Integrated Solid Waste Management System in Karachi

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Abstract: **Solid Waste management has been a fundamental amount of every human civilization. Waste Management is bone of contention presently in Karachi. Karachi is the largest mega metropolitan city of Pakistan and the capital of Sindh province. Positioned on the Arabian Sea, Karachi is also known as "City of Lights" and "The Bride of the Cities" with a population of about 24 million which makes it the 7th largest urban agglomeration and the largest city in the Muslim world. Karachi is generating approximately 15,000 tons of waste per day, where waste management system was observed and calculations were done for the amount of waste generated per day, per month and per year using life cycle assessment methodology.**

Keywords: **Solid Waste Management, Life Cycle Assessment, Karachi, Waste generation**

I. INTRODUCTION

Solid Waste Management (SWM) can be exemplified as the order connected with the control of era, stockpiling, accumulation, exchange, preparing and transfer of Municipal Solid Waste (MSW), in a way which is administered by the best principles of public health, economics, engineering, aesthetics and other ecological contemplations. One of the consequences of the global urbanization is increasing volumes of solid waste. According to estimates about 1.3 billion metric tons of municipal solid waste was generated globally in 1990[3]. These figures suggest that solid waste management (SWM) has become a large, complex and costly service. Most municipalities in developing countries spend a large proportion of their budgets on the collection, transport, and disposal of solid wastes[1].

The waste management method will encourage to moderate assets and defend the surroundings. Municipal solid waste management may be an extremely neglected issue for environmental management all told low and most middle-income countries. Ineffectively oversaw waste streams are perpetrating adverse environmental encroachment and will lead to health hazards. Ecological and Environmental concerns are expecting constantly expanding significance in the municipal solid waste decision-making process.

In most cities in developing countries, municipal solid waste management costs consume 20-50% of municipal revenues yet collection service levels remain low with only 50-70% of residents receiving service and most disposals being unsafe. Poor solid waste management is a threat to public health and reduces the quality of life for urban residents. Moreover, the situation is likely to worsen due to continuing population growth and urbanization in developing countries[4, 5].
Most attempts to improve solid state waste management in urban center in developing countries have focused on the technical aspect of different means of collection and disposal. Municipal waste management in most low and middle income countries draws on significant proportion of the municipal budget, yet current practices pose a serious threat to the environment and to public health and well-being[2].

Currently solid waste in West Pakistan has not been allotted during an ample and correct manner in assortment, transportation and disposal or marketing no matter the scale of the city: thus the environmental and hygienic conditions became a lot of serious year by year, and folk's area unit laid low with living such conditions. The scope of issues relating to solid waste management is incredibly wide and involves the thought of all the aspects concerning solid waste and its management, either directly or indirectly. These facet could embody rate of urbanization, pattern and density of urban areas, physical coming up with and management of development, physical composition of waste, density of waste, temperature and precipitation, scavenger's activity for reusable separation, the capability, adequacy and limitations of various municipalities to manage the solid waste i.e. storage, collection, transportation and disposal.

Integrated Solid Waste Management (ISWM) may be a comprehensive waste hindrance, recycling, composting, and disposal program. A good ISWM system considers the way to forestall, recycle, and manage solid waste in ways in which most effectively shield human health and also the atmosphere. ISWM involves evaluating native desires and conditions, so choosing and mixing the foremost applicable waste management activities for those conditions. The main ISWM activities are waste hindrance, employment and composting, and combustion and disposal in properly designed, created, and managed landfills.

Waste prevention—also referred to as "source reduction"—seeks to stop waste from being generated. Waste hindrance methods embody victimization less packaging, planning product to last longer, and reusing product and materials. Waste hindrance helps cut back handling, treatment, and disposal prices and ultimately reduces the generation of gas.
Recycling may be a method that involves assembling, reprocessing, and/or recuperating waste materials (e.g., glass, metal, and plastics, paper) to form new materials or product. Some recycled organic materials are wealthy in nutrients and might be wont to improve soils. The conversion of waste materials into soil additives is termed composting. Employment and composting generate several environmental and economic advantages. Maybe, they produce jobs and financial gain, offer

valuable raw materials to trade, and manufacture soil-enhancing compost, and cut back gas emissions and also the variety of landfills and combustion facilities. Disposal (landfilling and combustion) are won't to manage waste that can't be prevented or recycled. A way to get rid of waste is to put it in properly designed, created, and managed landfills, wherever it's safely contained. Differently to handle this waste is thru combustion. Combustion is that the controlled burning of waste, that helps cut back its volume. If the technology is out there, properly designed, created, and managed landfills may be wont to generate energy by methane gas. Similarly, combustion facilities manufacture steam and water as a byproduct that may be wont to generate energy. University of Karachi was set up through the senate as a Federal University in 1951 and converges 1200 sections of land of area. Nonetheless, through another demonstration of the parliament in 1962 its standing was re-imagined as college of the region of Sindh. On twenty third Gregorian timetable month, 1950 the Karachi University Act was passed and when a change in 1951, it totally was established and scholarly A. B. A Haleem was designated as its underlying chief. For the essential 2 years, the University of Karachi stayed as an examination University for the identified with schools. Inside the year 1953, it began its instructing and examination exercises at 2 schools of Arts and Science. Opened with an underlying admission of fifty understudies, the college is as of now a sprawling structure of fifty-three Departments and twenty world classification and to a great degree regarded investigation Centers and Institutes, underneath eight schools of Arts, Science, Moslem Studies, Pharmacy, Management and body Sciences, Law, Education and drug. At present, the enlistment of standard understudies at the field is marginally more than twenty 4,000. There are more than 800 instructors and very 2500 supporting representatives.

The University inside the beginning was housed in little structures neighboring the Civil Hospital. In the meantime, because of rapid development, it started to be felt that the house inside which the college was working wasn't sufficient for its needs. Besides, the air of the full and polluted space wasn't tributary to educating and investigation. Along these lines, a plot of 1279 sections of land of area was non-heritable on the group Road (now University Road) and on eighteenth January 1960 the college was moved to the new field. In this way started, a substitution presents the lifetime of the college. The day keeps on being celebrated by changed past understudies' Association furthermore the University organization together.

The University of Karachi saw a substitution period of expedient improvements by and large circles once Dr. Ishrat-ul-Ebad Khan assumed control as Governor of Sindh and Chancellor of the schools inside the region. His profound individual interest and responsibilities inside the college issues is a present supply of proceeding with enthusiasm for instructive, investigation and administrations initiates at the scholarly development at the field. Effectively finished office is introductory of its kind inside the nation. The Garden adds loads of excellence to the field from one perspective while on the inverse it is an open examination lab for the Plant researchers.

Development of lodgings for the meeting school and examination understudies and additional offices for M.Phil/ Ph.D researchers have any expanded probabilities for quality and fast investigation. The perpetual private issues at the field likewise are required to unwind halfway with the culmination of late squares of the workers pads. of these and bunches of option triumphs were on account of dynamic supportive gestures the college got from the upper Education Commission furthermore the Chancellor of the University. Various late advancement comes are on the iron block while a few others are at changed phases of fulfillment. The University is right now moving rapidly on the trail of advancements making the most of its due part inside the national improvement.

1. Methods

1.1 Study Area

The University of Karachi is a Public segment university situated in Karachi, Sindh, Pakistan. It was built up through the parliament as a Federal University in 1951 and distributed more than 1400 acres of land (5.67 km2) of area. It serves an on-grounds understudy populace of roughly 24,000. As per the Higher Education Commission (HEC) of Pakistan, it is hierarchical among the top 7th Universities in 2014 and top eighth in 2015 of the nation. There are more than 52 offices and 19 research foundations/focuses, which are giving training to more than 48,000 understudies including understudies from remote nations. Around four percent of the college's understudies are outsiders who originate from 23 unique nations in locales as different as Central Asia, South Asia, the Middle East and Europe. Below Figure 1 clearly shows the study area i.e. University of Karachi

Fig. 1: Study Area

1.2 Critical Information Required to Effective Plan for ISWM:

1. Number of private staying units and lodging densities
2. Number of business foundations by sort (eateries, markets, and so on.)
3. Number of government/institutional structures by sort (schools, healing facilities, and so on.)
4. Kilometres, width and state of boulevards and streets, including essential, optional and unchanged streets
5. Traffic examples and transportation foundation
6. Land use designs

1.3 Life Cycle Assessment Methodology

Table 1: Initial Characteristics of study Area

Country	Pakistan
Province	Sindh
City	Karachi
Town	Gulshan-e-Iqbal town
Targeted location	University of Karachi
Income area	Classified as a middle income
Per capita waste generation	0.75kg
Estimated population of the university	
Students	40,000
Faculty members	1000
Supporting staff	3000
Admin staff	2500
Total	48,000

Total Amount of Waste Generated:

Population X per capita waste generation = 48,000 X 0.75

= 36,000 kg/day

= 36,000kg /1000

= 36 tons/day

= 36,000kg X 7

= 252 tons/week

= 34.875 X 30

= 1080 tons/month

Percentage of Materials According to the Composition in the Total Solid Waste Generation of University of Karachi:

Total amount of waste generated in tons/day X %age of the material/ 100

Food remains:

36 X 20/ 100 = 180 tons/day

= 180 X 7 = 1260 tons/week

= 180 X 30 = 5400 tons/month

Plastics:

36 X 25/ 100 = 9 tons/day

= 9 X 7 = 63 tons/week

= 9 X 30 = 270 tons/month

Tins/Metals:

36 X 15/ 100 = 5.4 tons/day

= 5.4 X 7 = 37.8 tons/week

= 5.4 X 30 = 162 tons/month

Rags:

36 X 5/ 100 = 1.8 tons/day

= 1.8 X 7 = 12.6 tons/week

= 1.8 X 30 = 54 tons/month

Paper/cardboards:

36 X 80/100 =28.8 tons/day

= 28.8 X 7 = 201.6 tons/week

= 28.8 X 30 = 864 tons/month

Glass bottles:

36 X 7/ 100 = 3.24 tons/day

= 3.24 X 7 = 22.68 tons/week

= 3.24 X 30 = 97.2 tons/month

Others:

36 X 3/100 = 1.44 tons/day

= 1.44 X 7 = 10.08 tons/week

= 1.44 X 30 = 43.2 tons/month

Approx. Distance from University of Karachi to Jam Chakro (Landfill site):

According to Google map, approx. distance from University of Karachi to Jam Chakro is 14.9 km via Shahrah- e-Usman, used which takes around 28 minutes to reach the destination. We can round it off up to 15 km.

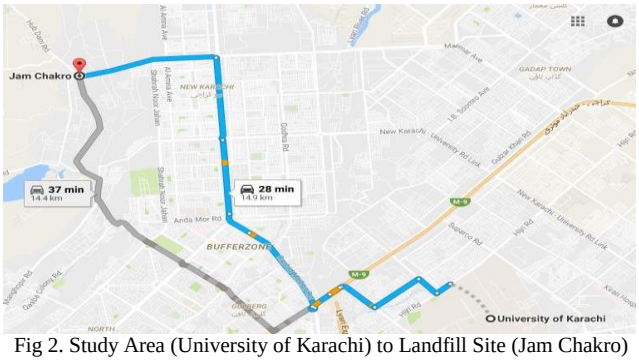

Fig 2. Study Area (University of Karachi) to Landfill Site (Jam Chakro)

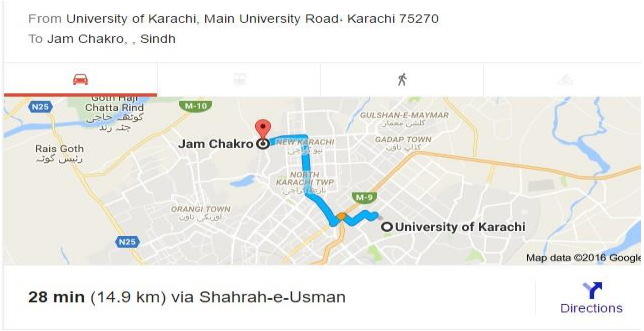

Fig 3. Total Distance from study area to landfill site

Per Ton Cost of Transportation**:**

Secondary transportation costs Rs.100/km and a truck would have to travel 30 km to go the landfill site and come back so;

Per ton cost of transportation = 30 X 100 = Rs. 3,000/-

Load Transfer per Day:

As we are considering biological waste only so we will use only food remains to calculate the load transfer per day:

Food remains = 180 tons/day

As 1 truck carries 1 ton of waste so 4 trucks would be needed:

Load transfer per day = 4 X 3,000 = 12,000 tons/day

Table 2: Labor charges for Truck

Workers	Salary/person
2 motor coolies	30,000
1 driver	18,000
Total (Rs.)	48,000

Per day per person labour charges = Rs. 48,000/30

= Rs. 1,600/-

Total labour charges

Labour charges = 1600 X 4

= Rs. 6400/-

Adding labour charges in load transfer per day
Load transfer per day = 12,000 + 6400

= 18,400 tons/day

= 18,400 X 7 = 1, 28,800 tons/week

= 18,400 X 30 = 5, 52, 000 tons/month

Amount of Waste Left Unattended:

Assuming only 60% of waste is transported so remaining 40% would be left unattended: Amount of waste attended = 180 X 60/ 100

= 108 tons/day

Amount of waste left unattended = 180 –108

= 72 tons/day

Cost of Recyclable Material; Economic Recovery:

- Paper sold in market @ Rs.10/kg
- Plastic sold in market @ Rs.5/kg
- Metals sold in market @ Rs.25/kg
- Glass sold in market @ Rs.5/kg

Paper:

28.8 tons/day = 28, 800 kg/day
28, 800 X 10 = Rs.2, 88,000/-

Plastics:

9 tons/day = 9000 kg/day

9000 X 5 = Rs. 45,000/-

Metals:

5.4 tons/day = 54, 000kg/day

54, 000 X 25 = Rs. 1, 35, 00, 00/-

Glass:

3.24 tons/day = 3240 kg/day
3240 X 5 = Rs. 1, 62,00/-

Total Finances Available:

Total finances = paper + plastics + metals + glass

= 2, 880, 00+ 45,000 + 54, 000 + 1, 350, 000

= 1, 699, 200Rs/day

= 11, 894, 400 Rs/week

= 50, 976, 000 Rs/month

Cost Benefit Analysis:

Cost of primary collection/transportation (per month) = x

As primary transportation costs Rs.50/day so per month cost would be:
50 X 30 = 1,500 Rs/month.
At least 1 sanitary worker is required for every 500 individuals so; x
= 48,000 X 1,500/ 500
x = 1, 440, 00 Rs/month
Cost of secondary collection/transportation (per month) = y

y= 12,000X 30

y = 3, 60, 000 Rs/month
Total cost of primary, secondary & tertiary collection/transportation (per month) = z

z = 144,000 + 360,000 + 552, 000

z = 1, 506, 000Rs/month
Total finances available per month after material recovery = a

a= 50, 976, 000 – 1, 506, 000

a = 52, 032, 000 Rs/month
Net profit (if any):

a – z = 52, 032, 000 – 1, 506, 000
= 50, 976, 000 Rs/month

II. RESULTS AND DISCUSSION

GTS stands for "garbage transferring station". These are another kind of ancillary stowage facility. From the above calculation, it can be perceived that we are possessing a revenue of 50, 976, 000 Rs/month that could be a mint of cash. Thus, the generated revenue should be expeditiously employed in the event of our waste program and conjointly for the welfare of

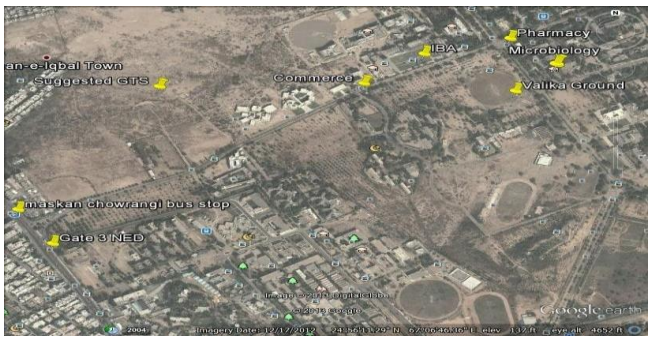

Fig 4. Suggested Garbage Transferring Station

the university. We are proposing GTS for University of Karachi near Maskan gate at latitude and longitude 24°56'11.29" N and 67 ° 06'46.36" E as it appears most apposite. The countrywide trending solid waste disposal has been toward construction of larger, additional remote, regional landfills. Monetary concerns heavily influenced by restrictive and social forces, square measure compelling factors resulting in this result. Financial concerns, particularly economies of scale, any promote development of huge regional facilities. To offset the high price of constructing and maintaining contemporary lowland, facility house owners construct giant amenities that attract high volumes of waste from a larger geographical area. By maintaining a high volume of incoming waste, lowland house owners will keep the per- ton tipping fees low that later on attract additional business. Rural and concrete communities' alike square measure finding that the foremost economically viable answer to their waste disposal wants is shipping their waste to those facilities. In these circumstances, a transfer station is the vital consolidation link in creating efficient shipments to those distant facilities.

The primary reason for employing a transfer station is to scale back the value of transporting waste to disposal facilities. Consolidating smaller masses from assortment vehicles into larger transfer vehicles reduces trucking prices by facultative assortment crews to pay less time traveling to and from distant disposal sites and longer collection waste. This conjointly reduces fuel consumption and assortment vehicle maintenance prices, and produces less overall traffic, air emissions, and road wear. Additionally, a transfer station conjointly provides:

- A chance to screen waste before disposal. Flexibility in choosing waste disposal choices.
- A chance to function a convenience center for public use.

Deciding whether or not a transfer station is suitable for a private community is predicated on deciding if the advantages outweigh the prices. Decision-makers got to weigh the design, siting, designing, and operative prices against the savings the

transfer station would possibly generate from reduced trucking prices. to help in creating this determination, public and personal decision-makers typically use third-party solid waste specialists. These specialists square measure aware of each the technical and restrictive problems that has got to be addressed in developing a productive waste transfer station. It's going to be useful to retain qualified consulting or engineering companies specializing in solid waste engineering. It's conjointly vital to notice that in some areas, the administrative unit would possibly need that the transfer station plans be certified by knowledgeable engineer. Again, this engineer ought to be a practiced solid waste skilled. Complicated comes May additionally need the help of architects, geotechnical engineers, lawyers, and different specialists. Though cost-effectiveness can vary, transfer stations usually become economically viable once the trucking distance to the disposal facility is larger than fifteen to twenty miles.

III. CONCLUSION

Integrated solid waste administration could be a propelled assignment and ought to include shifted disciplines. A blasting project ought to exemplify every short-run and long objective. It ought to furthermore offer a harmony between 3 fundamental variables: natural control benefit of running the project and group needs. To build up a system one must fathom the key standards worried in dealing with each component and their outcome on each other. suppose, if the fiery debris produced by burning of city waste tests bound and determined venturesome, then either the cinder ought to be detoxified or it ought to be arranged in an exceedingly exceptionally composed landfill/landfill cell. In this manner, before and additionally ignition inside the system, one must find out the attributes of the heater cinder so right transfer take after is encased inside the project. On an area or group level, incorporated strong waste administration programs basically incorporate the consequent 5 stages:

1. Waste supply ID and portrayal
2. Economical waste grouping
3. Reduction of volume and danger of the waste to be disposed of
4. Land transfer or burning of the waste
5. Improvement of the essential four stages to downsize esteem and natural effect

IV. RECOMMENDATIONS

It is recommended that following steps should be taken and implemented within the premises of University for Integrated solid waste management system:

1. Manual sweeping in departments and corridors
2. Vacuum sweeping on roads of the university
3. Mechanized Washing of roads
4. Department to Department Waste Collection
5. Container based Waste Collection
6. Transportation of Solid waste to the Disposal Site.

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