"A Study on waste management and recycling in Bangalore"

Prof. Krishna Reddy B N [1], Adarsh Arya[2], Anish Sinhal[3], Sujal Agrawal[4], Harshit Agarwal[5], Jishnu M T. [6]

[1]Associate Professor, Jain (Deemed to be University) Center for Management Studies, Bengaluru

Under the Guidance of Prof. Krishna Reddy B N

[2,3,4,5,6]Students, Jain (Deemed to be University) Center for Management Studies, Bengaluru

Abstract

The study examines existing problems in waste collection and waste sorting together with waste disposal approaches while analysing environmental deterioration caused by growing population patterns and urbanization in Bangalore. The government and private institution waste policies along with plastic and electronic waste management lack definitive effectiveness measures. The paper demonstrates why sustainable waste solutions need enhanced technology with appropriate policies to build global landfill systems. These programs operate in the world yet evidence shows that neither the local collector industry nor small-scale recycling businesses participate. Waste management requires utmost emphasis because sustainability and resource recovery and circular economy and community conservation goals require it in order to persist over time.

Keywords: *Waste Management, Recycling, Sustainability, Resource Recovery, Policy Reforms.*

Introduction

Garbage disposal and recycling are some of the emerging international concerns by reason of urbanization, industrialization, and population increment. It is roughly projected that by the year 2050 the amount of municipal solid waste generated should be 3.4 metric tons per annum globally. Every year, over 62 million tons of waste is produced in India and more than half of this waste is not treated. India is a country that is much under pressure when it comes to waste management and Bangalore, the fastest-growing city is contributing to this problem more than the rest.

India generates 1.6 lakh tons of waste every day, the quantity is expected to double by the year 2030. The improper ways of waste disposal led to vast losses and negative health impact to the health of the environment in the form of methane emissions from the dumps that are considered to be among the biggest culprits for the emission of greenhouse gases. At present, the Indian population manage to recycle about 30 percent of the waste that could easily be increased. Nevertheless, recycling helps to save much energy and minimize greenhouse

gases. Recycling turns seventeen trees with 4,000 pounds of carbon emissions into one ton of paper saving materials.

Main five issues include electronic waste whose rate of increase is estimated at 20-30% annually and plastic. The generator quantity of e-waste in India is 2 million metric tons per year and plastic waste is also a crucial environmental concern major in oceans. Some technologies that are currently developing are chemical recycling and AI-based waste sorting to improve the recycling operations and reduce contamination.

The cyclic economy plays a role in generating rubbish at the same time avoiding the creation of waste and recycling all possible items. While undertaking, there are various strategies such as India's Swachh Bharat Abhiyan and the initiative of Zero Waste Cities which shows an indication to enhance the prospects of recycling measures and efficient waste management.

Review of Literature

1. "Solid Wastes: Engineering Principles and Management Issues" – Tchobanoglous, Theisen & Eliassen (1977) Consequently, this investigation aims to offer a technical knowledge of waste management infrastructure. The practicality of using various processes and methods for waste processing and recycling can be found out with the help of this technique. Therefore, issues relating to waste collection, treatment and disposal as well as the methods and design of landfills are also covered in this book thus it is quite useful for any city which is facing the problem of urban waste increase.

2. "Garbage in the Cities: Refuse, Reform, and the Environment" by Melosi (1981) This book gives a historical perspective of waste management subject and reforms in the policy system. It contributes to the knowledge of the development of modern waste disposal system and help in understanding how legislations have influenced the development of waste management systems. Also, it pinpoints on how the issue of public health has been a factor to the advancement of municipal waste management over time.

3. "Market-Based Incentives and Residential Municipal Solid Waste" – Miranda et al. (1994) The paper tries to analyze some of the possible ways of encouraging efficiency in the management of wastes. It also assists in evaluating prospective economic frameworks in regard to Bangalore's waste management. Keywords: taxation for waste generation and rebate for waste recycling have been recommended and embraced with a positive impact on public responsibility as proposed in this study.

4. "Determinants of Recycling Behavior: A Synthesis of Research Results" – Hornik et al. (1995) This work aims at examining the factors that make the general public to recycle or not to recycle. It offers an understanding of ways that the government of the city that is Bangalore can enhance the level of recycling through behavior

modification 8. Also, it pinpoints the function of convenience, money motivation and environmental concern in creating replenishment recycling behavior.

5. "Environmental Impacts of Solid Waste Landfilling" – El-Fadel et al. (1997) Some of the topics discussed in this paper include landfill pollution, production of methane gas, and contamination threats. This report focuses on two major problems – the presence of groundwater pollution by the landfills that are located in Bangalore and climatic change. The paper also describes other types of landfill management that have been proposed such as gas for energy recovery.

6. "Perspectives of Solid Waste Management in India" – Kurian (2002) This paper aims to explore the current and future situation of India in solid waste management issues and solution. It shows voids in the existing policy guidelines, as well as some possible solutions that can be applied to the case of Bangalore. Literature review proved that decentralised model will also assist Indian cities in coping with high volumes of wastes.

7. "Municipal Solid Waste Generation, Composition, and Management: The World Scenario" – Karak et al. (2012) In this paper, various examples of the best practices in waste management all over the world have been discussed and compared. It is useful in comparing the rate of waste generation in Bangalore with the international indexes. Also, it presents the differences in waste generation in different economic regions, which is useful in different region approaches towards waste.

8. "Comparative Analysis of Solid Waste Management in 20 Cities" – Wilson et al. (2012) The study is focused on waste collection rate, recycling approach, and policy application of twenty cities around the world. It assists to determine what is working best so that Bangalore can emulate it. The implication are to support the perception that when segregation of wastes is well implemented in cities then the recycling level is high accompanied by low landfill disposal.

9. "A Review of Waste Management Practices and Their Impact on Human Health" – Giusti (2009) This paper aims to analyse the consequences of ill disposal of wastes. It will be useful providing a tool in comprehending the effect of poor waste disposal on peoples' health in Bangalore. The paper demonstrates the relationship between air and water pollution, their effects on diseases due to the uncontrolled discharge of wastes.

10. "Disaster Waste Management: Literature Review" – Luther et al. (2011) This review presents strategies that are applicable in the post-contamination period. Thus, it is helpful in formulating strategies to deal with waste disposal in Bangalore in cases such as floods or any natural disasters. It also has recommendations on the measures of quick waste removal and other procedures for handling emergent waste management cases.

11. "Household Recycling Knowledge, Attitudes, and Practices Towards Solid Waste Management" – Babaei et al. (2011) This paper explores the perceptions held by the people with regard to recycling efforts. It outlines

options that could be taken by Bangalore to increase the feasibility of awareness creation so as to increase the level of recycling. It also examines social and psychological aspects of factors that impact on the level of recycling in households.

12. "Evaluation of the Effect of Recycling on Sustainability of Municipal Solid Waste Management in Thailand" – Menikpura et al. (2012) This paper analyses the concept of sustainability with special focus on recycling. This contributes to the knowledge of how Bangalore could incorporate the recycling into the systems of waste management. This paper outlines the effects of enhancing the implementation of recycling programs in terms of the economic and environmental impacts.

13. By taking the initiative to reduce waste generation or Zero Waste Strategy the following paper "Minimizing the Increasing Solid Waste", Song, Li & Zeng 2015. Concerning the paper under analysis, it is necessary to concentrate on the topic focusing on the concept of zero waste as well as the ways in which it can be implemented in urban environment. It also tells how Bangalore, one of those escalated cities, can improve and take a model for zero-waste involvement by implementing EPR and promoting sustainable consumption. However, the study also explores the possibilities of the no waste cities and obstacles in the field.

14. "Recycling Participation and Information Dissemination" by Oke and Kruijsen (2016) These respondents indicated that 30% of households did not have knowledge of correct way of handling recyclable materials. It has more stress on the point that effective education programs need be imparted in Bangalore to improve the level of recycling. Besides, the study seeks to address the following questions: what part does the government play in promoting segregation of wastes, and does the use of social media help in the accomplishment of the set goals?

15. "Role of the Informal Sector in Urban Waste Management" – Aparcana (2017) This research shows that about 63 percent of the recyclables are processed through the informal channels. This specific case underlines the necessity for the state to give the credential identity of the informal waste pickers and incorporate them into the system of the Bangalore. The paper also examines how policy actions could be used to bring interaction between formal and informal areas of wastage.

16. What a circular is the global economy? A Sociometabolic Analysis" – Haas et al. (2016) The objective of this study is to assess the resource utilisation and material recycling efficiency. It assists in evaluating the possibilities for changing Bangalore's economy for circularity as it may in relation to material recycling and reuse. The experiences presented in the paper show the existing tensions regarding material consumption and resource sustainability.

17. This paper investigates sustainable construction waste management through the lifecycle approach and the 3R method (Reduction, Reuse, Recycling) - Mohammed, M., Abdullahi, M. E., & Yusuf, M. B. The analysis detects three significant waste elements that stem from design problems and procurement system shortcomings as well as inadequate site management strategies. Waste prevention together with its minimization and recovery promote sustainable waste management according to this study which highlights several obstacles faced by the Malaysian construction industry while emphasizing necessary policy reforms and technological advances and effective waste management methods for boosting social sustainability. The study recommends both systematic waste priorities and governmental involvement for developing better sustainable waste management in construction works.

18. "The Future of Waste Management: Trends, Opportunities, and Challenges for The Decade (2021-2030)" – ISWA (2021) This paper offers forecast of waste management outlook with a focus on the circular economy style. This has shown how Bangalore can adopt smart waste processing systems in order to address the issue of waste management properly. Also, the paper describes the use of artificial intelligence and automation in the current contexts of waste management.

19. "Scenarios of Waste Management in Bangalore" – BP Naveen (2021) This paper seeks to understand the status of waste management in Bangalore and finds out that 60% of waste produced is collected, and 15% is treated. Some of them include inadequate infrastructure, lack of enforcement and low awareness among the public. Some of the interventions estimated include; decentralisation of waste treatment, better waste source separation and incorporating of the informal waste recyclers. Such information enables identification of main problems and perspectives for improvement in waste management in Bangalore.

20. This study “Review of the Effects of Recycling in Urban Waste Management Systems” by Kaza et al. (2021). This paper aims at establishing how recycling minimizes the use of landfill and enhances garbage sustainability. It covers the aspects like waste management, particularly sorting process, citizens’ involvement, and technologies promoting waste recycling. The paper focuses on the comparative analysis of the best practices of recycling. These suggestions prove useful in increasing the intensity of recycling in Bangalore as well as in creating management policies.

Research Design

The research utilizes a combined methodological approach that blends quantitative and qualitative assessment of waste management systems and recycling operations in Bangalore. The study explores waste generation patterns together with assessment of existing policies and examination of new waste management system solutions. The research gathers data through first-hand (survey responses and stakeholder interviews and

observation studies) as well as second-hand information (government reports and academic papers and industry studies). The research uses stratified random sampling to obtain households and businesses yet relies on purposive sampling for choosing officials and waste management experts. Different evaluation methods including descriptive statistics, comparative analysis and SWOT analysis help identify major obstacles and potential opportunities. Every aspect linked to ethics remains strictly supervised through the enforcement of informed consent measures and data confidentiality provisions. The research functions to detect priorities in public policies combined with contemporary technological solutions and citizen understanding levels to produce directed recommendations for enhancing waste management systems in Bangalore.

Objectives of the study

The objectives that we are trying to fulfil with this research are that as follows:

- To assess waste generation and recycling rates in Bangalore.
- The feasibility assessment of deploying innovative waste management methods throughout Bangalore should be conducted.
- To analyse the effectiveness of existing policies on waste management in the city.

Research Methodology

Thus, the study will use both primary and secondary data sources. The data would be obtained from first-hand questionnaires to officials and waste management companies, as well as a waste picker community. The secondary data source will involve using data from government reports and records of municipalities. Concerning the best practices of waste management, recommendations will be made to the Bangalore City after evaluating case studies of waste management. Incorporation of other high-tech options that have not yet been developed and proven commercially viable will be assessed based on providers of technology and experience from pilot plants. Lastly, concerning attitudes and behaviours that influence waste management will be explored through survey using focus group discussion with cooperating participants and key informant's interviews.

Research Gap

As is evident from the research, there are no specific statistics available with regard to waste generation, level of recycling, and the waste handling market in Bangalore. There is no understanding about the problems existing in the city in this perspective. Lack of information regarding culture and behavioural patterns on waste management practices has been one of the limitations. Technologies like AI and chemical recycling are referred to but the actual usage of these within Bangalore's waste management system has not been researched for this paper. However, more effective criticisms of the government policies or any activity performed by the informal sector in waste management has not been conducted yet. All these gaps have been addressed in the present

research study and the outcomes serve as localized focused data insights pertaining to Bangalore in respect to the waste management practices.

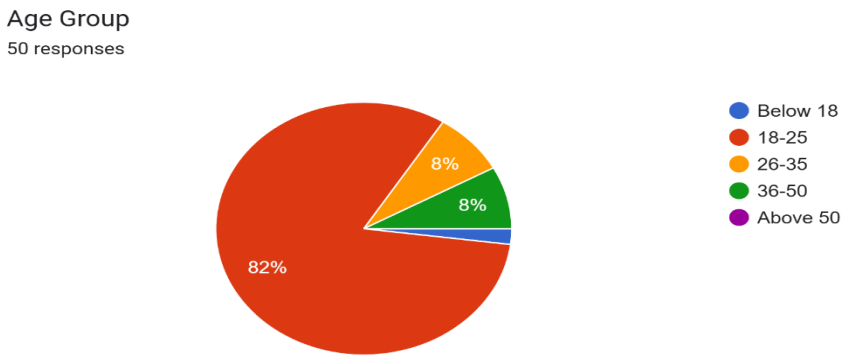
Limitations of Waste Management:

- The practice of proper waste segregation fails to meet targets at residential areas despite existing regulations. The mixture of waste materials creates processing obstacles that result in added stress for landfill facilities.
- The city does not possess enough infrastructure facilities which are necessary to process waste as well as manage recycling and composting activities. The actual operational capacity of waste processing facilities remains below their technical maximum because of both operational and technical operational difficulties.
- Urbanization and Population Growth Rate: Increasing population and urban sprawl outpace the development of waste management systems. As a result, landfills are overflowing and there is illegal dumping.
- Public Awareness is Lacking: Many residents lack proper knowledge of the best way to dispose of waste, methods of recycling, and the significance of reducing waste. This means that effective waste management is impeded.
- Informal Recycling Sector: Informal sector plays a vital role in recycling but it does so unregulated and unsafe, therefore the whole recycling process is not effective.

Data Analysis & Interpretation

The findings from a conducted survey can be explored to understand waste management and recycling practices in Bangalore. A total of 50 participants submitted their responses which underwent analysis focused on demographic information and waste disposal practices along with recycling knowledge and facing barriers and possible enhancements.

- **Demographic Profile**



Data:

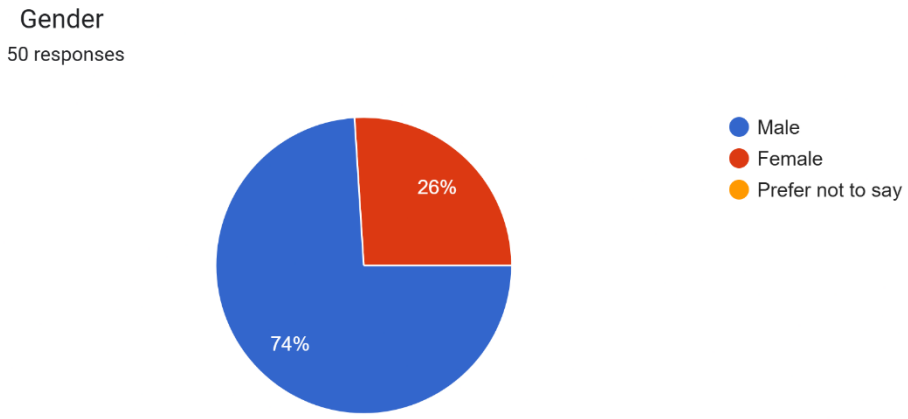
18-25 years: 82%

26-35 years: 8%

36-50 years: 8%

Description:

Homogeneous data shows that 82% of participants belong to the 18-25 age group because young adults actively participate in waste management discussions. Research findings show that awareness programs targeting younger adults would most likely produce greater results in behavioral modification. The apparent low response rate from aged participants stems either from disinterest or technical barriers when participating in the survey. Future research should implement strategies to achieve an even representation across various age groups so that waste management opinions gain a wider range of perspectives.



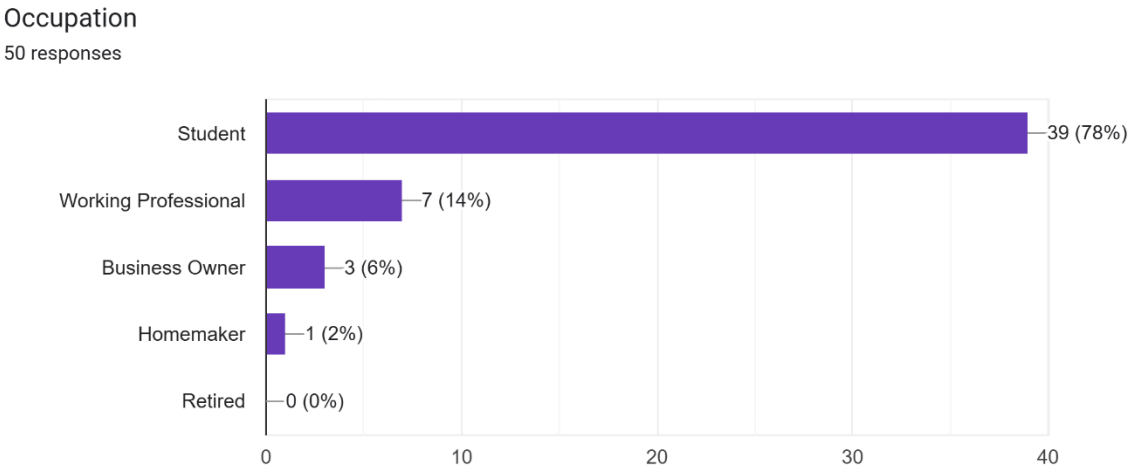
Data:

Male: 74%

Female: 26%

Description:

Most survey participants turned out to be male which might suggest environmental discussions show varying levels of interest between male and female participants. The discussion of waste management needs more female participation since both men and women contribute to household waste disposal. The study requires improved outreach because sampling bias has produced an insufficient number of female respondents. Gender-specific waste disposal patterns should be investigated through additional research because they may present distinct disposal patterns.



Data:

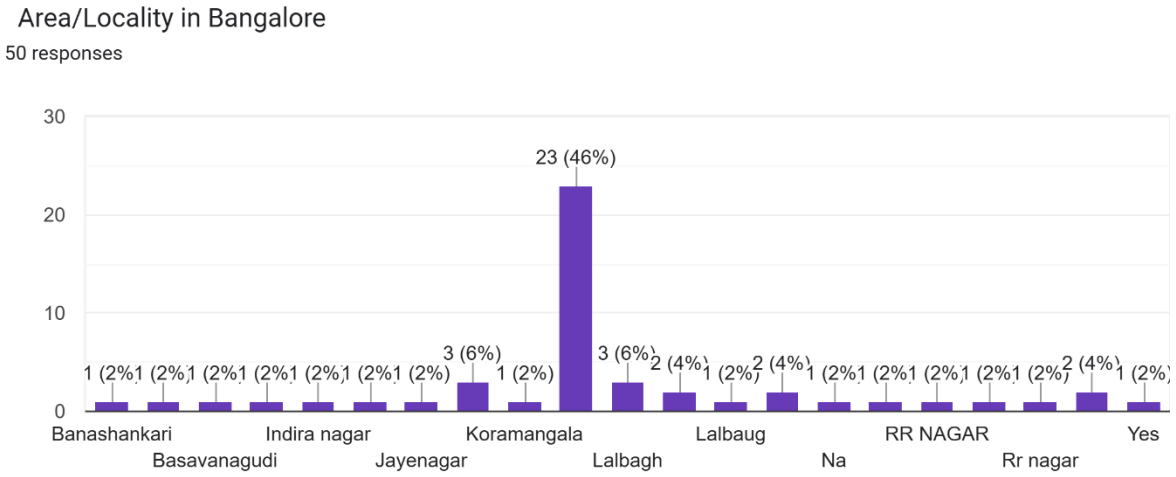
Students: 78%

Working Professionals: 14%

Business Owners: 6%

Description:

A majority of participants in the study identified as students which demonstrates that youth strongly care about waste management issues. The results indicate that educational establishments have significant potential to form sustainable waste management values among their students. The low number of business owner participants suggests that these owners either do not know about waste recycling policies or show little interest in them. Business owners together with working professionals deserve additional targeted outreach because their participation will deliver necessary insights concerning waste management approaches in professional settings.



Data:

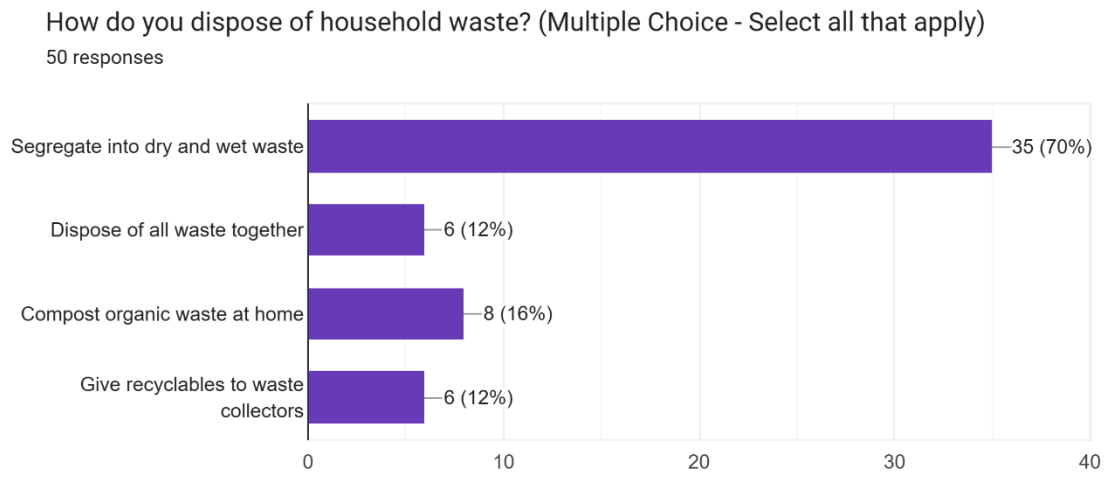
Koramangala: 46%

Whitefield: 6%

Description:

Waste management strategies need to focus on local needs because most participants resided in Koramangala. The high number of respondents from Koramangala indicates either serious waste management issues or intense survey attention in that area. Policies which target waste disposal efficiently need to understand the unique habits regarding waste management in different regions. The research would benefit from expanding the survey area to include additional regions outside Koramangala because it produces an immediate snapshot of waste management issues in one district.

- **Waste Disposal Practices**



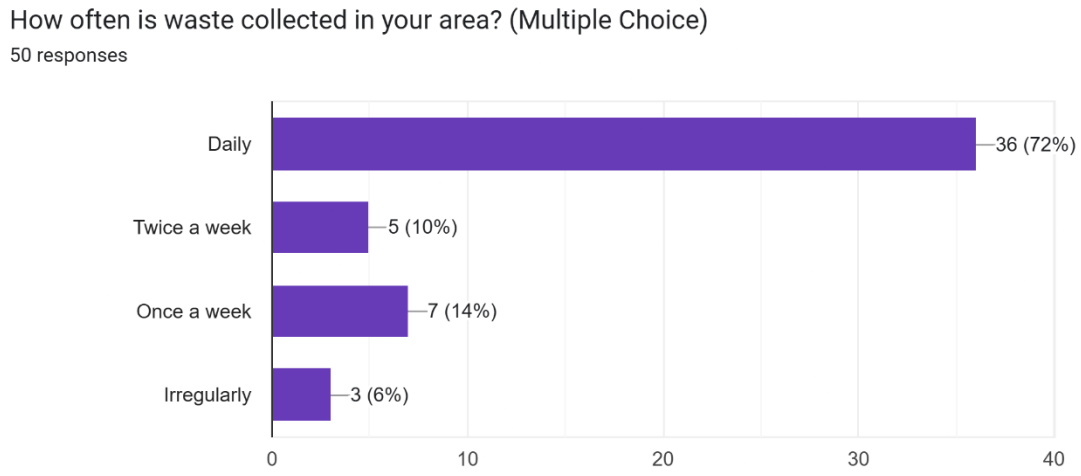
Data:

Segregate waste: 70%

Compost organic waste: 16%

Description:

Most participants practice waste segregation whereas a small portion of people still mix all their waste but need more awareness about it. The waste segregation awareness efforts have proven successful yet still show knowledge gaps in certain population groups. The process of separating waste remains essential for recycling systems because the government should maintain strategies that boost the numbers of participants. More research should examine why participants fail to follow waste sorting protocols so that appropriate prevention strategies can be created.



Data:

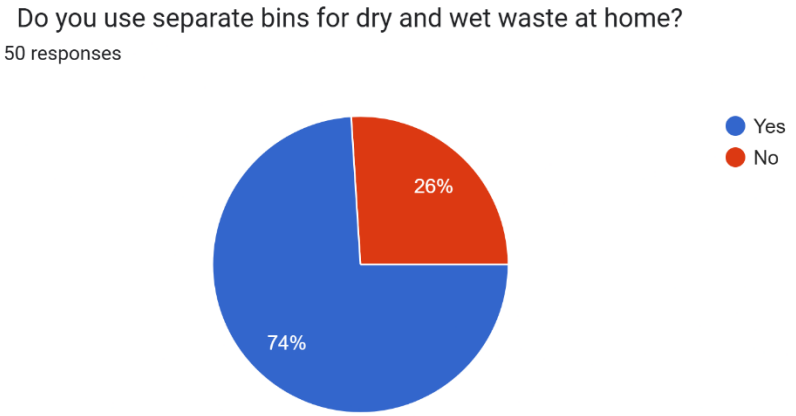
Daily: 72%

Twice a week: 10%

Irregular: 6%

Description:

The majority of respondents receive daily waste collection but irregular waste collection remains a problem in certain regions of the study site. Municipal waste collection occurs daily since this practice ensures hygiene levels and blocks pollution formation. Some parts of the area experience irregular waste collection which indicates both inadequate service and possible delivery obstacles. The problems stem from weak waste collection systems and lack of municipal accountability so improvements in these areas will help resolve them.



Data:

Yes: 74%

No: 26%

Description:

A majority of the respondents separate trash into different bins even though there exists a need for better education regarding those who still do not separate waste. Proper waste processing along with recycling becomes possible through dry and wet waste separation using separate bins. These individuals represent 26% of the population because they are either not aware of the segregation system or they cannot access proper rubbish disposal facilities. The implementation of labelled waste bins together with waste segregation program participation from community members would enhance the compliance level.

Data:

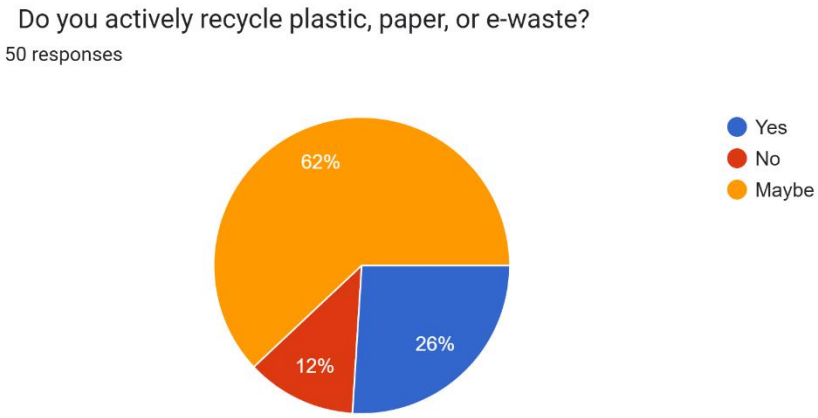
Yes: 30%

No: 56%

Description:

Survey results indicate that most of the population remains unaware about waste collection sites as a result of inadequate infrastructure and poor communication systems. Offensive waste disposal techniques including public dumping might emerge because of such ignorance. Better waste management participation depends on increasing public education through various communication channels including visual signage and electronic map displays and education programs. Local government authorities must maintain easy-to-understand accessibility of waste disposal area information for residents.

➢ **Recycling Awareness and Practices**



Data:

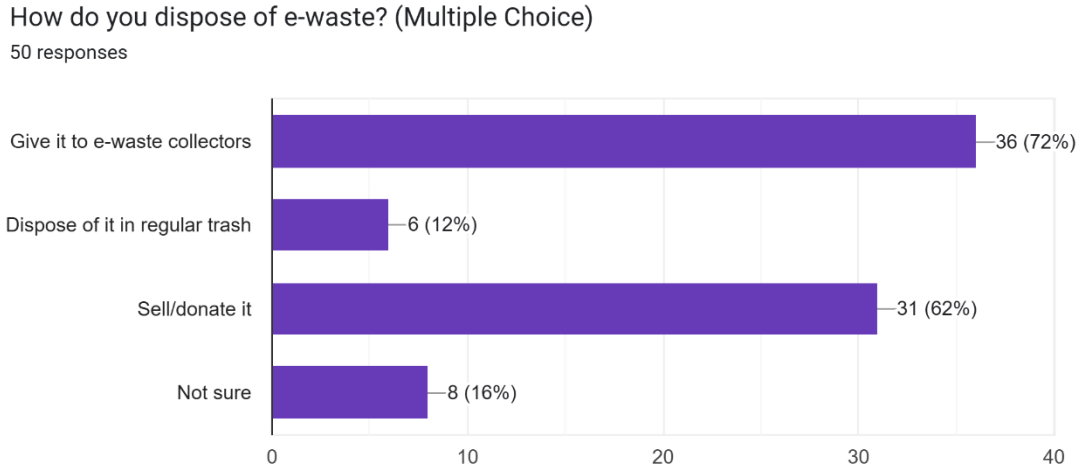
Maybe: 62%

Yes: 26%

No: 12%

Description:

The limited knowledge of recycling indicates that people require better instruction on responsible waste disposal practices. People participate less in recycling programs because they lack sufficient awareness about it. Public and private institutions need to work together for establishing user-friendly recycling systems. The learning curriculum of schools and colleges needs to incorporate units about sustainability and waste management practices.



Data:

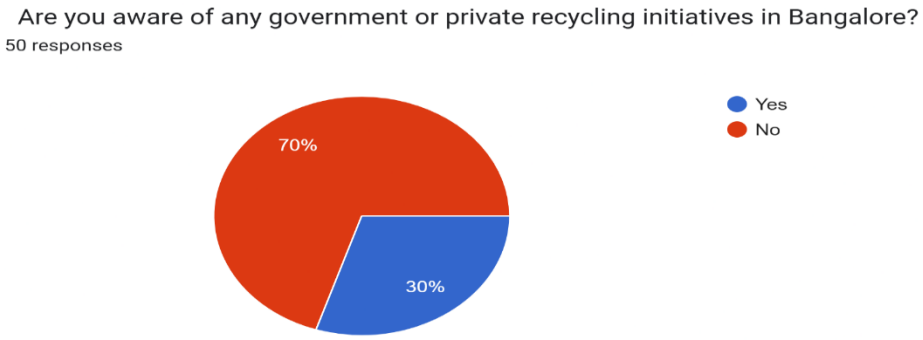
Give to e-waste collectors: 72%

Sell/donate: 62%

Dispose in regular trash: 12%

Description:

Research shows most people properly discard their waste electronics although a small number puts them into normal garbage streams that create environmental perils. Electronic waste disposal needs careful attention as such waste contains dangerous elements which include lead and mercury. More efforts should direct themselves to establishing readily available collection centres for e-waste disposal. Enhanced awareness about e-waste disposal risks will enhance general compliance levels.



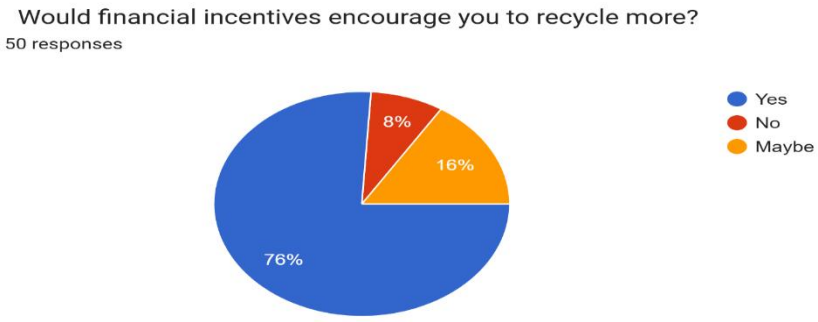
Data:

Yes: 30%

No: 70%

Description:

The large population remains uninformed about recycling initiatives because they need more widespread promotional efforts. Increased public awareness results from applying social media together with organizing community events. Through a government-initiated partnership with corporations the government can create workplace recycling initiatives.



Most people would recycle more if they received payment for doing so according to 76% of the participants.

➢ Challenges in Waste Management

Participants found these main problems to exist:

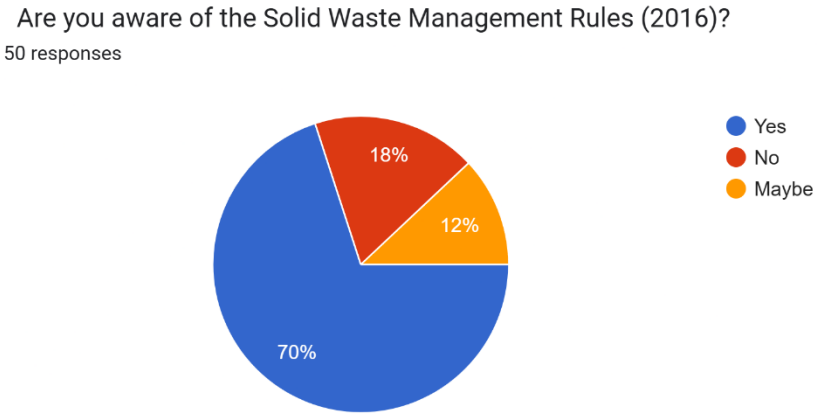
No access to recycling facilities: 62%

Lack of proper waste collection: 58%

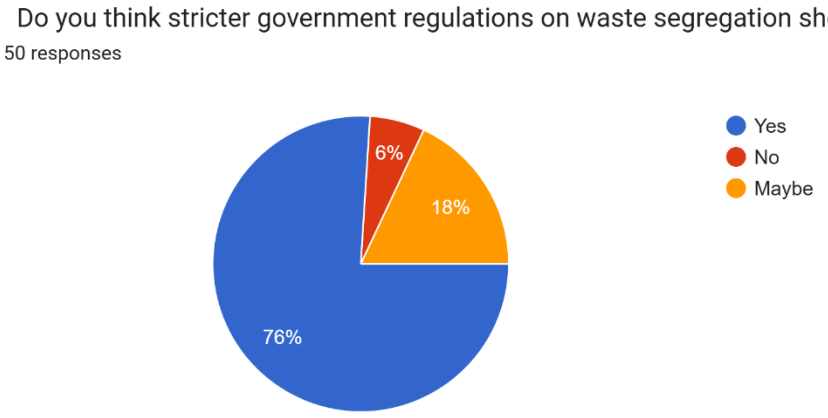
Inconvenient disposal methods: 22%

Poor enforcement of waste management laws: 22%

➢ . Policy Awareness and Willingness to Participate



Under the Solid Waste Management Rules of 2016 70% of people know about the rules but 18% do not.



People strongly support that government needs to enforce waste separation rules more strongly across the country.

The people want to help strengthen waste management programs that their communities run.

- **Suggestions for Improvement**

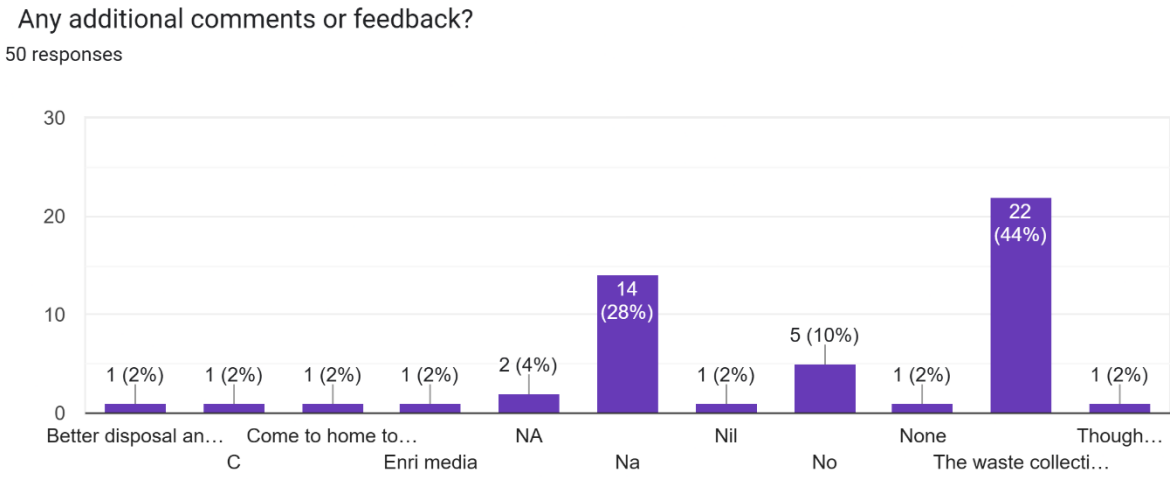
Respondents made several proposals to enhance waste handling practices. The respondents strongly supported running educational courses about waste management. Other recommendations include:

Better waste collection infrastructure.

Home collection services for waste.

Banning plastic packaging.

Stricter government regulations.



Summary of Findings

- The investigation demonstrates pressing waste management and recycling problems in Bangalore which need immediate action.
- Large-scale urbanization combined with industrial development causes rapid waste production which makes Bangalore one of the major contributors to India's 1.6 lakh tons everyday waste output. The improper disposal of waste causes environmental contamination, health-related risks and creates excessive conditions that saturate landfills.
- A significant portion of 30% of residents fail to practice waste segregation which results in reduced recycling performance. When discharging mixed waste into the environment there is a higher risk of environmental harm as well as methane gas emissions.
- The processing capacity for waste materials stands at 30% since the remaining 70% becomes landfill waste. Although informal waste collectors manage 63% of recyclables their work condition remains dangerous because regulation does not exist.
- The annual increase of e-waste growth stands at 20-30% and regular trash continues to receive 12% of discarded e-waste items. The improper disposal of plastic materials creates a substantial environmental crisis.

- The majority of 70% of respondents know about waste management laws yet enforcement measures continue to be weak. Inefficient waste management occurs because of weak compliance monitoring systems and insufficient public awareness and lack of accountability.
- Sustainable waste management in Bangalore requires four essential actions to include enhanced waste segregation laws with better infrastructure and sector integration and public awareness initiatives.

Suggestions

The study implies several solutions to tackle Bangalore's waste management problems.

- Reinforcing approach systems and administrative authorization
- Progressed reusing technology development combined with waste management infrastructure receive support from participants.
- The strategy would enhance public educational campaigns and motivational programs to develop open interest and mindfulness.
- Warm economy methods together with waste-to-energy operations deserve advancement.

Conclusion

Effective waste disposal and recycling are a difficult task in this city because of the increased rates of urbanization, population, and inadequate facilities. Despite this, improper waste disposal, lack of effective segregation methods, overfilling of the existing landfills and low levels of awareness among the inhabitants are still evident in the city courtesy of the adopted policies such as the Solid Waste Management Rules of 2016. The informal sector is an important sector in the recycling chain, but it operates under perilous and unhygienic environments and circumstances, making the complexity of waste management pronounce. However, it implies that the key challenges will be addressed by incorporation of technological innovation, community appeal to increase support and policy reviews to ensure strict compliance. The problems may be solved by changing the economy to a ‘circular’ economy approach, decentralised waste management, and investing in waste-to-energy technologies in Bangalore. It is for this reason that initiatives towards improving the current waste management situation in Bangalore has to involve not only professionals but also the government, private sector and even the citizenry with strong conservational measures.

References

1. Tchobanoglous, G., Theisen, H., & Eliassen, R. (1977). *Solid wastes: Engineering principles and management issues*. McGraw-Hill.

2. Melosi, M. (1981). *Garbage in the cities: Refuse, reform, and the environment*. Texas A&M University Press.

3. Miranda, M. L., Bauer, S. D., & Aldy, J. E. (1994). *Market-based incentives and residential municipal solid waste*. Journal of Policy Analysis and Management, 13(4), 681–698.

4. Hornik, J., Cherian, J., Madansky, M., & Narayana, C. (1995). *Determinants of recycling behavior: A synthesis of research results*. Journal of Socio-Economics, 24(1), 105–127.

5. El-Fadel, M., Findikakis, A. N., & Leckie, J. O. (1997). *Environmental impacts of solid waste landfilling*. Journal of Environmental Management, 50(1), 1–25.

6. Kurian, J. (2002). *Perspectives of solid waste management in India*. Journal of Environmental Studies, 15(3), 27–38.

7. Karak, T., Bhagat, R. M., & Bhattacharyya, P. (2012). *Municipal solid waste generation, composition, and management: The world scenario*. Waste Management, 32(3), 953–965.

8. Wilson, D. C., Velis, C., & Cheeseman, C. (2012). *Comparative analysis of solid waste management in 20 cities*. Waste Management & Research, 30(3), 237–254.

9. Giusti, L. (2009). *A review of waste management practices and their impact on human health*. Waste Management, 29(8), 2227–2239.

10. Luther, L., Seldman, N., & Jones, C. (2011). *Disaster waste management: Literature review*. Environmental Protection Agency Report, 45, 1–38.

11. Babaei, A. A., Alavi, N., Goudarzi, G., Taban, N., & Yavari, A. R. (2011). *Household recycling knowledge, attitudes, and practices towards solid waste management*. Journal of Environmental Health Science & Engineering, 9(1), 25–34.

12. Menikpura, S. N. M., Sang-Arun, J., & Bengtsson, M. (2012). *Evaluation of the effect of recycling on sustainability of municipal solid waste management in Thailand*. Resources, Conservation & Recycling, 65, 11–19.

13. Song, Q., Li, J., & Zeng, X. (2015). *Minimizing the increasing solid waste through zero waste strategy*. Journal of Cleaner Production, 91, 12–21.

14. Oke, A., & Kruijsen, J. (2016). *Recycling participation and information dissemination*. Resources, Conservation & Recycling, 104, 49–58.

15. Aparcana, S. (2017). *Role of the informal sector in urban waste management*. Habitat International, 59, 110–120.

16. Haas, W., Krausmann, F., Wiedenhofer, D., & Heinz, M. (2016). *What a circular economy is: A sociometabolic analysis*. Journal of Industrial Ecology, 21(3), 654–667.

17. Mohammed, M., Abdullahi, M. E., & Yusuf, M. B. (2020). *A review on achieving sustainable construction waste management through 3R (Reduction, Reuse, Recycling)*. Environmental Technology & Innovation, 20, 100223.

18. ISWA (International Solid Waste Association). (2021). *The future of waste management: Trends, opportunities, and challenges for the decade (2021–2030)*. ISWA Publications.

19. Naveen, B. P. (2021). *Scenarios of waste management in Bangalore*. Energy Nexus, 1, 100004.

20. Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2021). *Understanding the impact of recycling on urban waste management systems*. World Bank Urban Development Series.