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Managing Municipal Solid Waste using New Technologies for Phulwarisharif, Patna

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Abstract: ***In India, the rising population combined with rapid urbanization has led to a significant surge in waste generation. This growing volume of waste has placed immense pressure on existing systems, making it essential to adopt efficient, modern, and sustainable waste management practices. Strengthening these systems is crucial not only for maintaining environmental quality but also for protecting public health and ensuring long-term urban sustainability. Due to improper disposal of solid waste particularly by waste management organizations, the collected wastes resembling a hill at dumping site and become a problem for both the environment and for the public. Patna, the capital of Bihar, is among the fastest-growing Indian cities in terms of population density and urbanisation. Patna is currently facing significant challenges in managing its solid waste effectively. The increasing population, rapid urbanization, inadequate waste collection systems, and improper disposal practices have all contributed to growing environmental and public health concerns across the city. This study will analyse the issues related to SWM in Phulwarisharif, Patna and focuses on the effective solutions for recycle municipal solid waste in Phulwarisharif , Patna. This study will discussed proper techniques which help in reduce the amount of waste diverted to landfills by waste to energy approach, thus leading to a zero-waste city.***

Key words: solid waste management, PMC, composition, energy, analysis.

I. INTRODUCTION

Waste are unusable materials or discarded things that no longer has use or they might be old, defective, not reusable, and unwanted. Waste is not only an environmental problem, but also an economic loss. The waste which contains all kinds of hazardous and non-hazardous wastes from different places referred as mixed waste. It contains food waste, plastics, cardboard, meat, blood, diapers, sanitary napkins, metals, stones etc. Because a basic facility of collection of waste from source is not available, this waste lying along the roads, streets, open spaces, drains, water bodies and outside our houses creating insanitary conditions. This waste is also seen being burnt or dumped in the landfills every day. These are resources, not waste.

A. Sources of Waste

1) Domestic waste – It include waste generated from residential areas ,mainly consisting kitchen garbage, wrappers, garden waste, cardboards, papers etc.
2) Industrial waste – This type of waste generated from industrial areas, may contains hazardous chemical. These waste must be disposed off carefully
3) Biomedical Waste- These waste generated from hospitals, nursing home, may contains infected garbage.
4) Agricultural waste- These wastes mainly generated from agricultural activities, containing fertilizer, pesticides etc.
5) Animal Waste- These wastes generated from excreta of animal.
6) Nuclear waste- These wastes generated from radioactive waste.

II. LITERATURE REVIEW

This section helps in identifying existing problems and gaps within the chosen area of study. It compiles relevant data and information related to the research problem while also providing direction for future investigations. An effective review summarizes, evaluates, and clarifies the available literature. Irrelevant works should be excluded, and peripheral studies should be examined critically to determine their usefulness.

Gupta, S. et al. (1998) observed that in the absence of waste segregation practices, recycling has remained to be an informal sector working on outdated technology, but nevertheless thriving owing to waste material availability and market demand of cheaper recycled products [1]. Armijo, C. et.al. (2008)

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The aim of this study was to set the basis for implementation of a recovery, reduction and recycling waste management program at the campus. It was found that the campus Mexicali I produces 1ton of solid wastes per day; more than 65% of these wastes are recyclable or potentially recyclable [2]. Narayana T (2009) observed that the lack of involvement of civil society in the management of municipal solid waste is a major problem. Municipalities should see to it that private participation is made attractive. Awareness campaigns should also be conducted so that the burden of the corporation for proper segregation of waste would be lessened by the participation of the people and recovery at the household or industry level [3].

Shekdar, A. (2009) proposed a multi-pronged integrated approach for improvement that achieves sustainable SWM in the context of national policy and legal frameworks, institutional arrangement, appropriate technology, operational and financial management, and public awareness and participation [4]. Chakrabarti T. et at. (2009) found that shortcomings pertain mainly to inadequate manpower, financial resources, implements, and machinery required for effectively carrying out various activities for MSWM. To overcome the deficiencies in the existing MSWM systems, an indicative action plan has been presented incorporating strategies and guidelines [5]. Grossmann D. et.al (2012) concluded that the solid waste generation and composition in Freetown was significantly affected by average family size, employment status, monthly income, and number of room(s) occupied by households [6]. Katiyar, R.B. et. al (2013) found that inappropriate bin locations and poorly designed community bins, collection vehicles that are in poor condition, inadequate labour for collection and transport of waste, and lack of waste treatment and disposal facilities were major problems in Bhopal. Thirteen samples were characterized physico-chemically and their promixate, ultimate analyses and calorific value were done in the laboratory. MSW in Bhopal has high moisture content and low calorific value, making aerobic composting the best treatment strategy [7]. Kaushal R. K. et al. (2014) attempted study on the changing trends of quantity and characteristics of MSW to find its impact on the performance and capacity planning of recovery/recycle, compost, incineration and landfill facilities [8]. Ravindra K.et al.(2014) suggested that the new frameworks should be framed focusing mainly on the properly design integrated waste management system as suggested with high recovery rates, cost-effectiveness, reducing the carbon emissions and other environmental impacts. Further, an attempt should be made by the stakeholders to formally organize the informal recycling activities [9].

Rana R. et al. (2015) concluded that the Chandigarh city produces about 370 tons/day of solid waste. Inadequate solid waste collection and mixed waste fractions are the major problems being experienced by the Chandigarh Municipal Corporation. It was suggested that daily door-to-door collection of waste would be done [10]. Dawane P.S. et al. (2015) concluded that the waste management system should adopt Proper collection, storage, processing, transport & disposal of waste so that the impacts of waste can be minimised & the quality of life can be improved [11]. Keisham S. et al. (2015) This analysis suggests a number of priority actions to move towards an increasingly integrated and sustainable MSWM system in India: During segregation of MSW, the collection of organic waste, which comprises 60% wt. of MSW, for either composting or anaerobic digestion should be encouraged, Increasing recycling rates and maximizing diversion of waste from landfill disposal, by introducing effective schemes to integrate both NGOs and the formal and local sectors into MSWM practices and to raise public awareness on the importance of recycling[12]. Zaman A. U. (2015) observed that zero waste is a holistic approach to tackling waste problems in the twenty-first century. Based on the review of the literature, this study concludes that zero waste is still in development [13]. Pandey B. et al. (2016) concluded that municipal solid waste is as a potential source of renewable energy that can be extracted from municipal solid waste to fulfil the energy demands several times of Bhopal city [14]. Esmaeilian B. et al. (2018) highlighted shortcomings of existing waste management practices and proposed a conceptual framework for a centralized waste management system. The proposed framework highlights the value of product lifecycle data in reducing waste and enhancing waste recovery and the need for connecting waste management practices to the whole product lifecycle [15].

Ghosh, A. et. al (2018) found that the selection of technology quite depends on the composition of the OFMSW. In this study, the existing OFMSW technologies in India were examined. Case-study approach was taken for this purpose along with some published secondary reports. Based on the findings, a sustainable framework has also been proposed, implementation of which may result in better waste management [16]. Parvez N. et al. (2018) investigated the issues related to SWM at IITR (Indian Institute of Technology Roorkee) campus and provide feasible solutions to be implemented at IITR campus for becoming zero waste campus. This paper identifies a need to implement a robust SWM at the IITR campus in India [17]. Das S. et. al (2019) provides an overview of a wide range of existing SWM strategies with the following key objectives: (i) to comprehensively describe current technologies, strategic innovations, and monitoring tools, (ii) to provide an overview of prevailing waste management scenarios across different countries, (iii) to identify the roles of life cycle assessment (LCA) and other modeling tools in SWM, and (iv) to showcase feasible approaches for sustainable recycling and utilization of solid wastes [18].

Singh A. (2019) concluded that the efficiency of waste management system can be maximized by the proper use of these optimization techniques. The analysis also revealed that the fuzzy-stochastic method was increasingly used for dealing with the waste management system uncertainty in recent times. This paper gives an overview of dealing with the uncertainty problems of waste disposal in urban areas [19]. Jha D.et.al (2020) reported that the Patna M.C. is just transporting the waste instead of managing it. The analysis also revealed that residents are throwing garbage mostly in door-to-door collection without segregation shown. The author also visited dumping location and indicates that Patna municipality is currently dumping the waste in a Ramchak Bairia site without segregating at the secondary level [20]. Kumar. R. et. al (2021) reported that allowing the current situation of waste management to persist will lead to a rapid deterioration in quality of life and environmental sustainability. We must act now to preserve the world for future, for human beings and help the poor to live a better life. Higher Education Institutions like NITTTR can act as a model for Solid Waste Management (SWM) in order to develop a framework for sustainable development in future [21]. Bedi Y.et.al (2023) reported that addressing water scarcity and waste management challenges is of utmost Importance for campuses in India. Embracing the principles of Zero Liquid and Solid Waste offers a pathway to sustainable practices, promoting water conservation, efficient usage, and responsible waste management. This study involves a comprehensive investigation into the prevalent practices of liquid and solid waste generation and management in campus buildings [22].

III. ADOPTED METHDOLOGY

The objective of this paper is to investigate the present waste management practices in Phulwarisharif, Patna, find out the composition of solid waste and investigate the main problem in segregation of the solid waste. Data were collected through questionnaires and interviews. A comprehensive investigation carried out on collection and disposing process of existing municipal solid waste (MSW) management system. MSW were analysed to determine the composition of waste generated in Phulwarisharif, Patna. Based on the findings, appropriate new technologies for improving MSW management were also recommended. The main objective of present study is to suggest suitable interventional measures and effective plant model to use instant mixed municipal solid waste treatment technology.

IV. DATA COLLECTION AND DISCUSSIONS

The Patna Municipal Corporation (PMC) is the civic body that governs Patna, the capital of Bihar. Patna Municipal Corporation is headed by a mayor and administers the city's infrastructure, public services, and supplies. On 15th August 1952 , Patna Municipal Corporation was established, in accordance with The Patna Municipal Corporation Act, 1951, published in the Bihar Gazettes (source: PMC website). Patna Municipal Corporation is governing body of the city of Patna. PMC managed the works of Patna by dividing city into six circles. These circles are New Capital Circle, Patliputra Circle, Kankarbagh Circle, Bankipur Circle, Azimabad Circle and Patna City Circle. As per details received from PMC office, Total waste generated in PMC is approx. 950 TPD, while quantity of solid waste disposed in secondary dumpsite, Gardanibagh is about 200 TPD.

In PMC, waste-transport vehicles often run overloaded, leading to issues such as garbage spillage, soil contamination, foul odor, and general nuisance along transportation routes. The problem becomes more severe during the monsoon, as leachate drips continuously from the vehicles while transporting waste to the dumping site. When garbage thrown on the streets and not removed regularly, it decomposes and produces unpleasant smells, further worsening the surroundings. It is observed that maximum part of waste is from food and fruit waste, obtained from residential areas i.e. around 42-47% of the waste. This means a higher proportion biodegradable waste. According to the CPCB survey Report, trend of waste generation in Indian cities can be easily interpret. Figure no 1 shows comparative chart on Solid Waste Generation trend in metropolitan cities like Delhi, Mumbai, Bangalore Patna.

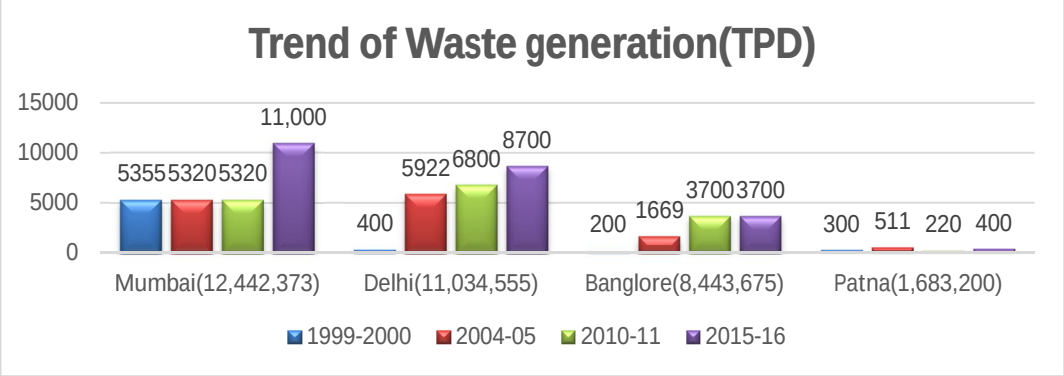


Figure No. 1 Trend of Waste Generation as per CPCB survey report

As per NEERI survey report (2004-05), Characterization of waste in Patna reported as compostables 51.96 % and recyclables 12.57 %. It indicates that major portion of waste is bio-degradable, which shows composting of waste can be easily implemented. Figure 4.3 shows the composition of waste in Patna.

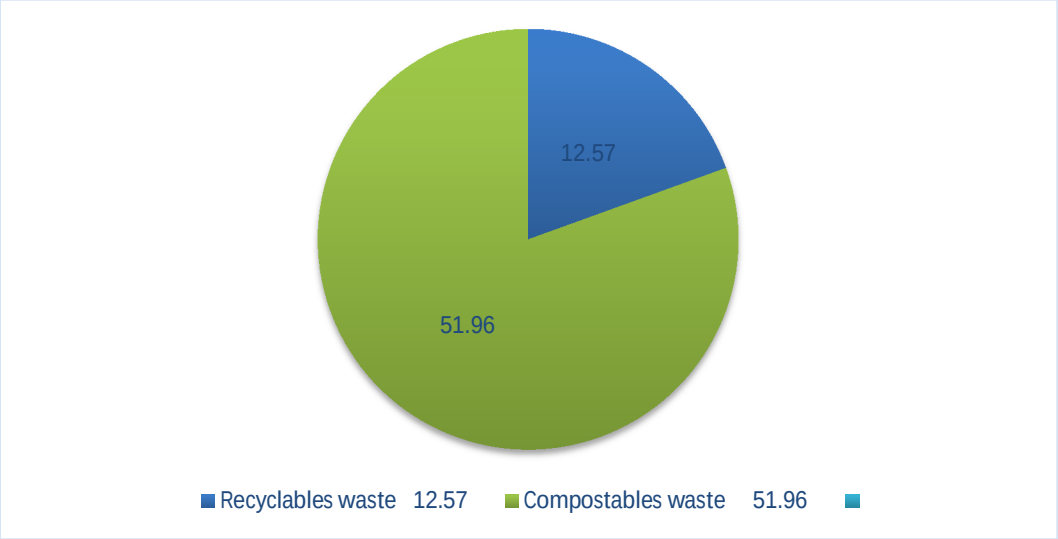
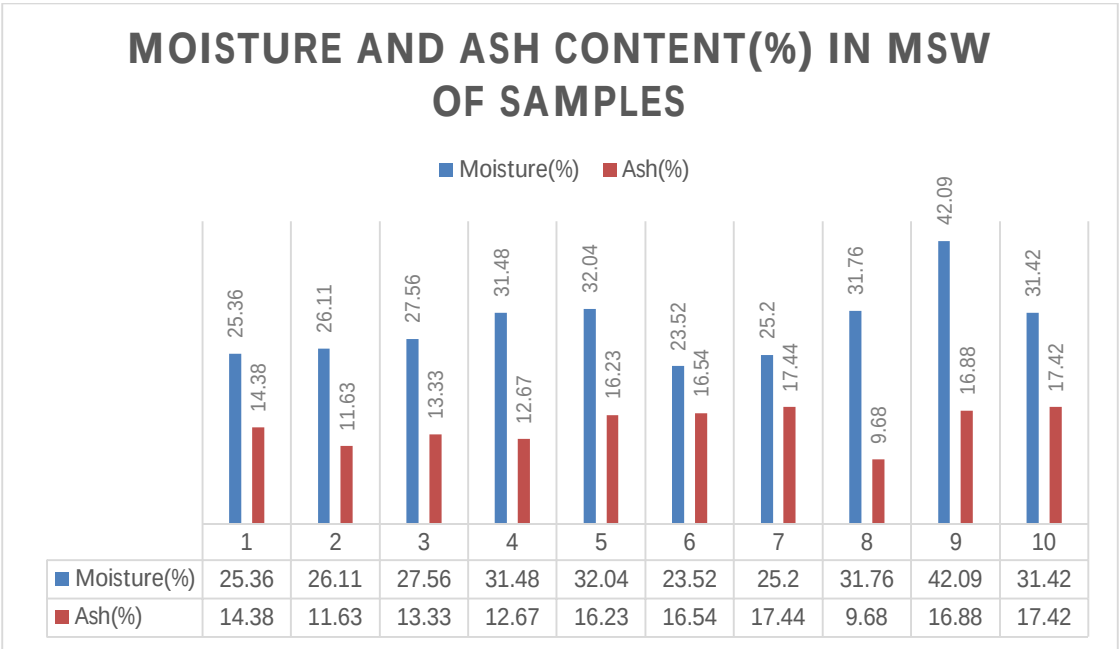


Figure No. 2 Percentage of compostables and recyclables of waste in Patna

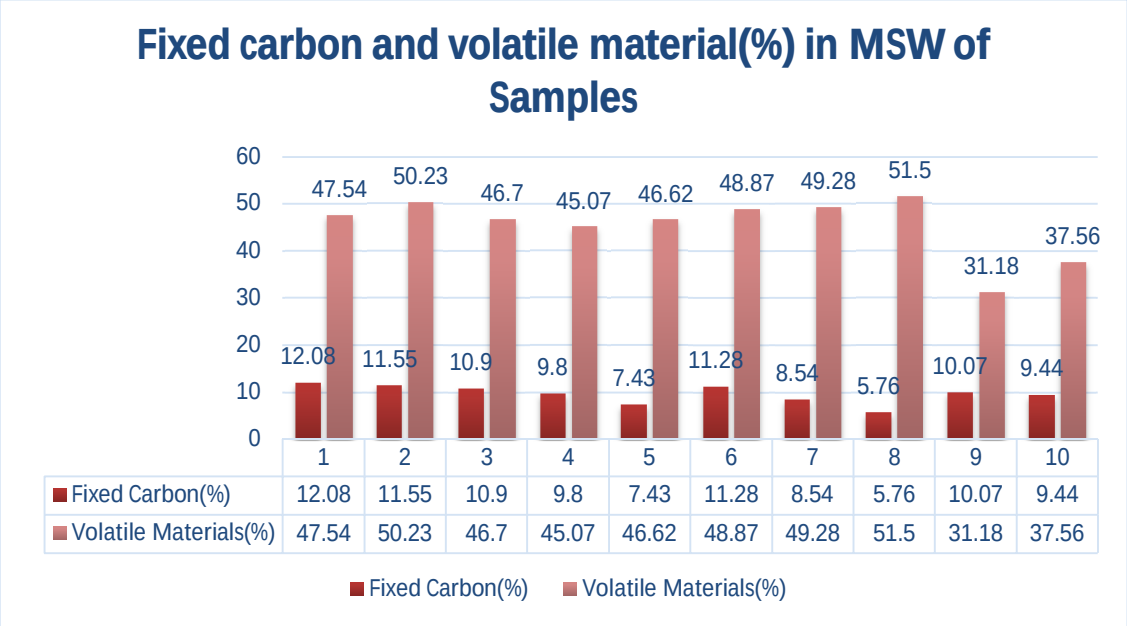
Samples were collected from various places such as residential areas, institutional areas, gardens, vegetables markets, Secondary Garbage Point, Gardanibagh and Ramchak-Bairiya dumping ground. Samples of 100 g were taken in three sample and dried in an oven at 105 °C for 24 h to a constant weight, cooled down with the help of desiccator, and then weight was recorded. Bomb calorimeter was used to find out calorific value in the laboratory, which provides calorific value of each sample. This density of samples is at the source. The data shows that the density of MSW is ranges between 256 kg/ m^3 – 420 kg/ m^3 kg. It can be seen that Lower calorific value of SWM is around of residential area is around 2200 kcal/kg and Higher Calorific value is around 2400 kcal/ kg.



	1	2	3	4	5	6	7	8	9	10
Moisture(%)	25.36	26.11	27.56	31.48	32.04	23.52	25.2	31.76	42.09	31.42
Ash(%)	14.38	11.63	13.33	12.67	16.23	16.54	17.44	9.68	16.88	17.42

Note: All the values are in percentage on dry weight basis.

Figure No. 3 Percentage of Moisture and Ash content in MSW in Patna



Note: All the values are in percentage on dry weight basis.

Figure No. 4 Percentage of Fixed carbon and Volatile Materials in MSW in Patna

Ultimate analysis of MSW collected from Phulwarisharif shows that Carbon – Nitrogen Ratio ranges between 19.58- 36.29 %, hydrogen ranges between 5.23-7.7% , Oxygen ranges between 40.43- 53.2 %. Average Value of Potash is 0.882%, average value of Phosphorous is 0.954 %. Figure No. 3 illustrate the percentage of Moisture and Ash content in MSW in Patna. Average Value of moisture content is 29.6 %. Average Value Of Ash content is 14.62%. Figure No. 4 shows the percentage of fixed carbon and volatile material in MSW.

V. RECOMMENDATION

In recent years, innovative waste management solutions have gained significant momentum, turning environmental challenges into opportunities for sustainable growth and resource efficiency. 10 TPD Municipal Waste Management project represents an ideal solution for small towns or Nagar Panchayats seeking sustainable waste management. Some technology of zero waste solutions is described here:

1) Dross Management Systems & Energy Solutions Pvt. Ltd. is a startup company in the field of environmental engineering with the innovative technology of scientifically disposing of Municipal Solid Waste. They designed, developed and manufactured "DROSS-MAGIC" machine, which is an instant un-sorted mixed solid waste disposal machine. Figure no. 5 describes briefly the process of pelletizing in DROSS Magic Machine.

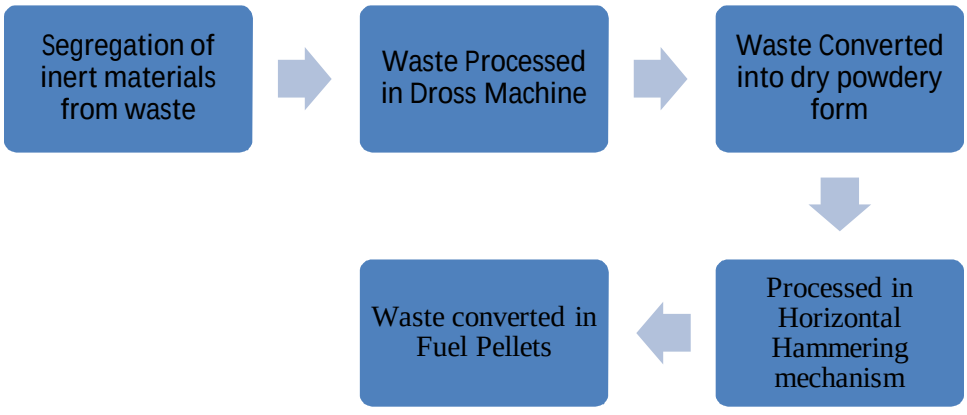


Figure No 5 - Process of Pelletizing in DROSS Magic Machine

2) GEW, Buxar is providing comprehensive systems that convert municipal solid waste into valuable resources like thermal and electrical energy, creating both environmental and economic benefits. Based on a zero landfill, decentralized model, this system transforms urban waste into energy and reusable products using our cutting-edge technologies. Figure no. 6 shows the process of Power generation at GEW Plant.

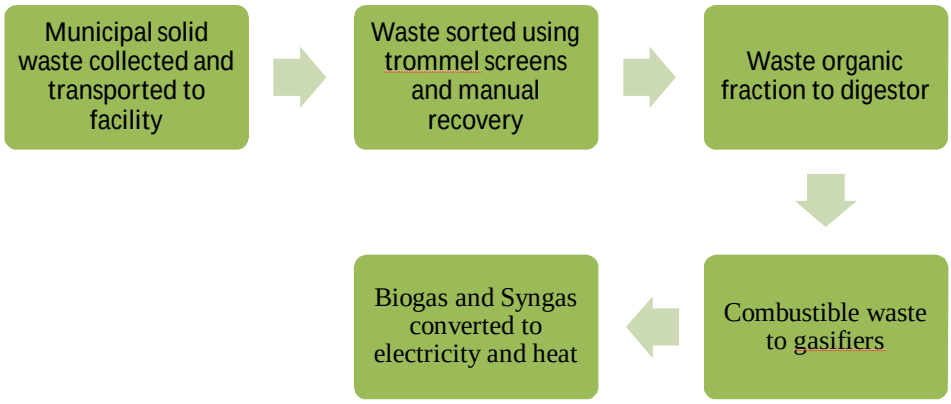


Figure No. 6- Process of Power Generation at GEW Plant

VI. CONCLUSION

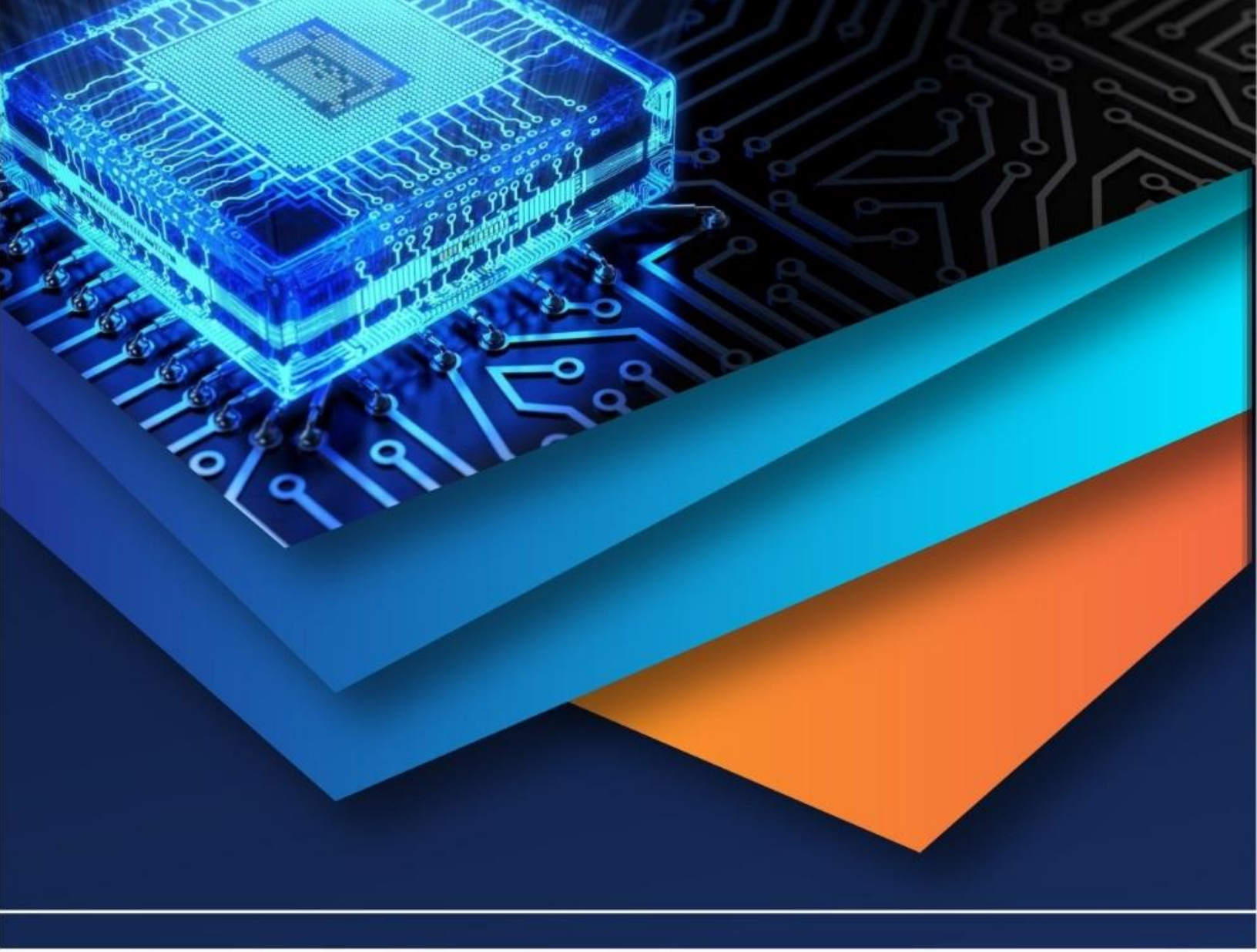
The generation of total solid waste in PMC is about 950 TPD, which is presently a part of the Municipal Solid Waste, can be well managed by a simple approach "waste to resource approach". This may reduce the pressure on the resources as well as landfill. Storage systems are inadequate, and the available vehicles are outdated and frequently require maintenance. Additional budget allocation is needed to keep them operational. The existing static container system needs replacement, as several community dustbins are in poor condition and many disposal sites are not situated in suitable locations. Community landfills need to be eliminated and one or more new pilot disposal sites need to be developed appropriately with treatment and engineered processing facilities for developing a zero-landfill policy. The nature of the wastes indicates that pelletizing would be the most appropriate method and provide solid fuel pellets that can be used as solid fuels in furnaces and boilers. MMSW can be converted into RDF pellets. By testing the calorific value of the fuel pellets, it is observed that the gross calorific value of the fuel pellets is about 4450.18 kcal/kg so can be used as an alternative fuel and is a cheaper alternative of the fossil fuel by providing them with a cleaner and sustainable solution. The nature of the wastes also indicates that obtaining biomass and syngas would be an alternate option for generation of heat and electricity.

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