Improving Solid Waste Management in Municipalities using GIS Analysis in smart Cities, Punjab

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Abstract: *Waste "to use or spend something in a careless way or for something that is not necessary". Solid waste is also known as trash or garbage in Developed Nations. It is a type of anything that has been discarded by people every day. Fundamental issue in 21_{st} century is to manage solid waste effectively and efficiently. The study majorly focuses on increase in performance for solid waste management at municipality's level in Smart Cities in Punjab State. The area is mostly residential and most of the solid waste is created in the home, such as food and vegetable's waste. At ground level Smart Cities in Developing countries have more challenges for solid waste management plan, due to their old infrastructure, Administrative problem, Lack of use of technology etc. Solid Waste Management (SWM) is a growing concern for governments across the world, as urbanization increases and populations grow. This note illustrates the use of GIS & ICT technology for developing a road map for solid waste and in monitoring and improving vehicle activity, waste container visits and hence secondary collection of solid waste in major municipality's in Punjab. Study majorly focus on three objectives ; identify the existing municipal solid waste management condition and their effect on different factors such as health and the environment; reallocation of waste collection bins in the study area using GIS and proposed route for collection. Solid waste management is the primary responsibility of the Municipal Corporations which have all these factors related to SWM collection, storage, segregation, transportation and most important disposal. GIS helps to develop the frame work for optimizing the waste collection and transport system. Study also proposed to show the placement of bins at equal distance. Policy that will be useful for improving performance in MSWM system with GIS and ICT technology and subsequently in reaching ever stricter environmental targets requested over time at both national and international levels translated to a municipal level. Punjab Generates 4300 TPD of Municipal solid waste Government of Punjab has formulated a scheme for SWM plants for all the major cities by arranging them in the form of cluster. The 146 urban local bodies (ULBs) also part in PPP mode for period of 25 year. The state divided into 8 clusters by the Punjab Pollution control board. Also by adopting new technologies like GIS & ICT can provide better road map has given to track overall system for MSWM. Based on the different analysis, study proposes various policy recommendations in terms of administrative challenges and technology incubation for SWM in the different municipalities in smart cities*

Keywords: Geographic Information system, Waste Collection, Municipal solid waste

1. Introduction

Solid Waste Management in the developing countries is the greatest challenges to counter. Solid waste management is the joint operation of all procedures like collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful. The Improper disposal of municipal solid waste can create unsanitary conditions, major health issues , environment issues and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease— that is, diseases spread by rodents and insects. The tasks of solid-waste management present complex technical challenges. They also pose a wide variety of administrative, economic, and social problems that must be managed and solved. Most of the solid waste management occurs due to poor arrangements of infrastructure and not optimizing the existing infra. Land filling is the one of the major example the waste disposal in any convenient location without taking into account health, welfare, environment conservation or cost efficiency .In 21_{st} century the growth of urban population is a major challenge. Urban population in Punjab is growing rapidly. At the dawn of the twentieth century, only 12.46 per cent of the total population of the then pre- partition united Punjab was urban. As per census 2001, Punjab is the fifth major urbanized state of India after Tamil Nadu (43.86 per cent), Maharashtra (42.40 per cent), Gujarat (37.35 per cent) and Karnataka (33.98 per cent).At the beginning of the twenty-first century, the urban population of Punjab has increased to 33.95 per cent, against 27.78 per cent for the country as a whole. Punjab Urban Population Out of total population of Punjab, 37.48% people live in urban regions. The urban population of Punjab increased by 25.86 percent during 2001-2011 periods and is expected to rise further.

https://www.census2011.co.in/census/state/punjab.html

Whereas the 'THE MUNICIPAL SOLID Waste (MANAGEMENT AND HANDLING RULES, 2000)' were notified by Ministry of Environment & Forest in the year of 2000, but even after passing a decade progress of Municipal Corporations is very poor for the implementation of Act. Municipal Solid Waste (MSW) in Punjab is dumped without treating, which is affecting environment and health of the citizens.

In this study we will consider Amritsar city for our research
The Punjab Pollution Control Board has divided Punjab into eight clusters. These clusters are formed by the urban local bodies to collect the solid waste from the cities. Government of Punjab has formulated a plan to set the plants in all major cities. Punjab Municipal Infrastructure Development Company (PMIDC) which is a government agency has given the responsibility to look after all the clusters. There are 146 urban local bodies in Punjab in 8 clusters. Urban local bodies are part of public-private partnership model for the

concession period of 25 years.

A. Amritsar Cluster
Present Status
1) No. of Urban Local Bodies attached-8
2) Approx. 25 acre Municipal land at Bhagtanwala, Amritsar is allocated to the project for Processing & Disposal Facility.

Amritsar Cluster: The cost of the processing plant project is 116 crore and cluster consists of 8 urban local bodies. At 21 acres of land in Bhatnawala near Amritsar will be used to process 650 TPD, in this 100 TPD will for RDF, 50 TPD for recycling unit, 350 TPD for compost plant and 130 TPD will used for sanitary landfill.

B. Other clusters are
Ludhiana, Jalandhar, Bathinda, Ferozpur, Patiala, Pathankot , GMADA clusters

Source:
https://www.ppcb.punjab.gov.in/en/waste-management/municipal-solid-waste

(i) Solid Waste Management

(a) Current status related to solid Waste management

Sr. No.	Urban Local bodies	No of Wards	No of Households	Population	Solid Waste Generated (MTperday)
1.	Municipal Corporation, Amritsar	85	245000	1382617	425
2.	Nagar Panchayat, Ajnala	15	3395	25000	7.0
3.	Municipal Council, Majitha	13	2633	15000	5.5
4.	Nagar Panchayat, Ramdass	11	1286	6970	2.0
5.	Nagar Panchayat, Rayya	13	2485	14581	2.0
6.	Municipal Council, Jandiala	15	6500	30000	10.5
7.	Nagar Panchayat, Rajasansi	13	2764	14698	4.5
	Total	165	264063	1488866	456.5

Sr. No.	Local Bodies	No of Village Panchayats /Blocks	No of Households	Population	Solid Waste Generated per day (MT)
1.	No of Villages Panchayats	861	250895	1219151	376.34

Source: District Environment Plan-Amritsar (18/11/2021) Ref No: 3512

C. Transportation infrastructure

Solid waste collection & transport infrastructure in Amritsar

Name of the settlement	Primary collection		Transportation						
	Garbage	Waste collection points	Rickshaws	Trucks	Open bins trucks	Tractor Trolleys	Dumper placer	Wheel barrows	Loaders
Municipal Corporation, Amritsar	--	--	--	11		66	12	--	7
Municipal Council, Jandiala	20	20	--	--	--	--	1	25	--
Nagar Panchayat, Rayya	13	--	20	--	--	2	--	15	--
Municipal Council, Majithia	35	20	10	--	--	22	--	26	--
Nagar Panchayat, Rajasansi	--	--	--	--	--	11	1	13	--

Source: Municipal Corporation- Amritsar, Municipal Council Rajasansi, Draft interim report on solid waste management at Majithia (Punjab) available at www.ada-asr.com

Source https://punenvis.nic.in/index3.aspx?sslid=2362&subsublinkid=3289&langid=1&mid=-1

As above mentioned details of Total waste of Amritsar per day 456.5MT per day and the transport facility in Amrtsar district for collection of bins and allocation of waste is very low.

Cities in Punjab are becoming less livable due to increase in problems (lack of infrastructure and services and individuals are significantly affected by availability of SWM collection. During last decade cities are low incomes countries, huge migration have been noticed in last decades. Also due to Tourism hub Amritsar city has lots of problems daily visitor in Amritsar is increasing day by day. Due to this waste also increase. Management of MSW is mostly complex nowadays due to increase magnitude of waste. The management and disposal of municipal solid waste are the biggest challenges to secondary cities. Global Urbanization is also one of the main reasons of solid waste management. Asia as whole spent about USD 25 Billion annually on SWM by 2025 it will increase by 25 Billion more that means total USD 50 Billion.
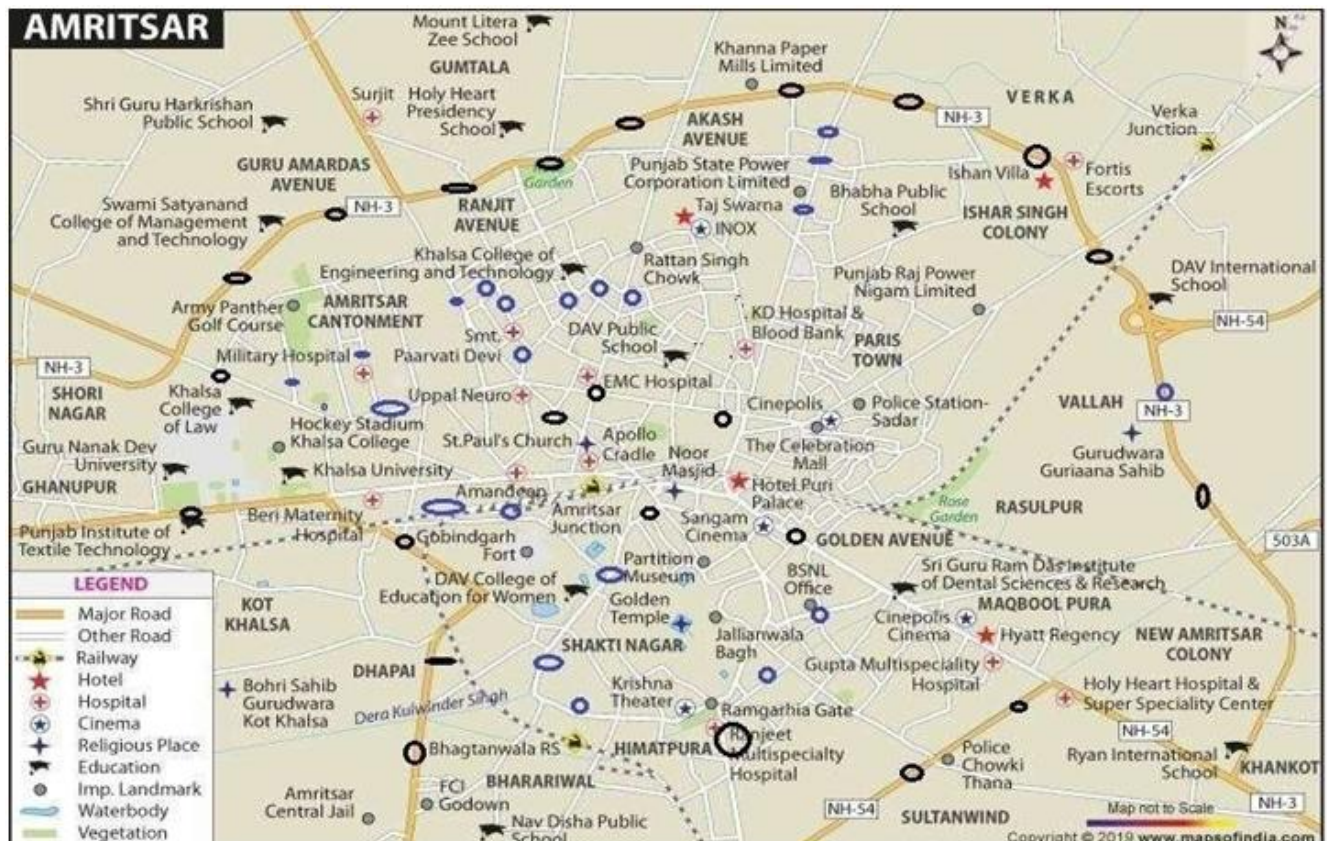
The transportation method play important role in SWM in all over. The poor management may lead to increase the diseases. Complicated waste management systems, in particular, situating MSW management and disposal facilities and optimizing waste collection and transportation, have been a favorite field of GIS applications since the birth of the technology. Waste created by households, Government sectors referred to as MSW . One of the effective solutions to such a problem is to adopt an efficient MSWM system. The MSWM system's implementation is influenced by several critical elements, including country regulations, environmental management strategies, economic and technological capabilities, and public education and environmental awareness .GIS is the new system to improve the SWM by contribution in proper planned manner in a cities. The majorly aim of research is to study the current status off SWM in Amritsar City and their effect on health and environment and provide solution for those mishaps in system. GIS technology helps to provide proper work frame to optimize the waste collection and transport system in the cities by Using GIS system allocation and re-allocation waste collection of bins and placed new bins in proper locations scheduling and re-scheduling waste collection using routing optimization The method included allocating and reallocating waste collection bins and rescheduling waste collection using GIS routing optimization.

2. Methodology

Study area geographically located at the latitude of 31.633980, and the longitude is 74.872261. Amritsar, Punjab, India is located at India country in the Cities place category with the gps coordinates of 31° 38' 2.3280" N and 74° 52' 20.1396" E. In this research study we have majorly considered Food and vegetable waste (Household) Plastic, Poly Bags, Glass, and Papers. There are very few bins placed in the city. Majorly placement of bins is only at Heritage Street but rest of the city does not have bins for collection of waste due to this residence of cities through garbage here and there. Those are not collected by the standard waste collection vehicle which deteriorates the environment due to irregular placement of waste sites and other prohibitive obstacles. A few bins or containers placed in the city of their existing site are insufficient in the area. The collection of waste is not proper. As a result, the largest portion of domestic waste is dumped on vacant plots. Waste not disposed of properly usually finds its way into sewers is eaten by animals or is burnt next to roads. Such actions are detrimental.

On Major Roads Bins will be used for Collection By using GIS technology we can create a route map for transportation and collection of bins also mapping in GIS. GIS analysis was used study shows and suggests that there must be 45-50 meter(BLACK CIRCLES) buffer should be maintained between bins which have already installed and new bins installed at a distance of 25m (BLUE CIRCLES)where more crowed area is Which help the transportation department to collection of bins from exact location or re allocation of bins whenever needed. We have tracked all the existing bins placed at different places but as said before they are not sufficient. Also there is not treatment plant is available in Amritsar. Uses route map with Major road from Link roads for optimization of route we use GIS technology. Furthermore of vehicles are needed for this purpose.

At present in Punjab only two municipal solid waste management plants in working one in Jalandhar and the other one in Hoshiarpur. The latter one is in good health while the former is poorly maintained. In Jalandhar waste is stored in the open dump yard and in a rainy season lot of water gathers in the plant. It is very dangerous as it liberates GHG's and may also lead to health hazards. In Hoshiarpur solid waste management is well maintained and solid waste bifurcates into the Biodegradable and Non-Biodegradable. The biodegradable solid waste is then processed to produce the vermicomposting. It is stored in the gunny bags.

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Proposed Plan for Placement of Bins & Re-allocation
Source: http://pmidc.punjab.gov.in

3. Conclusions

The study aimed to identify the current situation of Solid waste management in Municipal corporations. Also find out the factor effecting the management for solid waste disposal or treated. The primary data is collected from various sources. The result of the analysis reveals how the factors affect human health and the environment and management. GIS analysis was used study shows and suggests that there must be 45-50 (BLACK CIRCLES) meter buffer should be maintained between bins which have already installed and new bins installed at a distance of 25m (BLUE CIRCLES) where more crowed area is. Also find out that the is installed is not at their proper locations and very far from dumping site. Re-allocation of bins must be installed by using GIS system. GIS network analysis is used to find the optimal routes for vehicles at dumping ground at Bhagtwala. There must be treatment plant installed because all the waste is dumped in open. It will assist authorities and planners in reducing the effects of MSW on public health, which inevitably demands its collection, safer treatment, and disposal. The suggested model also supports municipal authorities in their decision-making process regarding MSW management. By using GIS and with low man power and little enhancement in transportation means (addition of some vehicles) will help the Management in cost and better result oriented.

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