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Evaluating the Determinants of Municipal Solid Waste and Impacts of Dumping Site on Communities

Zahid Saqib*, Rashid Saeed and Muhammad Qasim
Department of Environmental Sciences, University of Gujrat, Hafiz Hayat Campus, Gujrat-50700, Pakistan

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Abstract. Solid waste (SW) is produced by domestic, commercial, construction and demolition activities due to an increase in population size and urbanization. Solid waste management (SWM) is a major challenge for cities in Pakistan because of the increasing generation of solid waste and its poor management practices. This study calculated the determinants of solid waste and measures the impacts of dumping sites on nearby communities by devising a questionnaire technique. The secondary sources of data included a comprehensive literature review of SWM. The results of this study identified the collection mechanisms for solid waste and the harmful impacts of solid waste on agricultural land, human health, biodiversity loss, groundwater pollution and air pollution. The variables of SWM were tested by statistical analysis, *i.e*., the ANOVA test, identified the difference among the means of the variables at $P<0.5$. The pearson correlation analysis of variables identified the relationship among the variables of SWM at $P<0.5$, for 500 respondents. Factor analysis provided the eigenvalues, the KMO measure of sampling adequacy, Bartlett's test of sphericity and the Total Variance Explained (TVE) at $P>0.5$, $n=500$ for the larger data set. In Pakistan, about 5 million people have died because of solid waste-related disorders. About 20 million tonnes of solid waste is generated in Pakistan every year, with an annual growth rate of 2.4%. By improving management, enforcing laws, properly planning dumping sites and adopting cost-effective methods, we can save ourselves and future generations from the harmful impacts of solid waste.

Keywords: population size, impacts, air pollution, factor analysis, management, cost effective

Introduction

The term solid waste can be described as non-liquid and non-gaseous products that are discarded by humans (Bing *et al*., 2016). Solid waste management is the process of collecting, treating and discarding solid material (Guerrero *et al*., 2013). These are the activities required to manage waste from its beginning to its final disposal (Khan and Abbas, 2014). Municipal solid waste is composed of organic (fruit and vegetable covers) and inorganic (wood, paper, plastic) forms, excluding medical, industrial and agricultural waste (Das *et al*., 2021). The quantity and quality of generated waste depend upon the human consumption pattern, such as living standards, socio-economic status and behaviour (Jin *et al*., 2006; Leton and Omotosho, 2004). The aim of solid waste management is to collect, follow treatment procedures and dispose of waste properly (Altaf and Deshazo, 1996). The improper disposal of solid waste management (SWM) can create many issues, such as air pollution, groundwater pollution, cleaning issues, public health issues, spreading diseases and littering issues (Zhen-Shan *et al*., 2009). This is how social and environmental degradation occurs (Wilson *et al*., 2012). The generation of waste is influenced by family size, the standard of living, education level and monthly income (Ojeda-Benítez *et al*., 2008). The accelerated growth of population, the solid waste increases of communities and thus difficulties becomes increases to the management of solid waste (Babayemi and Dauda, 2009). Excessive consumption of resources is a major problem of waste management, which causes threats to health and the environment and needs to be managed effectively (Liang *et al*., 2021).

Increasing population and migration towards urban areas are causing an increase in solid waste production (Ali *et al*., 2014). The generation of solid waste from urban areas is almost 90% that is disposed of in open areas, where it accumulates, causes various diseases and damages the environment (Babayemi and Dauda, 2009). About 55,000 tons per day of solid waste are generated in the urban areas of Pakistan (Ashraf *et al*., 2016). The improper disposal of solid waste may cause various diseases, such as vector-borne diseases, which mainly occur because of mosquitoes, flies and insects, which cause public health issues (Rong *et al*., 2017; Zhen-Shan *et al*., 2009). Uncontrolled municipal solid

*Author for correspondence;
E-mail: zahidsaqib12@gmail.com

waste can enhance the breeding of dengue mosquitoes (Khalid and Ghaffar, 2015). In 2010, about 40,000 cases of dengue virus infections were reported, among them, 17,256 cases (with 279 deaths) were registered in Lahore (Khan and Abbas, 2014). Solid waste is disposed of in open areas, where it creates various health and environmental degradations (Shekdar, 2009). Open dumping, burning and landfills are common solid waste management practises in Pakistan (Tan *et al*., 2015). Dumping sites produce pungent smells and cause illness in nearby communities (Korai *et al*., 2016). Moreover, disposal sites can create serious health issues in nearby societies (Ayeleru *et al*., 2018).

The municipal solid waste management (MSWM) authorities face various difficulties in the management of solid waste because of a lack of expertise, the law and its enforcement and adequate resources (Rong *et al*., 2017; Boadi and Kuitunen, 2005). The improper management of solid waste may lead to degrading the environment and putting public health at risk (Gowda *et al*., 2014). Urbanization and the lack of an effective recycling mechanism for organic solid waste are the biggest challenges for Pakistan (Khan *et al*., 2016; Khan *et al*., 2012; Kuo *et al*., 2008). To protect nearby communities from dumpsites, solid waste should be managed properly (Mian *et al*., 2017). Municipal authorities cannot manage solid waste because of financial issues (Sharholy *et al*., 2007). Massive investments are needed to ensure the proper management of solid waste (Sujauddin *et al*., 2008). Long-term strategic plans must be developed to manage solid waste and also make sure monitoring and evaluation of solid waste management activities are done on an annual basis (Zurbrügg *et al*., 2005; Sharholy *et al*., 2008). Therefore, this study aimed to classify the determinants of solid waste and the issues related to improper solid waste management in Kharian, Gujrat, Pakistan. This study provided a framework for solid waste measurement, the impacts of solid waste on nearby societies and management practices for municipal solid waste.

Material and Methods

This study identified the issues related to improper solid waste management. This study provided the measurement practices of solid waste, *i.e*., waste segregation at the source level, waste production and consumption practices and also provided variables to categorize the impacts of solid waste on living communities.

Research site. The study was conducted in Kharian, Pakistan, in the district of Gujrat. Kharian is the capital of Kharian Tehsil. According to the latest census of Pakistan, conducted in 2017, Kharian city has a population of about 87,419 people. In Kharian city, open dumping of solid waste occurs near the Bider Majran Road, which was commonly known as the Pubi site. This causes various vulnerabilities to nearby societies, including ground water pollution, air pollution, public health issues and land pollution. Due to these issues, different diseases occur, such as allergic diseases, irritation of the eyes, plague, dengue and stomach problems.

Research objectives. To evaluate the determinants (sources, generation and composition) of solid waste; To identify the impacts of dumping sites on the local community and management practices related to municipal solid waste management (MSWM).

Research methodology. The descriptive nature of this study included primary and secondary data sources. The primary data was collected through a closed-ended, structured questionnaire. An interview-based questionnaire survey was designed to examine population behaviour and attitudes towards waste management. The questionnaire included demographic information (gender, age, education, employment and income status) and questions correlated to solid waste management, *i.e*., effects of solid waste, organic waste as fertilizer, negative impacts of odour on health, concern about improper waste management, impacts of solid waste on agricultural land, effects of solid waste on plants and trees, ground water pollution due to improper solid waste management and air pollution due to incineration of solid waste. The scale used to collect the responses of the respondents was a "likert scale" in a series ranging from "strongly agree, agree, satisfied, disagree and strongly disagree". To draw samples from the targeted population, a simple random sampling technique was used for data collection. The sample size was 500 respondents (n = 500) from the areas related to the dumping site in Kharian city, which included the general public, academic scholars, the self-employed and job holders. The secondary source of information used in this study included various publications, *i.e*., journals, books, newspapers, magazines and solid waste management reports.

Figure 1 shows the theoretical framework of this study. Solid waste included all types of solid material discarded

by societies. This study encompasses the determinants of solid waste, including the waste generation rate, quality and composition. The negative impacts of solid waste are evaluated through questionnaire-based responses. The responses and validity of questionnaires were measured by statistical analysis. After data analysis, this study identified the various management practices that are adaptable and handled by the solid waste management authorities to minimize the impacts of solid waste and dumping sites.

Determinants and sources of solid waste. The determinants of solid waste include solid waste generation, sources, composition and collection methods developed by the municipal committee. The data on solid waste generation, quantity and composition were collected from sanitary staff, the municipal committee and waste collection staff. The analyses and calculations were based on the available data. Solid waste generated from residential areas, vegetable markets, commercial areas, domestic waste, hotels and restaurants. In Kharian city, solid waste was generated mainly from twelve areas: Sattar pura, dara Mohallah, Anarkali bazaar, Dr. Sajjad Guliana road, Tanga stand, Ada Dinga road, Fruit mandi, Nia Arra, Nia bazaar chowk, Main bazaar, Dinga road and Jinnah colony/G.T. road.

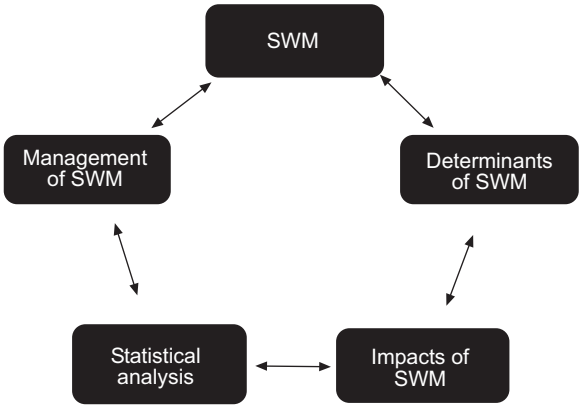

Fig. 1. Theoretical framework of study.

Measurement of solid waste generation. The quantity of solid waste produced from selected areas of Kharian city was measured in tons. The solid waste generated from the selected areas was measured in terms of per capita per day and presented in Tables.

Table 1 presents the measurement of the solid waste production rate in per capita/day consumption from the selected areas of Kharian, Gujrat. The Table presented the collection of solid waste/day and the data was compiled and retrieved from the Municipal Committee (MC), Kharian. The collection of solid waste from the selected areas was 20 tons/day.

Table 2 presents the measurement of the solid waste generation rate in terms of per-month consumption from the selected areas of Kharian, Gujrat. For monthly collection of solid waste/day consumption = 20 × 30 days = 600 tons/month. After calculating the whole data, we can derive almost 600 tons of monthly

Table 1. Measurement of solid waste generation (per capita/day consumption, source: MC Kharian)

Cities	Waste generation (tons/capita/day)
Sattar pura	3 t/capita/day
Dara mohallah	2 t/capita/day
Anarkali bazaar	1 t/capita/day
Dr. Sajjad Guliana road	2 t/capita/day
Tanga stand	2 t/capita/day
Ada Dinga road	1 t/capita/day
Fruit mandi	1 t/capita/day
Nia Arra	1 t/capita/day
Nia bazaar chowk	2 t/capita/day
Main bazaar	2 t/capita/day
Dinga road	1 t/capita/day
Jinnah colony/G.T road	2 t/capita/day
	Σ values = 20 tons/ capita/day

Table 2. Measurement of solid waste generation (per month consumption; Source: MC Kharian)

Cities	Generated waste (tons/capita/month)
Sattar pura	50 t/capita/month
Dara mohallah	51 t/capita/month
Anarkali bazaar	56 t/capita/month
Dr. Sajjad Guliana road	53 t/capita/month
Tanga stand	52 t/capita/month
Ada Dinga road	61 t/capita/month
Fruit mandi	54 t/capita/month
Nia Arra	56 t/capita/month
Nia bazaar chowk	60 t/capita/month
Main bazaar	57 t/capita/month
Dinga road	58 t/capita/month
Jinnah colony/G.T road	50 t/capita/month
	Σ values = 658 tons/ capita/month

consumption of solid waste in Kharian city from the above mentioned areas.

Composition of solid waste. Municipal solid waste comprises the most useful products, which can be used for beneficial purposes because it has much potential for recovery, reuse and recycling of materials. It has economic, environmental and socially beneficial products. It has a great variety of useful products, which include paper, glass, pulp, organic waste and animal manure. They can be used to make useful products, and they can also go into the recycling process. By using these materials for further use, we can enhance the value of solid waste and educate the public about the 3 R's (reduce, recycle and reuse). This study would help us minimize solid waste. By consuming more, we can reduce our solid waste production.

Results and Discussion

The survey outcomes were examined using the Statistical Package for Social Sciences (SPSS) version 22 and MS Excel. Descriptive statistics (frequency, mean and standard deviation), the ANOVA test, Pearson correlation analysis and factor analysis (FA) were used for data analysis. The data is presented in tables and graphs. An interpretation of these graphs would help with a better understanding of the data. The impacts of dumping sites nearby on the societies have been measured by the questionnaire filled out by the respondents. The results of the questionnaire are shown in Tables and Figures.

Table 3 shows the gender status of 500 respondents, there were 400 males and 100 females who took part in this close-ended, designed questionnaire-based interview survey. The overall behaviour of the public was very supportive and they felt no hesitation in cooperating with us in this research. The maximum age group of 163 respondents was from 25 to 34 and the minimum of 63 respondents was above 54. The highest level of education among the 163 respondents was intermediate. The employment status of the maximum of 163 respondents was private jobs. The highest income level of the 163 respondents was 20,000 to 25,000 rupees.

Figure 2 shows the variables for solid waste management (SWM). Part a of Fig. 2 shows that a maximum of 51.67% of respondents disagreed about waste segregation. Basically, segregation or sorting of waste is a process by which waste is separated into different forms, *i.e*., wood, metal, glass etc. Part b in Fig. 2 shows the concern of 50% of the respondents about the negative effects of solid waste on humans. Part c in Fig. 2 shows that a maximum of 40% of the respondents disagree about the usage of organic waste as a fertilizer, while a minimum of 21% of the respondents agree about the consumption of organic waste as a fertilizer for their agricultural land. Part d in Fig. 2 shows that odor has a negative impact on nearby societies, where the majority of the 68.3% agree, while only 2% of the population denies the impacts of odour.

Table 3. Descriptive analysis of demographic information (DI) (source: SPSS)

Variable	Options	Frequency	Mean	Std. deviation
Gender	Male	400	1.22	.415
	Female	100		
Age	18-24	98	2.53	1.033
	25-34	163		
	35-44	81		
	45-54	95		
	Above 54	63		
Education	Below matric	98	2.33	.857
	Intermediate	163		
	Bachelor	81		
	Master	95		
	Above master	63		
Employment status	Govt. job	98	2.68	1.142
	Private sector	163		
	Own business	81		
	Agriculture	95		
	Other	63		
Income status	15,000-20,000	98	2.63	1.008
	20,000-25,000	163		
	25,000-30,000	81		
	30,000-35,000	95		
	Above 35,000	63		

Figure 3 shows the variables for solid waste management (SWM). Part a of Fig. 3 shows that about 35% of residents have concerns about improper waste management and littering issues. Part b of Fig. 3 shows that a maximum of 46% of the population revealed their concern about the negative impacts of solid waste on agricultural land. Part c of Fig. 3 shows that 43% of inhabitants revealed that flies cause diseases in humans. The fly-causing ratio is high and this causes malaria and other epidemic diseases in humans. Part d of Fig. 3 shows that 28% of respondents revealed that improper solid waste management can cause degradation

of plants and trees, thus removing vegetation cover, which may lead to reduced carbon sinks, dirty air and habitat loss (Sujauddin *et al*., 2008).

Figure 4 shows the variables for solid waste management (SWM). Part a of Fig. 4 shows that 55% of the population considered that solid waste can cause groundwater pollution, while only 3% of the population disagreed about groundwater pollution because of improper solid waste management (Saqib *et al*., 2022). Part b of Fig. 4 exposes the views of 81% of the population's awareness that solid waste can be used to produce useful products. Part c of Fig. 4 shows that 61% of the population considered that air pollution could be caused by incinerating solid waste in an open area (Saqib *et al*., 2018). Part d of Fig. 4 shows that 83% of the population disagrees that waste segregation at the source is beneficial because they have no knowledge about waste segregation. This proved that the population needs awareness about waste segregation at the source level.

Statistical analysis. In this study, the analysis of variance test was used to calculate the variance among the means of the variables. Correlation analysis was used to assess the relationship for the variables of impacts of solid waste, *i.e*., effects of solid waste, concerns for improper solid waste management and air pollution due to the incineration of solid waste. Factor analysis (FA) was used to convert the variables of solid waste management (SWM) into a single data set, analyze the total variance of the variables and also provide the correlation of the variables designed for this study.

ANOVA test. The ANOVA test was used to calculate the difference among the means of dependent variables related with the effect of the measured independent variables.

Education and effects of solid waste. The ANOVA test was executed to associate the effect of education on the effects of solid waste. The output showed the significant result of education on the effects of solid

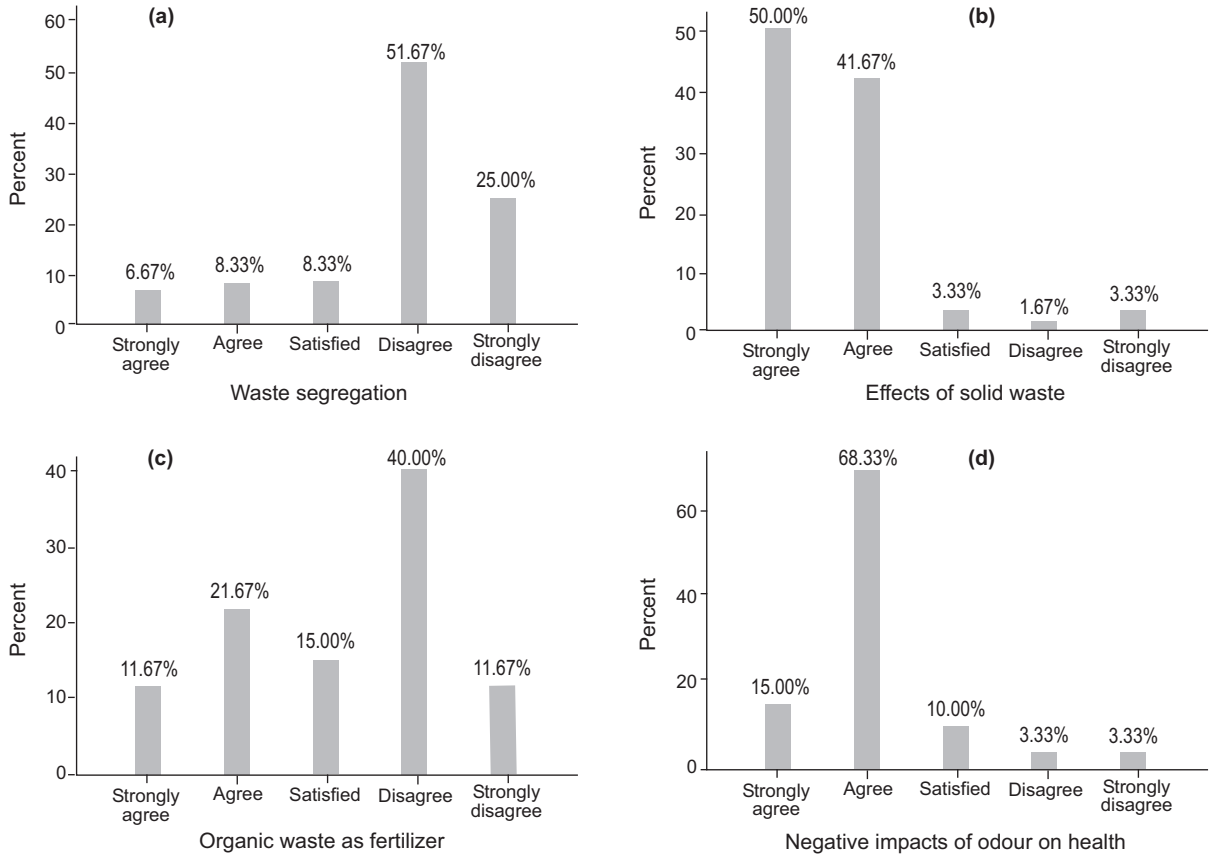

Fig. 2. Variables for SWM = **(a)** waste segregation; **(b)** effects of solid waste; **(c)** organic waste as fertilizer; **(d)** negative impacts of odor on health (source: SPSS).

waste at the P<0.5 level for the conditions [F (4, 55) = 1.439, P=0.23]. Therefore, the null hypothesis that there was no difference in the means was nullified. The results indicated that the education of the respondents is significant for assessing the effects of solid waste on communities. It is obvious that a literate society can better report the negative impacts of solid waste *i.e*., poor management, health effects and ethical considerations (Al-Khatib *et al*., 2009).

Education and improper solid waste management. An ANOVA test was executed to associate the effect of education on improper solid waste management. The output expressed the significant result of education on improper solid waste management at the P<0.5 level for the conditions [F (4, 55) = 1.817, P=0.13]. Therefore, the null hypothesis that there was no difference in the means was nullified. The results indicated that the education of the respondents is significant for evaluating the impacts of improper solid waste management. Educated communities play a vital role in identifying the gaps associated with improper solid waste management *i.e*., littering, hazardous waste, extinction of plants and animals and health issues. The results of the ANOVA test are supported by the literature (Saqib *et al*., 2023; Ayeleru *et al*., 2018; Ojeda-Benítez *et al*., 2008).

Education and air pollution due to incinerating of solid waste. An ANOVA test was executed to associate the effect of education on air pollution due to the incinerating of solid waste. The output expressed the significant result of education on air pollution due to the incinerating of solid waste at the P<0.5 level for the conditions [F (4, 55) = 1.059, P=0.38]. Hence, the null hypothesis that there was no difference in the means was invalidated. The results indicated that the education of the respondents is significant for evaluating the

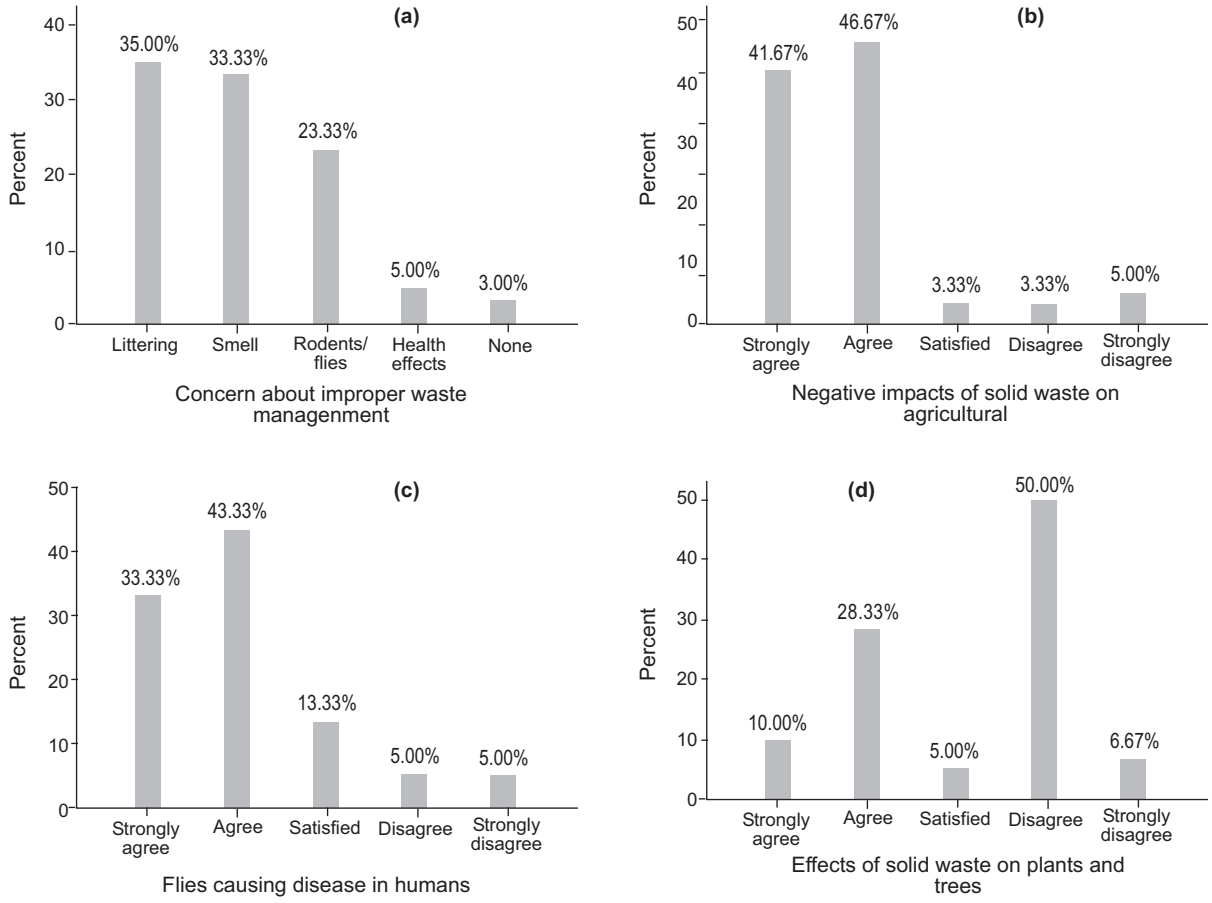

Fig. 3. Variables for SWM = **(a)** concern about improper waste management; **(b)** impacts of solid waste on agricultural land; **(c)** flies can cause disease in humans; **(d)** effects of solid waste on plants and tress (source: SPSS).

effects of incinerating the solid waste in open spaces to reduce mass. The incinerating process may release toxic fumes into the atmosphere and cause air pollution (Omari *et al*., 2017). Air pollutants *i.e*., particulate matter, metals, oxides of nitrogen and sulphur, cause lung cancer and heart diseases in humans (Saqib *et al*., 2023; Liang *et al*., 2021).

Correlation analysis. This study used the Pearson correlation to evaluate the linear relationship between the variables of solid waste management. The outcomes of the analysis depicted that there was a perfect positive relationship between effects and impacts of solid waste on flora and fauna at P<0.5, r=.267 and n = 500, which shows that effects of solid waste are faced by the population and negative impacts of solid waste on biodiversity also cause biodiversity loss and aesthetic concerns in living communities.

Table 4 shows the correlation analysis of variables of solid waste management designed for this study, including effects, flora and fauna, water pollution and air pollution. This study identified the perfect positive relationship between flora and fauna and water pollution at P<0.5, r=.288 and n = 500, which shows the direct association of biodiversity loss and water pollution with improper solid waste management and describes that improper solid waste management may harm biodiversity and also cause degradation of underground water sources for domestic consumption. This study evaluated the perfect negative relationship of air pollution and water pollution at P<0.5, r=-.055, n = 500, which indicated that water pollution is caused by improper waste management and air pollution may be caused by the incineration of solid waste management, while air pollution and water pollution are not directly linked with improper waste management (Omari *et al*., 2017).

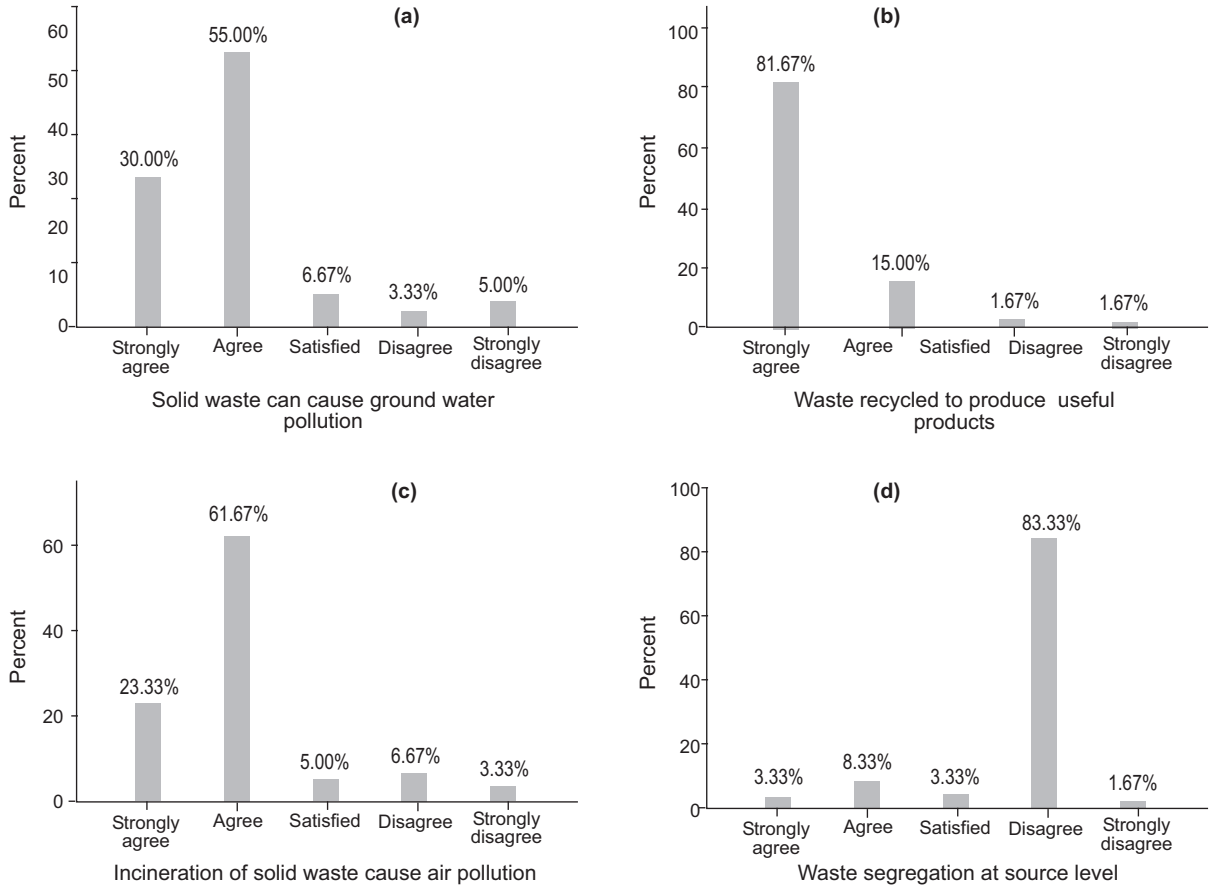

Fig. 4. Variables for SWM = **(a)** solid waste cause ground water pollution; **(b)** waste recycled to manufacture products; **(c)** air pollution due to incineration of solid waste; **(d)** waste segregation at source level (Source: SPSS).

Table 4. Correlation analysis of solid waste impacts (source: SPSS)

Variables	Measures	Effects	Impacts on flora and fauna	Water pollution	Air pollution
Effects	Pearson correlation	1	0.267*	0.244	0.041
	Sig. (2-tailed)		0.039	0.060	0.757
	N	500	500	500	500
Flora and fauna	Pearson correlation	0.267*	1	0.288*	0.084
	Sig. (2-tailed)	0.039		0.025	0.523
	N	500	500	500	500
Water pollution	Pearson correlation	0.244	0.288*	1	-.055
	Sig. (2-tailed)	0.060	0.025		0.677
	N	500	500	500	500
Air pollution	Pearson correlation	0.041	0.084	-.055	1
	Sig. (2-tailed)	0.757	0.523	0.677	
	N	500	500	500	500

*. Correlation is significant at the 0.05 level (2-tailed).

The results of the correlation analysis are evidenced by the literature (Namlis and Komilis, 2019; Edjabou *et al*., 2017; Thanh *et al*., 2010).

Factor analysis (FA). The current research included factor analysis to convert large variables into smaller variables by taking the average variance from each variable. The extraction method used for variable reduction was principal component analysis (PCA) and shared similarities with the factor analysis of 500 samples interrelated to the solid waste management *i.e*., negative impacts of odor on health, negative impacts of solid waste on agricultural land, effects of solid waste on plants and trees, solid waste can cause ground water pollution, incineration of solid waste cause air pollution and flies cause diseases in humans. The KMO measure of sampling adequacy achieved the sample value at P>0.5 of 0.49 (Kaiser-Meyer-Olkin measure of sampling adequacy =0.49), which shows that adequate samples were composed to conduct this study. Bartlett's test of sphericity was significant at (X2 [15] = 33.702, P<.001), and this study encompasses an adequate number of correlations among variables to conduct factor analysis. By analyzing the scree plot and eigen values >1 to determine the underlying components, the analysis yields six factors explaining a total of 68.958% of the variance in the data.

Table 5 shows the total variance explained (TVE) of variables of the solid waste management, including odor impacts on health, impacts of solid waste on agricultural land, effects on plants and trees, solid waste causing ground water pollution, incineration of solid waste causing air pollution and flies causing diseases in humans. This study included 500 respondents (n = 500), who filled out questionnaire responses related to solid waste management. The percentage of variance explained in the initial eigenvalues for factors was as follows: 28% for odour impacts on health, 22% for impacts of solid waste on agricultural land, 17% for improper solid waste management's effects on plants and trees, 12% for solid waste causing groundwater pollution, 10% for incineration of solid waste causing air pollution and 7% for flies causing diseases in humans because of improper solid waste management.

Figure 5 presents the scree plot of the eigen values of all six factors related to solid waste management. The eigen value is a measured score of all factors and is used to conclude which factors should be extracted. In

Table 5. Total variance explained (FA-PCA) (source: SPSS)

Factors	Eigen values	Variance (%)	Cumulative (%)
Odour impacts on health	1.730	28.839	28.839
Impacts of SW on AL	1.357	22.624	51.463
Effects on plants & trees	1.050	17.494	68.958
SW cause groundwater pollution	0.779	12.976	81.934
Incineration of SW cause air pollution	0.631	10.510	92.444
Flies causing diseases	0.453	7.556	100.000

Note: SW = solid waste; AL = agricultural land.

a scree plot, vertical scaling on the y-axis presents eigen values, while horizontal scaling on the x-axis presents the values of all six factors. The calculated eigen values from the cumulative variance for the factor 1 (odour impacts on health) was 1.73 (28.839%) which was very strong and identified that improper solid waste management produce odour which has negative impacts on nearby communities, while disturbing their aesthetic values too, the eigen value for factor 2 (impacts of solid waste on agricultural land) was 1.357 (22.624%), which was strong and identified that improper solid waste management cause destruction of agricultural land due to littering and dumping of solid waste on agricultural sites, the eigen value for factor 3 (effects on plants and trees) was 1.050 (17.494%) which identified that improper solid waste management cause damage to trees and plant species due to construction of dumping sites by deforestation, while the weak eigenvalues for factor 4 (solid waste cause groundwater pollution) was 0.779 (12.976%), factor 5 (incineration of solid waste cause air pollution) 0.631 (10.510%) and factor 6 (Flies causing diseases) was 0.453 (7.556%) which were very weak and identified that improper solid waste management cause damage to groundwater resources, produce air pollution by incinerating of solid waste or burning of waste on dumping sites to reduce its mass and flies cause various vector borne diseases in humans. This result of factor analysis for improper solid waste management is supported by the literature (Chhay *et al*., 2018; Wang and Geng, 2015; Rahardyan *et al*., 2004).

Solid waste management system in Kharian city. Municipal committee (MC) Kharian has its own waste collection vehicles, which were almost 10 and other collection equipment. Each vehicle collects waste twice a day, one route in the early morning and the second route is done after evening and then dumps this waste on dumping site. However, the following steps are included in the waste management system of the municipal committee (MC) in Kharian: Generation of solid waste; Collection of solid waste at primary sources; Street cleansing; Transportation of solid waste by using vehicles and bins; Dumping of solid waste.

Figure 6 shows the mechanism of solid waste management in Kharian, Gujrat. This study identified the sources of solid waste, which included waste generated from households, commercial places (*i.e*., markets, shopping malls) and public places (*i.e*., parks, tourism sites and bus stands). The generated solid waste is stored at the nearby solid waste collection points that were pointed out by the municipal authorities within a city. After collection, solid waste is transferred to a specified dumping site for its final disposal. This study acknowledged the open dumping of solid waste generated in the areas of Kharian city, whereas incineration or closed dumping of solid waste is practiced globally to reduce the impacts of solid waste.

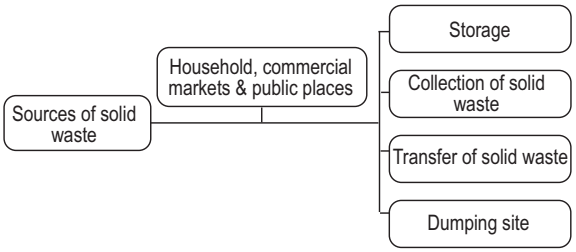

Fig. 6. Mechanism of SWM in Kharian.

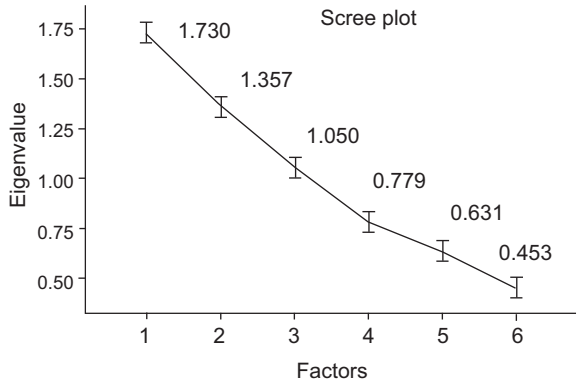

Fig. 5. Factor scree plot and eigenvalue (source: SPSS).

Recommendations for solid waste management. There are some recommendations for management of solid waste:

- Open dumping must be prohibited to reduce pollution and protect land.
- The dumping site should be preferably barren land.
- Government and municipal authorities should revise laws regarding the sorting of waste and dumping sites these laws should require that dumping sites be well fenced, away from residential areas, and managed to minimize their effects on the environment.
- Allocation of sufficient funds according to current needs to manage solid waste generation.

- Get feedback from the communities, as they are a good source for providing the information.
- Repairs and purchases of new equipment should be conducted at regular intervals in order to increase their effectiveness.
- Solid waste-carrying vehicles must be covered to avoid littering.
- The media should play a role in spreading awareness about waste segregation and the usage of different waste bins.
- Educate people about waste management on an individual basis; In order to reduce waste from dumping sites, use an incineration plant and composting methods.
- Adopt 3R's (reduce, reuse and recycle) strategies, which ultimately produce less waste and promote recyclable products mechanisms throughout the market.
- Promoting guidelines for environmentally friendly onsite handling, storage, processing, collection, transport and disposal of municipal solid waste.

Conclusion

This study identified the insufficiencies related to the solid waste management system and the impacts of improper solid waste on communities. This study acknowledged the ineffectiveness of the solid waste management practices of the municipal committee. The variables of solid waste management were insignificant at $P<0.5$ and identified the negative impacts of solid waste that affect the health of the communities and cause environmental degradation *i.e*., ground-water pollution, spreading of diseases, negative effects of odour and air pollution due to lack of waste segregation at the source, low operational efficiency of transport, poor collection systems, dumpsite issues and an insufficient recycling system. This study provided a framework to overcome the negative impacts of solid waste and stated that the municipal committee should make investments to bring new equipment, vehicles and other modifications to redefine the solid waste management program's roles and responsibilities to all the customers and stakeholders. This study suggested that the government should take the initiative and work with the collaboration of the public and private sectors along with the municipal authorities to implement segregation of waste, recycling techniques and revise rules for dumping sites to improve solid waste management practices.

Limitations of study. This study is restricted to an outstanding level owing to the confidential data of administrative organizations. The available resources have made this study much more useful in depicting the actual problems and their possible remediation. This study provided enough information to enterprise a framework for the measurement of solid waste and its impacts on society, which needs to be managed effectively.

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Conflict of Interest. The authors declare that they have no conflict of interest.

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