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Study on Solid Waste Management System in Rangpur City Corporation (RpCC) and Suggestion for improving the System Using LEAN Tools

Samiun Alam, Md. Firoz Kabir, Md. Julfikar Khan Tasin, Taiyaba Islam Toma, & Md. Abdullah al-Amin

Abstract

A healthy urban environment depends heavily on effective waste management. Recently, a large number of city/urban areas have sprung up in Bangladesh, where daily production of solid waste is rather high. Rangpur City Corporation (RpCC) is a recently built city with 33 wards in the northern region of Bangladesh. Only 15 of them out of the total practice solid waste management. The essential area of RpCC is covered by these 15 wards. This study aims to detail the solid waste management procedure as well as the current state of various garbage dumping locations inside the research region. In order to evaluate and keep track of the trash dumping places, the primary data was directly gathered via field survey in order to assess and monitor the waste dumping points. Besides, additional data/information were collected from books, journal, and websites. This study suggests the lean tool kanban and visual management to keep the solid waste management process standard and keep on the road of continuous improvement. Kanban is very helpful to avoid breakdown of solid waste management process. On the other hand, visual management also can take a part to make the solid waste management easier and more helpful to avoid any fault in this process by its implementation.

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1.0 Introduction

Solid waste encompasses unwanted materials resulting from human and animal activities related to material creation and consumption. The discipline of solid waste management aims to regulate the entire process of waste, including generation, storage, collection, transportation, processing, and disposal, in alignment with standards of public health, economics, engineering, aesthetics, and environmental considerations. This discipline also prioritizes public opinion, emphasizing responsible practices. Notably, solid waste management has emerged as a significant and complex challenge, particularly in rapidly urbanizing, industrializing, and populous metropolitan areas, often found in emerging nations. An effective method to tackle solid waste management is the recycling of municipal solid waste (MSW), which has proven to be a viable and favorable approach. Recycling involves repurposing waste, either into new substances or back into their original materials. This practice holds economic, social, and environmental advantages. The research site for this study was the territory of Rangpur City Corporation (RpCC), where solid waste management encompasses a range of tasks, including administrative, financial, legal, planning, and engineering responsibilities. This multidimensional field requires intricate interdisciplinary connections across domains such as engineering, political science, urban planning, geography, economics, public health, sociology, demography, communications, and conservation.

In northern Bangladesh, a recent metropolis named Rangpur City Corporation has emerged, demanding meticulous waste management strategies to ensure its sustainability and healthiness. The city's rapid economic expansion due to urbanization and industrialization has led to increased migration from rural to urban areas, resulting in heightened standards of living. However, the growing population generates substantial volumes of waste, posing risks to both the environment and human health. While it's challenging to completely eliminate waste due to its inherent connection with human activities, minimizing its impact remains crucial.

The term "solid waste" encompasses various sources, classifications, compositions, and properties of waste. While certain materials might hold value in different contexts, they often lose their significance to possessors seeking to dispose of them. Food waste, for instance, consists of remnants from animals, fruits, and vegetables after being handled, prepared, cooked, and consumed. The distinctive characteristic of these remains lies in their rapid decay, especially pronounced in warmer climates. This rapid decomposition gives rise to unpleasant odors and underscores the urgency of managing food waste efficiently.

This decomposition process often gives rise to offensive odors (Moniruzzaman et al., 2011; Halder et al., 2014). Rubbish encompasses both combustible and noncombustible solid refuse generated by households, institutions, commercial enterprises, etc., excluding food waste and other highly perishable materials. Combustible rubbish typically comprises materials like paper, cardboard, plastics, textiles, rubber, leather, wood, furniture, and garden trimmings. In contrast, non-combustible rubbish consists of items such as glass, ceramics, tin cans, and aluminum cans, as well as ferrous and nonferrous metals, along with soil (Moniruzzaman et al., 2011; Halder et al., 2014).

Materials that remain after burning wood, coal, coke, and other combustible wastes for heating, cooking, and waste disposal in homes, businesses, institutions, and industrial or municipal facilities are classified as ashes and residues, excluding residues from power plants. Ashes and residues typically comprise finely powdered substances, cinders, clinkers, and small quantities

of partially burned materials. Residues from municipal incinerators also contain items such as glass, ceramics, and various metals.

Wastes from razed buildings and other structures are classified as demolition wastes (Moniruzzaman et.al. 2011; Halder et.al. 2014). Wastes from the construction, remodeling, and repairing of individual residences, commercial building, and other structures are classified as construction wastes. These wastes are often classified as rubbish (Moniruzzaman et.al., 2011; Halder et.al., 2014). Wastes such as street sweeping, roadside litter, litter from municipal litter containers, catch-basin debris, dead animals, and abandoned vehicles are classifies as special wastes (Moniruzzaman et.al., 2011; Halder et.al., 2014).The solid and semisolid wastes from water, wastewater, and industrial waste treatment facilities are included in this classification. The specific characteristics of these materials vary, depending on the nature of the treatment process (Moniruzzaman et.al., 2011; Halder et.al., 2014). Wastes are residues resulting from diver's agricultural activities – such as the planting and harvesting of row, field, and tree and vine crops, the production of milk, the production of animals for slaughter, and the operation of feedlots – are collectively called agricultural wastes (Moniruzzaman et.al., 2011; Halder et.al., 2014). Wastes that possess chemical, biological, flammable, explosive, or radioactive attributes capable of causing significant and immediate harm to human, plant, or animal life fall under the hazardous waste classification. Such materials are commonly encountered in liquid form, although they can also manifest as gases, solids, or sludges. Regardless of their state, the management and disposal of these wastes demand meticulous attention and precautionary measures (Moniruzzaman et al., 2011; Halder et al., 2014).

Information on the properties of solid wastes is important in evaluating alternative equipment needs, systems, management programs, and plans, especially with respect to the implementation of disposal and resource and energy recovery options. The properties of solid wastes are the physical and chemical composition of solid wastes. These properties depend upon the source of generation, the location of the source, the season, economic conditions, types of wastes, and many other factors.

2.0 Literature review:

In their first part of the work Halder et.al (2014) gathered data and calculated average MSW generation per capita is 0.40kg/person/day, which is close to many developing countries. In the second stage of their work, they used low calorific value and high moisture content characteristics to determine suitable options and energy recovery from solid waste management shown in the improved system. Approximately 4.482MWh/day electrical energy is found in the waste. In conclusion, they suggested installing a 5-10MW power plant based on the present waste generation from Rajshahi City Corporation to produce electricity and reduce the adverse impact of solid waste on the environment.

Moniruzzaman et.al. (2011) found that waste collectors were the first link in a long chain of recycling of solid waste. In the initial stage of their study, they identified many individual waste collectors and dealers who have been performing recycling activities as a source of income for a long time in Bangladesh. In their research work, a traditional recycling practice of solid waste was investigated and analyzed in the Khulna city of Bangladesh. Their study exposed that 7.2 % (37.23 tons/day) of the total generated waste or 53.2 % of the recyclable solid waste (RSW) was recycled daily in Khulna. In their study they proposed three models to evaluate the possibility of organizing the unorganized waste recycling practice and they found the third model seems to be feasible both economically and socially. According to their study, approximately 2000 waste collectors are involved in collecting 34 tons/day of RSW and selling

it to dealers. A total of 450 dealers are involved in the recycling process. Dealers are categorized as Small-Scale Recycling Dealers (SSRDs), Medium Scale Recycling Dealers (MSRDs) and Large-Scale Recycling Dealers (LSRDs). The authors of this paper showed in their work that it is possible to organize the recycling activity so that waste collectors can lead a secure and better life.

Sarker and Rahman (2018) discovered throughout their research that Rangpur City Corporation's (RpCC) waste management procedures are not up to the standards of a city corporation. There are generally four main sources from which solid waste is produced, according to their research, which they found in RpCC. House or dwelling, institution or organization, industry or mill, and open roadway are among them. The quantity of rubbish discarded improperly and in significant quantities in dustbins was also found. Following their collection by sweepers at the closest disposal sites, those items were then picked up by truck and deposited at a central disposal site. Their research methodology outlines the many actions that were taken in order to get the desired results. In order to complete the literature survey, they used both primary and secondary data/information; the former was gathered directly from RpCC's cleaners, the conservancy department, and community service providers, as well as from an open group discussion. The latter was gathered from various journal articles.

To see the actual perspective of the dumping locations, the study's authors conducted a GPS survey. The data mentioned above were then studied in the next step of their work to comprehend the actual pictures of the waste management process within the research region. According to organizational features in Rangpur City Corporation, there are 140 hospitals and clinics for city inhabitants, 7 katcha bazars (4 pucca and 3 katcha), and roughly 236 garbage collection locations in this city. To oversee all executive orders, there is a chief executive officer and a mayor of the city. 573 persons are employed directly and indirectly in this agency to handle the city's trash. Although there are some organized procedures for garbage collection and disposal in the various wards, the overall waste management process is hampered by a shortage of people and technical waste collecting and disposal equipment. Using the mean value over a number of days, they determined the quantity of trash. According to waste density studies, the middle-income group produces the most household trash (0.243 kg/cap/day) when compared to other income categories. However, there is hardly any variation in the rate of waste produced between the high- and middle-income groups. Residential waste density ranges from 302 kg/m3 to 325 kg/m3. Due to the high population density, the low-income group's waste density has been determined to be the greatest among the three residential income categories. On the other hand, market garbage has been shown to have a density that is nearly twice as high as domestic waste (569.44 and 583.33 kg/m3). They then examined garbage dumping locations in RpCC. Their research indicates that the majority of the RpCC is not included in the waste management system and that there are not enough dustbins or main garbage collection points. The survey also revealed that the Rangpur City Corporation (RpCC) lacks a formal trash management monitoring mechanism. Therefore, they recommended using Geographic Information System (GIS) as a useful tool to track the waste management scenario. A comprehensive database may be created using a GIS application to track the state of various trash dumping and collection locations. This tool can also recommend additional secondary and central disposal places. For proper monitoring and management developing and updating a complete GIS database on waste dumping points could be a new approach to waste management in the context of Bangladesh.

Mian et.al. (2012) said that their study mainly focused on the status of solid waste management practice in Mymensingh Municipal area usually in ward no 04 and 06. Their study identifies the lacking of waste management. In their study both qualitative and quantitative data were collected through direct field observation of the study area, focus group discussion with the

stakeholders, and secondary information was also collected for proper documentation, like research articles, books, and periodicals. At the initial stage, the primary data was collected through a questionnaire survey and secondary data was collected from Mymensingh municipality. Then data was classified according to the contents. From the survey, authors found that the solid waste management in Mymensingh municipal area appeared to be inadequate and it should be improved. They suggested that solid waste should be disposed off scientifically through sanitary landfill and recycling. Also, higher priority needs to be assigned to the management of municipal solid waste by the local authority and a systematic approach needs to be adopted for optimizing the entire operation of solid waste management encompassing segregation at source, timely and proper collection, transportation routes, and types of vehicles and development and proper operation of a sanitary landfill site.

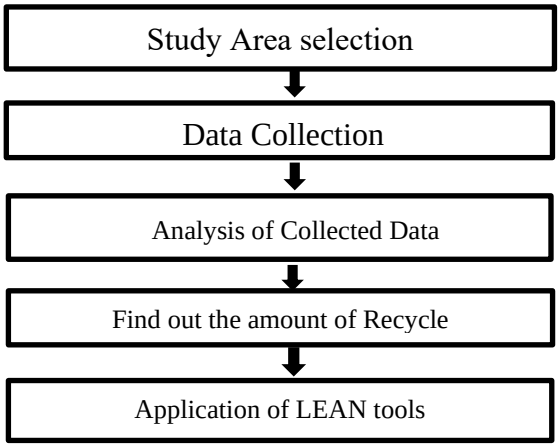
2.1 Summary of the Review

The full process of gathering, processing, and discarding solid wastes is referred to as "solid waste management". The trash is gathered from various sources and disposed of throughout the waste management process. The collection, transportation, treatment, analysis, and disposal of waste are all part of this process. Based on the benefits and limits mentioned by the many researchers, the literature review, the processing approaches, and debates.

2.2 Research Gap Analysis

A key reason for concern is the astronomically massive amounts of garbage that are either improperly handled or go uncontrolled, as well as the rising amounts of waste produced globally. If waste management procedures continue to advance at their current rate, the negative effects of inefficient waste management will probably not be sufficiently mitigated. Based on the anticipated expansion in trash creation, the difference between the garbage that is now created and the waste that is effectively handled would widen further under a "business as usual" situation. Simply maintaining the current situation will require significant investment and development assistance. It will be necessary to significantly increase investment and support programs to scale up waste collection, disposal, and treatment capacity to both cover rising waste generation and gradually close the existing service gap in order to improve public health and environmental conditions locally and globally. The scope of present environmental problems would significantly expand without a significant improvement in waste recovery and disposal procedures as well as garbage collection coverage.

3.0 METHODOLOGY



Research Methodology

3.1 Study Area Selection

Rangpur City Corporation (RpCC) is one of the twelve City Corporations in Bangladesh and is located in the Rangpur division, northern region of the country. The geographical coordinates of Rangpur City Corporation are 25.56° North and 89.25° east. It is newly added city corporation of Bangladesh in Rangpur that's why there is no proper management of solid wastage. The population of RpCC increases day by day thats why the amount of solid waste increases day by day. Because of poor management of solid waste, RpCC will going noted as a polluted city. It is high time to solve this problem and make a proper model to manage solid waste in Rangpur City Corporation. It can make the city life healthy. The area of RpCC is 205.76 square kilometers and this area in need to manage its solid waste properly. That's why it is selected as our study area**. Figure-1** shows the map of RpCC.

Figure 1: Map of Rangpur City Corporation

3.2 Data Collection

We pay a visit to get a clear scenario of the solid waste management and recycling practices of Rangpur city in Bangladesh through field surveys, visits and direct communication. **Figure3.3** shows different places where our survey done. We have visited RpCC office and their dumping station, the area of RpCC (1-33 wards) to get the clear scenario of solid waste management process in Rangpur City Corporation. We have noted total population, total solid waste generation, number of dustbins in action etc and the procedure they maintained to manage solid waste management in RpCC.

Figure 2: Waste Collection Area

3.3 Analysis of Collected Data: We collected different types of data which is needed to make a scenario of RpCC. Total population, generation of total solid waste, area of RpCC, wards in RpCC, total number of dustbins in action and needed others data were collected by field

surveys, visits and direct communication. By analyzing collecting data, we make a clear scenario of current solid waste management in Rangpur City Corporation. On the basis on current scenario of solid waste management and analyzing collecting data we make a proposed management model to manage solid waste.

3.4 Find out the Amount of Recycle

Recycle is very important things to reuse and reduce the pollution. In RpCC, the amount of recycle is not healthy. We make a filed survey by visiting different shop which is related to it. Then we find out the amount of recycle in RpCC.

4.0 Data Analysis

4.1 Total Population of RpCC: Population means total number of people lives there. Rangpur City Corporation contain 33 wards. Areas of 33 wards are 205.76 square kilometers. Different wards carry different number of populations. Total population in RpCC is 599464.As a community Rangpur City Corporation carries a large amount of family. They generate different types of solid waste which in need proper management to dump and recycle them. Number of family lives in RpcC is 136258.There is 33 wards and the total numbers of family is the summation of ward base number of families.

4.2 Generation of Waste: Any unwanted or unnecessary things refer to waste. Those of them matches with the specification of solid waste is called solid waste. Solid waste management of RpCC covered only 15 to 30 no. ward. Each family generates in RpCC is 1.089 kg/day. Total solid waste generation in RpCC is 148384.96 kg/day. **Table 1** shows "**Specific Generation of Waste**"

Table 1: Specific Generation of Waste

Serial No	Wastage Name	Wet Weight (%)	Generation/Day (Kg)
1	Plastic	15%	22257.74
2	Electric	2%	2967.699
3	Food	50%	74192.48
4	Fabric	5%	7419.248
5	Paper	7%	10386.95
6	Wood	5%	7419.248
7	Metal	1%	1483.85
8	Industrial	1%	1483.85
9	Clinical	3%	4451.549
10	Sanatory	1%	1483.85
11	Bricks	5%	7419.248
12	Ceramic	2%	2967.699
13	Leather	1%	1483.85
14	Rubber	1%	1483.85
15	Others	1%	1483.85
		Total Generation	148385 Kg/Day

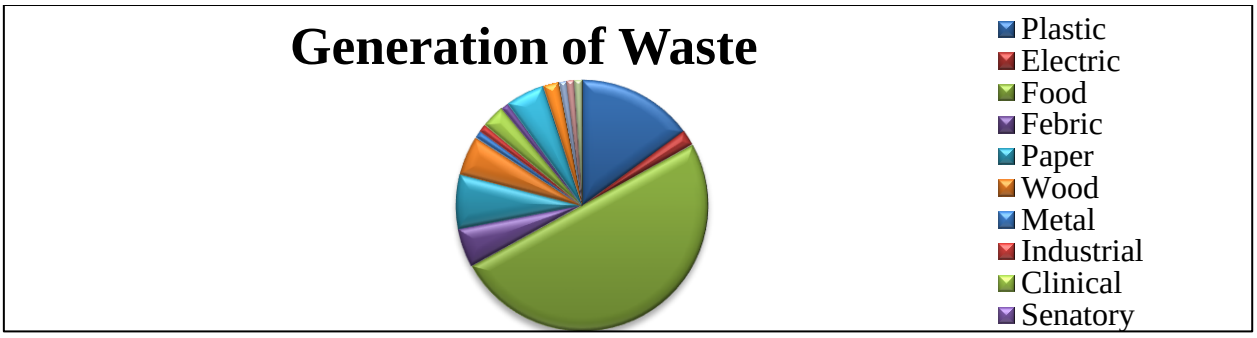


Figure 3: Pie Chart according to percentage of solid waste

4.3 Ward Based Generation of Specific Waste: Different types of solid waste generate from everyday life. Plastic, Electric, Food, Fabric, Paper, Wood, Metal, Industrial, Clinical, Sanitary, Bricks, Ceramic, Leather, Rubber is most generated solid waste in or everyday life. Some of them going to recycle and remaining waste going to dump in the dumping station of Rangpur City Corporation. The most generated solid waste is food and it is around 50%. We determined the ward-based generation of specific item on the basis on total waste generation in every ward in Rangpur City Corporation.

We determined it in Kg/day. We know previously that, the solid waste management in Rangpur City Corporation covers only 15-30 wards. Rest of the tables are on appendix.

4.4 Number of Dustbin: To collect solid waste RpCC uses contrite dustbin with the capacity of 1.5 tons for each. From 16 to 30 wards RpCC uses 85 dustbins. Escape 15-30 wards they have no dustbin to operate solid waste management. Table (bellow) shows the current scenario of dustbins in Rangpur City Corporation and it is 85 in number which is used to manage solid waste at Rangpur City Corporation area. Ward no 15-30 are in action. **Table 2** shows **"Total Dustbin in RpCC"**

Table 2: Total Dustbin in RpCC

Ward Number	No. of Current Dustbin
01-15	-
16	3
17	2
18	4
19	10
20	8
21	6
22	9
23	5
24	10
25	7
26	4
27	5
28	6
29	2
30	4
31-33	-
Total	85

4.5 No of Dustbin Properly Uses and Their Capacity: RpCC have 85 dustbins but all of them are not in use. To collect solid waste RpCC uses contrite dustbin with the capacity of 1.5 tons for each. Total dustbin on service in RpCC is 60 but 85 dustbin stands here.Total capacity of on service dustbin is 90000 kg.

5 Result and Discussion:

5.1 Number of Proposed Dustbin to improve Solid Waste Management: In RpCC, there is total 33 wards in their area. RpCC operate their waste management in 15-30 wards with 85 dustbins. But in real, 60 dustbins in action to manage solid waste. On the basis of Solid waste generation, here the number of proposed dustbins which is need to operate solid waste management properly all over the RpCC (1- 33 Wards). The capacity of those dustbin each 1.5 tons and it is concrete in nature. It is highly recommended to manage solid waste in RpCC properly. **Table 3** shows "**Proposed Dustbin to improve Solid Waste Management**"

Table 3: Proposed Dustbin to improve Solid Waste Management

Ward No.	Current Capacity (Kg)	Capacity (Kg)	Total Generation Kg/Day	Required Dustbin	No. of Proposed Dustbin
01	-	-	3257.199	2.171466	3
02	-	-	3997.719	2.665146	3
03	-	-	3490.245	2.32683	3
04	-	-	7192.845	4.79523	5
05	-	-	2102.859	1.401906	2
06	-	-	3139.587	2.093058	2
07	-	-	3472.821	2.315214	3
08	-	-	4511.727	3.007818	3
09	-	-	5260.959	3.507306	4
10	-	-	5070.384	3.380256	4
11	-	-	2920.698	1.947132	2
12	-	-	2974.059	1.982706	2
13	-	-	3781.008	2.520672	3
14	-	-	5264.226	3.509484	4
15	-	-	5254.425	3.50295	4
16	3000	4500	5246.802	3.497868	4
17	1500	3000	6359.76	4.23984	5
18	4500	6000	4063.059	2.708706	3
19	9000	15000	6322.734	4.215156	5
20	9000	12000	3209.283	2.139522	3
21	6000	9000	3433.617	2.289078	3
22	10500	13500	4526.973	3.017982	3
23	4500	7500	4865.652	3.243768	4
24	10500	15000	2751.903	1.834602	2
25	7500	10500	9900.099	6.600066	7
26	4500	6000	3447.774	2.298516	3
27	6000	7500	2256.408	1.504272	2
28	6000	9000	8334.117	5.556078	6
29	3000	3000	3270.267	2.180178	3
30	4500	6000	5502.717	3.668478	4
31	-	-	3270.267	2.180178	3
32	-	-	4925.547	3.283698	4
33	-	-	5007.222	3.338148	4

5.2 Implementation of LEAN Tools to Manage Solid Waste in RpCC

To improve the quality of solid waste management here proposed to use Visual Management and Kanban, by using this the process of solid waste management turn into more sustainable process and improve its quality.

5.2.1 Visual Management

- **Visual Indicator:** Can used on Dustbin and Van to indicate which will used for wet waste and which for dry waste.
- **Visual Signal:** It need little power to operate that's why it can be used on power operated vehicles to indicate that what is the reason of use those vehicles on field of Solid Wastage Management.
- **Visual Guarantee:** In this term it refers to using of sensor, GPS and so on special equipment. This term can use to prevent misuse of Vehicles which is involved with the management system.

5.2.2 Kanban: Kanban is a lean tool which is helpful to make continuous improvement of solid waste management. To implement, a Kanban card will use in dustbin which indicates the maximum level of remain solid waste in dustbin. When solid waste reaches to maximum limit the operation will start. It is a continuous process to keep dustbin clean and management of solid waste more effective. The flow of continuous improvement to dustbin by using Kanban card/table is bellow.

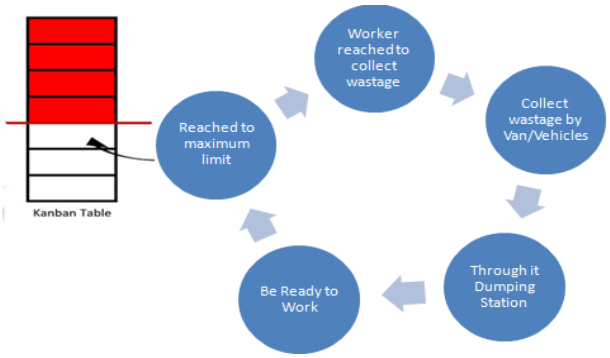


Figure 4: Flow of continuous improvement to dustbin by using Kanban card/table.

6.0 Scenario of Recycle: Total amount of recycle is 11540 kg /Day out of 148384.96 kg/Day. The overall percentage of recycle amount is 9.73%. We calculate the percentage and amount of recycled waste (kg/day).

6.1 Survey on Recycle: Recycle is very important part of solid waste management. Some of solid waste are going to recycle. In RpCC there is different types of shop which collect Metal, Plastic and Papers to recycle. The amount of recycle of Metal, Paper and Plastic which is 51.75 kg/day, 220 kg/day and 450 kg/day.

6.2 Percentage of Recycle: In RpCC, recycle process is not broad in area. There is a little amount of recycling occurring. Papers, Metals, and Plastics are used to recycle in RpCC. The amount of recycling of Plastic, Paper, and Metal is 40.44%, 71.24%, and 70.09%. The total amount of recycling is 11540 kg /Day out of 148384.96 kg/Day. The overall percentage of recycling amount is 9.73%. We calculate the percentage and amount of recycled waste (kg/day). In the **table below** we showed the result.

Table 4: Percentage of Recycle in RpCC

Serial No	Wastage Name	Wet Weight (%)	Generation/Day (Kg)	Amount of Recycle (kg)	Percentage of Recycle (%)
1	Plastic	15%	22257.74	9000	40.44
2	Electric	2%	2967.699	-	-
3	Food	50%	74192.48	-	-
4	Fabric	5%	7419.248	-	-
5	Paper	7%	10386.95	7400	71.24
6	Wood	5%	7419.248	-	-
7	Metal	1%	1483.85	1040	70.09
8	Industrial	1%	1483.85	-	-
9	Clinical	3%	4451.549	-	-
10	Sanatory	1%	1483.85	-	-
11	Bricks	5%	7419.248	-	-
12	Ceramic	2%	2967.699	-	
13	Leather	1%	1483.85	-	-
14	Rubber	1%	1483.85	-	-
15	Others	1%	1483.85	-	-

6.3 Summary of result:

The area comprises a total of 33 wards, with 15 wards actively engaged in waste management initiatives. The collective daily waste generation amounts to 148,384.96 kilograms. A network of 85 dustbins is in place, of which 60 are currently operational. The recycling rate stands at 9.73%. Currently, the Solid Waste Management RpCC focuses on 15 specific wards, but there is a proposed expansion plan encompassing all 33 wards within the City Corporation. A

noteworthy aspect of this expansion is the intent to introduce 115 additional dustbins, considering the existing count of 60 in use. Furthermore, there's a plan to implement LEAN tools, such as KANBAN and visual management, as part of these waste management endeavors.

7.0 Conclusions

We have selected our study area as Rangpur City Corporation. It is located in Rangpur division in Bangladesh. We select RpCC because it is a newly added city corporation in Bangladesh and the management of solid waste in it is not so good. It is high time to make a change in the management of solid waste. If they fail their management of solid waste properly, it will make this city polluted a survey was conducted and analysis of data then all of them turn into a result. We selected our study area as Rangpur City Corporation. The geographical coordinates of Rangpur City Corporation are 25.56° North and 89.25° east. The area of RpCC is 205.76 square kilometers In RpCC, there are 33 wards. Different wards carry different numbers of populations. The total population in RpCC is 599464. Solid waste management of RpCC covered only 15 to 30 no. wards. Each family generates RpCC is 1.089 kg/day. Total waste generation over RpCC is 148384.96 kg/day. RpCC uses a contrite dustbin with a capacity of 1.5 tons each. From 15 to 30 wards RpCC uses 85 dustbins. Escape 15-30 wards have no dustbin to operate solid waste management Total dustbin on service in RpCC is 60 but 85 dustbin stands here. The total capacity of on service dustbin is 90000 kg. On the basis of Solid waste generation, we proposed dustbin to manage solid waste. The capacity of those dustbins each 1.5 tons and it is concrete in nature. It is highly recommended to manage solid waste in RpCC properly. We proposed 115dustbin to operate solid waste management in RpCC. To improve the quality of solid waste management here proposed to use Visual Management and Kanban. By using this, the process of solid waste management turn into more sustainable process and improve its quality. In RpCC there is different types of shop which collect Metal, Plastic and Papers to recycle. The amount of recycle of Metal, Paper and Plastic which is 51.75 kg/day, 220 kg/day and 450 kg/day. The recycle percentage of Plastic, Paper and Metal is 40.44%, 71.24% and 70.09%. Total amount of recycle is 11540 kg /Day out of 148384.96 kg/Day. Overall percentage of recycle amount is 9.73%.

8.0 Recommendations:

In the future, creating a comprehensive waste transportation network diagram could greatly facilitate solid waste management for Rangpur City Corporation. This visual representation could enhance the efficiency of waste collection and disposal processes. Further advancements could involve conducting detailed cost analyses for the solid waste management procedures. By identifying cost-saving measures, the overall process could be made more economical, benefiting both the environment and the community. Exploring innovative approaches to enhance the recycling process holds significant potential for the future. By optimizing recycling techniques, the volume of materials diverted from landfills could increase substantially, contributing to a more sustainable waste management system. Future efforts might also focus on implementing LEAN tools within the organization. This approach could streamline operations, reduce waste, and enhance overall sustainability and effectiveness. By adopting LEAN principles, Rangpur City Corporation could operate in a more efficient and environmentally responsible manner.

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