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KADAPA MUNICIPAL CORPORATION DOOR TO DOOR GARBAGE COLLECTION AND SOLID WASTE MANAGEMENT SYSTEM: A SURVEY ON ITS IMPLEMENTATION, IMPORTANCE AND EFFECTIVENESS

Arifa sulthana[1], A. Muni Kumari*[2], Lankala Ravindranath Reddy[1], Maddigalla Chandra sekhar[1], S. Babulla[2]

[1]Department of Public Health Section, Municipal Corporation, Kadapa 516001, India.

[2]Department of Genetics and Genomics, Yogi Vemana University, Kadapa 516005, India.

*Corresponding author

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ABSTRACT

Municipal waste management is one of the primary and essential tasks for environmental sustainability. Solid waste management is highly problematic in urban cities. With the increasing population improper solid waste management polluting many densely populated areas. For scientific disposal of waste, Ministry of Environment, Forest and Climate Change Government of India has notified the, Solid Waste Management System in 2016. In Kadapa town it was brought to momentum in March 2022 as CLAP (clean Andhra Pradesh) under the government for door to door segregation of garbage and collection. The results indicate that door to door collection system is very effective. The system developed with implementation of technologies for composting and processing of solid waste. The steps taken to motivate people, creating awareness and the dedication of the municipal employees and workers is appreciable. Daily collection of segregated waste is the base for reuse, recycle and to completely remove the garbage at vulnerable points in the town.

Keywords: Segregation, municipal waste management, recycling, composting.

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1. INTRODUCTION

Municipal waste management is essential aspect of urban development for sustainability. Amount of waste generated increases with urbanization. Waste management is directly related to health and environment. Efficient waste management systems can promote cleaner and healthier environment. This study explores the importance of municipal waste management, its challenges and potential solutions. Segregation of waste at home itself is very much essential and primary responsibility of each individual [1]. Door-to-door collection system of the segregated waste by municipality in a town is a positive move towards reducing environmental pollution[2].Waste management, reducing the amount of waste land filled, originating new circular economies, especially when we have limited economic resources are major tasks. Waste collection, transporting to the processing unit and recycling are essential steps in waste management. The present study focuses on the various stages of solid waste management (SWM) system in Kadapa town. Solid waste is segregated and managed as wet, dry and hazardous waste. According to the solid waste management rule 2016 [3] it is the responsibility of the citizen to divide the waste and give to waste collector. After segregation and collection the solid wet waste is sent to compost preparation and dry waste is sent for recycling. Solid waste management is the key step to control environmental pollution. India is a developing country due to poverty, population growth and urbanization and limited economic resources it is challenging to develop solid waste management system. Solid waste management is one of the major challenges in India where tons of waste is generated every day [4]. Increase in population and population density resulting in waste generation and accumulation. SWM is a challenge at high density populated areas where some people throw garbage on roads (Fig 1) it is hazardous to health and environment and it is also difficult task for municipal workers to segregate such waste.

Fig. 1: Waste thrown on road side

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Segregation of the waste at generation point is essential before collection and again segregation of unsegregated waste after collection is done before recycling. Collection, transport, treatment, recycling and scientific disposal are everyday tasks of Municipal Corporation in urban towns in India. With limited resources solid waste management is a difficult task to address and fulfill completely. Municipal solid waste generated per each person is increasing as a result of urbanization and economic growth. Waste management is a major task faced by many urban local bodies (ULB). Waste is disposed on land at various locations named as dumping yards located outside and near to towns. Dumping yards result in soil, air and water pollution (Fig 2). Apart from pollution it is causing severe damage to human health [5]. People staying near this location are living in a very unhygienic environment and facing severe health problems. Old people and small children, who cannot do any hard work, are depending on picking up paper, plastic and metals from the waste

Generated from the town and sell to earn little money. It is quite risky to work in such environment without proper knowledge about hazardous materials. Waste in dumping yard is burned and such activity results in release of poisonous gases smoke and ash resulting in health and environment risks (Fig 3).

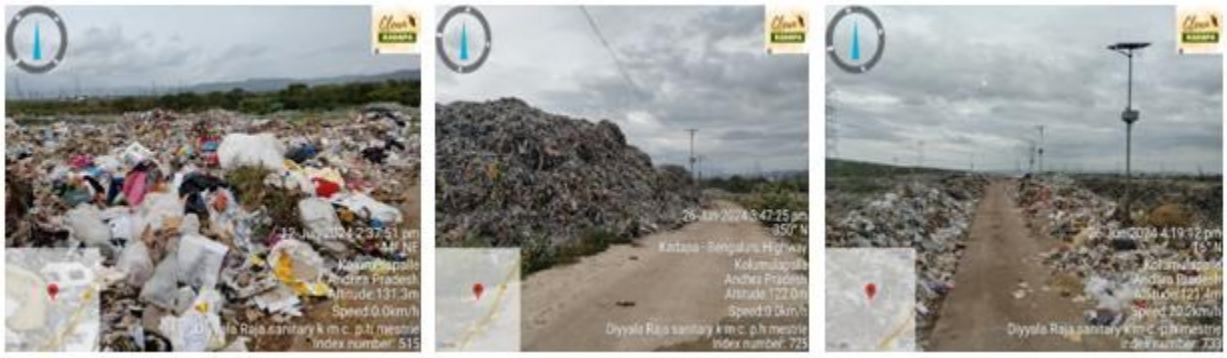

Fig. 2: Dumping yard

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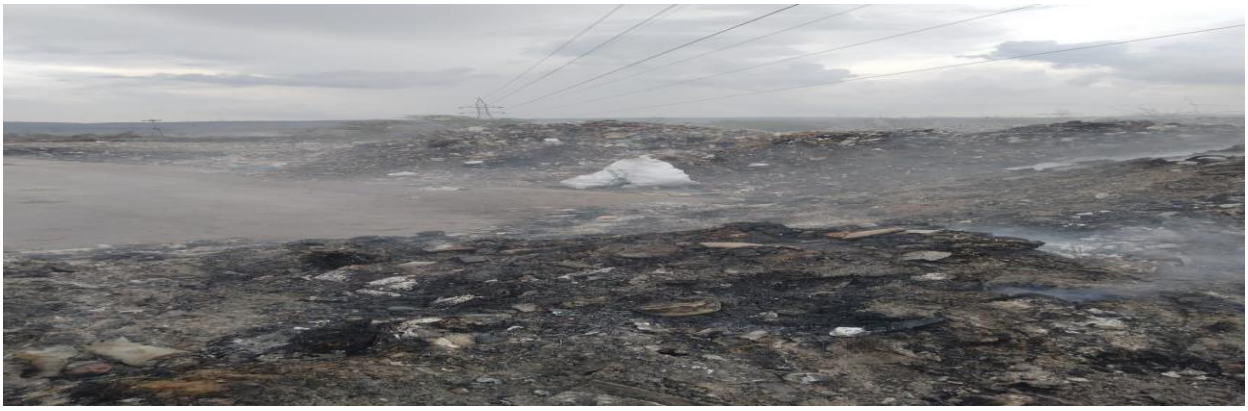

Fig. 3: Waste burning in dumping yard

Priority is given to control pollution on waste dumps and SWM focuses on retaining the useful resources at dumping yards recycle and generate useful products within economy, by using specialized waste processing facilities that can separate recyclable materials.

Waste generated at various places is disposed irresponsibly. Single use plastic is major content in disposed garbage [6]. It is difficult to recycle thin plastic below 50micron thickness. Plastic covers have been banned in many countries. Plastic is an organic material and it is not bio degradable and a threat to environment. So it is necessary to create awareness to segregate the waste as dry and wet waste. The dry waste contains plastic, paper, cardboard, thermocol, wood, metals etc. Wet waste contains food, vegetables, fruits plants etc. The wet waste and dry waste are to be handled separately and recycled for useful products.

Sustainable SWM is current need to save environment and economy. The SWM should include improved technology, missionary and scientific approach. There should be a collective effort and involvement of Government, Municipal employees, public, corporate and agriculture sector. Each individual should feel the responsibility and have an awareness of urgent need to save the environment [7]. India is transforming in to modernization towards a leading economy, with high quality infrastructure to meet the needs of people. Towns are being converted to corporations and

Developing to meet the needs of modern world. This activity should consider and take necessary action towards environment safety and sustainability. The waste management rules in India were introduced by the ministry of Environment and Forests (MoEF) [8].Waste management regulations

In India at national and state levels are governed by law, policies and guidelines. The environment (Protection) Act 1986 legislation empowers central government to take measures

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for environmental protection and conservation. It's a legal framework of various rules and regulations related to waste management in India. Solid waste management rules 2016 regulate the solid waste management in India. The frame work of waste management focuses on segregation at the source, minimization of waste, recycling and safe disposal of solid waste. Biomedical waste management rules 2016 specify regulation of biomedical waste generated from health care facilities such as hospitals, clinics, laboratories etc.,. The segregation, collection, treatment and disposal of the waste generated at health care facilities is done with care to prevent its adverse effects on public health and the environment. E-waste (Management) Rules 2016 address the management and handling of electronic waste (e-waste), this includes the collection, segregation, recycling and disposal. Producers, consumers and recyclers must follow the rules to ensure safe and environmentally safe management of e-waste. Plastic waste management rules 2016 aim at regulating the manufacturing, sale and usage of plastic products for minimizing their adverse impact on environment. These rules regulate Plastic waste collection, recycling and disposal. Construction and demolition Waste Management Rules 2016 provide guidelines for management of construction and demolition (C&D) waste. It promotes the reuse, recycling and proper disposal of C&D waste. Hazardous waste management rules 2016 govern the management of the hazardous wastes [9]. The generation, collection, treatment and disposal are focused. It aims at ensuring the safe handling of hazardous waste to prevent harm to human health and environment. Municipal solid waste management rules 2016 provide the guidelines for the management and handling of municipal solid waste (MSW) in urban areas. Individuals industries and government bodies should adhere to the rules and regulations for effective waste management practices and mitigate environmental and public health risks associated with improper handling/disposal of waste. Municipal solid waste regulation and schemes in India the environmental protection act came into India in 1986, central government has to regulate all forms of waste and solve SWM in India. According to the act such measures has to take central government for prevention, control of pollution. In order to implement these municipal authorities shall undertake phrased programs to ensure participation of community in waste segregation. According to national environmental policy (NEP) municipal waste is major cause of soil pollution. The policy mainly focused on Reduce, Reuse and Recycle by using the relevant technologies and substitute the non-biodegradable materials to biodegradable and reusable materials. Encourage the community to participate waste management activities by ULBS (Urban Local Bodies). With this background we write this report to analyze the effective waste management system of Kadapa town, in Andhra Pradesh, India. This study can help in implementation and improvement in waste management in towns like Kadapa.

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2. METHODOLOGY AND RESULTS

Solutions for Efficient Municipal Waste Management:

Addressing the challenges of municipal waste management requires a multifaceted approach:

a. Integrated Waste Management Systems: Implementing integrated waste management systems that combine waste reduction, recycling, composting and landfilling can optimize resource recovery and minimize environmental impact.

b. Public Education and Engagement: Launching educational campaigns to raise awareness about waste management practices and the importance of recycling can encourage behavior change among residents.

c. Infrastructure Development: Investing in the development of waste collection, segregation, and recycling facilities, as well as sanitary landfills and waste-to-energy plants, is essential for improving waste management infrastructure.

d. Policy and Regulation: Enacting and enforcing regulations related to waste management, including waste segregation, recycling targets, and penalties for illegal dumping, can help create a conducive environment for effective waste management.

e. Public-Private Partnerships: Collaborating with the private sector and engaging communities in waste management initiatives can leverage resources and expertise to improve service delivery and infrastructure development.

The above approaches are met in step by step process:

2.1. Distribution of Tricolor bins: For the effective implementation of Solid Waste Management Rules, 2016, it is the responsibility of producers or generators to segregate waste into three categories wet, dry and hazardous waste [10]. There are 100 wards in the Kadapa city. In each ward there is one Ward Sanitation and Environment Secretary (WSES) supervising the ward Public Health (PH) workers to carryout sanitation work. Kadapa Municipal Corporation (KMC) has started implementing house hold segregation by distributed tricolor dust bins and awareness for behavioral changes. Only after segregation they can hand over the segregated waste to authorized waste collectors or local bodies. Wet waste is biodegradable; dry waste includes plastic, paper, metal, wood among others; and domestic hazardous waste include hospital waste napkins, empty containers of cleaning agents, mosquito repellents, etc. For this Kadapa Municipal Corporation provided tricolor bins green-wet waste, blue-dry waste and red for hazardous waste (Fig 4) for each and every household in the city.

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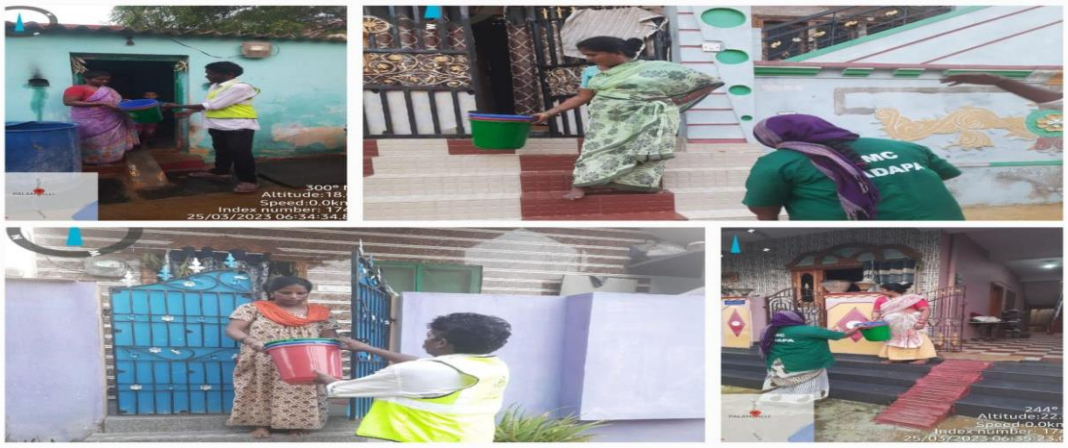

Fig 4: Distribution of three color bins to households by KMC at Kadapa

2.2. Awareness about segregation: IEC activities by WSES,SHG groups and IEC enforcement team to segregate the waste in three different color bins in schools, colleges, house hold clusters, shops, hotels, shopping malls, street venders, markets etc. At every public places in the city by door to door awareness, rally, street play, mike announcement and other activities. Segregation of wet and dry waste awareness activities at schools included Swachhata Ke Do Rang Posters, awareness about wet and dry waste, conducting poster competitions , prize distribution to well performed students (Fig 5).IEC awareness on segregation of wet and dry waste at household level included door to door campaign and rangoli competition for households (Fig 6).

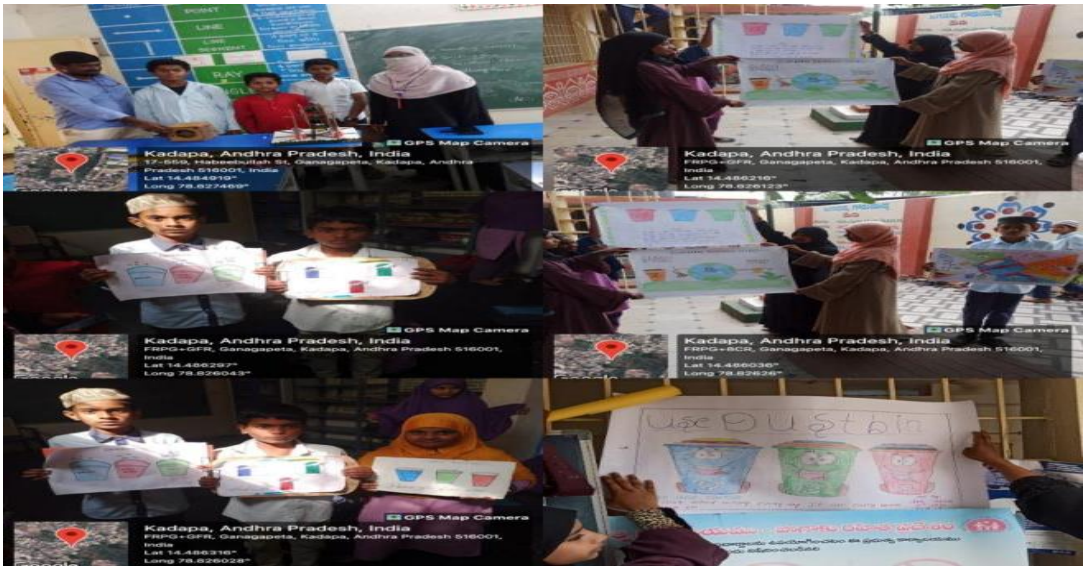

Fig. 5: Segregation of wet and dry waste awareness activities at schools

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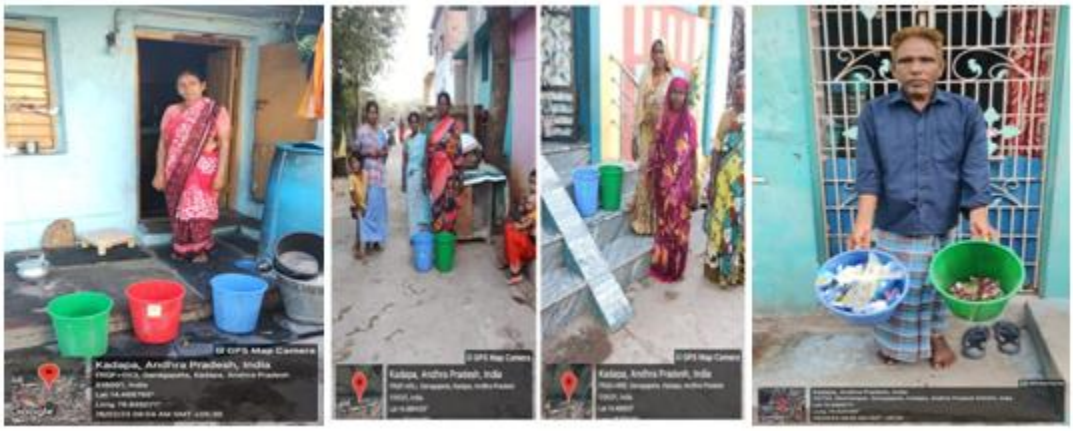

Fig 6: IEC awareness on segregation of wet and dry waste at household level

2.3. Garbage Collection: Municipal workers were trained to collect wet and dry waste separately from each house. To collect the segregated garbage CLAP (Clean Andhra Pradesh) autos are arranged by the government with separate containers for wet and dry waste (Fig 7).

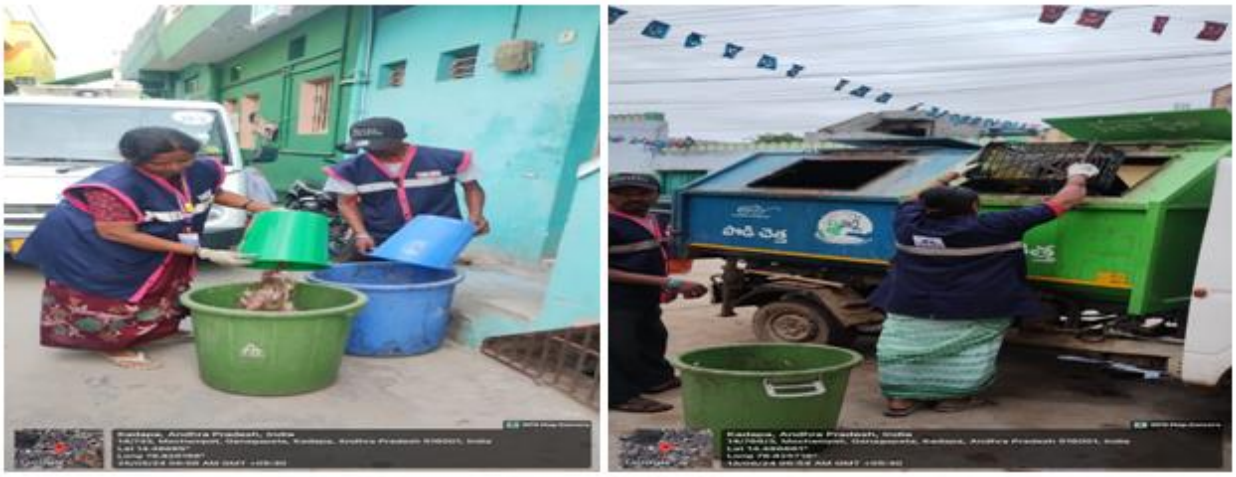

Fig 7: Collection of wet and dry waste by municipal workers

Segregation of waste at generator level is key point in SWM in ULBS (Urban Local Body). To adopt segregation at house hold level in Kadapa, measures have been implemented. KMC also encourages public to reuse the waste materials under the programme. The percentage of segregation at Kadapa town (Table: 1) is to be improved and participation of public is very essential. After collecting door to door the CLAP vehicle transports garbage to respective GTS (Garbage Transfer Station) every day (Fig 8).

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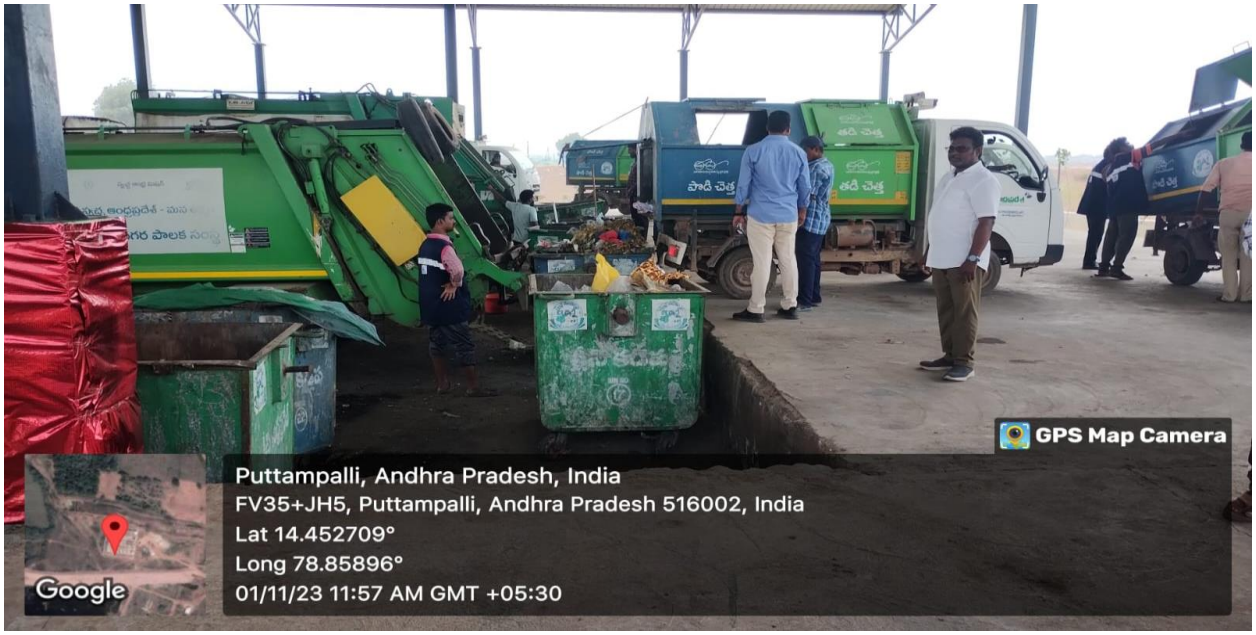

Fig 8: CLAP vehicles at GTS

Hazardous waste like napkins, medicinal and hospital waste discarded in safety manner [11]. However a majority of Kadapa is yet to implement segregation of waste at source, be it household, restaurant or other waste generators. There are three GTS at KADAPA. Weight is measured for every trip and noted (Fig: 9).

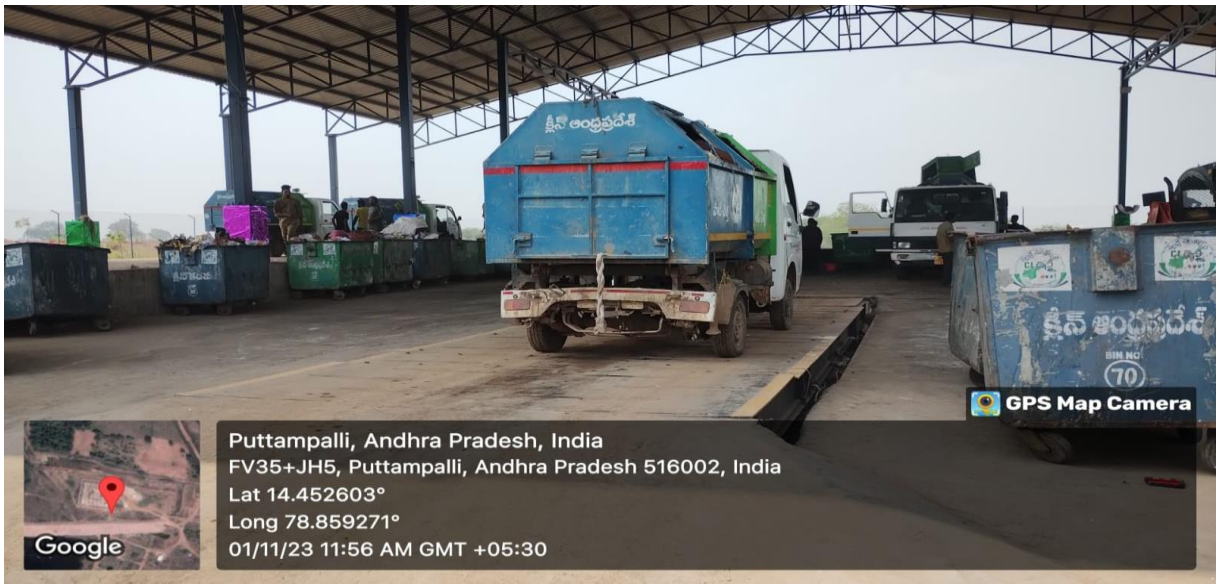

Fig 9: Checking the weight of collected waste at GTS

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Table 1: Segregation percentage at source

zone urban local body	number of wards	number of houses	population	percentage % of segregation	percentage% of segregation aimed	Segregation Standard deviation
East	28	21731	100609	80	100	14.14
South	26	19047	80878	70	100	21.21
North	24	17648	81574	60	80	14.14
West	22	19381	96853	50	80	21.21

Every day, Kadapa Municipal Corporation monitors ward and zone wise trips (Table 2) and weight covered (Table 3) by CLAP garbage autos and analysing the data of trips and weight of garbage collection. As per analysis number of trips must be increased in north zone to reach the target. Every day instructions are given to all the WSES (ward sanitation and environment secretory) for the better improvement of trips and weight of garbage to be collected.

Table 2: Zone Wise Clap Trips Abstract

(1-4-2024 to 20-4-2024 Excluding Sundays)

ZONE	CLAP VEHICLE COUNT	TARGET OF TRIPS	NO OF TRIPS COVERED	PERCENTAGE	Trips Standard Deviation
EAST	28	1456	1364	93.68	65.05
SOUTH	21	1092	1051	96.25	28.99
NORTH	20	1040	862	82.88	125.87
WEST	21	1092	994	91.03	69.30
TOTAL	90	4680	4271	91.26	289.21

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Table 3: Zone wise Garbage Weight and Percentage (1-4-2024 to 20-4-2024 excluding Sunday) (in MT Metric Ton)

Zone	waste generated/day	Target	Achieved	wet waste	percentage	Standard Deviation (20 days)
east	59.27	1007.56	891.7	3.9377	88.50	81.93
south	46.03	782.55	589.76	3.1071	75.36	136.32
north	48.69	827.81	562.09	3.4605	67.90	187.89
west	48.47	823.94	655.67	3.0725	79.58	118.98
total	202.46	3441.86	2699.22	13.5778	78.42	525.13

2.4. Garbage Processing: At GTS stations wet and dry waste are segregated. And sent for processing. The segregation at GTS is carried out manually and also by using the machinery.

2.5. Dry Waste: Dry waste is sent to the Material Recovery Facility (MRF) centres (Fig 10). At MRF dry waste is sorted as paper, cardboards, plastic, glass, electric waste(E-waste),cloths and slippers etc., (fig 11). Useful materials are sent for reuse at orphanage and remaining are sent for recycling.

Fig 10: Material Recovery Facility (MRF)

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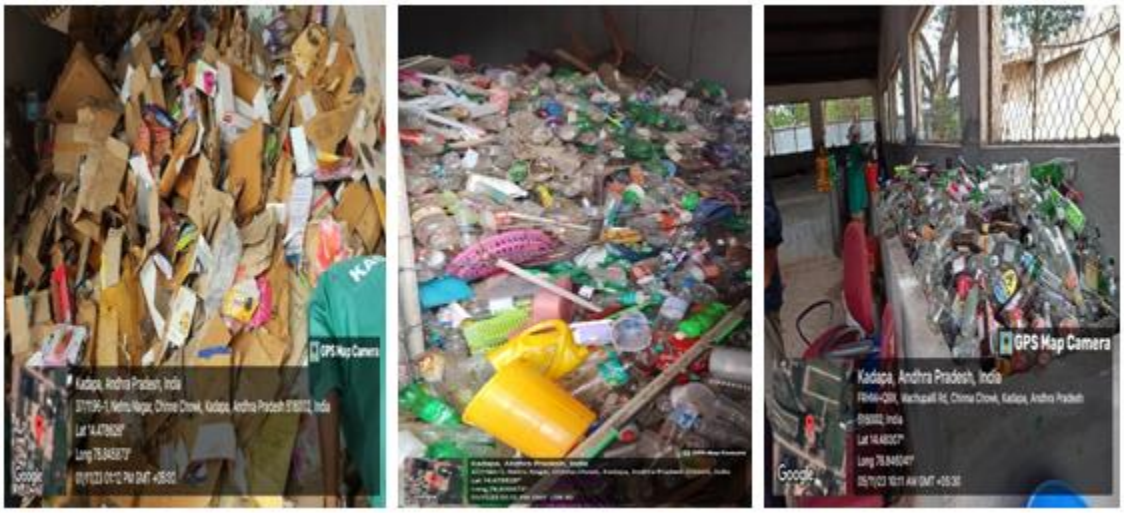

Fig. 11: Dry Waste segregation for processing

2.6. Recycling: Recycling is the recovery and reuse of materials from collected waste. Kadapa municipal corporation MRF centres collaborate with Shakthi plastic industries, where all dry wasteincluding plastic, paper, metal, wood etc. sent to recycling and recycled into different household products like tiles, chairs, benches etc. (Fig 12). And the remaining waste which is not recycled is send to cement factory, used in cement preparation.If we segregate solid waste at source then we can recycle the solid waste very efficiently. In the case of dry waste we can adopt proper recycling methods and waste become usable. De-centralized and individual centric approach is followed to recycle the solid waste. The Municipal Corporation uses the solid waste collected at GTS at various public places prepared by using waste materials.

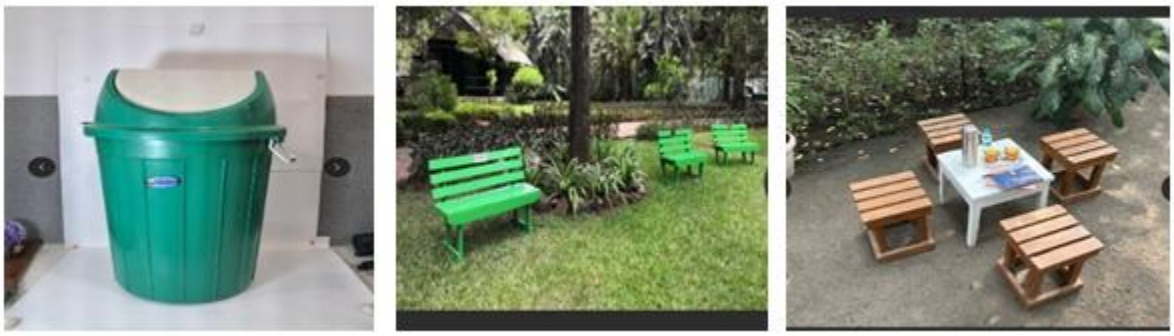

Fig. 12: Items made with Recycled plastic

2.7. Waste to Art: As part of reuse community people are encouraged to do different articles with solid waste generated at home (Fig 13)

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Fig 13: Reusing the solid waste

2.8. Wet waste: Biodegradable organic wet waste like vegetable peels, used tea, Fruits, leftover food etc. is sent to composting center. Composting is economical way of converting organic waste matter in to useful product by maintaining ecological balance. There are two composting centres at Kadapa 1. Ukkayapalli-Vermi and Microcomposting centre (fig 14), 2. Putlampalli-Microcomposting centre. For the preparation of compost waste collected is first sorted for the removal of all non-biodegradable solid waste like plastic metal etc., and biodegradable waste is added in shredder machine to make smaller particles for better decomposition. The shredded wet waste is added to the pits and inoculated with earth warms and EM (Effective Medium: Chlorine free water 90ml + Jaggery 5kg + curd 3 kg) solution is added. Continues aeration is maintained by frequent mixing for 40-45 days and wet waste is converted to compost (15).

Fig. 14: Composting centre

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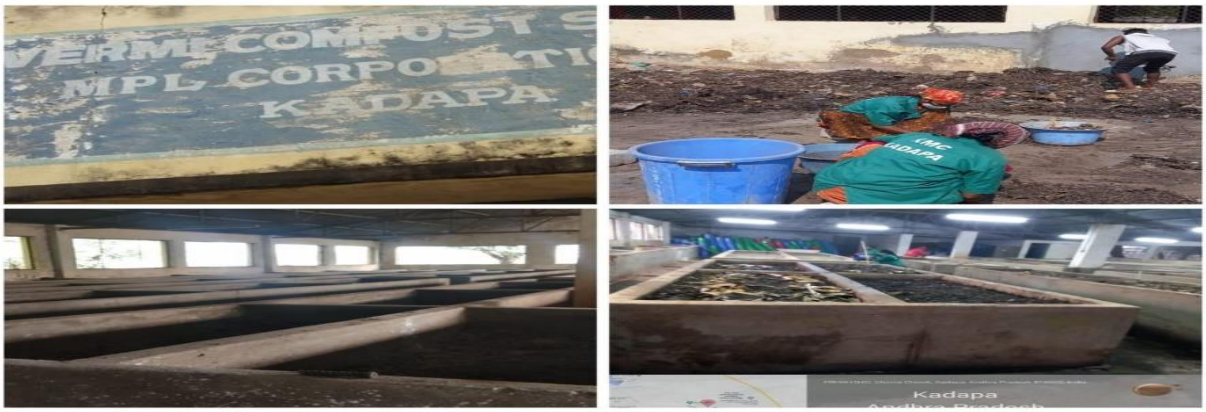

Fig 15: Vermicomposting

2.9. Composting awareness and training: School student visits are encouraged to the GTS and Micro composting center (MCC) to bring awareness on waste segregation at household level and cultivate the habit of waste segregation and disposal (Fig: 16).

Fig. 16: School Student visit to GTS and MCC

Composting training is given at both household and corporate level. By aerobic disintegration organic matter disintegrates by layering with soil and by the activity of soil bacteria, fungi, wet waste converts in to compost. Currently, about 500 houses have started doing home composting by following home composting methods (Fig 17) [12].

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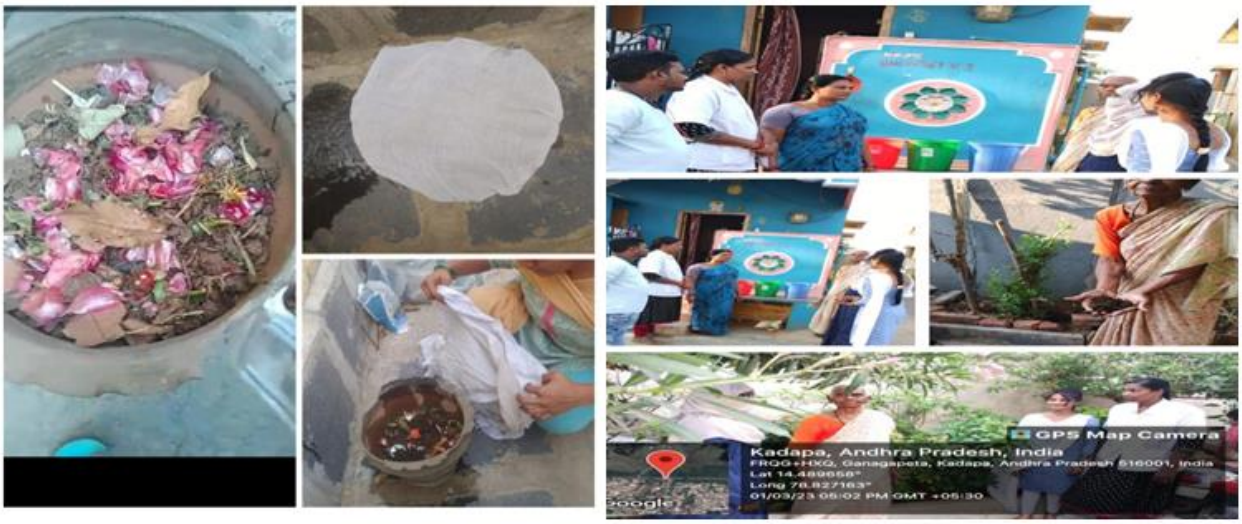

Fig 17: Home composting by households.

2.10. Dumping Yard: Dumping yardsin Kadapa located at Kolumulapalli NH40 Kadapa to Bengaluru highway. About 98 acres of land filled and covered with the waste. Waste sorting is done with latest technology by using machinery Traumer with conveyer belt machine for sorting Legacy waste (Fig 18). After sorting the soil mixed with degraded waste is made in to powder form it can be used as manure.

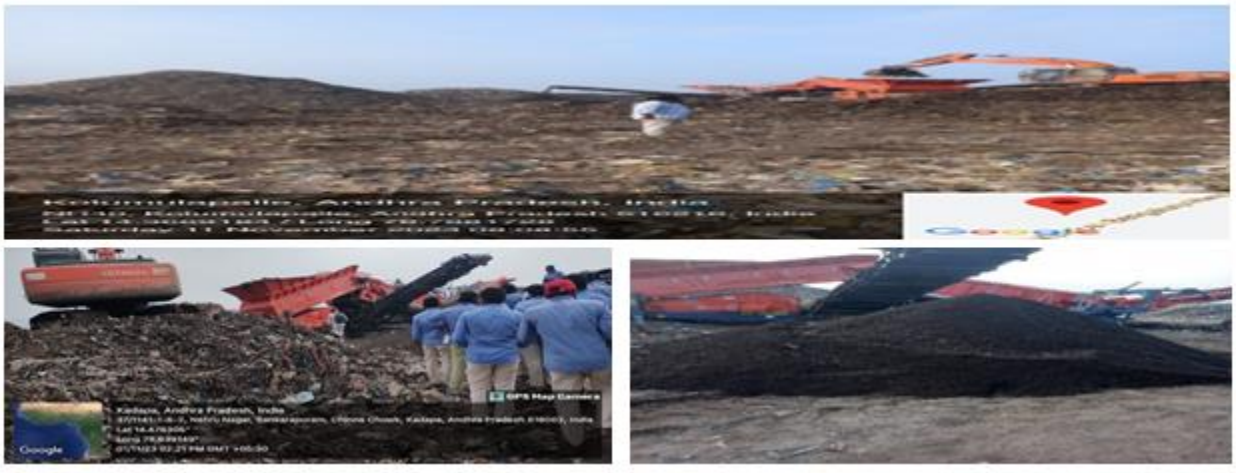

Fig 18: Waste Processing at dumping yard using Traumer with conveyer belt machine

Sorted organic waste is separated (Fig 19). It is processed by following the windrow composting and bioremediation methods. Plastic waste is separated and sentto cement factory [13]. The dumping yards are following cleanliness by doing plantation.

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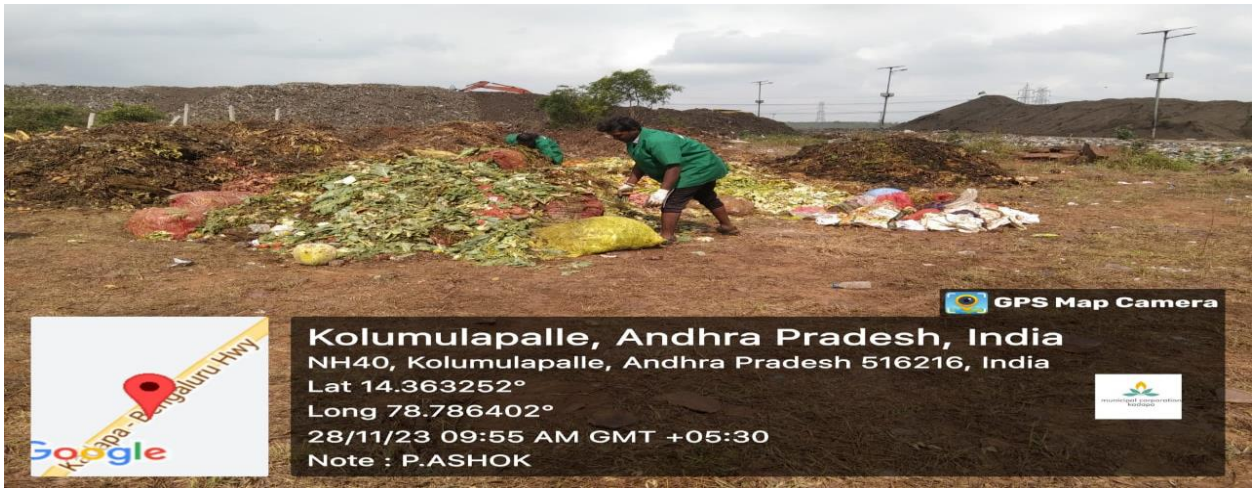

Fig. 19: Organic waste at Dumping Yard

3. DISCUSSION

Effective municipal waste management is vital for several reasons. Improper disposal of waste can lead to pollution of air, water, and soil, endangering ecosystems and human health. Waste management practices such as recycling and proper landfill management help reduce environmental degradation. Accumulation of waste can harbor disease vectors such as rodents and insects, leading to the spread of diseases. Adequate waste management minimizes health risks associated with uncollected garbage and contaminated environments. Many materials in municipal waste, such as paper, plastic, and metals, can be recycled or repurposed. Proper waste management facilitates resource recovery, conserving valuable materials and reducing the strain on natural resources Despite its importance, municipal waste management faces several challenges [14]. Urban population growth leads to increased waste generation, overwhelming existing waste management infrastructure and services [15].Many cities lack sufficient facilities for waste collection, segregation, recycling and disposal. Inadequate infrastructure exacerbates problems such as illegal dumping and uncontrolled land filling. Public awareness about waste segregation, recycling and proper disposal practices is often lacking, hindering efforts to implement effective waste management strategies [16]. Establishing and maintaining waste management infrastructure requires significant investment, which may be challenging for cash-strapped municipalities, particularly in developing countries. Municipal waste management refers to the collection, transportation, recycling, disposal, and monitoring of waste generated by households, businesses, institutions, and other non-industrial sources within a defined municipal area [17]. It encompasses various activities aimed at minimizing the environmental impact of waste while ensuring public health and safety. Now in Kadapa most of the garbage points are

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eliminated completely by Rangoli events, CLEAN KADAPA events conducted to clean the vacant lands with participation of secretaries, sanitation workers and public. The awareness programs conducted resulting in public participation for segregation of waste at generation point it is a good move towards clean Kadapa. Similar reports indicate the positive results by awareness programs [18]. Corporation encourages each ward to be transfer into dust free, garbage free city. Reusable materials collected from dry waste are utilized and recycled accordingly [19]. The wet waste is converted to manure and used for plant growth promotion [20]. Waste management regulations of India can be achieved by following the guidelines and adopting for implementation [21]. The government, authorities, workers and people should work together to get success and result per the local requirements. The progress depends on commitment and long term achievement depends on consistency. The present report is an example how to achieve the gales for environment safety. It is quite alarming as the waste generated is increasing every day and waste land filled with garbage is exponential stage. So it is quite necessary to take immediate steps to save the environment. The same procedure as discussed in the work can be implemented with improvement or changes to apply for other areas in the country as per the local environmental conditions. Improvement in facilities provided to municipal workers and technology improvement and application depends on local government policies. The commitment of authorities and workers can influence the people to orient themselves towards health and hygiene.

4. CONCLUSION

Efficient municipal waste management is essential for promoting sustainable urban development and protecting the environment and public health. By addressing the challenges through integrated approaches, public engagement, and investment in infrastructure, cities can develop robust waste management systems that contribute to cleaner, healthier, and more livable communities. It is imperative for governments, businesses, and communities to work together to achieve effective waste management and build a more sustainable future. The process is continues and it needs lot of effort. This study helps in understanding the effectiveness for implementation at any other place in India.

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REFERENCES

[1] Sahoo KC, Soni R, Kalyanasundaram M, Singh S, Parashar V, Pathak A, Purohit MR, Sabde Y, Stålsby Lundborg C, Sidney Annerstedt K, Atkins S, Rousta K, Diwan V. (2022). Dynamics of Household Waste Segregation Behaviour in Urban Community in Ujjain, India: A Framework Analysis. Int J Environ Res Public Health. 19(12):7321. doi: 10.3390/ijerph19127321.

[2] DegliEsposti A, Magrini C, Bonoli A. (2023) Door-to-door waste collection: A framework for the socio - Economic evaluation and ergonomics optimisation. Waste Manag. 156:130-138. doi: 10.1016/j.wasman.2022.11.024.

[3] Singh S, Vashisht MG, Malik I, Dahiya P, Bhattacharya S. (2022) To study the awareness about solid waste management rules among nursing professionals in a tertiary care hospital in India. J Family Med Prim Care. (6):2417-2422. doi: 10.4103/jfmpc.jfmpc_1150_21.

[4] Kumar S, Smith SR, Fowler G, Velis C, Kumar SJ, Arya S, Rena, Kumar R, Cheeseman C. (2017) Challenges and opportunities associated with waste management in India. R Soc Open Sci. 4(3):160764. doi: 10.1098/rsos.160764.

[5] Njoku PO, Edokpayi JN, Odiyo JO. (2019) Health and Environmental Risks of Residents Living Close to a Landfill: A Case Study of Thohoyandou Landfill, Limpopo Province, South Africa. Int J Environ Res Public Health. 16(12):2125. doi: 10.3390/ijerph16122125.

[6] Hopewell J, Dvorak R, Kosior E. (2009) Plastics recycling: challenges and opportunities. Philos Trans R SocLond B Biol Sci.364(1526):2115-26. doi: 10.1098/rstb.2008.0311.

[7] Wang S, Zhou Z, Tian K. (2022) Environmental awareness and environmental information disclosure: An empirical study based on energy industry. Front Psychol. 13:1038040. doi: 10.3389/fpsyg.2022.1038040.

[8] Kumar S, Smith SR, Fowler G, Velis C, Kumar SJ, Arya S, Rena, Kumar R, Cheeseman C. (2017) Challenges and opportunities associated with waste management in India. R Soc Open Sci. 4(3):160764. doi: 10.1098/rsos.160764.

[9] Kumar A, Thakur AK, Gaurav GK, Klemeš JJ, Sandhwar VK, Pant KK, Kumar R. (2023) A critical review on sustainable hazardous waste management strategies: a step towards a circular economy. Environ SciPollut Res Int. (48):105030-105055. doi: 10.1007/s11356-023-29511-8.

[10] Sahoo KC, Soni R, Kalyanasundaram M, Singh S, Parashar V, Pathak A, Purohit MR, Sabde Y, StålsbyLundborg C, Sidney Annerstedt K, Atkins S, Rousta K, Diwan V.(2022) Dynamics of Household Waste Segregation Behaviour in Urban Community in Ujjain, India: A Framework Analysis. Int J Environ Res Public Health. 19(12):7321. doi: 10.3390/ijerph19127321.

[11] Kumar A, Thakur AK, Gaurav GK, Klemeš JJ, Sandhwar VK, Pant KK, Kumar R. (2023) A critical review on sustainable hazardous waste management strategies: a step towards a circular economy. Environ SciPollut Res Int. (48):105030-105055. doi: 10.1007/s11356-023-29511-8.

[12] Margaritis M, Psarras K, Panaretou V, Thanos AG, Malamis D, Sotiropoulos A. (2018) Improvement of home composting process of food waste using different minerals. Waste Manag. 73:87-100. doi: 10.1016/j.wasman.2017.12.009.

[13] Shanker R, Khan D, Hossain R, Islam MT, Locock K, Ghose A, Sahajwalla V, Schandl H, Dhodapkar R. (2023) Plastic waste recycling: existing Indian scenario and future opportunities. Int J Environ SciTechnol (Tehran);20(5):5895-5912. doi: 10.1007/s13762-022-04079-x.

[14] Pheakdey DV, Quan NV, Khanh TD, Xuan TD.(2022) Challenges and Priorities of Municipal Solid Waste Management in Cambodia. Int J Environ Res Public Health. 19(14):8458. doi: 10.3390/ijerph19148458.

[15] Voukkali I, Papamichael I, Loizia P, Zorpas AA. (2024) Urbanization and solid waste production: prospects and challenges. Environ Sci Pollut Res Int. 31(12):17678-17689. doi: 10.1007/s11356-023-27670-2

[16] Fadhullah, W., Imran, N.I.N., Ismail, S.N.S. *et al.* (2022)Household solid waste management practices and perceptions among residents in the East Coast of Malaysia. *BMC Public Health* **22**, 1. https://doi.org/10.1186/s12889-021-12274-7

[17] Nimita Jebaranjitham J, Selvan Christyraj JD, Prasannan A, Rajagopalan K, Chelladurai KS, Gnanaraja JKJS. (2022) Current scenario of solid waste management techniques and challenges in Covid-19 - A review. 8(7):e09855. doi: 10.1016/j.heliyon.2022.e09855.

[18] Trushna T, Krishnan K, Soni R, Singh S, Kalyanasundaram M, Sidney Annerstedt K, Pathak A, Purohit M, StålsbyLundbog C, Sabde Y, Atkins S, Sahoo KC, Rousta K, Diwan V. (2024) Interventions to promote household waste segregation: A systematic review. Heliyon. 10(2):e24332. doi: 10.1016/j.heliyon.2024.e24332.

[19] Kheirabadi S, Sheikhi A. (2022)Recent advances and challenges in recycling and reusing biomedical materials. CurrOpin Green Sustain Chem. 38:100695. doi: 10.1016/j.cogsc.2022.100695.

[20] Tzortzakis N, Gouma S, Dagianta E, Saridakis C, Papamichalaki M, Goumas D, Manios T. (2012) Use of fertigation and municipal solid waste compost for greenhouse pepper cultivation. ScientificWorldJournal.2012:973193. doi: 10.1100/2012/973193.

[21] Deeksha dave (2022) Journey of waste management regulations in India: A historical account. Int J of Basic and Applied Sciences. 11(4):96-101.

