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Implementation Analysis of Municipal Solid Waste Management in Dinanagar City of Punjab, India

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Abstract

Unscientific waste management is increasingly becoming a major reason for environmental issues in Indian cities. Unlike previous municipal solid waste management in cities of Punjab (India), this study analyses the implementation of solid waste management. Also, examine the factors responsible for the dysfunction of the municipal corporation of Dinanagar (MCD) city of Punjab (India). To fulfil the research objectives, primary and secondary data are collected from various sources for qualitative and quantitative analysis. However, some drawbacks and flaws were found in the existing practices of Municipal Solid Waste Management. The internal consistency and validity are measured using Cronbach's alpha. The importance- performance analysis and Strengths, Weaknesses, Opportunities, Threats analysis is performed to conclude the present scenario of MCD. This study is eventually concluded with some suggestions to waste managing authorities and researchers for contribution in improvement of current system.

Key Words: Waste generation, Sources, Characterization, Treatment techniques.

Introduction

Indian government introduced and implemented the various rules, policies and schemes to manage and handle the different types of waste [1].With rapid increase in modernize population the challenges to manage the trash is encountered in developing countries. The review article is presented the challenges related to economic optimization of SWM [2]. The classification of waste modelling methods based on regions, time series interval, waste stream are reviewed in article [3]. According to literature, one major reason behind poor WM is inhabitant's perception, concern, behaviour, participation and awareness [4]. So, different methods and technologies are developed by the researchers such as Geographical Information System aided methods MSWM using mathematical modelling , simulation optimization method are also developed. The authors proposed Genetic Algorithm to solve the issue of transportation cost involved in collecting the generated waste from various source sites to transfer station and to other interlinked stations such as incineration, composting and landfills. In the article, author presented a new simulation optimization method based on firefly algorithm and procedure with MSWM case study [5-9]. The review article is presented the challenges related to economic optimization of SWM [2]. The classification of waste modelling methods based on regions, time series interval, waste stream are reviewed in article [3]. According to literature, one major reason behind poor WM is inhabitant's perception, concern, behavior, participation and awareness [4]. The typical characterization of waste in India is Biodegradable, Non-biodegradable, hazardous. Based on characterization three main ways followed to manage and handle the waste are: centralized, decentralized, integrated SWM. Biodegradable waste is preferably handled at decentralize level as it reduces its value with delay in treatment. Whereas non-biodegradable and hazardous trash can be managed at centralized level as, it generally requires establishing a long-term plant investment, which are successfully run with at least 5 tons of waste as per drafts of SWM. The proper utilization of wastes leads to the advantages such as reducing Greenhouse Gas emission, biogas generation, quality compost production, soil fertility improvements etc. [10].

MSWM in India

The study contribute to evaluate the status of MSWM in India and suggest some significant improvements for better functioning of waste management [11, 12]. The author of highlights the current practices of MSW in Puducherry, proper record of generated, col-

lected, treated, and disposed waste is needed as per rules drafted by GoI. The physical & chemical composition is also a necessary aspect to be maintained by municipality authorities. The Government of Delhi have realized the seriousness of the situation and framed guidelines in the form of the Master Plan (2005–2021) for disposal and treatment of MSW for the entire state of Delhi [13]. It is concluded that any substantial change in the present scenario is not possible without a three-way partnership of the government, the private sector and the citizens [14]. Explores alternative approaches to municipal solid waste (MSW) management and estimates the cost of WM in Mumbai, India. The first approach is community participation and the second is private sector participation [15]. Moreover, there is a need to further analyse the role of PPP (Public Private Partnership) in waste management. Greenhouse gas emission inventory from landfills of Chennai has been generated by measuring the site-specific emission factors in conjunction with relevant activity data as well as using the guidelines of IPCC 1996 methodologies for CH4 inventory preparation. It is also important to study MSW reaching to landfills along with the generation and composition determination at source for CH4 emission inventory as intermediate stages of waste handling also influence its quantity. The segregation of waste at source and promotion of recycling or reuse of segregated materials reduces the quantity of waste and the burden on landfills, and provides raw materials for manufacturers [16]. The data of MSWM, Allahabad obtained from ArcGIS maps are responsible for the retrieval, update and visualization of the information required. The present investigation is a case study of Lucknow the main metropolis in Northern India, which succumbs to a major problem of municipal solid waste and its management. A qualitative investigation using strengths, weaknesses, opportunities and threats analysis (SWOT) has been successfully implemented through this community participation study. It was observed that the SWOT analysis was an excel- lent tool to explore the possibilities and ways for initiating and successfully implementing the MSWM program [17, 18]. Guided with the specific objective of analysing the implementation of various SWM programs in Ludhiana city, the study found political commitment, facilities provided to the staff, participation of public and commercial sector significantly affected the successful solid waste management implementation. The study also revealed some problems from administration that affected implementation at the initial stages like inadequate resources, inadequate land for final disposal of waste, lack of integrated solid waste management plan, public unawareness, shortage of staff etc. Characterization of the existing municipal solid waste (MSW) in Jalandhar, India, has been performed to evaluate its suitability for various waste-processing technologies [11, 19]. The study contribute to evaluate the current status of MSWM in India and suggest some significant improvements for better functioning of waste management. After a thorough review of articles on Indian cities: [12, 13, 14, 15, 16, 17, 18, 19, 20, 21], it is observed that problems and challenges related to MSWM are different in different cities so there is need to monitor the WM practices at local level. The rise in population and urbanization also increases trash generation. As the lifestyle of the population changes, the number of produced garbage kinds also increased. For MSWM, the collection of waste materials from primary, secondary or other source is the major problem. According to municipal corporations and in literature, it is clear that the expenditure over waste management is almost 70-80 percent of municipality's total budget. Instead of trash treatment, the major objective of this research is to concentrate on waste minimization by examining existing adapted strategies. This study will lead to better waste management planning and decision-making. In addition, waste will be managed self-sustainably to some extent through effective application of suggestions keeping in view the Government of India regulations.

Waste management practices in Punjab is more challenging because of various reason such as human resources, financial and political constraints influencing the effectiveness of SWM process in the cities.

The Municipal Corporation, Dina agar city of Punjab (India) is facing many hindrances due to insufficient funds for maintaining the services related waste management, non-supportive behaviour of urban local bodies, unawareness and lack of interest of inhabitants. For more details about the study area, refer to table
The article present assessments of current implication as per following aspects

1. Sources of waste generation.
2. Quantification & Characterization of waste.
3. Citizen's awareness and participation.
4. Willingness to pay for SW services.
5. Suggestion to implement more effective & sustainable waste management plan.

Table 1: Details of Study area-Dinanagar

Parameters	Numbers or %
Municipal Corporation Area:	14.36 km sq.
Total No. of wards:	15
Total Houses:	5637
Population in each ward:	376(approx.)
Total Population(2011):	23976
Present Population(2021):	25376(approx.)
Literacy rate:	88.66%
Male Literacy:	92.26%
Female Lieracy:	84.73%
State avg. Literacy rate:	75.84%

Source: Census of India and MCD

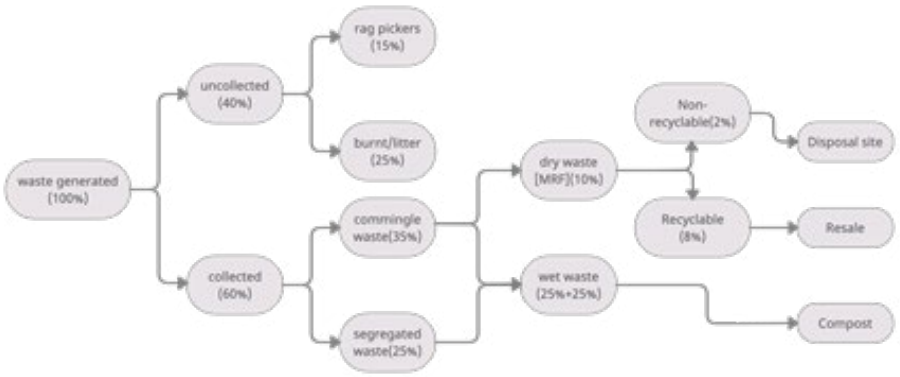

Figure 1: Life cycle of waste in Dinanagar city

Sources & Characteristics

The generators of MSW are broadly categorize into Residential and Non-residential waste. Further, the residential waste includes kitchen waste(left over food items), paper, cardboard, plastic, sanitary waste, inert and Non-residential waste includes bulk quantity of refused fruit, vegetables, packaging cardboard, plastic, construction & demolition waste, Industrial, restaurants & hotels waste etc. In Dinanagar, the average Municipal solid waste generation is about 6 metric tonnes(only of residential area, no record found for non-residential contribution in trash production), and typical physical composition of waste is mainly three types biodegradable, nonbiodegradable, and hazardous. No any record is available for chemical composition of waste generated in city.

Table 2: Gap analysis

Parameters	Existing	Benchmark	Gap-existing
Waste collection	60% of waste generated	100%	40%
Waste treatment	65% of waste collected	100%	35%

Source: Municipal corporation of Dinanagar

Problem Identification

The Indian government establishes new targets to minimize the quantity of biodegradable waste in landfill or dumping sites. To achieve this target, the composting is primarily solution in small municipality like Dinanagar. Using this technique the waste volume is reduced by 50-65%. Composting can be done either manually or mechanically. Presently, 33 number of manual composting pits at different locations are successfully maintained by Municipal Corporation of Dinanagar(MCD). There is need to improve the collection, treatment and disposal rate of generated waste. The population of Dinanagar is 25376 (table 5) inhabitants and 15 square km land area which is further distributed in 15 wards with average of 376 inhabitants each. The MSW generated is only about 0.2-0.25 kg/capita/day, of which 60% is wet waste, 40% is dry

waste and only 50-60% of generated waste in the city is collected with the utilization of presently provided collection services. In particular, material recovery facility(MRF) is also adapted by the MCD to treat all metal, paper and plastic from the perspective of cost management. The need of effective and efficient MSWM is increasing as the poor management contributes adverse effects on economy, health, environment and one major threat is increase in Green House Gas(GHG) emissions which further responsible for global warming due to uncollected/untreated waste lying in open dump sites. The inefficient collection and treatment services are the reasons for gap existence in present practices of MCD (see table 2).

Waste Management

Almost in every residential regions of 15 wards, the unpleasant view of openly dumped commingle waste is spreading odor, threat of health issues, causing environmental problems, stray animals(-like dog, cow) are creating more mess with waste(like diapers, sanitary napkins and left over food). The blockage of sewage is also a very frequently faced problem especially in rainy season. Because, the delay in treatment of biowaste leads to low quality of compost. Further, it can be used for gardening purpose and the rest can be convert into revenue by marketing which could be led to compensate the expenditure by some extent. The life cycle of waste in the city is shown in figure 1.

Common Indicators Influencing the Functioning Of MSWM

Citizen's Participation (CP)

In the earlier plans of waste management it was a belief that public participation is the least most factor affecting the MSWM but in recent years the researchers and the experiences proved that it is the most primarily aspect to be focused for proper utilization of waste as resources. Without citizen's participation, it is impossible to meet the challenges emerges out from the waste quantification. So, it is important to think out off the box to handle and manage with the issues related with WM. It is necessity to inspire and aware each other about the impacts of poor waste management.

The negligence towards its bad effects will be finally ended up with the loss of inhabitant's life.

Waste Minimization (WM)

Now a day, to manage the waste production in the country, concept of waste minimization becomes more important to focus. This practice will led to converge towards the successful achievement of waste management objectives. It is the most effective way to reduce the quantity of waste, the cost associated with its handling and its environmental & aesthetic effects. Waste minimization strategies requires national or state level interventions such as extended producer responsibility can be established for waste like electronics, batteries, ban to use or sell certain types of products and packaging that cannot be reused, repaired, recycled or composted. Waste minimization usually requiring ULB support or action such as awareness & education programs, developing & promoting at source level reduction programs, banning the use of plastic products by replacing with recyclable and reusable material.

Five R's Policy (FRP)

The technique of five R's is responsible for sustainable and zero waste objective of solid waste management. The definition of 5 R's are: REFUSE, REDUCE, REUSE, RECYCLE, RECOVER.

- Refuse: Say no to non-biodegradable material or products.
- Reduce: Replace the non-biodegradable with biodegradable material.
- Reuse: Do not use disposable products. Replace them with more sustainable alternatives.
- Recycle Use the material which can be transform into another usable form.
- Recover: Convert the kitchen waste into compost.

By adopting these 5R's policy in daily routine life, the challenges of waste management can be achieved effectively and efficiently.

Segregation at Source Level (SAS)

Segregation of waste into different fractions at source level is an essential practice for effective and efficient WM. Unwanted material should be stored at source level until it is collected for disposal or treatment by the waste collectors. It should be separated by waste generators into three fractions: wet, dry and hazardous. Apart from these wastes horticulture waste, construction & demolition and sanitary waste should be collected separately and designated for treatment. Segregated collection and transportation of waste from source to destination is highly essential in SWM system.

Waste Collection (WC)

Waste collection is next essential step after segregation at source level. Inefficient waste collection services has an bad impact on public health and aesthetics of cities. waste collection is divided into primary and secondary collection. Primary collection refers to the collection of waste directly from waste generators. Secondary collection includes picking up waste from community bins, waste storage depots and transfer to treatment facilities or disposal sites. A well synchronized primary & secondary collection and transportation system is essential to avoid container's overflow and waste littering in the city.

Service Charges (SC)

Households that produce the majority of solid waste and are directly affected by uncollected solid waste should be able to participate in improving SWM. As a result, the contribution of city dwellers to SWM service plays a significant role in improving SWM in the community. As result, service rates for SWM should be set at a level that discourages illegal dumping while still maximizing cost recovery. Before it's implementation, the proposed sanitation cost must be changed based on willingness and ability to pay. At present only 1500(as per record provided by MCD) shown in table 5) households are paying for the waste management services. The

residents are paying directly to waste collectors as an incentive. So, it is not a part of revenue for MCD. MCD expects to receive |197,295 every month in revenue from households. When correctly collected, this revenue covers 85% of the cost of providing 100% solid waste collection coverage in study area.

Training & Awareness of WM Staff (TAS)

The workers involved in collection and treatment process of Waste Management should be trained enough to run the system effectively. The number of safai sewaks, sewadars, laborers etc working with MCD are 72, which is more than enough but as per formal talk with municipal authorities" The maximum number of workers are females(not to be involved in field work), of old age or suffering from some disease, some(the most efficient workers) are deputed at ministers and their relatives residents for personal(cooking, cleaning, gardening etc) purposes". Their work and duties are divided as sweeper, collector from primary and secondary source , separator at transfer station and manage and inspect working of composting plant etc. A sanitary inspector further supervises the overall working of workers. No record is available in terms of components of generated waste, physical-chemical composition of collected, treated or disposed waste. The lack of well-qualified and experienced staff to manage finance, accounts, propose and suggest to generate the revenue from the collected resources. The present staff is not capable to maintain the proper records which is responsible for insufficient planning and processing of waste management. Other professionals like environmental engineers, medical officers, security and legal personnel's are also lacking in present WM practices.

Selection of Appropriate Technique (SAT)

The treatment of produced waste depends upon its quantity, sources, physical & chemical composition, collection services, disposal facility and perception & participation of inhabitants. The sources of waste are domestic, commercial, fruit and vegetable market, fish and meat market, green waste from parks, gardens, construction & demolition etc. The physical composition includes food, plastic, paper, metal, rubber, glass, sanitary pads, napkins, diapers, wood, textile, dust, stone and inert. As per record available by MCD the maximum fraction of generated waste is biodegradable. In small cities, the most effective and efficient technique to manage the waste is manual decomposition of biowaste at decentralized level which includes kitchen waste (left overs of food and vegetables), wet paper, cardboard(non-recyclable). The rest waste is transfer to material recovery facility (MRF) for further segregation and treatment accordingly. At present both (manual composting and MRF) techniques are adapted by MCD. But the improper & manipulated record, delayed & incomplete waste collection, processing of whole generated waste, awareness & participation of residents, dedication of workers, political influence in the system are the major reasons behind inefficiency of MSWM in Dinanagar.

Marketing of Resources (MR)

Marketing of resources obtained from city waste is also become more challenging after collection & segregation of recyclable material and compost prepared from biowaste. For complete utilization of resources, an effective marketing strategy has to be designed. The compost produced at different composting plants of MCD is distributed free of cost to the citizens. The wet waste collected at MRF is further sold via waste collectors. The rate list of recyclable or resalable material is given in table 4 as per local waste collector.

Environmental & Economic Effects (EEE)

Another main effects of poor management of solid waste are environmental and economic effects. The improper planning of SWM destroy the soil, water, air and habitat. Leachate released from the openly dumped waste contaminates the soil, air and water which is very harmful for plants, animals and human. Scavengers and stray animals invade the roadside garbage and litter the waste causing aesthetic damage to the surroundings. As organic solid wastes decompose, release an unpleasant stench that pollutes the environment. Waste items such as plastic and rubber emit poisonous gases into the atmosphere. The clogging of drains by plastic trash causes water logging, which encourages mosquito breeding and the spread of diseases.

Political Role (PR)

The role of politicians is very important and influential in local areas of small municipalities. Without the support of political leaders, the proper implementation of SWM is not possible. The study area is divided into 15 wards and each ward is associated with a municipal commissioner (MC). Waste generated in each ward is given in the table 5. It should be MC's responsibility to inspect the working of MCD in the associated ward. They can promote the campaigning to aware and inspire the residents of ward. They should be more interactive with the public to resolve their problems. A responsive and dedicated leader can contribute in sustainable SWM. Both the national and local governments must make a clear commitment to waste management in order to improve the city's garbage condition. National strategies for proper waste management should be vigorously promoted. To attract more attention to this sector, the jobs available to both skilled and unskilled labour should be made more appealing. Public knowledge and education on many facets of waste management should accompany political commitment.

National Policies & Initiatives (NP)

MSWM in urban areas has emerged as one of the biggest challenge encountered by developing countries like India, in terms of not only environmental and aesthetic impact but also the potential threat to public health, resulting from improper and non-scientific handling of municipal waste. Acknowledging the magnitude of this challenge, the GoI launched Swachh Bharat Mission (SBM) on 2nd October 2014 with a goal to make India clean and open def-

ecation free. Under SBM 100% scientific management of MSW has been identified as one of the critical objectives. The GoI has taken several initiatives to achieve these objectives. As a part of these initiatives the government is facilitating Market development assistance in form of fixed financial assistance of |1500 per tonne on sale of city compost to farmers to boost sales of compost. The Central Electricity Regulatory Commission (CERC) has notified generic tariff for Waste-to-Energy (WtE) of |7.90 per unit of power and the government has mandated 100% procurement of power generated from WtE plants. These initiatives will ensure financial viability of setting up of waste-to-Compost (WtC) and WtE plants.

In order to assist cities and states to understand and effectively implement SWM systems, the Ministry of Urban Development, in partnership with Government of Germany has published the revised MSWM manual 2016, in alignment with the SWM rules 2016.

Citizen's Awareness (CA)

Inhabitants of the region are responsible for waste generation. Public awareness is critical to the successful implementation of SWM's strategic plans. The public understands and attitudes toward waste disposal have a direct impact on the SWM plan. Several academics concluded that it is a critical aspect in determining the fate of any area's waste management strategy. Local government units should stimulate citizen engagement by providing widespread information. Non-governmental organizations (NGOs) might be enlisted to help organize public awareness campaigns. It is also critical to encourage the usage of composts made from organic resources. The decomposition period of different waste materials is shown in table 3. The media has a significant role to play in public education.

Table 3: Decomposition period of waste material [12].

S.No.	Waste material	Decomposition rate
1.	Kitchen waste	10-14 days
2.	Paper	3-4 weeks
3.	Cotton cloth	2-5 months
4.	Wood	10-15 years
5.	Metal	100-500 years
6.	Plastic	more than 1 million years

Effective & Efficient Management (EEM)

The city's integrated SWM policy is a necessity for improvement. To prioritize the best waste management techniques, the MCD should use the waste hierarchy model. By developing a national strategy, it is feasible to gather the necessary resources, develop norms and processes, and establish other supporting organizations. Only a nationwide plan, which engages the entire country in developing a well-developed strategy, would provide an effective solution to the solid waste problem. SWM entails the planning and long- term implementation of all aspects of a waste management plan that are relevant to the region's waste management. The available waste management strategy must be adopted and implemented in such a way that local governments are prepared to face any issues that may arise. Innovations should also be integrated into the planning.

Waste Record & Accounting (WR)

The analysis of implementation of SWM is completely dependence upon the proper maintenance of waste record in terms of quantification, composition. Based on record, the better planning and decisions can be made for successful and sustainable SWM.

Methodology

The methodology adopted for preparing this article is mainly based on literature review and the data collected by means of questionnaire survey, interviews with citizens of different localities (low,medium and high income regions), local waste collectors, waste management staff of MCD, persons involved in commercial sector. The reason behind selecting this method is that,

Table 4: Rates of Recyclable Material

S.No.	Recyclable material	Resale rates(in Rs. per kg)
1.	Copper	350
2.	Aluminum	100
3.	Steel	35
4.	Rigid iron	25
5.	Plastic bottles	22
6.	Mix plastic	20
7.	Rigid plastic	19
8.	Light iron	18
9.	Paper	12
10.	News paper	10
11.	Cardboard	10
12.	Glass	3

Table 5: Estimated ward wise population and waste generation*Source: Municipal corporation of Dinanagar

Ward No.	Total Houses*	Population	No. of houses paying for WM*	Waste generated (in kg/day)
1.	497	2236	120	457
2.	466	2097	125	429
3.	523	2354	150	481
4.	425	1912	130	391
5.	388	1746	165	357
6.	438	1971	125	403
7.	393	1768	50	362
8.	415	1868	120	382
9.	256	1152	100	236
10.	276	1242	75	254
11.	428	1926	80	394
12.	264	1188	50	243
13.	283	1274	70	260
14.	231	1040	90	213
15.	354	1593	50	326
Total	5637	25376	1500	5188

Figure 2: SWOT analysis of WM in MCD

There is no proper record maintained by MCD. The data operator in the form of hard copies records all data manually, and by observing the figure, it was quite clear that the data is completely manipulated just to meet the guidelines issued by GOI. So, the assumed data is used as per standard waste generation value and the state wise data available at different online sites and research articles. The quantitative analysis is performed on numeric data collected from various primary and secondary locations. The qualitative analysis is further expressed and explained in narrative form based on interview, small group discussions & responses collected in structured questionnaire survey from samples selected in the categories: low, middle and high-income localities.

The SWOT analysis of present practices of MCD is briefly described in figure 2.

Quantitative & Qualitative Approach

Literature review is broadly used to prepare the questionnaire, which contains respondent's personal information like age, gender, qualification, total family members, along with the knowledge, awareness, and participation interest about SWM in city. The maximum responses are collected through Google form to follow the COVID-19 guidelines. The responses from the staff workers is collected via interview by following the measures of COVID-19 instructions that is wearing masks and maintain the precautionary distance. The questionnaire is broadly divided into three sections of indicators: 1. Inhabitants, 2. Waste management staff & Actors, 3. Policies & initial.

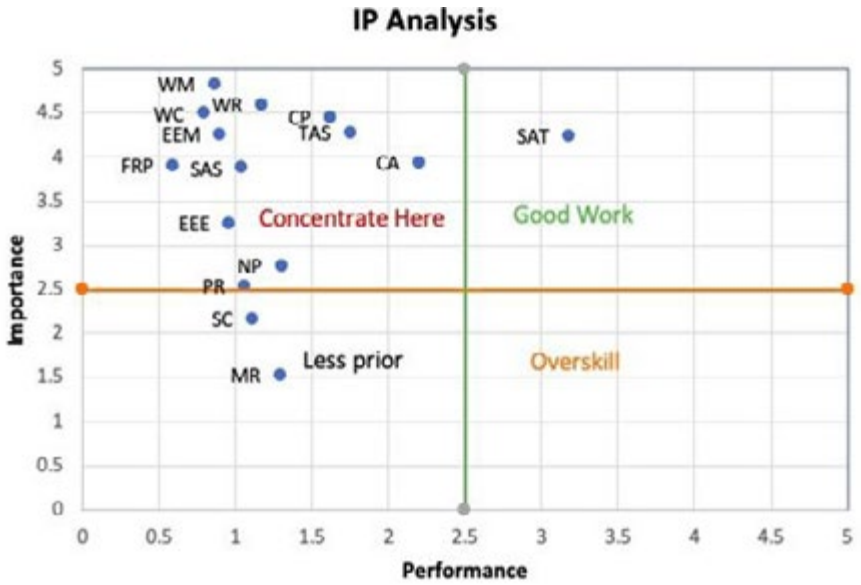

Figure 3: Quadrant chart-Importance Performance Analysis

The included questions are designed based on importance and performance of existing practices. The respondent has to give rank between 0 to 5 as per the experience and knowledge with respect to the particular question. Based on collected responses the importance-performance analysis is completed using excel and the IP chart is shown in figure 3. In table 6 the performance and importance column are representing the mean of total responses w.r.t each indicator. The internal consistency analysis of collected data is performed using R with Cronbach's alpha.

Results & Discussion

Proper Planning of SWM

The proper planning to manage the generated waste in city is a most essential part of Municipal Corporation. The first step is to maintain the record related to the waste like waste generation, sources of waste production, physical & chemical composition of waste. This data is necessary to decide the transportation services to collect the waste from primary and secondary sources. The selection of treatment facility is depending upon the composition of waste production in city. The data collection of waste by MCD from every aspect is very poor. Still the selection of appropriate technique for waste treatment is satisfactory. Mainly two waste treatment facilities are adopted.

Table 6: Importance Performance score Analysis

S.No	Indicators	Performance	Importance
1.	CP	1.62	4.45
2.	WM	0.86	4.83
3.	FRP	0.59	3.9
4.	SAS	1.04	3.88
5.	WC	0.79	4.5
6.	SC	1.11	2.17
7.	TAS	1.75	4.28
8.	SAT	3.18	4.24
9.	MR	1.29	1.52
10.	EEE	0.96	3.25
11.	PR	1.06	2.54
12.	NP	1.3	2.77
13.	CA	2.2	3.94
14.	EEM	0.9	4.26
15.	WR	1.17	4.59

By MCD, one is composting of biodegradable waste and second is material recovery facility. No doubt, these two are sufficient for treatment of collected waste but only 60% of generated waste is collected by MCD. Moreover, 65% of collected waste is treated using available facilities because of commingled waste, which cannot be segregate manually. Finally, the uncollected waste creating the several common issues like odor, choking of sewage etc and the untreated waste if dumped to open dumpsites.

The district authorities are encouraging and motivating the concept of no bins and no landfill site by focusing on the zero waste approach. Although efforts to achieve zero waste are insufficient for addressing resource, conservation challenges. The main reason for this are continued reliance on waste management approaches that have proven inadequate to address the increasing complexity of solid waste and limited data quantifying and characterizing waste generation patterns [22].

SWM involves many technologies associated with controlling waste generation, handling & storage, transportation, processing & final disposal. Ineffective management of MSW cause degradation of valuable land resources and create long term environmental & human health problems. A sufficient and sustainable waste management strategy is required to balance the need for development, the quality of human life and environment [22, 23].

Availability of Equipment & Funds

In-spite of various schemes or policies are framed for funds to improve WM services by GoI, the acceptance of grant proposal is not an easy task. The waste management problems related to small municipalities are not much important to focus on by the government. On the other end, any establishment, which depends on government funding to manage waste related services, will never be able to perform effectively and efficiently. The lack of instruments like brooms, brushes, dustpans & bins, choppers etc has led to improper cleanliness services. As per records provided by data operator of MCD, one separator machine is installed but not in functioning condition. One bailing machine is also installed which

is in functioning condition. Moreover, the three E-rickshaws, three trolleys, six cycle rickshaws and four hand carts are used for collection and transportation purposes like transfer waste from secondary point to MRF, to compost pits in local nearby areas. The number of waste bags/bins provided for collection of segregated wet and dry waste from secondary point located near PSPCL(Punjab State Power corporation limited) is 60(30 for wet waste + 30 for dry waste). The total number of composting pits is 33, out of which 26 are lying filled at different location (near municipal council(6/7), sewa kendra(9/11), singowal road(11/15)) in the city. All the composting plants are managed scientifically and the manure is distributed free of cost to people as per the demand. One MRF is also developed at singowal road, to segregate the recyclable material from collected dry waste which is further sold via local waste collectors. An agreement is also executed on 22/02/2021 between "THE SHAKTI PLASTIC INDUSTRIES, Mumbai" and MCD, district Gurdaspur for purchase/lift/process and disposal of mixed plastic waste under "The Punjab Municipal Act, 1911" and "Punjab Municipal Corporation Act, 1976".

Descriptive Analysis

Importance performance chart and scores are constituted based on responses (shown in table 7) collected from the citizens of Dinanagar. The internal consistency & validity of collected responses is performed using coefficient alpha (also known as cronbach's alpha).

Table 7: Response frequency

Indicators	0	1	2	3	4	5
CP1P	0.17	0.27	0.33	0.23	0	0
CP1I	0	0	0.02	0.07	0.35	0.56
WM2P	0.36	0.42	0.22	0	0	0
WM2I	0	0	0	0	0.17	0.83
FRP3P	0.42	0.58	0	0	0	0
FRP3I	0	0	0.17	0.07	0.46	0.3
SAS4P	0.24	0.48	0.28	0	0	0
SAS4I	0	0	0.13	0.17	0.39	0.31
WC5P	0.44	0.33	0.23	0	0	0
WC5I	0	0	0	0	0.5	0.5
SC6P	0.31	0.27	0.42	0	0	0
SC6I	0	0.54	0.04	0.13	0.29	0
TAS7P	0.17	0.26	0.32	0.2	0	0.05
TAS7I	0	0	0	0.13	0.46	0.41
SAT8P	0	0	0.3	0.22	0.48	0
SAT8I	0	0	0.08	0.08	0.36	0.48
MR9P	0.49	0	0.24	0.27	0	0
MR9I	0	0.67	0.14	0.19	0	0
EEE10P	0.22	0.6	0.18	0	0	0
EEE10I	0	0	0.15	0.45	0.4	0
PR11P	0.21	0.52	0.27	0	0	0
PR11I	0	0	0.46	0.54	0	0
NP12P	0.19	0.32	0.49	0	0	0
NP12I	0	0.37	0	0.12	0.51	0
CA13P	0	0.27	0.41	0.17	0.15	0
CA13I	0	0.09	0.05	0.14	0.27	0.45
EEM14P	0.41	0.28	0.31	0	0	0
EEM14I	0	0	0	0.14	0.46	0.4
WR15P	0.22	0.39	0.39	0	0	0
WR15I	0	0	0	0.05	0.31	0.64

Table 8: Internal consistency analysis (-) indicates the reverse order of ranking

Indicators	alpha	correlation	mean	sd
CP1P-	0.67	0.254759	3.38	1.022771
CP1I-	0.67	0.233417	0.55	0.715979
WM2P	0.66	0.417917	0.86	0.75237
WM2I	0.68	0.117238	4.83	0.377525
FRP3P-	0.65	0.459812	4.42	0.496045
FRP3I-	0.69	0.04228	1.11	1.023906
SAS4P	0.67	0.301158	1.04	0.723627
SAS4I	0.67	0.227993	3.88	0.997775
WC5P	0.66	0.364242	0.79	0.795124
WC5I-	0.67	0.30323	0.5	0.502519
SC6P	0.64	0.590311	1.11	0.851558
SC6I	0.64	0.673897	2.17	1.348812
TAS7P	0.68	0.18003	1.75	1.242147
TAS7I	0.67	0.174783	4.28	0.682834
SAT8P	0.69	0.021649	3.18	0.868995
SAT8I-	0.65	0.525136	0.76	0.911431
MR9P	0.66	0.412223	1.29	1.320354
MR9I-	0.67	0.235712	3.48	0.797471
EEE10P-	0.67	0.195442	4.04	0.634369
EEE10I	0.68	0.136521	3.25	0.70173
PR11P	0.66	0.410833	1.06	0.693695
PR11I-	0.66	0.339648	2.46	0.500908
NP12P	0.66	0.389869	1.3	0.771984
NP12I	0.68	0.127879	2.77	1.398809
CA13P	0.68	0.176834	2.2	1.005038
CA13I-	0.65	0.53882	1.06	1.269853
EEM14P	0.68	0.149841	0.9	0.84686
EEM14I-	0.66	0.373542	0.74	0.690776
WR15P-	0.66	0.301907	3.83	0.76614
WR15I-	0.67	0.154316	0.41	0.587668

Table 9: χ^2 test at 95% level of significance

EEM with other indicators	χ^2	df	*p*-value
CP	17.629	6	0.007229
WM	11.189	4	0.002452
FRP	1.021	2	0.6002
SAS	8.2861	4	0.08164
WC	9.5515	4	0.0487
SC	16.361	4	0.002571

TAS	32.202	8	8.57E-05
SAT	20.813	4	0.0003449
MR	12.913	4	0.01171
EEE	0.65504	4	0.9568
PR	3.5048	4	0.4771
NP	47.083	4	1.47E-09
CA	12.959	6	0.04369
WR	1.9134	4	0.7517

Phase is 0.65-0.69 with respect to each indicator. As shown in table 8. The significance of defined indicators with effective & efficient management is also done using chi-square test shown in table 9. Importance performance analysis of 15 indicators is represented in figure 3 in the form of quadrant chart. The quadrant chart is divided into four sections: first, second, third and fourth quadrant divided as good work, concentrate here, less prior and possible over-skill respectively. The indicator defined as selection of appropriate technique is lying in first quadrant, which means the treatment facilities presently used by MCD are satisfactory. Presently, MCD has adopted composting of organic waste and material recovery facility for other waste materials. IP analysis shows that the indicators SC (Service charges) and MR (Marketing resources) are lying in less prior category. Rest of the 12 indicators are required to focus for improved and better working of municipal solid waste management in Dinanagar city. The IP scores are given in table 6.

Conclusion

The study, which had the explicit goal of analysing the implementation of several SWM programs in Dinanagar city, discovered that improper record about quantification, collection, treatment and disposal of wastes, personnel facilities, and public, political commercial sector commitment all had a substantial impact on the success of solid waste management implementation. The study also revealed some administrative issues such as a lack of resources, unscientific land for final waste disposal, a lack of an effective and efficient solid waste management plan, public awareness, staff training, and poor enforcement of laws and regulations. For effective and successful waste management in the Punjab city of Dinanagar, adequate resources, encouraging workers, providing monetary incentives for recyclable items, developing a strong policy, incorporating technological innovations, political leadership support, encouraging waste reduction, composting, and recycling techniques have been recommended. Other linked areas that have a direct impact on the city's SWM but are understudied were discovered. The topics include waste management finance and revenue from local sources, commingled waste analysis in the city, and adequate logistics and modern technologies for SWM to be used in the city. Future research will focus on urban growth and related concerns in order to gain a better knowledge of these difficulties and find solutions for enhancing environmental sanitation and long-term development in small cities like Dinanagar.

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