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Analyzing Barriers Faced by Government Institutions Regarding Solid Waste Management in Karachi

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ABSTRACT

The study identifies the barriers that have led to ineffective and inefficient solid waste management in Karachi. This qualitative study was done using the interpretivism approach. Structured interviews with individuals who belonged to governmental institutions, i.e. SSWMB, KMC, DMCs, and the Cantonment Boards of Karachi, were conducted. After using thematic analysis, the major factors affecting waste management were developed and categorized into 6 areas. This study reveals that there is a strong institutional framework, to run the operations. The major factors that led to ineffective solid waste management are inadequate infrastructure, weak strategic planning, and lack of commitment to the targeted task assigned, non-existence of proper fee collection, challan system, political influence, and non-delegation of authority. There is not much cooperation and participation of the general public, shopkeepers, commercial institutions, and hospitals, in solid waste management activities. This study further, determines Scavengers, Shepherds, Afghan and Builder mafias are major barriers to waste management activities in Karachi. The findings of this research will be useful for the stakeholders in decision and policy-making and will improve the solid waste management system

Introduction

Solid waste management refers to waste in a solid form that is produced by households and non-dangerous solid waste from industries, commercial activities, hospitals, and street sweepings (Henry et al., 2006; Schübeler, 1996). Due to urbanization, expansion in population, fast-growing activities, the amount of solid waste increasing (Staley & Barlaz, 2009; United Nations Environment Programme, 2009). It is a nuisance and burgeoning trouble for local and national Governments to ensure effective, efficient, and sustainable management of waste (Aleluia & Ferrão,

2016). Local Governments should pay more attention to segregation, transfer, sorting, treatment, recovery, trading, and disposal of waste, in an integrated manner (Aparcana, 2017).

Insufficient solid waste management processes can create an unhygienic environment that can impact human health moreover it can cause contamination and blocked drainage that may invite insects' attraction, rodents, and flooding(Aleluia & Ferrão, 2016; Henry et al., 2006; Zaman & Lehmann, 2011). Impacts on human health include transference of infection, personal injuries, and other diseases(Hashemi et al., 2014). Inadequate disposal of solid waste may increase operational and disposal costs (Oguntoyinbo, 2012).

Currently, SSWMB is collecting and disposing of waste of an entire city of Karachi, through contractors by procurement M/S Hangzhou Jinjiang Group of sanitation Services Co.Ltd (DMC Malir & West) and M/S Changyi Kang Jie sanitation Engineering Co Ltd (DMC East & South) employees under the control of SSWMB manage and collet waste from houses and bring it to Micro and Macro waste points and perform road sweeping, contractors pick waste from waste points and dispose it to GTS and Landfill sites, however, Districts Korangi and Central manage solid waste through their Sanitation Departments and dispose waste of areas, under their jurisdictions and dump waste at GTS and landfill sites directly. Staff and machinery of both Districts, like other Districts of Karachi, are under process to be given to SSWMB. There are six cantonments in Karachi, they manage and dispose of their waste under their jurisdictions and pay to dump costs to SSWMB for disposal of waste at GTS and Landfill sites of SSWMB and KMC.SSWMB also does not collect waste from industries and hospitals. After the establishment of SSWMB, the domain of KMC is cleaning of natural drainage channels(Nullahs) and incineration of hospital waste .B&R department of every DMCs of Karachi also clean small natural drainage channels(Nullahs) under their jurisdictions. Cleaning of some important roads of Karachi is under the control of KMC. Green waste of Karachi is being managed separately by the Department of parks of KMC. There are some foreign-funded projects Click and Sweep that contribute to waste management and cleaning of drainages of Karachi. The institution of the Military of Pakistan also participates in strategic planning with these departments regarding solid waste management.

Solid waste management has been a topic of debate by the stakeholders of Karachi, after the 18th amendment the Government of Pakistan formally decentralized many functions from central to provincial Governments, consequently, the provincial and local Governments of Sindh have primary responsibility for solid waste management, within its governed areas. Therefore Sindh Government established the Sindh Solid Waste Management Board under SSWMB Act 2014 (Assembly et al., 2014) to serve the whole province having complete responsibilities of solid waste management.. There are five garbage transfer stations Qasba, Baldia Town, Sharafi

Goth, Dhobi Gath, and EBM causeway) and two landfill sites (Jam Chakro and Gond Pass).

The board does not collect garbage from Hospitals, Industries. Karachi Port Trust, Defense Housing Authority Karachi, DMCs Central& Korangi, and other Cantonment areas of Karachi. The domain of KMC is cleaning of natural drainage channels and incineration of hospital waste. There are six cantonments in Karachi, they manage and dispose of their waste under their jurisdictions and pay dumping costs to SSWMB for disposal of waste at Garbage Transport System (GTS) and Landfill sites of SSWMB and KMC. There are no reliable current trash generation statistics available, however 12000 tonnes per day was reported by (Mahmood & Khan, 2019) With the increasing development of population and economic activity, the amount of solid waste is predicted to significantly increase. Solid waste generation is expected to reach 16,000 to 18,000 tons per day by 2020, according to estimates UNESCAPE, (2013). According to Khatri et al., (2021) waste generation of Karachi is 16000 tons.

SSWMB with its team and through contractors performs a door-to-door collection, Manual sweeping of internal roads and streets, mechanical sweeping of main roads, mechanical washing of main roads, placement of dustbin equipped with e-chip and connected with command & control, real-time movement of all garbage vehicles. The SSWMB has established a complaint management system and awareness program for the community. The core objectives of SSWMB are transportation, collection, reduction, reuse, recycling, resource recovery, and incineration, landfilling, segregation, transfer, sorting, treatment, recovery, trading, and disposal of waste, in an integrated manner.

In reality, ever-increasing contributing factors at commercial, household, and industrial levels, the amount of negative externalities all over the metropolitan has contributed towards civic and health issues, exacerbated by the Government and public apathy. Therefore, concerning waste management authorities are indispensable for effective disposal of solid waste in Karachi and for providing a healthy, hygienic, and fulfilling environment to the city

The focus of this study is to determine the barriers to effective solid waste management in Karachi. Moreover to highlight the issues caused by ineffective management of solid waste such as health issues, non-generation of revenue, defacement of the beauty of the city, waspish behavior, cause of arguments and altercations, etc.

Literature Review

Afzal, (2021) reported numerous challenges are present in the existing solid waste management system of Karachi, as a result, it has never shown better improvement, same can be managed to apply geographic information systems in waste management activities. Additionally benefits of GIS was also reported by (Khan et al., 2018)

According to Iqbal, (2021), reselling the 16,550 kg of total recyclable garbage generated by the institution can yield roughly 252,012 Pak Rupees. Overall, the findings of his study showed that there is significant potential for the university to move toward a self-sustaining integrated system of solid waste management, which can be accomplished by implementing the proper waste collection, segregation, waste reselling, and composting systems suggested in this geographical study. The same case can be applied in Karachi. In addition to UNESCAPE, (2013) study for solid waste management revealed that there should be waste disposal charges on disposal of solid in Karachi. According to Aslam et al., (2021) Karachi's solid waste management system is in terrible shape and requires major upgrading. The active engagement of local governments and all demographic groups is required for the qualitative enhancement of SWM. To maintain the waste management system's cost and sustainability, trash reduction initiatives must be encouraged with the participation of the informal sector.

The theoretical framework used by Yukalang et al., (2017) is based on the Integrated Sustainable Waste Management (ISWM) model, which "requires integrated studies of complex and multi-dimensional systems"(Yukalang et al., 2017). This method integrates three main dimensions for analyzing a waste management system: first, the inclusion of management site stakeholders with an interest in solid waste management, second, an understanding of the movement of waste materials from generation to final disposal, and third, the identification of aspects that frame the study (such as technical & physical, organizational, socio-cultural, financial and legal & political barriers) (Aparcana, 2017). The model's application has aided in identifying obstacles to successful solid waste management in Karachi. Identifying the barriers can aid in the creation of solutions to waste problems in this metropolitan city as well as in other newly urbanized areas with similar issues, resulting in improved solid waste management effectively and efficiently.

There must be more accountability between the people and the government, as the public does not have easy access to information about the government's factors or actions. For the government to run correctly, both computerized and manual data should be retained, and this will aid future governments by allowing them to be aware of projects. After talking with concerned authorities, it was discovered that no computerized data of solid waste of Karachi is preserved. To make work more efficient, relevant staff should be hired. (Mahmood & Khan, 2019). Socio-economic

benefits can be taken by the implementation of a comprehensive solid waste management system that is predicted to have a significant positive impact on the city's socio-economic situation. The construction of waste-to-energy and formal recycling sectors will provide new jobs for city people and have a favorable impact on the city's economy as a whole. People's livelihoods, as well as their general health and well-being, are predicted to improve as a result of sustainable solid waste management in Karachi (Khan et al., 2018).

According to Khatri et al., (2021) Pakistan has a huge potential for generating electricity from renewable energy sources. According to this study, the Karachi municipal committee disposes of about 5,480,000 tonnes of combustible solid trash every year in the city of Karachi, which can generate 1263.372 MW of electricity. This may be utilized to address the city's 633 MW energy gap. In comparison to other traditional ways, solid waste characteristics suggest that new generation incineration technology is the most reasonable technology to utilize in Karachi since it effectively provides clean energy. Incineration can supply Karachi's ever-increasing energy needs while also reducing the aggregate amount of solid trash by 95 percent.

Material and Methods

This qualitative study was done using the interpretivism approach. Sixteen structured interviews with individuals who belonged to governmental institutions, i.e. SSWMB, KMC, DMCs, and the Cantonments Board of Karachi, were conducted using purposive sampling technique.

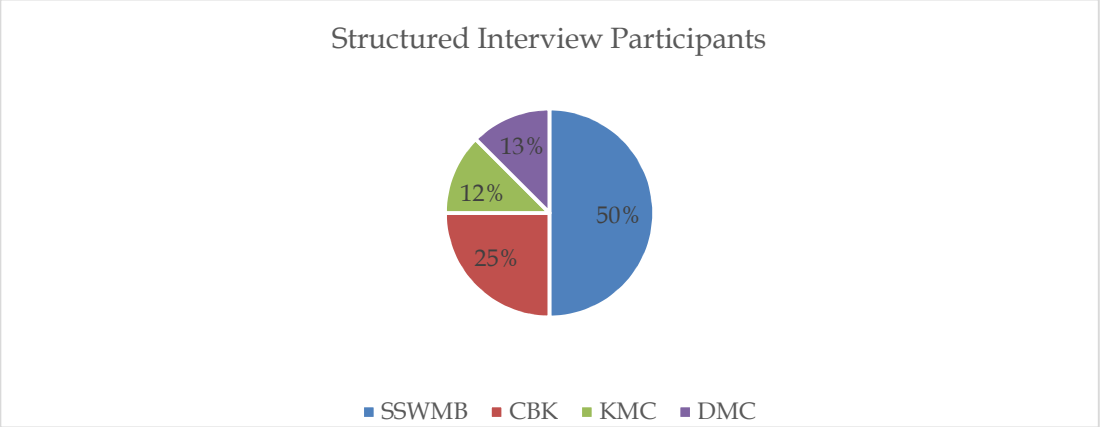
Data was gathered from a variety of sources using a variety of techniques including interviews of the persons involved in managing solid waste, observation, and site visits to understand the perspectives and perceptions of participants concerning solid waste management in different areas of Karachi city and to prevent biases. The research was carried out in the jurisdiction of Karachi. This study reflects the perspectives of the key personnel's of the management of solid waste, including Sindh solid Waste Management Board (SSWMB), different cantonment boards of Karachi like Cantonment Board Malir (CBM), Cantonment Board Faisal (CBF), Cantonment Board Clifton (CBC), Cantonment Board Karachi (CBK), and Karachi Municipal Corporation (KMC) and two District Municipal Corporation (DMCs) of Korangi and Central.

Fieldwork took place in June and July 2021, researcher conducted 16 interviews. The sample size of 10 is appropriate for qualitative research (Sandelowski, 1995) According to Marshall et. al. (2013) the sample size of twelve interviewees can be enough for data saturation in qualitative research.

The meetings were executed with high-ranking executives like Secretary and Directors SSWMB Directors KMC and DMCs, concerned officers of cantonment

boards, in addition to, some interviews were taken from officials also. The researcher took field notes. Attending meetings gave the researchers the chance to get to know about all waste management activities. In addition to waste collection points were also observed. The researchers even visited the landfill sites. Each interview took between 60 to 80 minutes to complete. Researchers note down the interview answers in the diary and probed them for thematic analysis (Thomas & Harden, 2008)

Sampling Framework



Structured Interview Participants	Number of Participants
Sindh Solid Waste Management Board (SSWMB)	
Officers	03
Officials	05
Cantonments Boards Karachi (CBC,CBM,CBK,CBF)	
Officers	04
Karachi Metropolitan Corporation(Municipal Services-KMC)	
Officers	02
Korangi and Central (DMC's)	
Officers	02
Total	**16**

Results and Discussion

The results are presented in the following section.

Technical and Physical Barriers

Residents can properly dispose of their garbage with the help of a well-functioning waste management system. The facilities and equipment used to temporarily store garbage (collection bins) or move collected waste to its eventual disposal location are components of a waste management system. (Yukalang et al.,

2017). The sections that follow describe the primary technological and physical difficulties to solid waste management that interviewees highlighted.

Insufficient Waste Collection Points

An issue of insufficient Waste Collection Points was cited by 10 interviewees (60 percent) as the most common obstacle to effective waste management. Three respondents mentioned that "Some mafias and influential groups create troubles and make influence to remove waste points in the city". Another interviewee told that "Sufficient Garbage Transfer Stations and Landfill sites were not established in Karachi to cope up the requirements of the increasing population". In contrast, it was told by Secretary SSWMB that "the construction of six modern GTSs in Karachi with Material Recovery Facility (MRF) and rehabilitation of two existing conventional landfill sites is under process".

Source: https://tribune.com.pk/story/1253428/dmc-korangi-model-kachra-kundis-built

Uncertainty of Waste Collection

In Karachi, waste collection routes are divided into seven areas, where trucks collect waste in each zone from Monday to Saturday. Although each truck has a set of collection routes, they sometimes fail to complete their daily tasks. During an interview it was told by the Secretary SWMMB that "tasks are being computerized to keep watch over waste collection activities, it was further told that SSWMB has installed trackers on trucks and there is a mobile application to track waste management activities to reduce uncertainty". On the other hand it was informed by three respondents "The situation of Karachi like poor infrastructure, political uncertainty, traffic problems, are the elements that have been caused uncertainty of waste collection"

Source: https://www.dawn.com/news/1429029

Waste Collection Vehicles Deficiency

The landfill sites are about 25-30 km away from the collection points, and there is no effective and organized waste transfer station where waste can be collected for sorting. Because of the distance between the landfill and the amount of waste produced each day, waste collection trucks only make a few trips to the landfill each day.

Among all interviewees (70 percent) said that waste collection trucks are insufficient and it is an obstacle to successful waste management. Additionally, it was reported by another responsible officer of SSWMB that "in 4 Districts of Karachi waste is being picked by a contractor who has sufficient vehicles to some extent, but especially in Districts Korangi and Central, vehicles and resources are deficient". Likewise, Director Korangi and Central districts Karachi informed that "Tenders for collecting waste in these Districts will be called soon. Machinery and employees will also be given to SSWMB like other districts of Karachi,"

Source: https://www.brecorder.com/news/40049245

Long Distance Landfill Sites and Traffic Congestion

10 interviewees (60 percent) said that long-distance landfill sites are also one of the biggest physical barriers in solid waste management. The landfill sites are about 25-30 km from the collection points. During this, outback cycle these trucks also cause traffic congestion problems, and due to this long-distance the operational cost increases, waste collection trucks only make a few trips due to traffic jams. One of the interviewees stated that "alternative techniques to dispose of waste should be adopted that can save time and money" Similarly two respondents suggested that "waste can be segregated at designated Kachra kundis for recycling and substantive materials can be sold to vendors, doing this the volume of waste can be reduced for disposal moreover, revenue can also be generated by doing this activity"

Inadequate Waste Bin Access

Waste bins are mounted along the curbside by service providers of solid waste management, ready for collection by waste trucks. Inadequate waste bin access was highlighted, by 11 interviewees (70 percent). Director DMC central stated that "there is no awareness to dispose of waste properly". In the same way, three respondents mentioned that" "People used to through waste in their streets they do not bother to access proper waste points. Even maids and manservants do not through waste in proper designated Kachra Kundis." (Waste points)

Burning and Illegal Dumping

Director KMC told that "People dispose of their waste materials on their own by burning it or dumping it in improper places. Burning waste is harmful to health and the environment moreover, people through garbage in natural drainage channels (Nullahs), this cause a great barrier to waste management, relatively the cost to clear Nullahs is very high as compared with normal waste management." The same information was provided by the four officials of SSWMB they informed that "people dump waste behind of their houses and in vacant plots or even in playgrounds this act create difficulties in the waste management activities".

Source: https://www.dawn.com/news/742634/the-sea-and-the-sea-of-garbage

Source: https://www.newsweekpakistan.com/government-forms-committee-to-resolve-karachis-issues/

Improper Facilities for Waste Separation

Waste separation is a crucial method for reducing the volume of solid waste. Since dumping is expensive, service providers' management wishes to reduce the amount of waste that goes to the Jam Chakro and Gond Pass landfill sites. Two interviewees highlighted that "waste separation is an important part of waste management". All respondents (100 percent) mentioned that "there is no structured waste separation system in place."

Amount of Waste

"The sheer amount of accumulated waste is a primary obstacle for successful waste management" expressed by fourteen interviewees (90percent). They told that "The use of disposable items is continuously enhancing in the society resultantly the amount of waste is also intensifying additionally, multiplying population is also alarming in this regard". According to Aslam et al., (2021) between 2017 and 2019, the solid waste generation increased from 10,435 to 15,600 metric tonnes per day (TPD).

Source: https://www.thenews.com.pk/tns/detail/564121-garbage-city

Space Constraints

The space constraints issue was highlighted by 6 interviewees (40 percent). Some interviewees stated "due to rapid increase in construction without town planning have made situation worsen to manage this megacity" likewise one interviewee also addressed "network of smaller roads are a hurdle in managing waste, residents through waste in backstreets instead to through in designated dustbins this habit of peoples is a noteworthy hurdle to dispose of the solid waste, many main roads connect a web of smaller roads and alleys is again barrier in solid waste management, as it is difficult to go in narrow streets to collect waste."

Additionally, one interviewee expressed that "due to increasing traffic congestion, waste collection trucks can find it difficult to collect waste. Furthermore, some of the alleys are impassable to clear due to encroachment and parking, thus trucks only collect trash from key or easily accessible highways/roads.

Limitation and Delimitation Issue

The limitation and delimitation issue was stated by 5 interviewees (30 percent). This issue arises when two service providers like the cantonment board and municipal cooperation have issues on the limitation and delimitation. Some people and municipal workers deliberately threw their solid waste into others' territory so that they would be free from collecting this waste as it's not present in their limitations now. This barrier causes solid waste to remain there for several days.

Socio-Cultural Barriers

Solid waste management issues are intimately tied to community engagement and awareness. According to the literature, encouraging people to participate increases awareness, input, and reception. (Staley & Barlaz, 2009). Socio-cultural obstacles relate to the social and cultural variables that influence people's actions

refers to lack of interest, low cooperation, lack of concern about waste management, and negative attitudes

Participation Deficit

Interviewees in this study believed that the public is not accurately disposing of garbage and do not care to separate waste moreover residents are reluctant to attend government-sponsored special meetings and tanning workshops where they can learn, how to handle their waste. Low public participation was indicated by all 16 interviewees (100 percent).

Failure to Cooperate

(90 percent) interviewees reported that cooperation of the general public and other commercial institutions such as shop keepers, hotel owners, big malls, hospitals, marriage halls, do not exist. There is also a lack of involvement by private companies in waste management activities.

Negative Attitudes

Respondents in the study highlighted the negative attitudes of the general public in the waste handling and disposing of the process. They do not care about the proper disposal of waste and blame each other for mishandling, people through their waste directly on the streets without feeling any guilt. This negative attitude of the general public was reported by 14 interviewees (90 percent). One interviewee expressed that "he has faced many disputes with the general public as they were unwilling to through waste at the proper place which was nearby with their homes".

Lack of concern for waste management

This issue was reported by (70 percent) of respondents. People do not want to spend their little money on the management of the waste even they do not bother to purchase a dustbin. Some interviewees stated that "people dispose of waste in piecemeal, they have no plan or strategy to dispose of the waste". One of the interviewees further disclosed that "the people mix all waste and do not take care to separate waste for any productive use"

Organizational Barriers

Many interviewees said that efficient waste management is hampered by organizational impediments that are discussed below:

Lack of Planning and Strategy

One of the interviewees disclosed that "there is a gap between planning, making strategies, and implementation". Two interviewees added that "SSWMB since its establishment failed to make various rules and regulations for the operational, administrative, human resource, and financial management for smooth functioning of the waste management activities." It was further reported by an officer during his interview that "there is an overlapping of municipal service functions among SSWMB and other Government departments."

Inadequate Policy

It was reported by 4 interviewees (25 percent) "the Government schedule of tariff, rate, charges, or fees levied has not been prepared yet resulted in a non-generation of potential revenue, which constituted weak administrative and financial management." One interviewee also addressed "there is a need of strategic policymaking and practical objectives followed by proper check and balance time to time"

Financial Barriers

It is vital to consider financial concerns while developing a solid waste management system. This relates to waste fees, including the public's capacity and desire to pay, as well as the ability of concerned departments to collect fees; and it also refers to the public's perception of waste value. Financial restrictions, according to the majority of participants, are one of the primary hurdles to efficient solid waste management in Karachi.

Non-existence of Waste Management Fee /tax

Three respondents mentioned that "the Government schedule of solid waste tariff, rates, charges, fees against the disposal of solid waste and structure to impose fines in case of any irregularity committed by anyone, has not been finalized yet, which is the immense barrier." Two interviewees added that "there should be a mechanism to impose fine in case of irregularities made by the public while improperly disposing of waste. Without having the authority to make challan against them, miss management cannot be handled"

Waste Has No Value

It was confirmed by the 13 respondents (80 percent) that "no any kind of revenue is being generated currently by any kind of power generation, segregation of recycled material from the waste collection, treatment, sale purchase, or disposal of any kind of waste." In comparison, some interviewees reported that "Afghan Mafia is generating a lot of revenue out of waste." When this situation was discussed with the

secretary SSWMB, he told that some projects are under consideration for implementation. The detail of these projects is given below

i. Debris will be picked up separately and will be brought to crushing plants

ii. Cow dung will be collected separately and will be utilized to generate revenue

iii. After segregation waste will be utilized to make energy (biogas, electricity, etc)

Legal and Political Barriers

Some legal and political barriers are a substantial hindrance to the management of solid waste

Inadequate and Weak Legislation

Four respondents mentioned that "we have no powers to regulate management activities as we cannot take any substantive action in case of any irregularity made by the public against their iterative behavior, they emphasized that there is a need for robust laws and SOPs to manage solid waste system"

Scavengers, Shepherds, Afghan and Builder mafias

"Scavengers, Shepherds, VIP Culture Afghan and builder mafia are the substantial barrier in solid waste management reported by 16 interviewees (100 percent) moreover, these mafias make a direct and indirect influence in solid waste management activities." Two interviewees added that "Scavengers and Afghanis are making too much money from the solid waste of Karachi. It is an industry for them. They segregate waste from Kachra Kundis and take valuable items after spreading non-substantive material here and there." One of the interviewees further disclosed that "shepherds also open out dustbins and disperse waste to find food for their animals. Moreover, builders make influence to remove Kachra Kundis in front of their buildings"

Growth of the Population

The quantity of rubbish produced in Karachi has increased in tandem with the city's growing population. Urbanization, increasing birth rate, frequent migration from other cities have created huge mismanagement for proper disposal of solid waste reported by 10 interviewees (60 percent).

Discussion

In this study, various themes were generated based on responses regarding solid waste management in Karachi. It was found that technical and physical Barriers, organizational barriers, social-cultural barriers, financial barriers, legal and political barriers, population growth are the main barriers to effective and efficient management of solid waste activities in Karachi. The technical and physical barriers were reported by (Afzal, 2021) moreover organizational barriers were highlighted by (Mahmood & Khan, 2019) socio-cultural barriers, financial barriers, legal and political barriers, population growth was robustly analyzed by(Yukalang et al., 2017). The outcome of the solid waste management process becomes unsuccessful due to a lack of funding and inefficient solid waste management. In Karachi, garbage collection and disposal equipment and manpower are insufficient (Sabir et al., 2016). The air quality, particularly at Jam Chakroo and Gond Pass, is extremely poor, the overall environmental condition is getting worst and the solid waste of Karachi is the main contributor to it(Abbasi et al., 2015). Garbage in Karachi is disposed of in two dumpsites in the north: Gond pass and Jam Chakro. Every day, the city generates approximately 12000 tonnes of rubbish. Only 4000 tonnes of this end up in landfills. The rest is burned in vacant lots, lawns, parks, and along highways(GEO News, n.d.).Solid waste management is far more than a technological problem. For the planning and operation of a sustainable solid waste management scheme, it is critical to understand and consider the environmental impact, financial and economic calculations, social and cultural challenges, as well as the institutional, political, and legal framework. (Zurbrügg, 2003)

Conclusion

Technical and Physical, Socio-Cultural, Organizational, Financial, and Legal &Political barriers are impeding the progress of efficient and effective solid waste management in Karachi, therefore strategies must be developed by concerned departments and policymakers, to cope up with this pathetic situation. All organizations dealing with waste management in Karachi have to ensure proper disposal of waste and provide a healthy, hygienic, and fulfilling environment to Karachi

Proper governance and long and short-term planning and strategizing are critical for the performance of these organizations. Instead of multiple agencies having overlapping responsibilities, SSWMB in Karachi should be under a single governing entity for effective implementation. Data availability and analysis regarding the volume of solid waste, its composition, trends, and its future projections including a proper feasibility study before initiation of any project is critical for effective strategizing of solid waste management in Karachi.

The availability of adequate human resources and their management is critical for effective performance. Proper and strict monitoring and evaluation, should be ensured for efficient and effective implementation of policies. SSWMB should not dependent on Government funding, instead, it should focus on self-generation of revenue from levy/charges for the lifting of solid waste from the city. Moreover, revenue can also be generated by selling substantive materials.

Waste materials can be converted and reused in a variety of ways (MDC, 2020), moreover, electricity can also be generated by the solid waste of Karachi (Khatri et al., 2021). This study's results will aid SSWMB, municipal departments, Cantonments, and policymakers in developing efficient and adequate solid waste management for Karachi city. This research could pave the way for the creation of new waste management strategies and frameworks.

Recommendations

The concerned institutions must work hard to implement effective recycling and composting initiatives. Getting people to think about the importance of waste and think twice before throwing stuff away will help to minimize waste volume dramatically (Zaman & Lehmann, 2011). All private-sector recycling activity is based on the "valuation" of materials, which means that even if an item is thrown away, it retains some value. Separating waste into recyclables, organic waste, and general waste has proven to be effective in other situations.

Relevant departments should start some awareness programs, developing and upgrading a waste management system has to be established (Staley & Barlaz, 2009). The proper collection of waste is an important element that must be ensured. Waste collection is one of the most important functions of concerned departments (Zaman, 2014). Waste bins can be color coded like blue, for paper recycling, green for organic recycling, red for land fill waste etc. for proper segregation and earning revenue by garbage.

In addition to Sindh Solid, Waste Management Board (SSWMB) must redesign its waste collection system and develop a consistent strategy that includes reducing waste generation, improving waste collection, transfer, and transportation to a final disposal site. Moreover, electricity can be generated from solid waste. According to the findings of a study conducted by Khatri et al.,(2021), 1263.372 MW of power may be generated from the city's 16,000 tons of waste Likewise, benefits can be taken after recycling solid waste.

Furthermore, there should be a permanent program to aware people regarding the disposal of waste on TV and news channels. In line with there should be one session of 20 minutes in a weak in all schools in which students should be aware regarding proper disposal of waste, this will surely be a grass-roots activity, second

parents will also learn from their children. Besides, that banner should be placed at different places to spread consciousness about the proper disposal of waste. Awareness-driven mobile messages can play a very significant role to the aware public about waste management. On the other hand, the authority should be delegated to concerns to impose penalties and issue challans.

At present, management of waste to a great extent is being done through procurement by contractors M/S Hangzho Jinjiang Group of sanitation Services Co.Ltd (DMC Malir & West) and M/S Changyi Kang Jie sanitation Engineering Co Ltd (DMC East & South) should be managed by SSWMB itself in a long run.

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