



Review Article

A Review of Solid Waste Management Practice in Dhaka City, Bangladesh

Suraiya Yasmin^{1,*}, Md Imranur Rahman²

¹Institute of Disaster Management and Vulnerability Studies, University of Dhaka, Dhaka, Bangladesh

²Urban and Rural Planning discipline, Khulna University, Khulna, Bangladesh

Email address:

suraiya.yasmin08@gmail.com (S. Yasmin)

*Corresponding author

To cite this article:

Suraiya Yasmin, Md Imranur Rahman. A Review of Solid Waste Management Practice in Dhaka City, Bangladesh. *International Journal of Environmental Protection and Policy*. Vol. 5, No. 2, 2017, pp. 19-25. doi: 10.11648/j.ijepp.20170502.11

Received: December 3, 2016; **Accepted:** February 21, 2017; **Published:** March 9, 2017

Abstract: Waste management is a challenging task as population is increasing and type of waste is changing. Waste management practice needs concern not only for its generation increasing but also for its inadequate practice. Waste generation is affected by socio economic factors, demography, seasonal factors, lack of awareness and weak management practice. With increasing rate of population the waste generation rate is also increasing in Dhaka city where a sustainable waste management practice is required to develop. This review article will attempt to summarize the recent year's state of waste generation and management practices. Desk research was done for the review literature and Google scholar was utilized for the bibliographic database. The review reveals that the uncollected wastes are dumped in open spaces and streets which clog the drainage system creating serious hazards, environmental degradation and health risks in the city. The waste management practice is not very satisfactory and needs adequate policy and awareness. Awareness on various aspects of waste management can help lessen waste generation and improve waste management processes.

Keywords: Waste Management, Waste Generation, Recycling

1. Introduction

Dhaka, the capital city of Bangladesh, is expanding with an enormous growth of population [1]. According to Bangladesh Bureau of Statistics the population of Dhaka Metropolitan was 6,487,459 in 1991 and 9,672,763 in 2001 and 14,543,124 in 2011 [2]. The growth rate of Dhaka City's population will remain high and it will be the top ranking megacity with a population of around 25 million by the year 2025 [3]. The issue of poor solid waste management (SWM) has become a challenge for governments of developing Asia and Africa [4, 5] because it is critical to the protection of public health, safety and the environment [6]. Many experts from various cities in developing countries have expressed serious concerns about improper waste treatment and disposal in these countries [7, 8, 9, 10, 11, 12]. Solid waste needs to be managed in a way that reduces risks to the environment and to human health, which has implications for its storage, collection and proper disposal

[13].

World Health Organization (2014) termed Dhaka as one of the mostly polluted cities [14]. Municipal Solid Waste are being generated at a faster pace, posing a serious management threat. Rapid growth of industries, lack of financial resources, inadequate trained manpower, inappropriate technology and lack of awareness of the community are the major constraints of solid waste management for the fast growing metropolis of Dhaka [1]. Both quantity and volume of this waste have increased rapidly as the city population [15, 16, 17]. Daily production of solid waste in Dhaka City is more than 4000 Metric Tons of which 200 Metric Tons hospital and clinical waste contain toxic chemicals, radioactive elements and pathological substances. The nature of solid waste is getting changed with the change of time and development. Solid wastes like polyethylene and other plastic goods cause

problems towards human health, environment and drainage system [18]. The issue of solid waste is not only because of the increasing quantities, but also largely because of an inadequate management system [19].

In Bangladesh, due to lack of motivation, awareness, commitment, expertise as well as money a considerable portion of wastes, 40-60%, are not properly stored, collected or disposed in the designated places for ultimate disposal [20]. The effectiveness of solid waste disposal depends upon the selection of proper site and current global trend of waste management problems stems from unsustainable methods of waste disposal, which is ultimately a result of inadequate planning [21]. The most common problems associated with improper dumping includes; diseases transmission, fire hazards, odour nuisance, atmospheric and water pollution, aesthetic nuisance and economic losses [22]. Controlling urban solid waste is an inevitable challenge in developing countries, basically in the larger urban centers like Dhaka city [23]. The increasing urban population made the Environmentalists think about the scientific waste management with topmost priority in urban planning in the developing countries. This paper focuses on reviewing the waste generation and management existing scenarios in Dhaka, Bangladesh.

2. Waste Management Practice in Dhaka Bangladesh

On a global scale, we currently are facing three major environmental crises: global warming, depletion of resources, and destruction of our ecosystem [24]. These crises are interrelated and connected to waste and waste management. A rising quality of life and high rates resources consumption patterns have had an unintended and negative impact on the urban environment generation of waste far beyond the handling capacities urban government and agencies [25]. The Dhaka City Corporation (DCC) is primarily responsible for collecting and managing waste in Dhaka, Bangladesh [26]. A significant amount of waste in Dhaka is not collected due to lack of infrastructure, funds and collection vehicles. Despite Dhaka's limited waste management service, community based door-to-door waste collection from households to local waste bins is considered as a success. Informal waste recycling systems is also highly effective in waste recycling and job creations for the poor [27, 28].

In case of household sector, wastes are typically collected in a non-segregated manner and placed into the slender containers at the households. Organizations outsourced by City Corporation (CC) collect the waste in vans through vanmen on payment basis and carry to the secondary collection points (containers or designated sites). Subsequently, the waste is carried by various sizes of trucks (of City Corporation or private organization authorized by the city Corporation) to the landfill sites situated at Matuail and Amin Bazaar. In this connection, an informal market operates to recycle a significant portion of the solid waste. The roles of

the Tokai or scavengers and door step, Hawkers are worth mentioning. Scavengers collect the recyclable items from both the landfills and open waste bins and finally sell it to a recycle waste dealer (Bhangari). The items are then washed, dried and sorted by the recycling dealers and traded in the market. Besides the scavengers, the Hawkers buy recyclables from door to door and trade with the Bhangari (receivables buyers). The pattern of waste collection in slum households is different to some extent. City Corporation in general, does not provide any waste management services in these areas. In case of city streets, the process of waste management is quite different. The city corporation through its cleaners (permanents and temporary) undertakes the cleaning of public places (roads, drains and parks etc) on a daily basis. Unlike household and public place waste management, commercial waste management is far complicated. The waste collected from the city is disposed to the final destination at land filling sites [29, 30].

Two important initiatives have been undertaken for Solid Waste Management (SWM) in Dhaka. One initiative was undertaken by Japan International Cooperation Agency (JICA) in 2005 with the objectives of formulating a master plan of Dhaka City and to develop capabilities and management skills of the Dhaka City Corporation. Another initiative, 3R Strategy was undertaken in 2010 by Department of Environment (DoE), Ministry of Environment and Forestry of the Government. The principle of reducing, reusing and recycling of resources and products is often called the 3Rs [26, 29]. Towards sustainable waste management, 3Rs can play a vital role to protect environment from greenhouse gas emission and convert waste into invaluable resources [26].

3. Waste Generation

The amount of waste generated in urban area is proportional to the population and the average income of the people. In addition, other factors such as climate, level of education, social and public attitude also may affect the amount and composition of waste [31]. As the growth rate of the population in Dhaka has been high during recent years, the amount of waste generation in Dhaka is increasing [32]. According to some sources, waste can be categorized as a) domestic waste, b) commercial waste, c) institutional waste, d) industrial waste, e) street sweepings, f) clinical waste and g) construction and demolition waste [18]. The contributions of different sectors to the total generation of Dhaka city, where nearly 76% of generated waste came from the residential sector, 22% came from the commercial sector, 1% from the institutional sector and rest from other sectors [33, 18]. The total waste generated in the Dhaka city of Bangladesh per day is 4,634.52 tons. Based on the total estimated urban population of the year 2005 (see Table 1), per capita waste generation rate is computed as 0.56 kg/capita/day [34, 18]. The waste generation rate generally varies between the dry and the wet season in Dhaka. In the rainy season, organic and perishable wastes contain more moisture so the bulk of waste contains more weight than in the dry season [32]. Solid waste

management has been an integral part of every human society and policies vary both within and between developing countries.

The Dhaka City Cooperation estimated that, of the total daily generation of 3500 tons of solid waste, 1800 tons are collected and dumped by the city corporation, 900 tons go to backyard and land filling, 400 tons go to road side and open space, 300 tons are recycled by the *Tokais* (mostly the children of slum dwellers), and 100 tons are recycled at the generation point. [18]. In a study by [35], it has been found that during wet season the waste generation rate increases by 46%. The seasonal differences in the municipal solid waste stream are not substantial. The most seasonably variable material in the municipal solid waste stream is food waste. Residential waste is relatively homogeneous. Although there are some differences in waste generation depending on demographic and other local factors, most households dispose of essentially similar types of wastes. Variation occurs in waste composition dependent upon income levels [32] and category of sources. Variation also occurs based upon the extent of source reduction and recycling opportunities [36]. According to the [30] (see Table 2) the highest income group produces almost double as much household waste as the lowest income group in Dhaka.

The waste sector in Bangladesh is also a significant contributor to greenhouse gas emissions because it generates methane. Excluding carbon dioxide, this sector produced 17 million metric tons of CO₂ - equivalent in 2005, or 27% of the nation's total non - CO₂ emissions. By 2020, waste related emissions were projected to increase by 22%, to 20 million metric tons [37]. In Dhaka waste generation is enormously affecting by increasing population. Other factors affecting waste generation are migration, socio economic factor, inadequate waste management practice, lack of awareness etc. The unplanned growth of Dhaka will influence the factors that affected waste generation and most likely worsen the situation.

4. Collection and Transportation

The Dhaka City Corporation (DCC) supervises municipal solid waste management in an area of 360 km² with a

population of 7 million estimated to generate 3000 to 4000 tons of waste per day [38]. The DCC openly states that its collection system cannot cope with the task of handling the large volumes of refuse produced by the ever-growing numbers of city dwellers, and that only 40-50% of the solid waste produced is being collected [38, 39]. DCC is responsible for secondary waste collection to remove waste from its dustbins/containers, and transport the waste to final disposal sites. Residents are responsible for bringing their waste to DCC's waste collection points where dustbins/containers are located. In 2002, DCC introduced an approval system of NGOs/CBOs/private organization for providing door-to-door waste collection services in all wards. DCC deploys facilities and manpower for secondary waste collection [18, 30].

According to [40], 50% of the daily generated waste remains uncollected in the city and disposed at official dump sites. Only 14-17% of the total municipal budget is used for solid waste management which is approximately 0.5 USD per capita per year. As a result, the uncollected waste is primarily dumped illegally in the neighborhood's streets, wastewater drains, ponds, lakes etc. or managed informally [39]. Uncollected waste has been recognized as the root of inferior environment such as scattered garbage, offensive odor, drain clogging, water pollution and mosquitoes. The waste volume is still increasing as the city grows although Dhaka City Corporation does not have a confident view to solve the problems of uncollected waste [30]. The overall waste collection situation is not very satisfactory. Huge amount of uncollected waste pollutes the local environment rapidly.

5. Disposal

The disposal and management of municipal solid waste are a global challenge, especially in developing countries due to its adverse environmental effects [41]. When waste is not properly collected, it will be illegally disposed of and this will pose serious environmental and health hazards to the Bangladeshis [42]. Solid waste management represents a prominent issue in light of the fact that it prompts land contamination if transparently dumped, water contamination if dumped in the swamps and air contamination if smoldered.

Table 1. Waste Generation Rate (WGR) and Total Waste Generation (TWG) in Dhaka city and other cities, 2004.

City/Town	WGR (kg/cap/day)	No. of City/Town	Total population	Population (2005)	TWG (Ton/day)		Average TWG
					Dry season	Wet season	
Dhaka	0.56	1	6,116,731	6728404	3,767.91	5,501.14	4,634.52
Chittagong	0.48	1	2,383,725	2,622,098	1,258.61	1,837.57	1,548.09
Rajshahi	0.3	1	425,798	468,378	140.51	205.15	172.83
Khulna	0.27	1	879,422	967,365	261.19	381.34	321.26
Barisal	0.25	1	397,281	437,009	109.25	159.51	134.38
Sylet	0.3	1	351,724	386,896	116.07	169.46	142.76
Pourashavas	0.25	298	13,831,187	15,214,306	3,803.58	5,553.22	4,678.40
Other Urban Centers	0.15	218	8,379,647	9,217,612	1,382.64	2,018.65	1,700.65

Source: [18]

Table 2. Waste generation rate in Dhaka city.

Sources	Domestic waste			
	Income level (Tk/month/family)	Rate (Kg/person/day)		
		Dry	Wet	Average
High Income group	>=20,000	0.588	0.438	0.513
Middle Income group	20,000>, >=10,000	0.371	0.428	0.400
Middle-Low Income group	10,000>, >=5,000	0.279	0.346	0.313
Low Income group	5,000>, >=3,000	0.326	0.345	0.336
Lowest Income group	3,000>	0.314	0.205	0.260
Weighted average	Kg/person/day			0.340

Source: [30]

Dhaka city is confronting serious environmental imbalance because of the uncollected transfer of waste on avenues and other open territories, obstructed seepage by tainting of water assets close uncontrolled dumping locales. Almost all the area of this city does not experience adequate waste management [43]. Dumpsites for municipal solid waste are situated on low-lying, flood-prone land. They are not managed as sanitary landfills, apart from efforts by JICA and Waste Concern at Matuail site [44].

DCC uses three landfill sites: namely, Matuail, Berri Band and Uttara; Matuail is the only official site owned by DCC. The rest (Berri Band and Uttara dumpsites) are private land. Operation method of solid waste at three landfill sites are open dumping (crude dumping) without control of incoming waste and no covering soil. The solid waste is dumped without surrounding bank at either Berri Band or Uttara. Three types of heavy equipment are used for final disposal; however, the provision is unstable because more than half of the equipment stock is broken [30]. Disposing of solid waste in open dumps is the most common method used for final disposal of urban solid waste. In some cities and towns there are designated dumping sites where the collected waste is dumped in unsanitary manner. No waste segregation, waste compaction or daily top seal are used in these dumpsites. The case is even worse in areas where there is no specific dumpsite. The collected waste is disposed through crude dumping in low-lying areas, nearby water bodies or on a vacant lot. Much of the uncollected waste is also disposed in the same manner. The entire waste disposal system is unsanitary which needs

urgent improvement [30]. Open dumping of wastes is harmful for environment and the landfill sites need to operate and maintain through scientific and systematic way.

6. Recycling

The study of [34] found that a substantial portion (69% to 77%) of solid waste in the urban areas is compostable. Average compostable content of the waste is 74% with the remaining 26% being non-compostable. The large quantity of organic contents present in urban solid waste composition indicates the necessity for frequent collection and removal. This also indicates good potentials for recycling of organic waste for resource recovery [39]. Households can play a predominant role, as they have the capacity to substantially reduce the amounts of unwanted waste at household level by segregating clean materials which have a recyclable value - such as plastic or paper - instead of mixing them with other fractions such as kitchen waste, and thus diminishing their potential recycling value [45]. Segregating recyclables at the household level, and thus ensuring their cleanliness and quality, can provide an interesting opportunity to enhance waste recycling, provide more resources to the recycling industry and augment incomes of the recyclables dealers and waste collectors (Feriwallas and Gariwallas) [46]. [47] and [48] in the context of SWM, have highlighted the importance of informal market as a significant components of SWM. Recycling industry raises a total of 436 ton/day of material recovery as shown in the Table 3.

Table 3. Estimated volume of recycled wastes in Dhaka City.

Material	a) Estimated generation of recyclable waste (ton/day)	b) Estimated recycled waste (ton/day)	c) Recycle rate	d) Contribution to waste reduction (b/3,200)
Plastic	124	103	83%	3.2%
Paper	260	168	65%	5.3%
Glass	46	24	52%	0.8%
Metal	27	41	*	1.3%
Compostable	2211	6	0%	0.2%
Others	99	94	95%	2.9%
Total	2767	436		13.6%

d) Assumed total municipal solid waste generation: 3,200 (ton/day)

* Generation amount of metal is estimated by averaging 60 samples of waste composition survey, which did not contain metal factory at all. While recycled volume of metal contains imported metal from other cities in the country that did not appear in the composition survey. With this mechanism it is understood the recycled volume exceeds the estimated generation amount.

Source: [30]

The amount recovered is the reduction of waste to be managed by DCC. Composting contributes very little to the waste reduction although the compostable waste has the largest portion among generated wastes [30]. Approximately 6% of the total labor force in Dhaka City is in the recycling sector [30]. The waste pickers search for the recyclable items from the containers and landfills. These waste pickers collect the recyclables and sell them to *Bhangari* (the petty traders), *Bhangaris* inspect the materials which have scrap values. Subsequently, they sell it to *Mohajans/ Paikar* (wholesalers), who clean up the materials and sell them, to different factories. These factories use the recyclable substances as raw materials and after some processing. Vanmen directly collect recyclable items from waste bin of households or containers and sell them to the *Bhangaris* (petty traders). The waste pickers operating in landfills risk their lives to search for new products from freshly dumped waste to get the best value after recycle [29].

Recycling already takes place at several levels via different stakeholders: at household level by waste producers, with trading by *Feriwallas* or during collection by *Gariwallas*, at municipal collection points, and on dumpsites by *Tokai* or municipal employees of the collection service. The system is however not optimized to secure a maximal value creation. In the current existing informal waste management system there is much scope for improvement at micro-level which can better exploit the value of recyclables. Source segregation at household level improves the quality of recyclables, and thus increases their value [39]. As opportunities exist to recycle wastes, the recycling facilities might have to grow at a similar pace to the generation of waste. Physical and chemical characteristics of solid waste are important to implement the waste disposal and management plan for the selection of resource and energy recovery potentials [36].

Recycled plastic materials are very competitive and meet a high demand on the industrial market. Using a scenario of a 100% plastic recycling rate (instead of 51% as estimated in 2006 by [45], with a thus significant increase in production of recycled pellets, estimates of potential foreign currency income are at USD 29.42 Million per year [49]. The largest fraction by weight of mixed municipal solid waste consists of organic biodegradable refuse (60 to 75%) [38,49]. Reducing this organic content by means of composting, or any other organic waste treatment technology, would have a strong impact on reducing the volume of waste to be collected and disposed [39]. Composting is sustainability in developing countries considering the numerous benefits such as production of organic compost, reduction of waste quantity for final disposal, reduced air pollution and ground water leachate and also creates employment and income and others. Composting is the most suitable for developing countries due to the low costing; low technology; low pollution effect and it has more benefits to the environment and the economy when compared to the disposal of organic waste into open dumps as is widely practiced in developing countries [50].

Proper utilization of waste can solve the urban waste

problem in a great way. Thus composting of organic waste can reduce a significant amount of landfill load and the remaining inorganic portions can be recycled for which a sustainable plan and public partnership is required.

7. Conclusion and Recommendation

The generation of waste is increasing by competing with the growing population. Dhaka City Corporation is responsible for the waste collection and transportation where an integrated and sustainable approach is necessary to introduce in Dhaka city. The uncollected waste creates a heavy drainage problem especially in the monsoon season. The open disposal and dumping system is unhygienic for environment where modern technology and equipment is needed. Major portions of waste do carry the compostable content which can be recycled in a scientific and sustainable way.

Public and private partnerships contribute to an effective Solid Waste Management and such partnerships can have a significant impact on the perceptions of what constitutes good urban governance [51].

Successful solid waste management in a sustainable way can be achieved only through a joint involvement of all stakeholders. Dhaka city has been growing without much of plan and the city lacks systematic waste management system as well. According to composition of waste, composting will be more sustainable way for resource recovery. In addition organizing recycling sector for inorganic waste, safe disposal of waste on the landfill site with sufficient leachate and gas collection system to reduce air and water pollution, health safety for the workers at the disposal sites should be ensured. Furthermore, both central government and Dhaka City Corporation should have some strict rule and ordinance to increase waste collection through formal sector instead of informal sector.

Effective solid waste management calls for the active participation of both formal and informal sectors. Informal sector can play an important role in initiating, innovating new concepts, providing technical knowledge and providing training to others. So for sustainable and effective management of solid waste in Dhaka city, active participation of both sectors should be recommended. If waste management process can start at primary level and community based programme can initiate then waste can be easily manageable. Now this is the time to rethink about waste disposal system and developing a wide range of systems and approaches to minimize the environmental hazard as well as reaching a profitable solutions using waste. In order to improve solid waste management in the Dhaka city of Bangladesh following recommendations can be considered:

- Develop a scientific and well organized waste management for collection, transport, and dispose of or recycling of solid waste.
- Develop a policy and long term strategic framework based on a renewed understanding of the environmental situation in Dhaka.

- Initiate immediate actions for empowering and capacity building of Dhaka City Corporation by the local and central government level to accelerate integrated approach.
- Waste collection practice should be improved by improving the working conditions of the waste pickers and thereby reducing the occupational health hazards and encourages NGOs and private companies to establish community based segregation at source.
- Waste recycling as a treatment option prior to disposal need to be addressed for resource recovery and Open dumping should be replaced with new safe options.
- Initiate a long-term awareness building, media demonstrations through NGOs and campaigning programme so that people get motivated about waste segregation, recycling, reuse, cleanliness and personal hygiene.

References

- [1] Rahman SH and Rahman S. Urban solid waste management using GIS technique: A case study on Mohammadpur Thana at Dhaka of Bangladesh. Proceedings of the International Conference on Solid Waste Management Technical, Environmental and Socio-economical Contexts – Waste Safe, Khulna, Bangladesh. 2009; 239-248p.
- [2] Bangladesh Bureau of Statistics. BBS. 2012.
- [3] Hossain S. Urban Poverty in Bangladesh: Slum Communities, Migration and Social Integration, IB Tauris: London. 2011.
- [4] Calo` F and Parise M. Waste management and problems of groundwater pollution in karst environments in the context of a post-conflict scenario: the case of Mostar (Bosnia Herzegovina). Habitat International. 2009; 33 (1): 63–72.
- [5] Zia H and Devadas V. Urban solid waste management in Kanpur: opportunities and perspectives. Habitat International. 2008; 32 (1): 58–73.
- [6] Hasan MR, Tetsuo K and Islam SA. Landfill demand and allocation for municipal solid waste disposal in Dhaka City—an assessment in a GIS environment. Journal of Civil Engineering. 2009; 37 (2): 133-149.
- [7] Berkun M, Aras E, Nemlioglu S. Disposal of solidwaste in Istanbul and along the Black Sea coast of Turkey. Waste Management. 2005; 25 (8): 847–55.
- [8] Pokhrel D and Viraraghavan T. Municipal solid waste management in Nepal: practices and challenges. Waste Management, 2005; 25: 555–62.
- [9] Barton JR, Issias I, Stentiford EI. Carbon—making the right choice for waste management in developing countries. Waste Management. 2008; 28: 690–8.
- [10] Chung SS and Lo CW H. Local waste management constraints and waste administrators in China. Waste Management, 2008; 28 (2): 272–81.
- [11] Imam A, Mohammed B and Wilson DC. Cheeseman CR. Solid waste management in Abuja, Nigeria. Waste Management, 2008; 28 (2): 468–72.
- [12] Sharholi M, Ahmad K and Mahmood G. Trivedi RC. Municipal solid waste management in Indian cities. Waste Management. 2008; 28 (2): 459–67.
- [13] Kassim SM and Ali M. Solid waste collection by the private sector: households' perspectives findings from a study in Dar-es-Salaam city, Tanzania. Habitat International. 2006. 30 (4), 769–780.
- [14] WHO. Air Pollution Monitoring Report of World Health Organisation (WHO). 2014.
- [15] Mukti SA. Solid Waste Management In Dhaka City: Problems And Prospects. International Journal of Innovative Research & Development 2015.2 (11): 33–37.
- [16] Center for Clean Air Policy (CCAP), Dhaka's Integrated Municipal Solid Waste Program, Bangladesh. 2012.
- [17] Bogner J, Pipatti R, Hashimoto S, Diaz C, Mareckova K, Diaz L, Zhang T. Mitigation of global greenhouse gas emissions from waste: conclusions and strategies from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. Working Group III (Mitigation). Waste Management & Research. 2008; 26 (1), 11-32.
- [18] Bahauddin KM and Uddin MH. Prospect of Solid Waste Situation and an Approach of Environmental Management Measure (EMM) Model for Sustainable Solid Waste Management: Case Study of Dhaka City. Journal of Environmental Science and Natural Resources. 2012; 5 (1): 99-111.
- [19] Tinmaz E and Demir I. Research on solid waste management systems: To improve existing situation in Corlu Town of Turkey. Waste Manage. 2006; 26 (3), 307-314.
- [20] Ahsan A, Alamgir M, Islam R, Chowdhury KH. Initiatives of Non-Governmental Organizations in Solid Waste Management at Khulna City. InProc. 3rd Annual Paper Meet and Intl. Conf. on Civil Engineering, March. 2005; 9-11.
- [21] Abbas II, Nai'ya R, Arigbede YA. Use of remote sensing and GIS in effective and efficient solid management planning: A case study of Samara, Zaria, Nigeria. Res. J. Earth Planet. Stud. 2011; 2: 46-52.
- [22] Mohammedshum AA, Gebresilassie MA, Rulindaa CM, Kahsaya GH, Tesfay MS. Application of GIS and Remote Sensing in effective solid waste disposal site selection in Wukro town, Tigray, Ethiopia. The Int. Arch. Photogram. Rem. Sens. Spatial Inform. Sci. 2014; 2: 115-119.
- [23] Afroz R, Hanaki K, Tudin R. Factors affecting waste generation: A study in a waste management program in Dhaka City, Bangladesh. Environmental Monitoring and Assessment. 2011; 179 (1): 509-519.
- [24] Aliani H A. Pro Poor solid waste management-For secondary cities and small towns in Asia and Pacific, Sustainable Urban Development Unit. ESCAP. 2012.
- [25] Agamuthu P and Tanaka M. Penerbit in Tanaka, M. Sustainable Society and Municipal Solid Waste Management, in Municipal Solid Waste Management in Asia and the Pacific Islands. Indonesia Penerbit ITB. 2010.
- [26] Chowdhury AH, Mohammad N, Haque MRU, Hossain T. Developing 3Rs (Reduce, Reuse And Recycle) Strategy for Waste Management in the Urban Areas of Bangladesh: Socioeconomic and Climate Adoption Mitigation Option. IOSR-JESTFT. 2014; 8 (5): 09-18.

- [27] Ahsan T, Zaman AU. Household Waste Management in High-Rise Residential Building in Dhaka, Bangladesh: Users? Perspective. *International Journal of Waste Resources*. 2014; 4 (1): 1-7.
- [28] Hai FI and Ali MA. A study on solid waste management system of Dhaka City Corporation: effect of composting and landfill location. 2005.
- [29] BIGD. The State of Cities: Solid Waste Management of Dhaka City– Towards Decentralised Governance. BRAC Institute of Governance and Development, BRAC University, Dhaka. 2015.
- [30] DCC-JICA report. The study on the solid waste management in Dhaka city” by Dhaka City Corporation, The People’s Republic of Bangladesh, Japan International Cooperation Agency. 2005; 2.
- [31] Pattnaik S and Reddy MV. Assessment of municipal solid waste management in Puducherry (Pondicherry), India. *Resources, Conservation and Recycling*, 2010; 54 (8): 512-520.
- [32] Nasrin ST. Urban Development on Municipal Solid Waste Management in Dhaka, Bangladesh. 2014.
- [33] Alamgir M. and Ahsan. A. Municipal Solid Waste and Recovery Potential: Bangladesh Perspective. *Iran. J. Environ. Health. Sci. Eng.* 2007; 4 (2): 67–76.
- [34] Enayetullah I, Sinha AHMM, Khan SSA. Urban Solid Waste Management Scenario of Bangladesh: Problems and Prospects. *Waste Concern Technical Documentation*, Dhaka, Bangladesh. 2005; 18.
- [35] Dhaka City Corporation (DCC) and Japan International Cooperation Agency (JICA). The Study on the Solid Waste Management in Dhaka City”, prepared by Pacific Consultants International and Yachiyo Engineering Co., Ltd. 2004.
- [36] Yousuf TB and Rahman M. Monitoring quantity and characteristics of municipal solid waste in Dhaka City. *Environmental monitoring and assessment*, 2007; 135 (1-3): 3-11.
- [37] EPA (U.S. Environmental Protection Agency). Emissions and Projections of Non - CO₂Greenhouse Gases from Developing Countries: 1990-2030. 2011.
- [38] Dhaka City Corporation. Solid Waste Management in Dhaka, Bangladesh. 2011.
- [39] Matter A, Dietschi M, Zurbrugg C. Improving the informal recycling sector through segregation of waste in the household–The case of Dhaka Bangladesh. *Habitat International*, 2013; 38: 150-156.
- [40] Hasan GMJ and Chowdhury AI. Municipal solid waste management and environmental hazards on Bangladesh. *Asian Journal of Water, Environment and Pollution*. 2006; 3 (1): 39-48.
- [41] Butu AW, Ageda BR, AA, B. Environmental Impacts of Roadside Disposal of Municipal Solid Wastes in Karu, Nasarawa State, Nigeria. *Internal Journal of Environment and Pollution Research*. 2013; 1 (1): 1-19.
- [42] Zahur M. Solid waste management of Dhaka city: public private community partnership. 2007.
- [43] UN Habitat. Solid Waste Management In The World’s Cities Water And Sanitation In The World’s Cities 2010. United Nations Human Settlements Programme, London, UK. 2010.
- [44] Scheinberg A, Wilson DC and Rodic L. Solid Waste Management in the World’s Cities, UN-Habitat’s Third Global Report on the State of Water and Sanitation in the World’s Cities, Earthscan. 2010.
- [45] Enayetullah I, Sinha AH, Hossain I, Islam S, Khan KH, Banu LA, Rahman M, Roy SK. Final report on composition of plastic waste and market assessment of the plastic recycling sector in Dhaka City. Unpublished results. 2006.
- [46] MoEF. National 3 R Strategy for Waste Management, Ministry of Environment and Forests, Government of the People’s Republic of Bangladesh. 2010.
- [47] Linzner R and Lange U. Role and size of informal sector in waste management – a review. *Proceedings of the ICE - Waste and Resource Management*. 2013; 166 (2): 69-83.
- [48] Alam MR, Sohel MH. Environmental Management in Bangladesh—a study on municipal solid waste management system in Chittagong. *The Cost and Management*, 2008; 36 (3): 25.
- [49] Enayetullah I, Sinha AHMM, Khan KH, Kumar Roy S, Kabir SM & Rahman M. Report on baseline survey on solid waste management in Uttara Model Town. Unpublished results. 2006.
- [50] Harir AI, Kasim R, Ishiyaku B. Exploring the Resource Recovery Potentials of Municipal Solid Waste: A Review of Solid Wastes Composting in Developing Countries. *International Journal of Scientific and Research Publications*, 2015; 5 (8).
- [51] Bhuiyan SH. A Crisis in Governance: Sustainable Urban Solid Waste Management in Bangladesh. *Nepalese Journal of Public Policy and Governance*. 2009; 24 (1): 63-80.