Journal of Geoscience and Environment Protection, 2023, 11, 49-66
https://www.scirp.org/journal/gep
ISSN Online: 2327-4344
ISSN Print: 2327-4336

Assessing the Factors Influencing Effective Municipal Solid Waste Management System in Barishal Metropolitan Areas

Tareq Mahamud Abir[1], Mallika Datta[2], Sumi Rani Saha[3]

[1]Associate Professor, Department of Sociology, University of Barishal, Barishal, Bangladesh
[2]Independent Researcher, Barishal, Bangladesh
[3]Assistant Professor, Department of Sociology, University of Barishal, Barishal, Bangladesh
Email: abirsocbu2016@yahoo.com

How to cite this paper: Abir, T. M., Datta, M., & Saha, S. R. (2023). Assessing the Factors Influencing Effective Municipal Solid Waste Management System in Barishal Metropolitan Areas. *Journal of Geoscience and Environment Protection, 11,* 49-66.
https://doi.org/10.4236/gep.2023.111004

Received: November 18, 2022
Accepted: January 17, 2023
Published: January 20, 2023

Abstract

Unorganized municipal solid waste (MSW) disposal system leads to stress on ecosystems and disturbs various nature cycles and human health. Solid waste management all over world is looked as a major challenge to civil bodies, especially in developing countries like Bangladesh. The proper management system of municipal solid waste depends on various factors like social, cultural, financial, political, environmental, physical and institutional and so on. The purpose of this study is to explore the leading factors that affect the solid waste management in Barishal city. For achieving this purpose, this research first has identified the socio-economic, cultural, physical and technical, institutional and environmental factors and then analyzed the factors which affect the solid waste management system in the study area. To achieve the purpose of the study, quantitative method has been used in this research. As a sample of this study, 150 household heads from total household members of the city have been selected randomly by using lottery method. A structured questionnaire has been constructed for collecting quantitative data. The quantitative data have been analyzed in this study by using SPSS Program, and Microsoft Excel. The findings of the study show that all city people know solid waste and solid waste management stakeholders present in the city and waste pickers collect all types of waste in the city and socio-economic, cultural, physical and technical, institutional factors affect the effective solid waste management in the study area where environmental factors have no influence on effective solid waste management in the study area. The study people have a bad impression of the current existing management system of the solid waste and they express their expectations where they mention that if municipal authorities improve the condition of the infrastructure, roads and ve-

hicles; allow more budgets to manage waste; take proper strategies and planning to manage waste smartly like imposing fines, set up rules, then the municipal authorities will be able to manage solid waste properly. Finally, this research has proposed some recommendations that might be helpful for the policy-makers in the study area for making policies and further research regarding solid waste management.

Keywords

Ecosystem, Solid Waste Management, Municipal Solid Waste Management

1. Introduction

The extreme drive of human society toward modern urban life generates enormous amounts of municipal solid waste since the generation rate is outpacing the rate of urbanization around the world, especially in developing countries like Bangladesh (Sujauddin et al., 2008). The amount of solid trash produced worldwide is increasing as a result of population growth, ongoing economic growth, urbanization, and industrialization (Henry et al., 2006). Within ten years, global municipal solid waste (MSW) generation doubled, from 0.68 billion tons in 2000 to 1.3 billion tons in 2010. Furthermore, by 2025, it is expected to reach 2.2 billion tons per year, and by 2050, 4.2 billion tons per year (Hoornweg & Bhada-Tata, 2012). Consumption rates in developing countries are accelerated by rapid population expansion and urbanization, as well as rapid economic growth (Aleluia & Ferro, 2016). At present, 1 million tons/day rate of trash creation, MSW output in Asia is anticipated to increase to 1.8 million tons/day by 2025. If it can't be adequately handled, the massive waste load of the urbanized world will have a severe influence on sustainable living, the local environment, and human health (Scarlat et al., 2015). China, India, Malaysia, Thailand, and Bangladesh have severe municipal solid waste management problems related to reports in several cities of these countries. Bangladesh is a densely populated country. In Bangladesh, a large portion of the population lacks access to waste collection services, and only a small percentage of the waste generated is actually collected by non-governmental organizations (NGOs) and community-based organizations (CBOs) in the late 1990s for a small fee (Alamgir & Ahsan, 2007). Bangladesh saw a rise in its urbanization rate from 28.97% to 36.63% between 2008 and 2018 with a trash production rate of 0.41 kg/cap/day in 2012, and about 22.4 million tons of rubbish were generated (Atlas, 2012). Due to an increasing population and increased production of trash per person, it is predicted that the amount would rise to around 47,064 tons per day and the generation rate would be 0.602 kg/person/day. Solid wastes are an enormous environmental threat and a societal problem in countries like Bangladesh (Riyad et al., 2014). Municipalities, which are often in charge of trash management in cities, face a difficult task of providing a system that is both effective and efficient for the res-

idents (Guerrero et al., 2013). Many factors are responsible for affecting the municipal solid waste (MSW) like socio-economic, cultural, institutional, physical, environmental and so on, which hinder the management of this huge amount of waste. Socio-economic characteristics, such as age, income, and education level, also have a substantial role in sustainable waste (SW) generation variations (Afroz, 2011). Household garbage accounts for 65% of all solid waste in Bangladesh. Dhaka, the 28th most populous city in the world (with over 10 million residents) and the fastest expanding, is facing an ever-increasing mountain of municipal solid waste from all sources, posing a major threat to surface and ground water, soil, and air. The lack of an integrated approach, a lack of coordination among stakeholders, and, most importantly, a lack of public awareness in current municipal solid waste management hides a significant opportunity to use waste as a resource for energy production, material recovery, composting, and other uses. Thus the main purpose of this study is to explore the leading factors that affect the solid waste management in Barishal city and the specific objectives of this study can be specified below:

1) To explore the perception of solid waste and solid waste management stakeholders in the city.

2) To elucidate the analysis of factors affecting the solid waste management in Barishal city.

3) To know the individual's perception of the existing management system of the municipal authorities and expectations from the municipal authorities to manage solid waste in the city.

2. Literature Review

2.1. Present Scenario of Solid Waste Management in Urban Areas of Bangladesh

There are more over 160 million people living in Bangladesh, and 29.4% of them reside in cities (Barrientos, 2019). In Bangladesh's urban regions, over 25,000 tons of solid garbage is produced per day, or 0.465 kilograms per person (Ahmed, 2019). Solid wastes in Bangladeshi cities come from residential areas, street cleaning, business premises, industrial facilities, hospitals, clinics, and other sources (Alamgir et al., 2003). These solid wastes are frequently deposited and heaped up in road corner dustbins, secondary disposal points, unoccupied spaces near marketplaces, road crossroads, and other such sites. In big cities, certain NGOs and community-based organizations are collaborating with local officials to improve the collecting system from homes and hospitals as shown in **Figure 1**.

2.2. The Physical Components in Weight Percentage of MSW & Current Waste Generation Rate in Major Six City Corporation in Bangladesh

The rate of garbage production in Bangladeshi cities varies from 0.25 to 0.70 kg/capita/day, with Chittagong (0.56 kg/capita/day) and Dhaka (0.70 kg/capita/day) producing the most waste as shown in **Table 1**. Nearly 78% of the total is generated

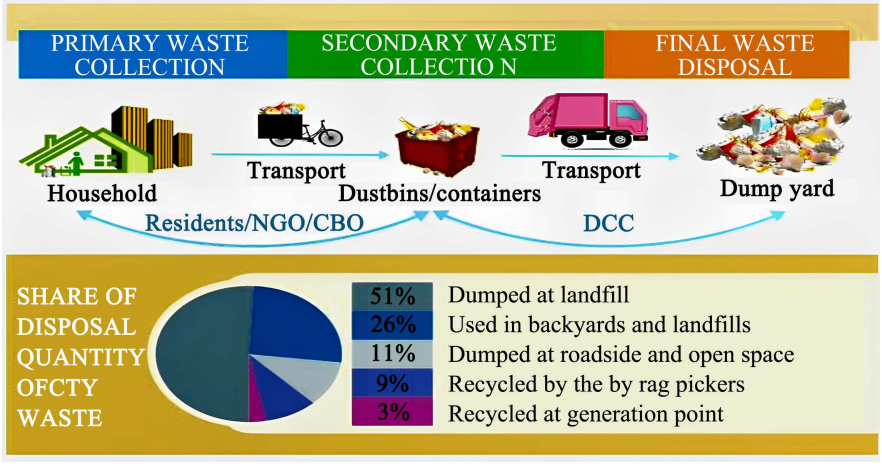

Figure 1. Waste management process in Bangladesh (Source: Waste Concern Technical Report Series, 2014).

Table 1. The physical components in weight percentage of MSW in major six cities in Bangladesh.

Components	DCC	CCC	KCC	RCC	BCC	SCC
Food and vegetables	68.3	73.6	78.9	71.1	81.1	73.8
Paper and paper products	10.7	9.9	9.5	8.9	7.2	8.4
Polythene and plastics	4.3	2.8	3.1	4	3.5	3.4
Textile and woods	2.2	2.1	1.3	1.9	1.9	2.1
Rubber and Leathers	1.4	1	0.5	1.1	0.1	0.6
Metal and Tins	2	2.2	1.1	1.1	1.2	1.1
Glass and ceramic	0.7	1	0.5	1.1	0.5	0.7
Others	10.4	7.4	5.0	10.4	4.5	9.9

Source: (Abedin & Jahiruddin, 2015).

by the residential sector, 20% by industry, and the remaining percentage comes from other sectors (Shams et al., 2017).

About 7690 tons of solid garbage is produced daily in Bangladesh's six largest cities as shown in **Table 2**. The overall waste stream's composition is made up of 74.4% organic material, 9.1% paper, 0.8% leather and rubber, 3.5% plastic, 1.9% textile and wood, 1.5% metal, 0.8% glass, and 8% other wastes (Alamgir & Ahsan, 2007).

2.3. Municipal Solid Waste Management Present Scenarios in Barishal City

The collection and transportation of solid waste in Barishal city is managed by the municipality, with a small participation of the household. More than 90% of the municipality solid waste is disposed and treated in an environmentally sound manner. From **Table 3**, we can observe existing solid waste management system of Barishal City Corporation.

Table 2. Current waste generation rate in major six city corporation in Bangladesh.

City Corporation	Population	Waste generation rate per day (Tons)	Year
DCC	9,206,783	6500	2021-2022
CCC	3,227,246	3000	2021-2022
KCC	718,735	450	2021-2022
RCC	552,791	358.19	2021-2022
BCC	419,351	300	2021-2022
SCC	532,426	54	2021-2022

Source: Author collected data from the website of six City Corporation of Bangladesh (2022).

Table 3. Existing solid waste management system of Barishal City Corporation.

Existing solid waste management system of BCC					
Types of transportation	Primary Source Storage and Collection	Secondary disposal site (SDS)	Secondary Collection and Transportation	Recycling	Ultimate Disposal
1) Motorized vehicles 2) Non-motorized vehicles	1) Waste is generally stored in polythene bags, plastic, and metal containers by city inhabitants. 2) Residents who live near the canals toss their trash into the canals. 3) Shopkeepers dump their trash on the market's front road.	On-site storage, such as a secondary disposal site (SDS), accepts MSW from the primary source and transports it to a designated place for processing/treatment.	MSW is collected from SDS by using motorizes vehicles and garbage is transferred from community bins to SDS using non-motorized vehicles. Some motorized vehicles, rickshaw vans, and hand trolleys gather the rubbish from communal bins along smaller roads and transport it to larger SDS.	Recycling shops can be found primarily in, Sadarghat, Rupatoli and Nottulabad bus stand, Chanmari market, Port road, Hat Khola hackers market and other locations in Barisal.	At Kawnia BCC runs one ultimate disposal site (UDS). All sorts of MSW, including some medical waste, are disposed of here. The open garbage that has spread around the site is ugly due to the lack of a sufficient mechanism for filling the space.

3. Conceptual Framework

3.1. Factors Affecting the Effective Municipal Solid Waste Management and Hypothesis

3.1.1. Socio-Economic Factors Affecting the Effective MSW Management

According to Sujauddin et al. (2008), the generation of waste is influenced by family size, education level, and monthly income, residential location, and community status that is also included in the socioeconomic factors where households have a significant role. The social side of waste management cannot be separated from the whole waste management system. Public knowledge, participation, and cooperation are important steps in the proper implementation of the solid waste management system, which is part of the social elements (Glawel et al., 2015). While it is obvious that a family with more people and high

monthly income produces more waste and few members and a low-income family produce little waste, some researchers have identified the phenomenon of "group living" and "common consumption" of the family, in which the household functions as a unit and most food products are shared (Thanh et al., 2010). The more a family is educated and aware of the negative consequences of poor solid waste management, the more they value excellent management (Kayode & Omole, 2011). Due to financial constraints, municipalities have been unable to manage solid waste. The significant financial outlay required to deliver the service (Sharholy et al., 2008). The supply of proper waste management services has been delayed by a lack of financial support, insufficient resources, the unwillingness of consumers to pay for the service and the improper use of economic mechanisms (Sujauddin et al., 2008).

Alternative hypothesis: There is a positive relationship between socio-economic factors and the effective solid waste management.

Null hypothesis: There is no relationship between socio-economic factors and the effective solid waste management.

3.1.2. Cultural Factors Affecting the Effective Solid Waste Management

Human activities generate trash, and the way these pollutants are kept, handled, collected, moved, transported, and disposed of poses grave health and environmental dangers. Family attitudes about waste separation are influenced by the real estate company's active investment and assistance, neighborhood residential committees' involvement in public participation, and the cost of collection service based on waste volume or weight (Zhuang et al., 2008). One element affecting trash treatment is authorities' lack of awareness of treatment systems (Chung & Lo, 2008). Waste management is typically thought to be solely the responsibility of local governments, with no expectation of citizen participation (Vidanaarachchi et al., 2006). It is generally regarded that waste management is the sole duty and responsibility of local authorities and that the public is not expected to contribute (Vidanaarachchi et al., 2006). People participating in decision-making (Sharholy et al., 2008), community awareness, and social indifference to contributing to solutions are cultural elements cited by various experts (Moghadam et al., 2009). Residents' negative attitudes and conduct can be considered cultural barriers, and residents, students, and entrepreneurs' insufficient trash separation is a barrier to effective waste management. People believe that recyclable waste has a poor value, so there is little incentive to sort it. The value of waste was viewed differently by businesspeople. While garbage may have value, some argue that it is not worth the effort to collect and repurpose waste. They usually delegate the collection of recyclables to housekeepers. Those who collect and/or sell the waste subsequently gain monetary value from it. Most individuals, on the other hand, believe that this is the most convenient and quick way to dispose of their trash (Yukalang et al., 2017).

Alternative hypothesis: There is a positive relationship between cultural factors and the effective solid waste management.

Null hypothesis: There is no relationship between cultural factors and the effective solid waste management.

3.1.3. Physical and Technical Factors Affecting the Effective Solid Waste Management

Developing or upgrading a waste management system begins with planning. Physical components and management challenges, such as strategic planning, public engagement, and financial management, are all part of MSW management (Wilson et al., 2013). Government must collect waste properly. One of the main functions of urban services is the waste collection, which is one of the key components of an integrated sustainable waste management system (Zaman, 2014). According to the literature, technical factors influencing the system include a lack of technical skills among municipal and government personnel (Hazra & Goel, 2009), deficient infrastructure (Moghadam et al., 2009), poor roads and vehicles (Henry et al., 2006), insufficient technologies, and dependable data (Mrayyan & Hamdi, 2006). Municipalities in poor countries are said to have difficulty managing solid waste because they continue to utilize the "collect, transport, and dump away" method. Traditional trash management systems have been chastised for their "one-size-fits-all" approach, which ignores the fact that each town or city, as well as its neighborhoods, has distinct waste management requirements (Eriksson & Bisaillon, 2011).

Alternative hypothesis: There is a positive relationship between physical and technical and the effective solid waste management.

Null hypothesis: There is no relationship between physical and technical and the effective solid waste management.

3.1.4. Institutional Factors Affecting the Effective Solid Waste Management

Institutional factors relate to organizational structures, procedures, methodologies, institutional capacities, and private sector involvement and affect the distribution of roles and responsibilities. An adequate division of responsibility, authority, and revenues between national, provincial, and municipal governments is essential for effective MSWM. Inter-municipal cooperation is critical in metropolitan areas where MSWM activities span multiple local government units (Schübeler et al., 1996). Municipalities frequently exhibit management shortcomings. Local waste management authorities lack organizational capacities (leadership) and professional knowledge, according to certain researchers who studied the institutional variables that affect the system. Furthermore, they concluded that the public domain information is extremely limited (Chung & Lo, 2008). It is extremely difficult to get an understanding of the complicated subject of municipal solid waste management due to the relatively limited information available, which is either incomplete or dispersed among numerous entities involved (Seng et al., 2010).

Alternative hypothesis: There is a positive relationship between institutional and the effective solid waste management.

Null hypothesis: There is no relationship between institutional factors and the effective solid waste management

3.1.5. Environmental Factors Affecting the Effective Solid Waste Management

The risks to public health posed by inappropriate garbage disposal prompt environmental considerations. Surface water pollution, groundwater penetration and contamination, and air pollution are all major concerns that are difficult to address and costly to remedy. Noise, dust, traffic, and trash, for example, can all have major annoyance effects on an operational level. The lack of environmental control mechanisms and appraisal of true consequences are the variables affecting the environmental side of solid waste management in developing nations (Matete & Trois, 2008). Ekere et al. (2009) stated that better systems require the participation of the general public in active environmental organizations.

Alternative hypothesis: There is a positive relationship between environmental and the effective solid waste management.

Null hypothesis: There is no relationship between environmental factors and the effective solid waste management.

All the above mentioned factors those are influencing effective municipal solid waste management in Barishal city are shown in Figure 2 as a conceptual framework.

4. Methods of the Study

This research is descriptive in nature. In this research quantitative research design has been employed for assessing the factors affecting the effective municipal solid waste management. A small-scale study, "Assessing the factors affecting effective municipal solid waste management", has been conducted in Barishal city which is a division of Bangladesh. Here the targeted population for the study is all the household members living in Barishal city. The accessible populations are those who were present during the data collection time and showed their concerned view on the issue to provide their valuable information. Household Head (Male or Female) have been selected as unit of analysis to collect data

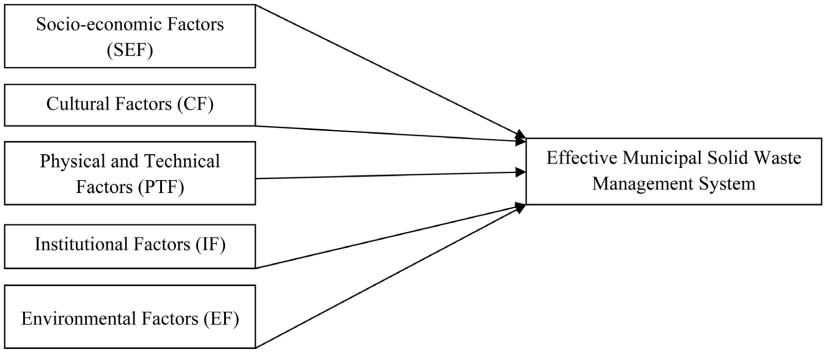

Figure 2. A Conceptual Framework for assessing the factors influencing effective municipal solid waste management.

about the entire household. The study has taken simple random sampling as a part of the probability sampling technique in which each sample has an equal probability of being chosen. In Barishal city the total population is 419,351 and total household number is around 53,000. For the comparative approach purpose 150 household head from total household at different areas in Barishal city has been selected randomly (using lottery method) as the sample of this study. For the study, the researcher has used the survey method to collect data from the study field. Secondary data have also been used in this study. A structured self-administrated questionnaire has been constructed and used for collecting survey data. Processing and analysis has the objective of bringing meaning to the data and display it to the reader. Before analysis the data has been edited then has been coded and tabulated. The data was analyzed using the Factor analysis technique and SPSS software version 23.0, and both the reliability and validity of the questionnaire have undergone extensive review and with the help of output tables containing frequency, percentage, etc. There is also a presentation with graphs or charts. Ethics in questions formatting and during data collection from the respondents have been maintained. The study purpose was informed to the respondents and their privacy has been maintained. Harmful questions to the respondents have been avoided.

5. Result and Discussion

5.1. Factors Affecting the Effective Municipal Solid Waste Management

5.1.1. Descriptive Statistics

The first output from factor analysis is a table of descriptive statistics (Table 4) that involves all the variables responsible for the solid waste management. Looking at the mean we can conclude that monthly income (4.61), education level (4.51), waste Management Fee Collection (3.60), family size (3.42), relationship between service providers and users (3.17) are the socio-economic factors that affect the solid waste management; lack of concern for waste management (4.56), participation in public awareness program (3.67), citizen's willingness to participate in solutions (3.45), blaming others (2.79) are the cultural factors affect the solid waste management; technological knowledge of municipal workers (4.25), condition of the infrastructure and roads to manage solid waste in the city Inadequate infrastructure, poor roads, and vehicles (4.23), irregularity of Waste Collection (3.35), inadequate infrastructure, poor roads, and vehicles (3.41) are the physical and technical factors affect the solid waste management; perception about the efficiency of the solid waste collection system of the municipal authority (4.37), inappropriate media for getting information about SWM (4.17), skilled personnel (3.44), perception of the institution of the municipality (3.38) are the institutional factors that affect the solid waste management in the city. On the other hand, no environmental factors have a significant effect on solid waste management except unsustainable landfill system (2.46) which has a moderate influence on the solid waste management.

Table 4. Table of descriptive statistics identifying main factors responsible for solid waste management using factor analysis.

Descriptive Statistics				
	Factors Affecting the Solid Waste Management	**Mean**	**Standard Deviation**	**Analysis N**
Socio-economic Factors	Family size (SEF1)	3.42	1.172	150
	Monthly income (SEF2)	4.61	0.692	150
	Education level (SEF3)	4.51	0.603	150
	Waste Management Fee Collection (SEF4)	3.60	1.416	150
	Relationship between service providers and users (SEF5)	3.17	1.061	150
Cultural Factors	Lack of concern for waste management (CUL1)	4.56	0.501	150
	Blaming others (CUL2)	2.79	1.461	150
	Citizen's willingness to participate in solutions (CUL3)	3.45	1.971	150
	Participation in public awareness program (CUL4)	3.67	1.471	150
Physical and Technical factors	condition of the infrastructure and roads to manage solid waste in the city (PHTEC1)	4.23	0.541	150
	Irregularity of Waste Collection (PHTEC2)	3.35	1.113	150
	Inadequate infrastructure, poor roads, and Vehicles (PHTEC3)	3.41	1.285	150
	Technological Knowledge of municipal workers (PHTEC4)	4.25	0.600	150
Institutional factors	Skilled personnel (INS1)	3.44	1.728	150
	perception of the institution of the municipality (INS2)	3.38	1.768	150
	Perception about the efficiency of the solid waste collection system of the municipal authority (INS3)	4.37	0.504	150
	Inappropriate media for getting information about SWM (INS4)	4.17	1.134	150
Environmental Factors	Leaders'/communities have in their environmental issues related to solid waste (ENV1)	1.50	0.501	150
	Unsustainable Landfill system (ENV2)	2.46	1.427	150
	NGO'S program can raise the awareness about SWM (ENV3)	1.77	0.709	150
	Mismanagement of solid waste creates health and environmental problems (ENV4)	1.81	0.839	150

5.1.2. Reliability Analysis of the Construct

It is concerned with the consistency and stability of the measurement. In the current study, there are five independent scales and one dependent scale used in survey questionnaire to measures the constructs of the research model. In this study, there were twenty one scales used in the survey questionnaire to measure the constructs in the proposed model: Socio-economic Factors (SEF), Cultural Factors (CF), Physical and Technical Factors (PTF), Institutional Factors (IF) AND Environmental Factors (EF) of solid waste management in Barishal city. A reliability coefficient was run on SPSS for each set of constructs and the results are presented in Table 5, which shows the Cronbach's alpha (a) value for each

Table 5. Cronbach's alpha reliability results.

Variables	Items Number	Cronbach's Alpha	Comments
Socio-economic Factors	5	0.918	Excellent
Cultural Factors	4	0.786	Moderate
Physical and technical Factors	4	0.835	High
Institutional Factors	4	0.784	Moderate
Environmental Factors	4	0.102	Poor

Source: Author's Calculation.

variable. The result of this analysis shows that all of the constructs got a high reliability and more than 0.70 except Environmental Factors (EF) Cronbach's a value result varied between 0.631 and 0.912. Overall, the result shows that all alpha values of the study instruments are reliable and exhibit appropriate construct reliability.

5.1.3. Hypothesis Testing

The structural model analyzes the relationships among the variables and the significance of these relationships (Table 6).

The results suggest that socio-economic factors, cultural factors, physical and technical factors, institutional factors, have a strong positive significant relationship with solid waste management. This is in line with hypotheses H_1, H_2, H_3, and H_4 respectively. We, therefore, accept these four hypotheses. The hypotheses for the variables environmental factors have no significant relationship with solid waste management however, rejected.

6. Discussion

From the analysis this study found that all of the respondents know the solid waste and they said that solid waste management stakeholders are present in the city and waste pickers collect all types of waste including household, institutional, construction, health care, agriculture, industry, and commercial.

From the analysis of descriptive statistics this study has found that socio-economic, cultural, physical and technical and institutional factors have influence on affecting the effective solid waste management in the study area. On the other side environmental factors have no significant influence on affecting the effective solid waste management in the study area. The result of reliability analysis shows that all of the constructs got a high reliability and more than 0.70 except Environmental Factors (EF). Overall, the result shows that all alpha values of the study instruments are reliable and exhibit appropriate construct reliability. And from the hypothesis testing this study found that socio-economic factors, cultural factors, physical and technical factors, institutional factors, have a strong positive significant relationship with effective solid waste management because

Table 6. Structural model and hypothesis testing.

		Estimate (Beta)	Estimated P-Value	Sig. Level	Decision
H_1	Socio-economic Factors	0.853	0.000	$P < 0.05$	Accept
H_2	Cultural Factors	0.321	0.000	$P < 0.05$	Accept
H_3	Physical and technical Factors	0.720	0.000	$P < 0.05$	Accept
H_4	Institutional Factors	0.541	0.000	$P < 0.05$	Accept
H_5	Environmental Factors	0.049	0.555	$P > 0.05$	Reject

Source: Author's calculation.

the correlation is significant at the 0.01 level among four factors (this is in line with hypotheses H_1, H_2, H_3, and H_4 respectively) and effective solid waste management. That's why these four hypotheses are accepted in this study. The hypotheses for the variables environmental factors have no significant relationship with effective solid waste management however, rejected as the correlation is not significant at the 0.01 level.

From the quantitative analysis this work shows that among total respondents most of the respondents said that the social factors like family size, income, education level, waste management fee collection and relationship between service providers and users affect the municipal solid waste management . According to their opinion it is mentioned that more family members and income are responsible for producing more waste and sometimes waste collection fee is the another reasons for not using city corporation's bins. But they said that maximum waste collector's behavior is well. In the aspects of cultural factors, the study has found that 52.0% of respondents contribute to MSWM and 48.0% don't contribute to MSWM. As reasons behind not to contribute in MSWM that the opinion of the respondents are that they some have no time to manage waste, another think it is the job of waste pickers, they have no concern about the impact of worst SWM and some blame all of the above reasons for mismanagement of solid waste. One blames others for producing more waste like some blame restaurants, shops, clinical members, industry while others blame household members in the city. Among total respondents most of the respondents had low willingness to the problems and to solve the problems related to solid waste services and some little respondents have participated in public awareness campaigns while a great portion of the respondents have no concern and participation about solid waste management related problems. From the quantitative analysis, it that all study people said that city's waste collection process is not appropriate. The timing of the waste pickers to collect waste is varying from locality to locality. In some locality waste is collected regularly where in the other locality waste collectors went sometimes. Available transportation facilities for SW collection in the city according to respondents is very little and insufficient. 40.7% of participants have said that the condition of the infrastructure and roads

to manage solid waste in the city is very bad, 34.0% said it is bad and according to 25.3% of participants it is not so good. The knowledge of the municipal workers (waste pickers) on technologies for solid waste management on technologies for SWM is very low according to respondents. All respondents have said that there have no waste separation facilities in the city. 52.0% of respondents are strongly agree, 36.7%respondents are agree and 11.3% of respondents are neutral among total respondents about municipal authorities don't have enough transportation, roads, vehicles to manage solid waste properly and they need to improve the condition of these transportations, roads, vehicles. From the quantitative analysis, this work has been found that all of the respondents have said that there are no appropriate waste reduction strategies in the city and City Corporation ever sends skilled personnel, while others said they send skilled personnel very rare for managing solid waste. The perception of the respondents about the institution of the municipality in terms of managing solid waste in the city according to most of the participant's perception is very bad and others have bad and not so good outlook. The efficiency of the solid waste collection system of the municipal authority (in terms of what is offered by the provider and what the users receive is very much low. All of the participants have said that there have no local available professionals in the field of SWM working appointed by municipality and recycling awareness campaigns arranged by the municipality. 23.3% of respondents get information and 76.7% don't get information from the municipal authority on the issues related to SWM properly because the information dissemination methods are ineffective in reaching households and residents, they heard that [the announcement] but didn't understand what they said, hearing problem due to the worst technological device. In the opinion about the municipal authority don't have proper institutional strategy and planning to manage waste properly and they need to adopt and implement the strategy and planning to manage waste smartly. From the quantitative analysis, this work has been found that all of the respondents have said that they do not know the environmental legislation for managing solid waste in the city and most of the respondents said in environmental issues related to solid waste. All of the respondents have said that the landfill system is not sustainable in the SWM system because they expressed that the landfill process is polluting soil, air, surface, and ground water, lack of rules and regulations to maintain the standard of the landfill in the city, illegal dumping by the people such as lack of awareness of environmental pollution, lack of control of engineering standard. 50.0% of participants get the information and 50.0% of participants don't get the information (inside or outside of the study area) about how to manage the waste from environmental organizations among total respondents. Among total respondents 20.0% learned box-type compost, 30.0% learned all types of compost from the organization about managing waste without hampering the environment. Among total respondents most of the respondent agreed that NGOs play a role to raise awareness about SWM. The participants revealed that city corporation authorities regarding SWM, 1 NGO volunteers, people of the genteel society can

bring awareness to the community about SWM. 60.0% have said that city authorities don't take steps for ensuring effective SWM and 40.0% have said that city authority impose fined or punished for illegal dumping. Among total participants 36.0% have said that people can't rely so much upon, 46.0% said people can't rely at all and 18.0% have said that people can depend little on city authorities to solve SWM problems. According to respondents, the overall performance rate of the city authority related to SWM over the past few years' performance is very bad. Finally they have been expressed their expectations. They expect that the city authority should allow sufficient budget; should take steps to bring awareness among all city people to manage waste properly; improve roads, transportation, vehicles that collect waste; should arrange recycling awareness campaigns; should appoint professionals related to SWM; should take necessary institutional strategies and planning to manage waste properly, should impose rules and regulations to control illegal dumping, to manage waste smartly without hampering environment. And finally the participants said that if municipal authorities take this step, the waste will be manage smartly without hampering environment and human beings, animal's life.

7. Conclusion

The population of Barishal city is increasing tremendously every year and so does its waste generation also increased. In this study, Barishal city was selected to analyze the factors that affect effective municipal solid waste management. The results of the study showed that socio-economic, cultural, institutional, physical, and technical factors have a positive relationship with the effective solid waste management because the correlation value is highly positive and the significant level is less than 0.05% level which means that these factors affect managing the effective solid waste in the study area. On the other hand, environmental factors have no relation with effective solid waste management in the study area because the correlation value is negative and the significant level is high more than 0.05% level in the aspects of environmental factors. So the hypotheses in the socio-economic, cultural, institutional, physical, and technical factors have been accepted and the hypothesis in the environmental factors has been rejected in this study. The alpha value in the socio-economic, cultural, institutional, physical, and technical factors is reliable and exhibits appropriate construct reliability except for environmental factors. This study found the waste management system of the study area cannot support the contemporary increase in waste generation. Composting plant is missing in Barisal. There are many hindrances of the BCC, including technical, organizational, social-cultural, and financial, the officials from the BCC and involvement of NGO, absence of integrated planning, physical and technological limitations, lack of coordination between the people, private organization, and government authority in the solid waste management. From a scientific, hygienic, and environmental point of view, the current status of solid waste collection and management is not acceptable. Environmental considerations were not determined to be a hindrance in

the issues confronting solid waste management procedures, based on the above. The remaining aspects, including socioeconomic problems, cultural challenges, technical issues, legislation enforcement, and good governance, as well as civil society inactivity, were identified as important roadblocks to BCC's solid waste management system. This study suggests that the city of Barisal Sadar's solid waste management needs to be improved, and the city corporation can make the city cleaner and more environmentally friendly by implementing an integrated waste management system that includes planning efficient collection routes, utilizing available resources, implementing a public awareness program, designing a sanitary landfill, and effective monitoring, assessment, and refinement systems.

8. Recommendation

In view of the findings above, the following managerial recommendations are made:

1) The municipal authority should look at why city people are hesitant to take part in managing waste. The behavior of homes in Barisal city toward solid waste minimization should be taken into consideration for the waste minimization program to be successful.

2) BCC should take steps to create energy from the metropolis's municipal garbage.

3) At the onsite stage, BCC shall put in place suitable mechanisms to guarantee that garbage is properly and adequately collected and treated.

4) BCC should allow enough finance for major projects such as energy generation facilities, in particular.

5) Environmental, waste creation, and waste minimization policies should be developed with an emphasis on raising awareness, promoting knowledge, and inspiring households.

6) Another way to reduce solid waste is by encouraging the residents of Barishal to recycle and separate their waste at the source, as is done in many developed countries.

7) Issues involving waste management staff must be handled properly.

8) It is necessary for municipal authorities to investigate technical difficulties such as advanced garbage equipment and city infrastructure.

9) In Barishal, not all families have access to a door-to-door rubbish pickup service. The BCC should keep an eye on this service, assess customer satisfaction, and ensure that all households receive the same level of service from the solid waste collectors.

10) Waste rules must be enforced; in other words, they must bite.

11) Young people could be motivated in school or college if themes on various environmental issues, such as trash management, were included in their curriculum. It will be simple for them to embrace waste minimization strategies later in life if they learn about it in school or college.

12) BCC needs to figure out how to teach the people how to sort (segregate) the waste from various places into components

13) Legal and commercial policy mandates, as well as higher taxes on virgin materials, should take that support recycling.

14) Citizens should be involved in waste management decisions, and the government should work hard to enhance the lives of its citizens.

15) Civil society should play a more active role in waste management issues.

16) Finally, it is suggested that additional research be performed to determine all other elements that contribute to inefficiencies in BCC solid waste management methods, such as behavioral attitudes and insufficient education, in addition to the issues outlined in this study.

Acknowledgements

My supervisor, Associate Professor DR. Tareq Mahamud Abir has been a huge support and inspiration to me throughout the preparation of this thesis. I would like to thank him from the bottom of my heart for all of his help. Last but not least, I want to convey my gratitude to my entire family for their support and inspiration.

Ethical Approval and Consent to Participate

All the required ethical clearances and approvals were granted.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Abedin, M. A., & Jahiruddin, M. (2015). Waste Generation and Management in Bangladesh: An Overview. *Asian Journal of Medical and Biological Research, 1,* 114-120. https://doi.org/10.3329/ajmbr.v1i1.25507

Afroz, R., Hanaki, K., & Tudin, R. (2011). Factors Affecting Waste Generation: A Study in a Waste Management Program in Dhaka City, Bangladesh. *Environmental Monitoring and Assessment, 179,* 509-519. https://doi.org/10.1007/s10661-010-1753-4

Ahmed, N. (2019). *When the Garbage Piles up.* The Daily Star.

Alamgir, M., & Ahsan, A. (2007). Municipal Solid Waste and Recovery Potential: Bangladesh Perspective. *Journal of Environmental Health Science & Engineering, 4,* 67-76.

Alamgir, M., Chowdhury, K. H., & Hossain, Q. S. (2003). Management of Clinical Wastes in Khulna City. In *Seminar on the Role of Renewable and Alternative Energy Sources for National Development* (pp. 146-155). Khulna University of Engineering & Technology.

Aleluia, J., & Ferrão, P. (2016). Characterization of Urban Waste Management Practices in Developing Asian Countries: A New Analytical Framework Based on Waste Characteristics and Urban Dimension. *Waste Management, 58,* 415-429. https://doi.org/10.1016/j.wasman.2016.05.008

Atlas, W. (2012). *Country Data: Bangladesh.* http://www.atlas.d-waste.com/

Barrientos, A. (2019). The Role of Social Assistance in Reducing Poverty and Inequality in Asia and the Pacific. Asian Development Bank Sustainable Development Working

Paper Series. No 62.

Chung, S. S., & Lo, C. W. H. (2008). Local Waste Management Constraints and Waste Administrators in China. *Journal of Waste Management, 28,* 272-281. https://doi.org/10.1016/j.wasman.2006.11.013

Ekere, W., Mugisha, J., & Drake, L. (2009) Factors Influencing Waste Separation and Utilization among Households in the Lake Victoria Crescent, Uganda. *Waste Management, 29,* 3047-3051. https://doi.org/10.1016/j.wasman.2009.08.001

Eriksson, O., & Bisaillon, M. (2011). Multiple System Modeling of Waste Management. *Journal of Waste Management, 31,* 2620-2630. https://doi.org/10.1016/j.wasman.2011.07.007

Glawel, U., Visvanathan, C., & Alamgir, M. (2015). *Solid Waste Management in Least Developed Asian Countries: A Comparative Analysis.* https://www.researchgate.net/publication/228362631

Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid Waste Management Challenges for Cities in Developing Countries. *Waste Management, 33,* 220-232. https://doi.org/10.1016/j.wasman.2012.09.008

Hazra, T., & Goel, S. (2009). Solid Waste Management in Kolkata, India: Practices and Challenges. *Waste Management, 29,* 470-478. https://doi.org/10.1016/j.wasman.2008.01.023

Henry, R. K., Yongsheng, Z., & Jun, D. (2006). Municipal Solid Waste Management Challenges in Developing Countries—Kenyan Case Study. *Waste Management, 26,* 92-100. https://doi.org/10.1016/j.wasman.2005.03.007

Hoornweg, D., & Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management.* World Bank.

Kayode, A. M., & Omole, F. K. (2011) Some Socio-Economic Factors Affecting Solid Wastes Generation and Disposal in Ibadan Metropolis, Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries, 3,* 55-64.

Matete, N., & Trois, C. (2008). Towards Zero Waste in Emerging Countries—A South African Experience. *Waste Management, 28,* 1480-1492. https://doi.org/10.1016/j.wasman.2007.06.006

Moghadam, M. R. A., Mokhtarani, N., & Mokhtarani, B. (2009). Municipal Solid Waste Management in Rasht City, Iran. *Waste Management, 29,* 485-489. https://doi.org/10.1016/j.wasman.2008.02.029

Mrayyan, B., & Hamdi, M. R. (2006). Management Approaches to Integrated Solid Waste in Industrialized Zones in Jordan: A Case of Zarqa City. *Waste Management, 26,* 195-205. https://doi.org/10.1016/j.wasman.2005.06.008

Riyad, A. S. M., Hassan, M., Rahman, M. A., Alam, M., & Akid, A. S. M. (2014). Characteristics and Management of Commercial Solid Waste in Khulna City of Bangladesh. *International Journal of Renewable Energy and Environmental Engineering, 2.*

Scarlat, N., Motola, V., Dallemand, J. F., Monforti, F., & Mofor, L. (2015). Evaluation of Energy Potential of Municipal Solid Waste from African Urban Areas. *Renewable and Sustainable Energy Reviews, 50*, 1269-1286.

Schübeler, P. (1996). *Urban Management and Infrastructure: Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries* (59 p.). UNDP/UNCHS (Habitat)/World Bank/SDC Collaborative Programme.

Seng, B., Kaneko, H., Hirayama, K., & Katayama-Hirayama, K. (2010). Municipal solid Waste Management in Phnom Penh, Capital City of Cambodia. *Waste Management & Research, 29*, 491-500. https://doi.org/10.1177/0734242X10380994

Sham, S., Sahu, N. J., Rahman, S. S. M., & Ahsan, A. (2017). Sustainable Waste Management Policy in Bangladesh for Reduction of Greenhouse Gases. *Sustainable Cities and Society, 33,* 18-26. https://doi.org/10.1016/j.scs.2017.05.008

Sharholy, M., Ahmad, K., Mahmood, G., & Trivedi, R.C. (2008). Municipal Solid Waste Management in Indian Cities—A Review. *Waste Management, 28,* 459-467. https://doi.org/10.1016/j.wasman.2007.02.008

Sujauddin, M., Huda, S. M. S., & Hoque, A. T. M. R. (2008). Household Solid Waste Characteristics and Management in Chittagong, Bangladesh. *Waste Management, 28,* 1688-1695. https://doi.org/10.1016/j.wasman.2007.06.013

Thanh, N. P., Matsui, Y., & Fujiwara, T. (2010). Household Solid Waste Generation and Characteristic in a Mekong Delta City, Vietnam. *Journal of Environmental Management, 91,* 2307-2321. https://doi.org/10.1016/j.jenvman.2010.06.016

Vidanaarachchi, C. K., Yuen, S. T. S., & Pilapitiya, S. (2006). Municipal Solid Waste Management in the Southern Province of Sri Lanka: Problems, Issues and Challenges. *Waste Management, 26,* 920-930. https://doi.org/10.1016/j.wasman.2005.09.013

Wilson, D. C., Velis, C. A., & Rodic, L. (2013). Integrated Sustainable Waste Management in Developing Countries. *Proceedings of the Institution of Civil Engineers: Waste Management Resource, 166,* 52-68. https://doi.org/10.1680/warm.12.00005

Yukalang, N., Clarke, B., & Ross, K. (2017) Barriers to Effective Municipal Solid Waste Management in a Rapidly Urbanizing Area in Thailand. *International Journal of Environmental Research and Public Health, 14,* 9-14. https://doi.org/10.3390/ijerph14091013

Zaman, A. U. (2014). Measuring Waste Management Performance Using the "Zero Waste Index": The Case of Adelaide, Australia. *Journal of Cleaner Production, 66,* 407-419. https://doi.org/10.1016/j.jclepro.2013.10.032

Zhuang, Y., Wu, S.-W., Wang, Y.-L., Wu, W.-Z., & Chen, Y.-X. (2008). Source Separation of Household Waste: A case study in China. *Waste Management, 28,* 2022-2030. https://doi.org/10.1016/j.wasman.2007.08.012