various sources could help in achieving tangible sustainability in the MSWM system. Also, the limited presence of a structured informal waste sector alongside private and public entities is a crucial element in tackling the obstacles related to managing MSW, this will contribute in transforming potential opportunities for India’s future cities.

(Prajapati, et al., 2021) over the years the municipal solid waste generation has increased. The environment, public health, and climate change have all been adversely affected by inadequate municipal solid waste management procedures. This research paper provides reviews on the existing MSW management practices, challenges and provides recommendations for improving MSW management for the city of Jaipur in Rajasthan state. Major challenges faced

by Indian cities include uncontrolled landfilling, failings in the implementation of MSW (management and handling) legislation, and inadequate public participation in management. Recommendations for improvement include public awareness campaigns, Public Private Partnership (PPP), investment in lined landfills, recycling, and waste-to-energy techniques. Findings show the challenges faced by Jaipur city in MSWM i.e. lack of awareness among citizens, governance, unregulated landfilling, segregation issues, and many others. This paper also recommends solutions or strategies that Jaipur City can adopt for effective and improved MSWM.

(Kaushal & Chabukdhara, 2014) it has been noted that waste production increases yearly in direct proportion to population growth and urbanization. This study attempts to provide a comprehensive review of the trend of the MSW components during the last four decades and also the forecasted Municipal Solid Waste components trend, in India, and also to evaluate the current and projected future status for identifying the problems of MSWM in major Indian cities. The findings show that there exists a high correlation between the GDP and the amount of municipal waste generated in the country. The higher the GDP of a country, higher the quantity of waste produced. MSW wastes vary depending upon the income of the states. High in high-income states and low in low-income states. MSW compositional changes of four megacities – Mumbai, Delhi, Chennai, and Kolkata, collection and storage of MSW, treatments, and disposal of MSW which include – composting, incineration, gasification technology, refuse-derived fuel, landfilling, then issues in MSW management and future challenges in MSW management and lastly opportunities from waste management are some important reviews that are made in this study. Hence, this study highlights the evolving waste composition trend and how important proper segregation and treatment are for the effective operation of waste management facilities.

(Jhat, Singh, Singh, & Gupta, 2011) municipal solid waste management is a critical issue. This study aims to examine the traditional practices of Municipal solid waste management, challenges faced towards achieving sustainable municipal solid waste management in low income group of cities and aimed to find the remedial measures. The findings show the criteria indicators of municipal solid waste management that are needed to be identified and addressed in each city. This study also discussed the municipal solid waste generation and storage capacities. Reuse and recycling at the source method adopted by low income groups. For achieving sustainable municipal waste management in low income groups, the concepts that are needed to be incorporated include; life cycle assessment, characterization of waste stream, capacity building and more.

(Rana, Ganguly, & Gupta, 2015) Chandigarh is said to be the first city in India which is developed in a planned manner and helped in developing a comparatively better solid waste management in comparison to other cities. This study aims to understand and demonstrate the functioning of the existing waste management system of Chandigarh and also suggest suitable measures for better management of the solid waste. The findings showed the primary and secondary collection of municipal solid waste, the involvement of public-private sector partnerships as a norm for effective MSWM. And the final disposal of municipal solid waste in Chandigarh is dumping. The existing problems of municipal solid waste management in Chandigarh are poor conditions of collection, littering by residents, distribution of labour and resources, inadequate maintenance, source separation and disposal methods needs more improvement. To tackle these issues Chandigarh municipal corporation took adequate steps and innovative measures, one of which is the use of global clean development mechanism which helps in reduction of greenhouse gas emission and lead to sustainable development. And the public private partnerships have proven to be successful and better alternative for effective management of municipal solid waste in Chandigarh.

(Rahardyan, Prajati, & Padmi, The influence of Economic and Demographic factors to waste generation in capital city of Java and Sumatera) Solid waste management shows a positive correlation with economic development on global scale. This research study aims to analyse the correlation between economic and demographic variables on waste generation in Java and Sumatera city, also identifies the local patterns that are related to the development of waste in these cities. The purpose of study is to develop a system of environmental-economic model that can be used for planning the capacity of the facility waste management systems. The findings show that are three patterns of waste generation in 16 cities in Java and Sumatera. Which include, low waste generation with Port/Trade and Trade/Plantation economic activity, secondly for high waste generation with low economic growth and Industry/Trade economic activity. And lastly for high waste generation and high economic growth and Industry/Trade economic activity. And also, Variables which are having effect to waste generation in 16 cities in Java and Sumatera, are economic growth, population density, Gross Domestic Product, and total of population.

(Akhtar et al., 2017) The unplanned and improper handling of the waste and disposing practices lead to increase in the solid waste management costs. The purpose of this study is to determine and quantify the level of awareness and willingness of the residential household in Gulberg -Lahore to pay for improved solid waste management system, in order to reduce harmful effects on the environment and the residents of the area. Statistical tests such as annova, Chi-square was performed to conduct analysis of the primary data collected. The findings show that there is a strong significance relationship between household income levels and amount of willingness to pay for improves solid waste management facility in the areas of Lahore. Also, current solid waste management system in the area is fair but needs more improvement in terms of improved collection efficiency and rates, recycling bins, and segregation of waste at storage. Hence, there is a need for upgradation of storage and collection

facilities to increase the collection efficiency and rates, an introduction of the recycling facility and segregation of waste at source.

(Dilsath & Prasada, 2021) Poor solid waste management has led to inadequate dumping of solid waste into open areas also causing environment pollution and also affecting the public health. This study intended to evaluate willingness to pay (WTP) of households for improved solid waste collection service in two selected zones of Kalmunai municipal council area. Around 140 households were sampled from both zones, 70 households per each zone. Data was obtained through face-to face interviews and regression model was used for analysis. The findings show that education level is highly correlated to WTP for improved solid waste collection service, same with income level. Gender is also highly correlated to WTP, and female gender is significantly influenced to the household's willingness to pay amount for improved solid waste management. Municipal solid waste collection in Sri Lanka primarily lacks substantive public participation. Therefore, the findings would help the government to understand the relevant characteristics of households and take an initiative to come up with a suitable fee for the waste collection services in those areas.

(Hagos et al., 2013) solid waste management is one of the crucial concerns for many rapidly growing cities in developing countries. This study aims to assess the current sanitary service fees and the willingness to pay (WTP) of residents for improved urban waste management, and to suggest mechanisms for cost recovery applying in Mekelle City, Ethiopia. This paper has used a cross-sectional survey of around 266 randomly selected households. Probit and Tobit models are used for analysis. The findings show that, the level of solid waste generated by the household per week, education of household head, environmental awareness, and house ownership type of solid waste service demanded by the households, income of households, and marital status are positively associated with WTP. Also, the results showed that the current city fee for sanitation in Mekelle is far below the WTP of the residents. And therefore, this

WTP can be a guide to the government in setting more appropriate fee that can be financed for the improvements in city solid waste management.

(Tendulkar & Ambadekar, n.d.) Menstrual waste management has a significant impact on sustainable development goals of almost all developing countries especially on the environment. Women face a lot of challenges when it comes to menstrual waste management. This paper research paper focused on understanding the existing menstrual waste management practices in Mumbai and try to find the solutions to treat the waste effectively. The findings show that the existing system is inadequate and inefficient, leading to a significant amount of untreated waste. The estimated volume of menstrual waste generated is much higher than what is being collected and treated. Separate collection and treatment systems should be established for menstrual waste, ensuring its proper disposal and treatment. Therefore, there is an urgent need for improved menstrual waste management practices in Mumbai. Also, to address such issue, awareness programs should be conducted to educate women about the proper disposal procedures for menstrual waste and impacts on environment of disposing menstrual waste inappropriately.

(Maurya, n.d.) the impact of menstrual waste on the environment is a pressing issue that needs to be addressed. This research paper aims to explore the full or known extent of the ecological consequences borne by the use of sanitary napkins, to identify the menstrual waste management systems available and also the ones that needs improvement. And this paper also focuses on exploring the health issues faced by women. The findings showed that Women and adolescent girls belonging to low-income groups often wear disposable sanitary napkins for more than the recommended hours due to socio-economic constraints which puts them at risk for medical complications such as reproductive tract infections (RTIs), cervical cancer, and interference with embryonic. India needs to focus on developing a circular economy since reusable cloth pads and menstrual cups are not a permanent solution. Large scale recycling techniques of all

kinds of menstrual products is the best way to handle menstrual waste management. Usage of biodegradable pads, washable cloth pads, reusable menstrual cups are some sustainable alternatives. And also, the best way to manage the menstrual waste is through bio-medical incinerators or large-scale recycling.

(Sharma1 & Nautiyal, 2023) Menstruation is a natural biological process. This research paper aims to study the menstrual hygiene knowledge, practices, restrictions and waste disposal challenges faced by adolescent girls and women of different regions of Dehradun district. Cross-sectional study was carried out and adolescent girls and women of different regions of Dehradun were surveyed, girls and women between the ages of 12 and 48 years old were taken into consideration. Sample size was 400. The findings showed the types of menstrual products used by women. Method of disposal adopted by girls and women differs, girls burnt or dispose/flush the menstrual material. Some girls/women who reused the cloth used during menstruation dried them either inside the house or outside in the sunlight and most of the women were aware about menstruation before reaching menarche. But on the other hand, women and girls lack awareness regarding proper menstrual hygiene management in the regions of Dehradun district.

(Kaur et al., 2018) Menstruation wastes are the wastes that are generated by a female in her reproductive years or during their menstrual cycle. The amount of menstrual waste that is getting generated day by day is increasing rapidly. This study aims to examine the menstrual hygiene management and waste disposal challenges faced by adolescent girls or women in developing countries with the help of existing literature. The findings show the cultural beliefs and restriction faced during menstruation by women in developing countries, discussed about the different types of menstrual products used by women, techniques used by women to dispose menstrual waste especially giving reference to India, the consequences of menstrual waste disposal faced by not disposing it in an appropriate manner and harming the environment,

teachers need to play a major role in creating awareness to the girls about menstrual hygiene management and disposal. Various strategies are discussed for the management of menstrual waste in schools and public toilets, such as, using reusable cloth pads, biodegradable products, setting up of incinerators and many other. However, This study reveals that lack of privacy is a major concern both in household and in schools. And, there is a big need to encourage adolescents at school levels to practice safe and hygienic behaviour towards menstrual waste and hygiene management.

(Kiran & Yashoda, 2020) Management of menstrual among rural families or rural areas is difficult as compared to people living in Urban areas. This research study focused on assessing how women in these areas manage menstrual waste, by conducting exploratory study with focused grouped discussions. Study was carried out in rural Telangana areas. The findings show the types of menstrual absorbents used by women in Telangana, where in most of the women use sanitary napkins during their menstrual cycle. Women dispose their menstrual waste in garbage, bury and burn it. After installing incinerators in the village and its schools more than 50% of the women started disposing their menstrual waste properly in incinerators. Also, the study findings show that there is a need to create awareness and educate women of rural areas about the pollution caused to environment and health hazards due to inappropriate disposal of menstrual waste.

(Lynch, n.d.) backcountry basically refers to non-urban areas, where access to basic sanitation and hygiene facilities is not systematically available. This study investigates women's practices of menstrual waste disposal in backcountry areas, and the potential environmental impact of these practices, with a view to identifying the personally and socially acceptable practices which are least degrading to the natural environment. The findings show that women are slightly aware and understand that disposal of menstrual waste in the outdoors leaves non- or very slowly decomposing material at the disposal site, potentially creating both ecological and

aesthetic pollution in the environment. Still there is lack of knowledge to women on the environmental impacts of menstrual waste and on alternative behaviours which reduce the impact. Burning and carrying out were identified as acceptable alternative disposal practices, Hence, burning is seen as the more problematic of the two options.

(Ganguly & Satpati, n.d.) the primary focus is mostly given to menstrual absorbent access and usage rather than giving equal importance to menstrual waste disposal or menstrual waste management. This research study aims to investigate the safe disposal of menstrual waste. The findings show that poor menstrual hygiene can pose physical health-related risks and urinary tract infections. Proper access to private facilities with water and safer low-cost menstrual materials could reduce such genital diseases. And the methods that can be adopted for safe disposal of sanitary waste are composting, using incinerators and deep-burial system and microwave technology.

(Poddar, 2023) Sanitary waste disposal has not received much importance in the existing literatures. This research paper aims to examine and analyze frameworks on menstrual waste disposal and key challenges for implementation while also recommending plausible policies for better waste management practices that support the needs of women and girls and the environment. The findings show one of the key issues is a lack of awareness about proper waste management practices. It also discussed the challenges of deep burial of menstrual waste, challenges of centralized and decentralized incineration. Several recommendations are also made for tackling the existing poor sanitary waste disposal methods. Sanitary waste management needs collaboration from the government as well as nongovernmental organizations in order to put social welfare at the forefront for improving the disposal system.

(Bhor & Ponkshe, 2018) Sanitary waste or menstrual waste is one of the crucial issues in today's scenario. This study investigates how women manage menstrual waste and the amount

of sanitary waste that ends up into landfill and also recommending best practices to be observed and put forth as a solution that is more economical, viable and rational than landfill dumping of menstrual waste. The findings show the types of menstrual products used by women during their menstrual cycle. And most of them use sanitary napkins. The menstrual waste technique used by women are burning, flushing down in the toilet, throwing in the river or open fields. Waste pickers were also surveyed and they claim that menstrual pads are thrown directly into the bins and they had to handle them with their bare hands. Which make them prone to infectious diseases. Potential health impacts women and waste pickers and impact on environment has also been discussed. One of the solutions highlighted by the author is setting up of the environment friendly incinerators which does not harm the environment or pollute it.

(Roxburgh et al., 2020) Menstruation and menstrual hygiene management have become increasingly recognised and seen as important as sanitation facilities. This study focuses to examine qualitatively, practices, preferences and social cultural norms surrounding menstruation among women using 3 types of sanitation facility, pit latrine, flush toilet, and UDDT. Data was collected through personal interview, around 31 women living in the city of Blantyre, Malawi were interviewed. The findings show that the two most commonly used menstrual absorbents by women were sanitary pads and cloth. Women living in Malawi faced number of restrictions during their menstrual cycle. They disposed their menstrual waste, either by burning, discarding it in pit latrines or dumping it in dustbins. Socio-cultural norms must be taken into account for the infrastructure to be effective. Further scope for research is quantifying the volumes produced of different types of menstrual waste and identifying their destinations in Blantyre, Malawi.

(Schmitt et al., 2022) Managing menstruation, privately and safely is a crucial task. Including maintenance of menstrual material and disposal. This research study aims to fill in gap in the MHM response literature and guidance around menstrual disposal and laundering of reusable

menstrual materials. To examine how displaced girls and women were managing their MHM needs, with an emphasis on menstrual disposal and laundering practices and challenges. Assessments were conducted in; Nigeria, Bangladesh and Jordan. Findings showed that, there is an urgent need for full range maintenance of tasks required to use disposable and reusable menstrual materials. Inconsistent access to basic hygiene facilities, ensuring easy access to female friendly toilets is seen to be a major challenge, during the day and night-time. lack of attention to menstrual waste disposal facilities. Future recommendations include; all solutions should be designed and delivered through continuous consultation and monitoring with girls and women to ensure their gendered needs are more effectively met.

(Ghimire, 2020) During menstruation women face ample of menstrual hygiene management (MHM) issues. This study aims to explore the experiences of female students and teachers during menstruation while they are at the campus and document them to unpack the realities of the phenomenon to persuade the campus authorities for better MHM on the campuses. Findings show that there was no provision of MHM supplies particularly for the sanitary pads, medicines in the campus during an emergency. The menstrual absorbent used by female students and women are either sanitary pads or cloth. The sanitation conditions or sanitation facilities were on a poor scale. Menstruation has a significant effect on the student's productivity level or performance level. The campus should take menstrual hygiene management as an important aspect of hygiene facilities and improve MHM. Suggestions are made that, creating awareness-raising and discussion sessions on overcoming the myths and taboos might also help the women and girls to enjoy their dignified menstruation rights.

(Olatumile & Ajayi, 2019) Menstrual waste creates a huge impact on the environment. This study aims to assess menstrual waste disposal practices and its implication on the environment. Primary data was collected through cross sectional survey and 194 females were surveyed, residing in Akungba-Akoko area of Ondo State. The findings show that education level has a

significant effect on menstrual waste disposal. And due to environmental illiteracy, there is certain negligence on part of the government on awareness and environmental policy issue. Also, poor health and waste disposal facilities. Therefore, it is very important that for the professionals to acknowledge the place of education (formal, informal and non-formal) in ensuring a free environment requiring the support of the government, non-governmental organizations and media outfits. This will ensure having menstrual waste disposal in environmental policy and create awareness about it among women as well as in the society.

CHAPTER 3

METHODOLOGY

METHODOLOGY OF THE STUDY

The main source of data for this study is both Secondary and Primary data. This study is divided into two parts. The study of solid waste management in India is fully based on secondary data and is a Panel dataset. Data has been collected for the period of 4 years from CPCB (Central Pollution Control Board), Reserve Bank of India (RBI), Census, and also from Annual industrial reports, for the years 2019-2022 of selected Indian states i.e. Haryana, Goa, Punjab, Madhya Pradesh, Himachal Pradesh, Odisha, Manipur, Tripura, Meghalaya randomly. The variables analyzed in this study include; Solid waste Generation, GSDP (Gross State Domestic Product), Industrial activity, and Urbanization rate. The dependent variable is Solid waste generation and the independent variables are – GSDP, Industrial activity and the urbanization rate of the selected states. These variables are chosen based on their theoretical significance and the availability of data. Panel data analysis is conducted using Rstudio, techniques such as Pooled OLS regression, fixed effect model, and Random effect model are employed to examine the relationship between the variables. If problems arise while testing the Panel data, such as Serial correlation and Heteroskedasticity, these are handled by applying the appropriate remedies, and robustness checks are performed to assess the stability and reliability of results.

The other part of this study is specifically focused on Menstrual waste management. A mixed-method approach is used. The primary data for this study is collected through an online survey to know about the disposal methods of menstrual waste adopted by women in Ponda-goa, also to study their willingness to pay (WTP) for the safe disposal of menstrual waste. The sample size of the study is limited to 100 respondents.

Secondary data was collected from the Ponda Municipal Council and a personal interview with the sanitary officer of the Ponda Municipal Council was also conducted to get information

about the existing practices of menstrual waste disposal procedure adopted by the Municipality. Statistical tools like pie charts and line graphs will be used for data analysis.

For the task of understanding the willingness to pay of women, Multiple Logistic regression is used for analysis. Multiple logistic regression allows for the inclusion of multiple predictor variables that may influence an individual's willingness to pay. Therefore, this method of analysis is most suitable for the model prepared to know the most accurate results. The variables analyzed in this part of the study include; the WTP – dependent variable. Income, education qualification, type of menstrual product, Environmental awareness, and Government role are used as independent variables.

CHAPTER 4

DATA ANALYSIS

4.1 INTRODUCTION

The generation of solid waste is highly dependent on economic indicators and can significantly influence the amount of solid waste generated year after year. Higher economic activity often correlates with increased consumption and production, leading to more waste generation. The generation of solid waste varies significantly across many regions in India with differing growth levels, reflecting the complex interplay between economic indicators and waste production. Many states exhibit distinct patterns of Solid waste influenced by factors such as GSDP, industrial activity, urbanization, consumption habits, and many others.

4.1.1 VARIABLES

GSDP: Gross state domestic product is a key indicator of the economic growth of individual states. Higher economic activity is often reflected in higher GSDP. And this often correlates with increased consumption and production leading to waste generation.

Industrial Activity: Industrial activity includes production, chemical usage, packaging waste and several other things. This eventually contributes to the solid waste generation. In the model mentioned below number of factories represents the industrial activity.

Urbanization rate: it typically measures the rate at which people are moving from rural areas to urban areas. Urbanization contributes to the generation of solid waste due to increase in population density, changes in consumption habits, improved standard of living, etc. In the model mentioned below urbanization rate of the selected states is taken into consideration.

Solid waste generation: the amount of production of discarded materials from various human activities, including residential, industrial, commercial and other.

Looking at the overall waste generation of the selected states along with economic indicators helps in understanding the dynamic relationship of solid waste generation and economic indicators in more depth.

Objective 1: This study aims to provide an overview on solid waste generation status of the selected Indian states in relation with economic growth, industrial activity and urbanization rate.

The model estimating relationship between Solid waste generation and GSDP along with other control variables is as follows:

MODEL: SWG (solid waste generation) = B0 + B1 logGSDP + B2 urbanization rate + B3 Industrial activity + u

4.1.2 Testing of the Hypothesis: -

1. **Log Gross State Domestic Product (GSDP)**

   H0: B1=0 (GSDP does not have any significant impact on solid waste generation)

   H1: B1>0 (GSDP has a significant positive impact on solid waste generation)

   P-value = 0.001143

   Since the p-value is less than 0.05, the null hypothesis is rejected. Thus, this implies that Log (Gross state domestic product) has a positive significant impact on the solid waste generation of the selected Indian states. And, it is statistically significant at 5% confidence level

2. **Urbanization rate**

   H0: B2=0 (Urbanization rate does not have any significant impact on solid waste generation)

   H1: B2 > 0 (Population density has a positive impact on solid waste generation)

P-value = 0.073488

Since the p-value is less than 0.05. the null hypothesis is rejected. Thus, this indicates that Urbanization rate has a significant impact on the solid waste generation of the selected states of India.

3. **Industrial Activity**

H0: B3 = 0 (Industrial activity does not have any significant impact on solid waste generation)

H1: B3 > 0 (Industrial activity does have a positive impact on solid waste generation)

P-value = 0.004340

Since the p-value is less than 0.05, the null hypothesis is rejected. Thus, this implies that industrial activity has a significance impact on the solid waste generation of the selected Indian states. And it is significant at 5% confidence level.

As mentioned earlier, in this study, three different estimation techniques or three different models were used namely Pooled-OLS, Fixed effects, and Random effects to analyze the relationship between overall solid waste generation and GSDP, urbanization rate, industrial activity of the selected states. After careful consideration and comparison of the results obtained from each model from the R-studio, it can be concluded that the random effect model provides the most appropriate and comprehensive framework for understanding the underlying dynamics of overall solid waste generation concerning the randomly selected states. Therefore, the Random effect Model best justifies the first objective.

Table 4.1: Results of an estimated model using Random effect estimation

Variables	**Coefficients**	**t-value**	**p-value**
Const	-1.9757e+04	-3.1073	0.001888 **

Log(GSDP)	1.2900e+03	3.2528	0.001143 **
Ind_actv	-5.7462e-02	-2.8524	0.004340 **
Urb	1.5520e-04	1.7898	0.073488 .

BP-LM Test

p-value = 0.0000000106 < 0.05

H0: Pooled-OLS model is appropriate

H1: Random effect model is appropriate

Since the p-value is less than 0.05, therefore we reject the null hypothesis. Thus, Random effect Model is applicable.

Hausman Test

P-value = 0.4273 > 0.05

The null hypothesis states that Random effect model is appropriate. P-value is greater than 0.05 so we fail to reject the null hypothesis. Therefore, Random Effect Model is applicable.

4.2 Hypothesis of the Study: -

Null Hypothesis: Waste generation does not positively depend on the level of urbanization rate, industrial activity and GSDP (Gross state domestic product).

Alternate Hypothesis: Waste generation positively depends on the level of urbanization rate, industrial activity and GSDP (Gross state domestic product).

According to the Random effect model, Gross state domestic product (GSDP), industrial activity and urbanization rate has a significant impact on the solid waste generation of the selected Indian states. Solid waste generation increases by 0.00129% when GSDP increases by

1 unit, and it is statistically significant at 95% confidence level. When there is 1 unit increase in industrial activity, the solid waste generation decreases by 0.057462%. and it is also statistically significant at 5% confidence level. The relationship between solid waste generation and industrial activity of the states is shown negative because the waste that industries generate contributes less to solid waste as compared to other wastes. It may contribute more towards hazardous waste, air pollution, and water pollution. Whereas the urbanization rate is marginally significant but only at a 0.01 significance level. Therefore, 1 unit increase in urbanization rate, solid waste generation increases by 0.0001552%.

Table 4.2: Results of random effect model robust standard error

Variables	**Random effect Model**	**Robust Standard Error**
Log (GSDP)	1.2900e+03 ** S.E (3.9659e+02)	4.52159e-05 *** S.E (9.79391e-06)
Ind_actv	-5.7462e-02 ** S.E (2.0145e-02)	0.132985 ** S.E (0.0486999)
Urb	1.5520e-04 . S.E(8.6715e-05)	0.000101115 ** S.E(4.70235e-05)

After testing for Serial correlation and Heteroskedasticity, the results showed the existence of heteroskedasticity in the model. After identifying heteroskedasticity in the random effect model, Robust standard error was used as a remedy to resolve this issue. The use of robust standard error has led to significant improvement in the precision of the estimates and reliability of the findings of this study. Prior to the correction, the standard errors associated with the coefficients were affected due to presence of heteroskedasticity, potentially leading to biased estimates. In the table mentioned above, the second column shows the coefficients and

its standard errors before correcting it. And, the third column of the table shows the coefficients and its robust standard errors after the implementation of the remedy. Here we can see that the standards errors have improved or better reported. However, with the implementation of robust standard error, it has not only addressed the issue of heteroskedasticity but has also improved the accuracy and reliability of statistical estimates and contributing to a more robust interpretation of the results.

Therefore, this model captured unobserved heterogeneity between the variables of the model and providing more efficient estimates and also allowing for generalization. Hence, based on the strengths of the theoretical groundwork, empirical analysis and accountability, the random effect model represents the most appropriate and robust specification of this study.

CHAPTER 4

MENSTRUAL WASTE MANAGEMENT IN PONDA

5.1 INTRODUCTION

In order to acquire first-hand knowledge of the inner workings of menstrual waste management carried out by the Ponda Municipality, a structural interview was conducted with the municipality officer who had all the information regarding how the municipality collects, segregates, disposes, and treats such waste. The officer reported the following information.

The menstrual waste collected within the city limits is then transported to a waste treatment plant located at Keriyan Khandepar after segregating it.

The officer reported that Ponda Municipal Council had informed the citizens to dispose of the menstrual waste as a separate waste when using door-to-door garbage pick-up service. But unfortunately, not every individual was ready to cooperate to do the same. Some of the citizens of the city would mix the menstrual waste with other dry wastes. Therefore, PMC (Ponda Municipal Council) collects menstrual waste as dry waste. Then the waste pickers have to segregate it from dry waste before sending it to the waste treatment plant.

The four primary steps involved in menstrual waste management are

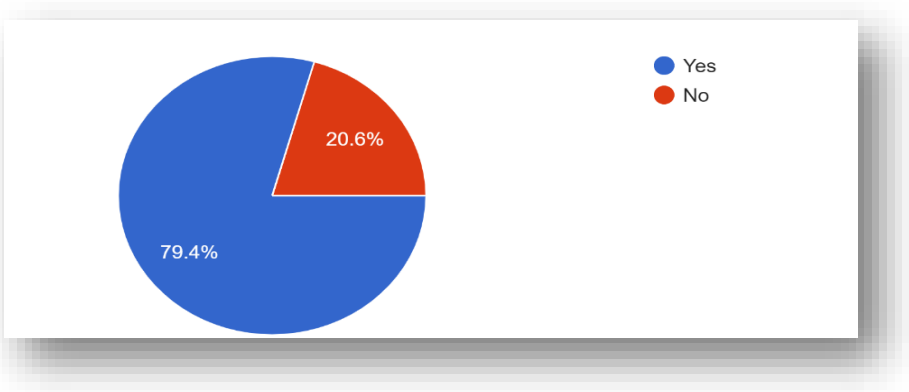
1. Collection from door to door
2. Segregation
3. Disposal
4. Treatment and final disposal

The menstrual waste that is collected and disposed of per month is 1.50 tons. i.e. 1500 kilograms. The technology used for the treatment of menstrual waste is Incinerators. Only one incinerator is set up at the disposal site, disposal of the menstrual waste is done using incinerators in several rounds. The remaining ashes of the previous round are again put into the next round of disposal. Treatment and disposal of menstrual waste takes place on a daily basis.

The incinerator has been installed by the Goa State Urban Development Agency (GSUDA), and installation and maintenance of the incinerator of 1.5 TPD to Ponda Municipal Council.

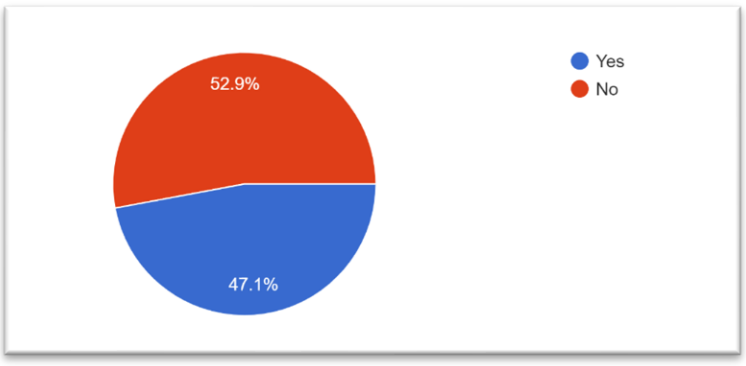
One of the problems associated with Incinerators is that disposal pads have chlorine` and plastic in them, when burned it releases extremely hazardous carcinogenic gases including dioxin furans when burnt at low temperatures.

Figure 5.2 Number of respondents using Municipal door-to-door garbage pick-up service to dispose of menstrual waste.



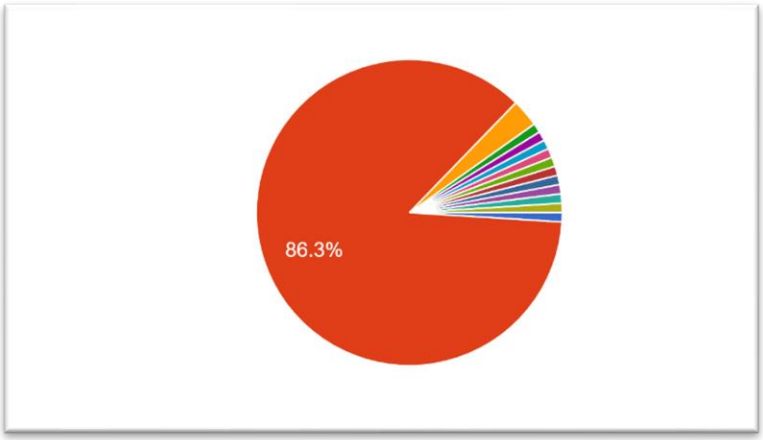
The results showed that 79% of the respondents use municipal door-to-door garbage pick-up services to dispose of menstrual waste. Whereas, 20.6% of the respondents do not use door-to-door pick-up services to dispose of menstrual waste.

Figure 5.3 Number of respondents disposing menstrual waste as a separate waste, when collected by the Municipality



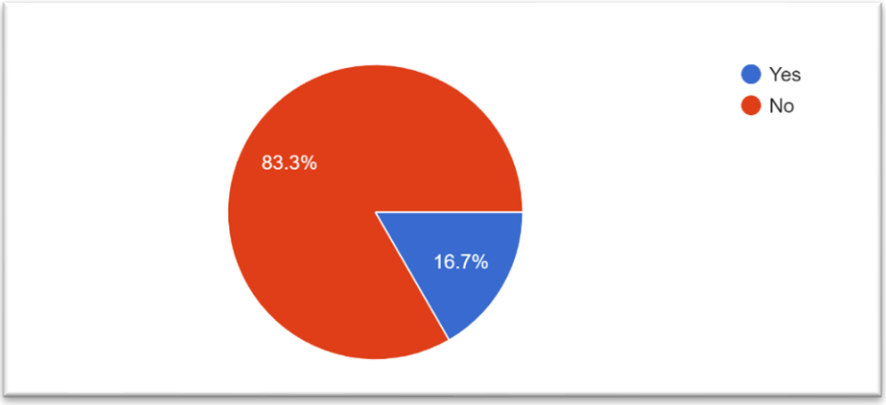
The results showed that 52.9% of the respondents do not dispose of menstrual waste as separate waste when collected by Ponda municipality. Whereas, on the other hand, 47.1% of the respondents dispose of menstrual waste as a separate waste.

Figure 5.4 Dispose of menstrual waste in Public toilets of Ponda



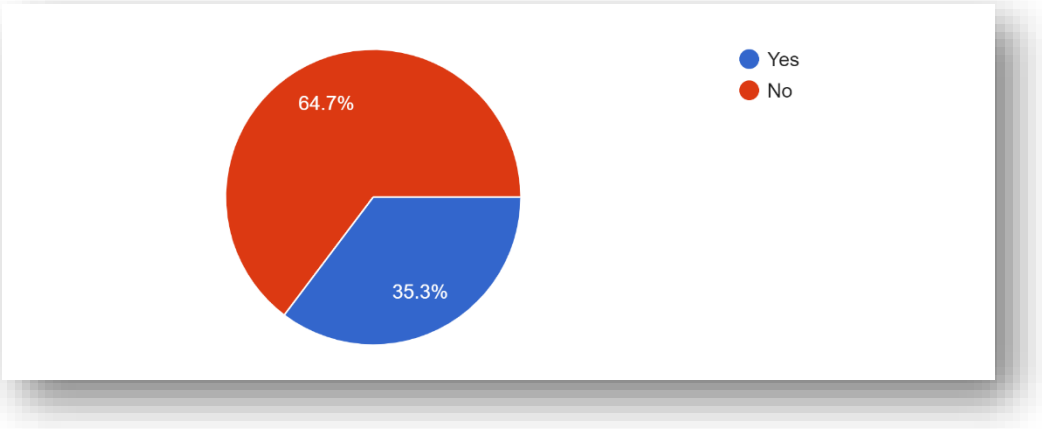
The results showed that around 86% of the respondents dispose of the menstrual waste in the dustbins that are made available in the public toilets of Ponda. They wrap such waste in paper or use disposable bags and then throw the waste in the dustbin. Whereas, the rest of the respondents do not feel comfortable in disposing of menstrual waste in public toilets, while some avoid using public toilets during their menses.

Figure 5.5 Incinerators in public toilets of Ponda



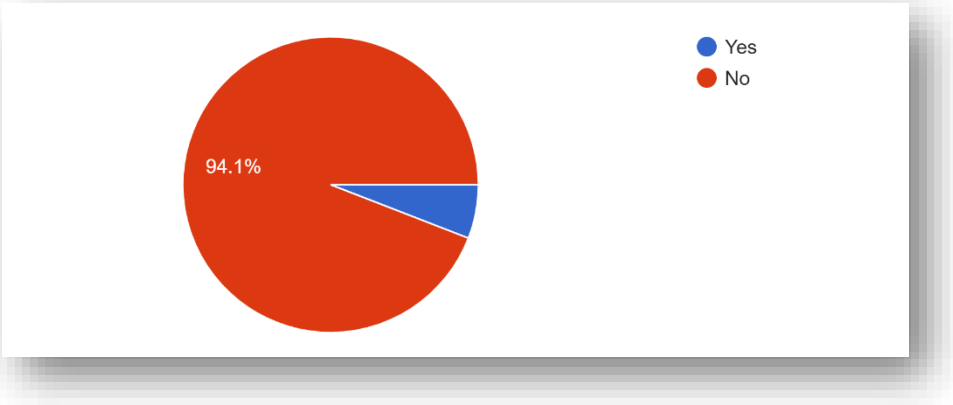
According to 83.3% of the respondents, there is no incinerators set up in the public toilets of Ponda. Whereas, 16.7% of the respondents say that there are incinerators made available in the public toilets.

Figure 5.6 Burning of Menstrual waste



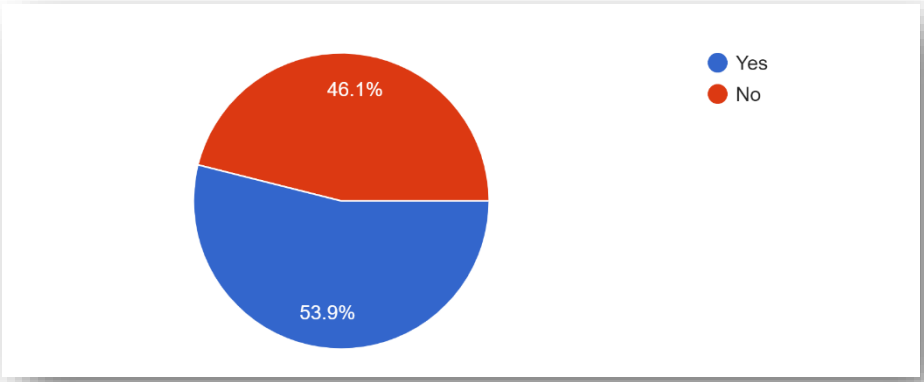
The results showed that 35.3% of the respondents have adopted the method of burning menstrual waste. Whereas, 64.7% of the respondents do not burn the menstrual waste.

Figure 5.7 Dumping in Fields



The results showed close to 95% of the respondents do not dump their menstrual waste in fields. Whereas, 5% of the respondents dump such waste in fields.

Figure 5.8 Challenges faced in finding appropriate disposal facilities of Menstrual waste

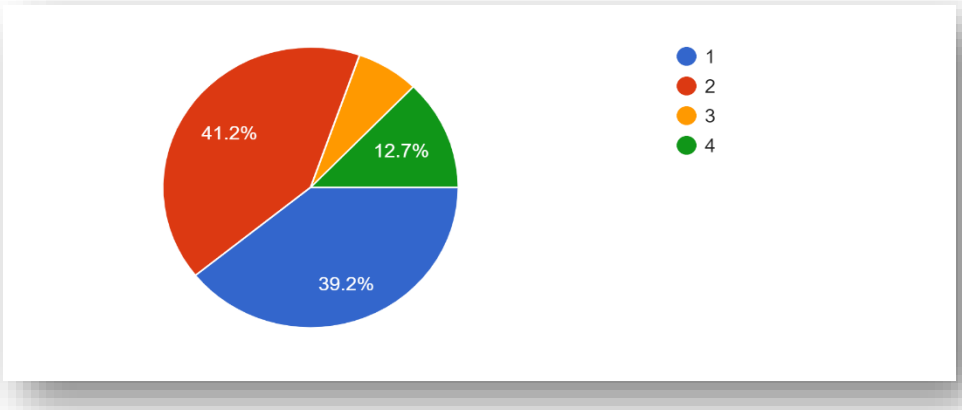


The results show that 53.9% of the respondents have faced issues/ challenges in finding appropriate disposal facilities to dispose of sanitary waste. The list of challenges faced by these respondents includes:

1. No proper dustbin is made available to dispose of menstrual waste
2. The dustbins are full and no space left to dump the menstrual waste.
3. No incinerators available
4. No municipal garbage collector visits certain areas of Ponda
5. No hygiene maintained in public toilets
6. Incinerators are set up but these do not function
7. No proper sanitation facility
8. Fewer dustbins are kept in the washrooms

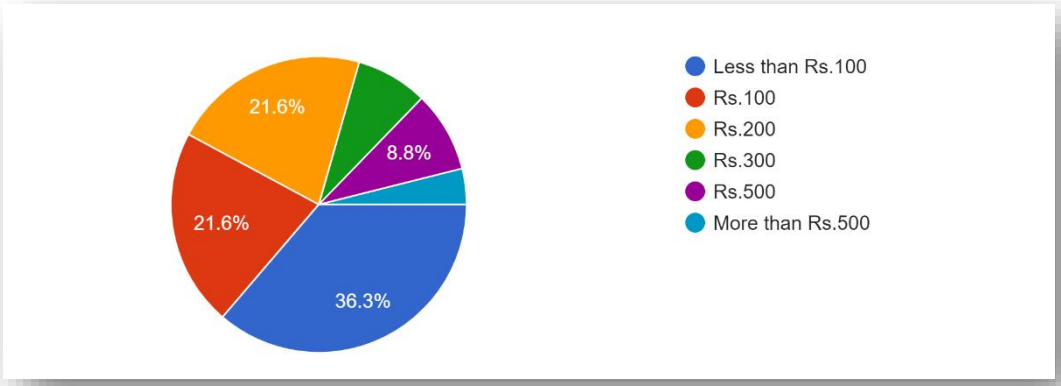
On the other hand, 46% of the respondents do not face any issues in disposing menstrual waste.

FIGURE 5.9 Number of respondents willing to pay



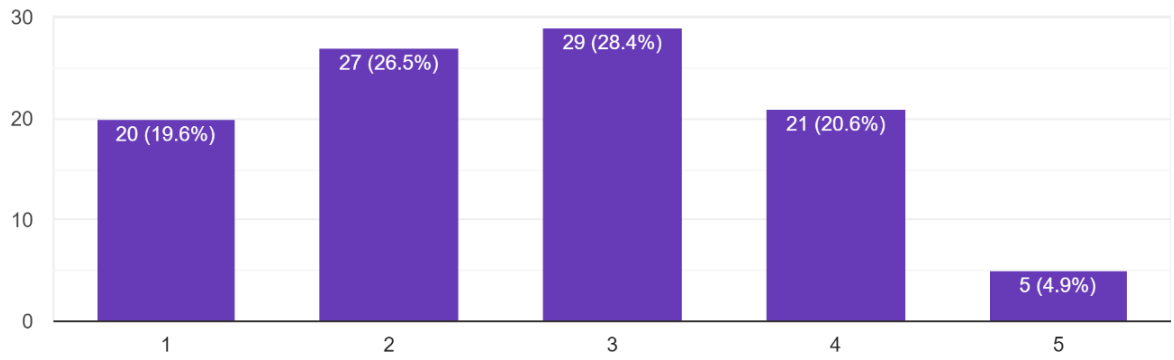
The above pie chart shows that 41.2% of the respondents are willing to pay a moderate amount, around 38.2% of respondents are willing to pay a small amount, 12.7% of the respondents are willing to pay any amount for the improved disposal of menstrual waste and 7% of the respondents are not willing to pay any amount.

Figure 5.10 Different amounts that respondents are willing to pay for the safe disposal of Menstrual waste



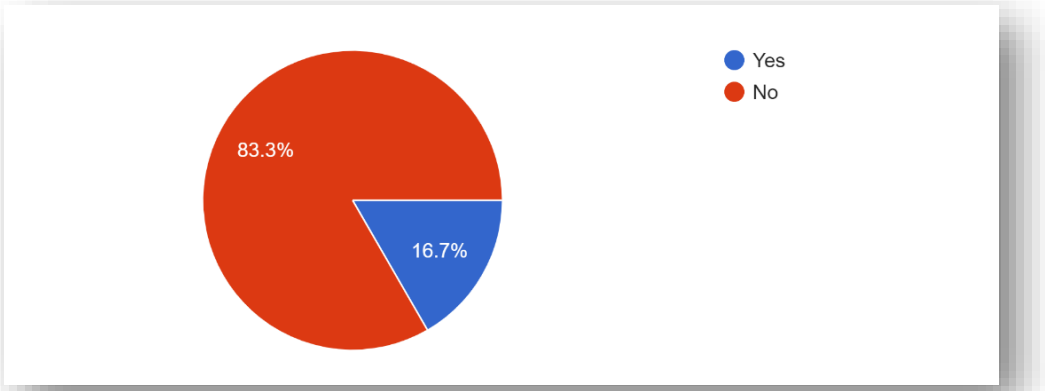
The above Pie-chart shows the respondents willingness to pay for a better menstrual waste disposal system over the current available one. 36% of the respondents are willing to pay less than Rs.100 for the safe disposal of menstrual waste. 21.6% of the respondents are willing to pay RS.100 and Rs. 200, these may be because they have a lower income. Whereas, 7.8% of the respondents are willing to pay Rs. 300 and 8.8% of the respondents are willing to pay Rs. 500 to dispose menstrual waste in an appropriate manner. And around 4% of the respondents are willing to pay more than Rs.500. These respondents and those willing to pay Rs.500 may be the ones who earn high income and highly educated because income and education is an important factor in determination of willingness to pay.

Figure 5.11 Environmental Awareness among Respondents



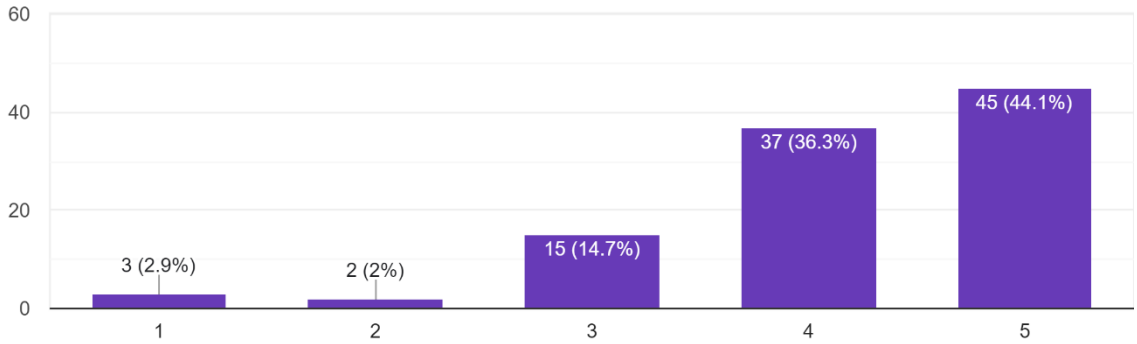
In the above bar graph X- axis represent the level of environmental awareness among respondents. Y-axis represent the percentage of awareness among respondents. The results show that 21% and 5% of the respondents are very much aware about the impact of disposing menstrual waste inappropriately would affect the environment. Rest of the respondents are moderately informed i.e. around 29% of the respondents. And the rest of the respondents are not at all aware about some inappropriate disposal practices of menstrual waste affect the environment.

Figure 5.12 Current Menstrual Waste Management Effectiveness



The results showed that 83% of the respondents believe that the current waste management system in Ponda is not equipped or efficient enough to process menstrual waste more safely. Whereas, 16.7% of the respondents believe the contradiction, that is, the waste management system in Ponda is equipped to process menstrual waste more safely. But here we can say that most of the respondents do not agree with this and the Ponda municipal council needs to work on improving their menstrual waste management system.

Figure 5.13 Government Role



In the above bar graph, X-axis represent the levels of how strongly respondents agree or disagree about the government role in providing menstrual waste management services and Y-axis shows the percentage respectively. The results show that 45% of the respondents believe that government plays a very important role in providing menstrual hygiene as well menstrual waste management services. Whereas 37% of the respondents believe that a little participation of the government is required to manage menstrual waste effectively. 15% of the respondents believe that there will be no difference even if government involves in looking into matter of safe menstrual waste management or not. Whereas, 5% of the respondents feel that government involvement is not required in management of menstrual waste or menstrual waste management services.

5.14 ANALYSIS – USING LOGIT REGRESSION

The fourth objective of this study is to understand women's willingness to pay for the safe disposal of the menstrual waste. To understand this, an online survey was conducted in Ponda. where in 100 respondents were surveyed and they were asked to state their willingness to pay (WTP) for proper disposal or improved disposal of menstrual waste. The dependent variable i.e. WTP is whether the women are willing to pay for the safe disposal of menstrual waste (if yes, they were asked to specify how much they are willing to pay) or not willing to pay. Here the Multiple Logistic regression model is used because the dependent variable has more than two categories. And it would help better explain the factors affecting respondent's willingness to pay.

The factors that affect WTP of the respondents for the safe disposal of menstrual waste can be explained with the help of Multiple Logit model.

MODEL 2: WTP (Willingness to pay) = B0 + B1 Education level + B2 Income + B3Type of Menstrual product + B4 Environment Awareness + B5 Government role + u

Hypothesis:

1. **Education level**

   H0: B1 = 0 (Education level has no significant impact on WTP)

   H1: B1 > 0 (Education level has a significant positive impact on WTP)

   P-value = 0.2960

   Since the p-value is greater than 0.05, the null hypothesis is failed to be rejected. And thus, the education level has no impact on the individual's willingness to pay.

2. **Income**

   H0: B2 = 0 (Income has no significant impact on WTP)

   H1: B2 > 0 (Income has a significant positive impact on WTP)

   P-value = 0.1408

   Since the p-value is greater than 0.05, the null hypothesis is failed to be rejected. Thus, this implies that income has no impact on the individual's willingness to pay.

3. **Type of Menstrual Product**

   H0: B3 = 0 (Type of menstrual product has no significant impact on WTP)

   H1: B3 > 0 (Type of menstrual product has a significant positive impact on WTP)

   P-value = 0.2310

   Since the p-value is greater than 0.05, the null hypothesis is failed to be rejected. Therefore the type of menstrual product used has no significant impact on respondent's willingness to pay.

4. **Environment Awareness**

   H0: B4 =0 (Environment awareness has no significant impact on WTP)

   H1: B4 > 0 (Environment awareness has a significant positive impact on WTP)

   P-value = 0.0481

   Since the p-value is less than 0.05, the null hypothesis is rejected. This implies that environmental awareness has a significant impact on the respondent's willingness to pay.

5. **Government Role**

   H0: B5 = 0 (Government role has no significant impact on WTP)

   H1: B5 < 0 (Government role has a negative impact on WTP)

   P-value = 0.8123

   Since the p-value is greater than 0.05, the null hypothesis is failed to be rejected. This implies that Government role has no significant impact on the respondent's willingness to pay.

5.13.1 Hypothesis of the study

Null Hypothesis: Women are not willing to pay extra for the safe disposal of menstrual waste in Ponda.

Alternative Hypothesis: Women are willing to pay extra for the safe disposal of menstrual waste in Ponda.

Dependent Variable: Yi = Willingness to pay (WTP)

Independent Variables: -

X1i = Education level

X2i = Income

X3i = Type of menstrual product

X4i = Environmental Awareness

X5i = Government role

Table 5.13.2 Results of Multiple logistic regression model

Variables	**Coefficients**	**Standard-error**	**p-value**
Const	0.41060	1.25078	0.7434
Educ. Level	0.25281	0.24062	0.2960
Inc	0.20919	0.14085	0.1408
Type.MP	-0.24107	0.19997	0.2310
Env.Aware	0.25330	0.12649	0.0481 *
Gvt.role	0.03645	0.15310	0.8123

From the above results of the multiple logit model, the variable environmental awareness is significant and determines respondents' WTP. But, as logit coefficients by themselves mean nothing until and unless they are converted into exponential values. To interpret the coefficients in terms of odds ratios, these coefficient values have to be modified in exponential values. This is because GLMs model the log-odds, so exponentiating gives the odds ratios and to get the multiplicative effect on the response variable. If the odds ratio is greater than 1, it means the likelihood of the outcome occurring as predictor variable increases and vice-versa.

Table 5.13.3 Exponentiate Coefficients: -

Variables	Exponentiate values
Const	1.507722
Educ.level	1.287639
Inc	1.232679
Type.MP	0.785787
Envt.Aware	1.28827
Govt.role	1.037122

After converting the coefficient values into exponential values, it can be stated that, the education level is 1.287639. which means that for every one year increase in education level, the likelihood of individuals willingness to pay increase by approximately 28%, holding all other variables constant. In simple terms, the respondent with high education level is about 28% more likely to be willing to pay for improved menstrual waste disposal as compared to the person with the lower education level.

Similarly, the odds ratio for income is 1.232679. which means for every one unit increase in income level, the odds of individuals willingness to pay increases by approximately 23%. In other words, respondents with different income levels, where some earn more and some earn less. The respondent with higher income is about 23% likely to be willing to pay for improved menstrual waste disposal as compared to the person with the lower income level.

The odds ratio for Type of menstrual product used by the respondents is 0.785787. it means that for every one unit increase in the type of menstrual product used by the respondents, the odds of being willing to pay decreases by 30%. Like if the respondents switch from using

disposable products to using reusable menstrual products, their likelihood of willing to pay decreases by 30% compared to the respondents who continues to use disposable products.

The odds ratio for environmental awareness is 1.28827. which means for every one unit increase in environmental awareness, the likelihood of individuals willingness to pay also increases by approximately 28%. So as people become more aware of the environment, they are willing to pay for improved disposal of menstrual waste.

And lastly the odds ratio for government role is 1.037122, it means for every one unit increase in the perceived importance of the government's role in menstrual waste disposal, there's a little over a 3.7% increase in the chances that respondents would be willing to pay for it. So as respondents feel the government play an important role in this, they become slightly more likely to be willing to pay for improved menstrual waste disposal.

Thus, it can be concluded that various factors slightly influence women's willingness to pay for improved or safe disposal of menstrual waste in Ponda city. Specifically, higher levels of education, income, government intervention and most importantly environmental awareness are associated with increased likelihood of willingness to pay. However, the type of menstrual product used has a relatively lower impact on willingness to pay. Overall, the rest of the factors could influence women's willingness to invest in improved disposal of menstrual waste and the Ponda municipal council should take an initiative to improve their disposal practices of menstrual waste.

CHAPTER 6

FINDINGS AND CONCLUSION

6.1 INTRODUCTION

This study which looked into exploring the relationship between solid waste generation of the selected Indian states and its economic indicators (GSDP, Urbanization rate, Industrial activity), and Menstrual waste management in Ponda-Goa has been productive at achieving the objectives of the study. This chapter includes the main findings of both the aspects of the study and the conclusion.

6.2 FINDINGS – SOLID WASTE GENERATION

India is said to be one of the fastest growing major economies globally. It has been experiencing rapid economic growth and development. However, the pace and extent of development can vary across different regions. This study selected 9 Indian states i.e. Haryana, Goa, Punjab, Himachal Pradesh, Madhya Pradesh, Odisha, Manipur, Tripura and Meghalaya. As these states experience rapid urbanization, economic growth and industrialization, all these economic indicators have a significant impact on the overall solid waste that is generated in these states. As the GSDP of the state increases the solid waste generation also rises. Which means that economic growth within these states is accompanied by an increase in waste production. It has been noted that the Gross state domestic product of all these selected states is showing an increasing trend, taking into consideration from the year 2019 to 2022. Therefore, the solid waste generation of these states is also showing an increasing trend for all these years.

Urbanization rate emerges as a key factor in influencing solid waste generation in these states. As the population density increases people move from rural areas to urban areas, leading to growth in cities, towns and states. As urban population grows and cities expand, there is a concurrent increase in waste production rates and lifestyle changes associated with urban living. States like Goa and Punjab has rapid urbanizing landscape and tourist influx,

experiencing a notable surge in solid waste generation. Industrial activity affects slightly less when it comes to solid waste generation since it contributes more towards other waste but it still has a significant impact on solid waste generation. Like states with higher levels of industrialization tend to produce larger quantities of waste, reflecting the impact of manufacturing and industrial processes on waste output. Madhya Pradesh, known for its industrial hub, exhibits a significant uptick in solid waste generation corresponding to the expansion of its industrial sector.

In conclusion, this study is successfully able to fulfil and justify its first objective of elucidating the positive relationship between solid waste generation and key economic indicators of the selected states. This highlights the importance of considering economic development dynamics in crafting effective solid waste management strategies.

6.3 FINDINGS OF MENSTRUAL WASTE MANAGEMENT IN PONDA

The other part of the study examined the disposal of menstrual waste practices adopted by women and the procedure of menstrual waste management adopted by Ponda municipal council. Also, this study focused on understanding the women's WTP for improved or safe disposal of the menstrual waste.

The main findings of this part of study are as follows:

1. The study shows that environmental awareness, education level, income of the individual and government role determines the women's willingness to pay for safe disposal of menstrual waste.
2. 52.9% of the respondents do not dispose of menstrual waste as a separate waste, they usually mix it in dry waste when collected by Ponda municipality.

3. 83% of the respondents stated that there are no incinerators set up in the public toilets of Ponda.
4. 53.9% of the respondents faced several issues in finding appropriate disposal facilities while disposing the sanitary waste.
5. 83.3% of the respondents used disposable pads most often during their menstrual cycle.
6. 35.3% of the respondents adopted burning as an option for disposing their menstrual waste.
7. 87% of the respondents are willing to pay for improved disposal of menstrual waste in Ponda.
8. 46% of the respondents lack awareness regarding the environmental harm caused by improper disposing of menstrual waste. And 53% of the respondents are conscious of the environmental damage resulting from improper disposal of menstrual waste.
9. 83.3% of the respondents feel that the waste management system in Ponda is inadequate for safely processing the menstrual waste.
10. 80% of the respondents think that providing menstrual disposal managements services is the responsibility of the government.
11. Ponda Municipality collects menstrual waste as dry waste, which is subsequently sorted by waste pickers before being transported to Keriyan Khandepar disposal site for treatment.
12. Ponda municipality employs incinerators to treat ad manage menstrual waste.
13. Also, the municipality officer mentioned during the personal interview that they require some support from NGO to create awareness programmes about proper disposal of menstrual waste among women in Ponda.
14. The suggestions that were made by respondents include; the Government should intervene and pay more attention towards menstrual waste management system. And

also provide adequate hygienic facilities for women in public toilets of Ponda, it has been noted that municipality garbage pick-up services is not made available in every area of Ponda-city. Therefore, door to door garbage pick-up services should be made available in all the areas of Ponda to collect this kind of waste. Also, the respondents mainly suggested that government should take an initiative to conduct programmes about how to properly dispose the menstrual waste and also make women aware about the impact on environmental caused by disposing the menstrual waste inappropriately.

6.4 CONCLUSION

It is evident that Economic indicators such as GSDP, Urbanization rate and Industrial activity play a crucial role in generation of solid waste across the selected states; Haryana, Punjab, Goa, Himachal Pradesh, Madhya Pradesh, Odisha, Tripura, Manipur and Meghalaya. This highlights the interconnectedness between economic development and environmental impact. The policymakers should prioritize sustainable development strategies that balance economic growth with solid waste management initiatives. Integrating sustainable practices into economic development plans foster resilience against environmental pollution and contributing to a more sustainable and equitable future for present and future generations.

When it comes to Menstrual waste management in Ponda- Goa, the responses of the respondents indicate that menstrual waste management is not reasonably good. The Ponda municipality has to take proper initiatives to manage disposal and treatment of menstrual waste in an effective manner. The women living in Ponda seems to have instinctive understanding of menstrual waste management and its impact on environment and it is showcased in their willingness to pay for better menstrual waste disposal practices.

Women's Participation in the management of menstrual waste plays an important role. The government also needs to undertake responsibility of providing better menstrual waste disposal facilities, especially in the light of increasing population pressure and women's demand with regard to improved menstrual waste disposal. There is an urgent need to adopt an integrated menstrual waste management program. The involvement and awareness of women towards effective menstrual waste disposal and treatment is gaining more attention. Therefore, their involvement in decision making and changing attitude and behaviour towards menstrual waste management plays a very important part in formulation of the policies.

Furthermore, it is important to consider the environmental implications of improper menstrual waste disposal and explore sustainable alternatives that prioritize both hygiene and ecological preservation. Collaborating with local authorities, community leaders or healthcare professionals can facilitate the development of comprehensive menstrual waste management solutions that address the needs and concerns of women while also promoting environmental sustainability.

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APPENDIX- I

QUESTIONNAIRE

Name_____

Place_____

1. Age
   - 18-24 years
   - 25-34 years
   - 35-44 years
   - 45-54 years
   - 55 and above

2. Education Qualification
   - SSC
   - HSC
   - Undergraduate
   - Postgraduate
   - None

3. Occupation
   - Student
   - Homemaker

- Self- employed
- Employed for wages
- Retired
- Unemployed
- Other- please specify_____

4. What is your annual household income?
   - Less than Rs. 25,000
   - Rs. 25,000-Rs. 50,000
   - Rs. 50,000- Rs. 200,000
   - More than Rs. 2,50,000

5. Which type of Menstrual product do you use most often during your menstrual cycle?
   - Tampons
   - Menstrual Cups
   - Disposable Pads
   - Reusable cloth pads
   - Cloth
   - Other (please specify) _____

6. Since when have you used that Product?
   - Less than 2 years
   - 2-5 years

- 5-10 years
- 10 or more years

7. Do you use the municipal door to door garbage pick-up service to dispose menstrual waste?
   - Yes
   - No

8. Do you dispose menstrual waste as a separate waste, when collected by the Municipality?
   - Yes
   - No

9. How do you dispose of your Menstrual waste in Public toilets?
   - Flush down the toilet
   - Thrown it in the dustbin
   - Other: Please specify_____

10. Where do you work?

11. How do you dispose of your menstrual waste at workplace? (Answer this question only if you work in Ponda)

- Flush down the toilet
- Throw it in dustbin

- Other: Please specify_____

12. Do you dispose the menstrual waste in water bodies?

- Yes
- No

13. Do you dump menstrual waste in open areas?

- Yes
- No

14. Do you dump menstrual waste in fields?

- Yes
- No

15. Do you burn menstrual waste?

- Yes
- No

16. Are incinerators set up in Public toilets of Ponda?

- Yes
- No

17. Have you encountered challenges in finding appropriate disposal facilities for menstrual waste? If yes please specify.
    - Yes _____
    - No

18. Do you think the current waste management system in Ponda is equipped to process menstrual waste in a safer manner?
    - Yes
    - No

19. On a scale of 1 to 5, how informed do you feel about environmentally friendly menstrual waste disposal methods?

1. Not informed at all
2. Slightly informed
3. Moderately informed
4. Very informed
5. Extremely informed

Willingness to pay for better Menstrual waste management

Suppose that you receive improved and proper menstrual waste disposal facilities, along with door to door collection completely as a separate waste. This includes provision of menstrual waste storage bags, door to door collection once or twice a week, transportation and safe disposal of menstrual waste in an environmentally friendly manner.

20. Would you be willing to pay for improved and safe disposal of menstrual waste in your city?

    1. Not willing to pay
    2. Willing to pay a small amount
    3. Willing to pay a moderate amount
    4. Willing to pay any amount

21. If yes, what is the amount per month you would be willing to pay?

    - Less than 100
    - 100
    - 200
    - 300
    - 500
    - More than 500

22. Can you specify the amount?

23. If not willing to pay, why?

24. On the scale of 1 to 5, do you think it is the government's role to provide the menstrual waste management services?

1. Strongly agree
2. Agree

3. Neutral
4. Disagree
5. Strongly disagree

25. Suggestions

_____

APPENDIX II - INTERVIEW SCHEDULE

1. What are the steps followed by Ponda Municipality to collect, segregate, dispose and treat menstrual waste?
2. Where is the menstrual waste treatment plant located?
3. How much amount of menstrual waste is generated monthly?
4. What type of technique is used to treat the menstrual waste at disposal site?