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Solid Waste Disposal Scenario of Three Ladies' Halls in the University of Chittagong, Chittagong, Bangladesh

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ABSTRACT

University of Chittagong (CU) is well known for its beautiful green campus. It had 11 student halls (plus two were under construction), of which three were ladies' halls named (Shamsun Nahar, Pritilata and Deshnetri Begum Khaleda Zia). But, due to lack of a proper waste management plan, wastes were found to be scattered in open areas of ladies' halls premises. So, to protect the environmental quality of three ladies' halls a research work has conducted during June 2012 to March 2013. Here researcher try to determine the waste generation rates, their physical composition and characterized them. At that time data about disposed wastes were collected weekly from kitchen, dining, canteen, bathroom, and halls premises at 8.00 to 11.00 am and wastes were measured by using weighing machine in kilogram (kg). Based on sources, wastes were categorized mainly on four types, such as: (1) kitchen waste, (2) dining and canteen wastes, (3) bathroom waste, and (4) others (veranda, corridor, and in and around the halls' campus) wastes. Overall, 18,505.0 kg wastes were disposed from different sources and among them 10,406.0 kg (i.e., 56.24%) were from kitchen, 1,218.5 kg (i.e., 6.59 %) from dining and canteen, 1,570.5 kg (i.e., 8.49 %) from bathroom and 5,310.0 kg (i.e., 28.68 %) from others sources. On an average each student of 3 ladies' halls disposed 0.029 kg waste per day that gave a total of 8.520 kg wastes during the 10 months of study period. The campus of The University of Chittagong is well known as a habitat of different types of wild animals. So, monthly waste dumping sites were visited and the wild animals those were seen eating foods from dumping wastes were identified with the help of field guides (Section e.g., Grimmett *et al.*, 2009; Ahmed *et al.*, 2009).

INTRODUCTION

Solid waste includes highly heterogeneous mass of discarded material from residential, commercial, industrial, agricultural mining activities (Alam *et al.*, 2002). Wastes are mostly produced through human activities, economic development and urbanization in the societies. These may be referred as unavoidable by products.

The world population is the total number of living humans on Earth. Urban population will grow up to 5 billion by 2030 (<http://www.unfpa.org/pds/urbanization.htm>). This rapid growth is a curse and threat for our environment because this people produce more and more wastes. In Bangladesh, an estimated 50 million city dwellers in 223 municipalities including the seven Metropolitan cities are producing about 20,000 tons of solid and liquid wastes (Faruqui, 2002). The total production of solid waste from all sources is 1,069 tons per day in Chittagong Metropolitan area (Shahin, 2005). The amount of solid waste produced from industries and clinics in the city are much lesser in quantity than domestic wastes (Anon., 2000).

The University of Chittagong (CU) is the third largest and one of the multidisciplinary universities in Bangladesh with 24,283 students, 862 faculty members and 1904 supportive staff. It was established on 18 November 1966 at Fatehpur under Hathazari upazila (sub-district), 22 km north of Chittagong city and 3 km southwest of the upazila headquarter (22°16'48"N and 91°28'24.6"E). Total area of the CU campus is about 709 ha and it is well known for its beautiful green scenario. But dumping

of wastes in open area filth the aesthetic beauty of the campus. So, it has become an essential task to manage the solid wastes of the CU campus in a scientific way.

Impact of Solid Waste Disposal on Environment

Solid waste causes serious problems in the developing countries like Bangladesh. Some of these are:

1. Open air dumping creates unhygienic situation and is an enormous threat to the residential students (Zahur, 2007)
2. Causes aesthetic problem such as nausea and vomiting due to foul odor (Zahur, 2007)
3. Promotes spreading of diseases and pollute water bodies (Zahur, 2007)
4. Soil can loss their fertility and become unsuitable for plants. This will affect other organism in the food wave;
5. Gases are produced in the landfills through aerobic and anaerobic decomposition of organic compounds, which are threat to the environment (Zahur, 2007)

Now-a-days solid waste management has become one of the major concerns in most developed and developing countries (including Bangladesh). Absence of proper waste management plan, the situation has become more wasteful in the recent time.

In CU campus waste dumping sites emit obnoxious smell and provokes vomiting for passerby. The waste burnt smokes also make unpleasant problem for the residential halls. If these solid wastes are not disposed in a safe distance, then these residential halls will face problem of environmental pollution. In fact, wastes are ruining the panoramic beauty of the Campus.

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Objectives

The major objectives of this study were to:

1. know the different types of solid waste disposed;
2. quantify different types of solid waste;
3. identify the waste dependent wildlife from the waste dumping spots; and
4. find out management approach of solid wastes.

MATERIALS AND METHODS

The study was carried out at three ladies' halls of CU Campus from June 2012 to March 2013. The total study area was divided into 3 sites (S-1 to S-3). Site 1: Shamsun Nahar (SN) hall covers an area of 1.417 ha. It is a five storied building and 741 students live in this hall. SN hall has 12 units of bathroom, 11 kitchens, 1 dining and 1 canteen. Site 2: Pritilata (PL) hall comprises an area of 1.417 ha. It is a four storied building and 731 students live there. PL hall has 16 units of bathroom, 16 kitchens, 1 dining and 1 canteen. Site 3: Deshnetri Begum Khaleda Zia (KZ) hall includes an area of 1.417 ha. It is a four storied building and 700 students live there. KZ hall has 20 units of bathroom, 20 kitchens, 1 dining and 1 canteen. Wastes were disposed by the students of the three ladies'

halls in the buckets, which have been placed in every spot such as kitchen, dining and canteen, bathroom, toilet and corridor. Kitchen, dining and canteen, and others wastes were measured weekly but bathroom wastes were measured in the last week of each month because these were cleaned once or twice in a month. All wastes were measured at every morning from 8.00 to 11.00. In KZ hall the surrounding wastes (including garden) were measured with the others wastes but not for the other two halls. It should be mentioned here that the garden wastes of SN and PL are disposed outside the hall premises, but in KZ hall these were dumped inside the hall premises. Wastes were put in a tray and verified with naked eyes to separate them into different categories by using one pair of forceps and weighing in kilogram (kg).

Major and minor wastes dumping spots (major- huge number of wastes dumping place and minor- small number of wastes dumping place) were located in and around the studied halls, among them SN had 1 major (big) and 14 minor (small) dumping spots, PL had 1 major and 2 minor, and KZ had 3 major and 2 minor spots. Waste feeding animals in the major dumping spots were observed with naked eyes.

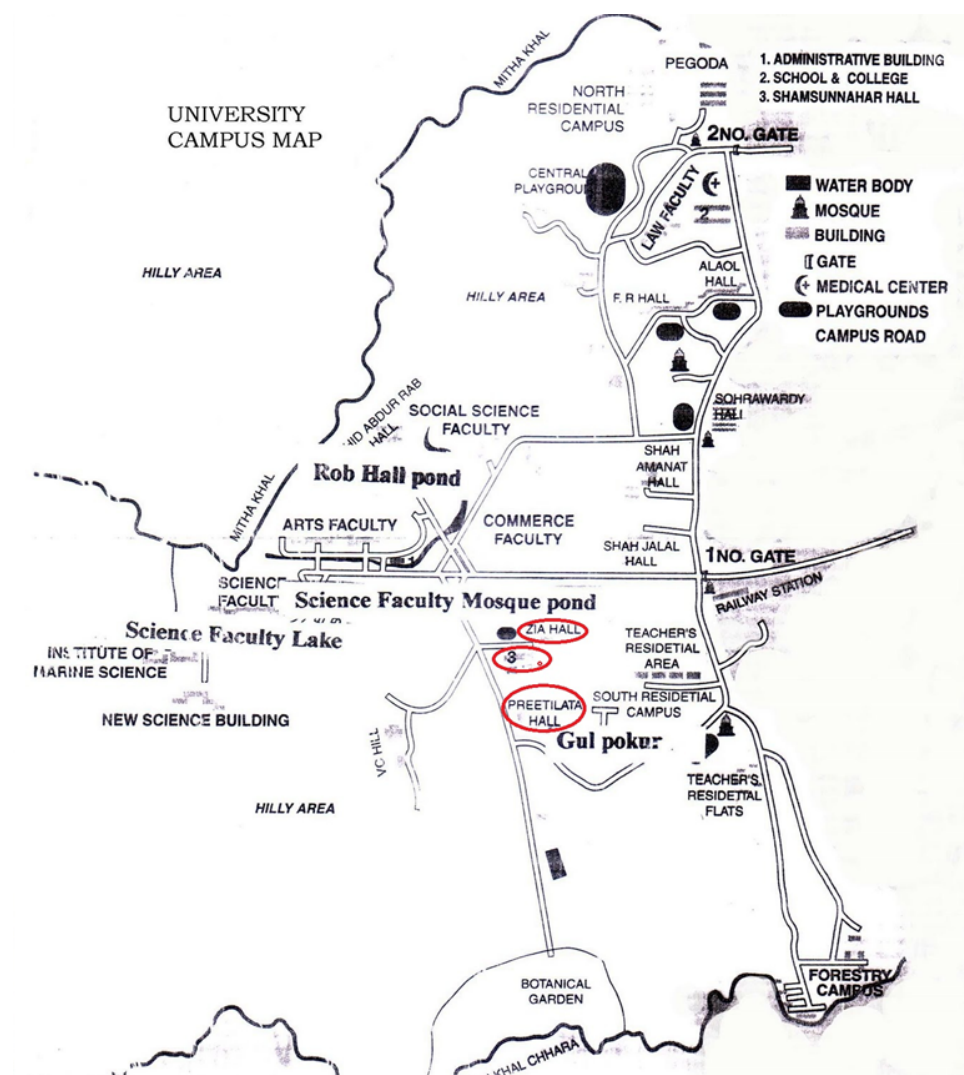


Figure 1: Map of the University of Chittagong showing the study area (edited by illustrator).

RESULTS AND DISCUSSION

The sources, types and physical nature of the disposed wastes (Table 1) from 3 ladies' halls were basically similar and mostly contained general wastes, and there were little hazardous wastes also.

Overall, 18,505.0 kg wastes were disposed from different sources of three ladies' halls, of which kitchen wastes were maximum (10,406 kg i.e., 56.26%), and dining and canteen wastes were minimum (1,218 kg i.e., 6.59%) (Figure 2).

Table 1: Different types of waste (kg) disposed from three ladies' halls of CU campus from June 2012 to March 2013

Months	Kitchen waste	Dining and Canteen waste	Bathroom waste	Others waste	Total Waste
July 2012	1252.0	128.5	182.5	472.0	2035.0
August 2012	565.0	66.0	104.0	295.0	1030.0
June 2012	1007.5	101.5	166.5	449.0	1724.5
September 2012	1085.5	128.5	151.5	527.5	1893.0
October 2012	1193.0	142.5	177.5	586.0	2099.0
November 2012	1059.0	127.5	167.5	603.0	1957.0
December 2012	1321.0	154.5	162.5	727.5	2365.5
January 2013	1048.0	133.0	158.0	597.0	1936.0
February 2013	1052.0	137.0	173.0	632.0	1994.0
March 2013	823.0	99.5	127.5	421.0	1471.0
Total	10,406.0	1,218.5	1,570.5	5,310.0	18,505.0

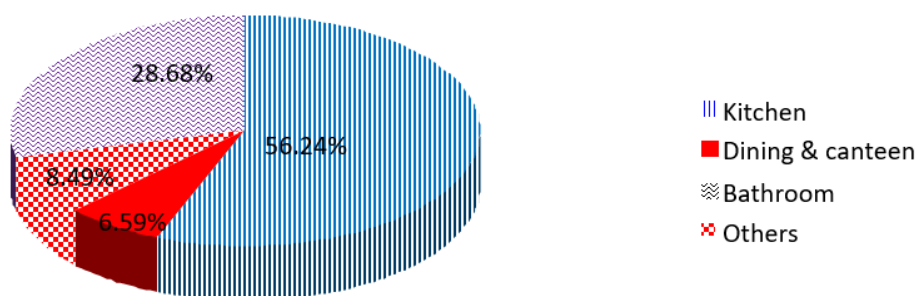


Figure 2: Wastes disposed from different sources of three ladies' halls in CU campus from June 2012 to March 2013.

Based on sources, the wastes were mainly four categories (Table 1): (1) kitchen waste, (2) dining and canteen wastes, (3) bathroom waste, and (4) others (veranda, corridor, and in and around the halls' premises) wastes.

Kitchen waste

Among the three halls, Shamsun Nahar (SN) hall has 11 small kitchen units, Pritilata (PL) hall has 16 units, and

Khaleeda Zia (KZ) hall has 20 units in different blocks for the students to provide kitchen/cooking facilities. Kitchen wastes include inedible parts of raw and cooked food items, carrying packets from markets and useless and/or broken containers. The sweepers clean these wastes every morning from 8.00 to 11.00 hours.

From the three ladies' halls of CU campus, 10,406 kg kitchen wastes were disposed during the study period and

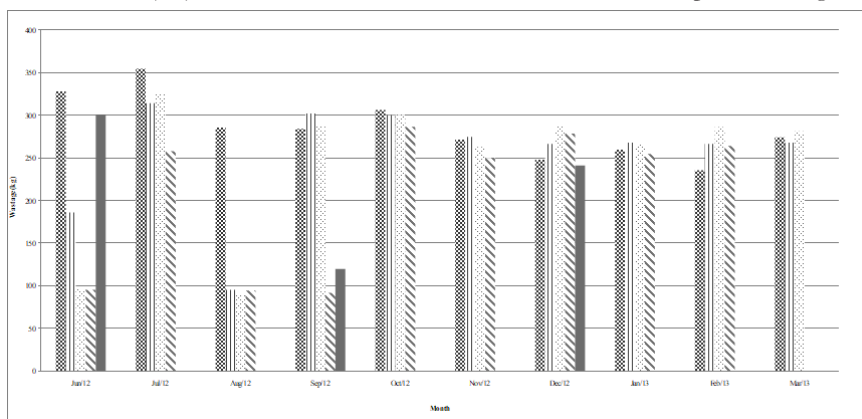


Figure 3: Weekly disposed kitchen wastes (kg) from three ladies' halls of CU campus.

each hall on an average disposed 221.41 kg of wastes. Among these three halls, SN hall produced 23.86%, PL hall 39.18%, and KZ hall produced 36.96% of total disposed wastes. PL hall disposed maximum kitchen wastes (4,076.5 kg), on the other hand SN hall disposed minimum (2,483 kg). Usually, the highest amount of wastes was disposed in the first week and the lowest in the last week of each month. The highest amount of wastes (354.5 kg) was disposed in the first week of July (Fig.3) because after one month summer vacation most of the students aggregated in the halls. On the other hand, the lowest amount of wastes (92 kg) was disposed in September (Fig.3) as the University classes were closed from 16 September to 1 November.

Dining and Canteen Wastes

Overall 1218.5 kg Dining and canteen wastes were disposed from 3 ladies halls, and each hall produced 406.167 kg wastes (i.e., 1.38 kg per day), SN hall's dining and canteen disposed 404 kg (i.e., 33.15%) wastes, PL hall 411 kg (i.e., 33.73%) and KZ hall 403.5 kg (i.e., 33.11%) wastes. There was a little variation in the amount of wastes disposed in different months, it was minimum (66 kg) in August during the vacation of CU campus. On contrary in the month of December most of the students gathered in these halls to attend in the admission test of first year honors, as a result the amount of disposed wastes were maximum (154.5 kg) in this month.

Bathroom waste

Bathroom wastes were mainly sanitary napkins, packets and containers of toiletries and cosmetics. In total 1,570.5 kg of bathroom wastes were disposed from three ladies' halls during the study period. Among the halls, KZ hall turned out maximum amount of wastes 781 kg (i.e. 49.73%) and minimum SN hall 326.5 kg (i.e. 20.79%). When we looked at the monthly calculation it was found that on an average 523.5 kg of bathroom wastes were disposed from each hall. During the study period the maximum bathroom wastes were disposed in July (182.5 kg) because after summer vacation (02-30 June 2012) most of the students were present in the halls due to their yearly final examination, and the minimum disposal was in August (104 kg) when a smaller number of students stayed in halls because of Ramadan and Eid-ul-Fitr vacation (08–30 August 2012).

During the study period, on an average each student of SN hall disposed 0.441 kg wastes i.e., 0.002 kg wastes per day. Similarly, on an average each student of PL hall disposed 0.634 kg of wastes during the study period i.e., 0.003 kg waste per day; and each student of KZ hall disposed 1.116 kg of wastes i.e., 0.004 kg waste per day. Moreover, each student of 3 halls produced an average of 0.724 kg bathroom wastes during the study period i.e., 0.003 kg per day. When we compared whether the amount of bathroom wastes disposed by each student of 3 halls differed significantly or not, ANOVA showed an overall

Table 2: ANOVA Table (Bathroom wastes)

Source	SS	Df	MS=SS/df	F=MS/error MS	Table F	p -Value	Comment
Month	0.003	9	0.0003	1.55	2.46(5%)	p >0.05	insignificant
Hall	0.02	2	0.01	48	3.55 (5%)	p < 0.01	significant
Error	0.004	18	0.0002				

Note: DF = degrees of freedom in the source, SS = sum of squares due to the source, MS = mean sum of squares due to the source, F= the F-statistic, Table F= table value

statistically significant difference among 3 halls except between SN and PL halls ($F = 48$ df = 2/18, $p < 0.01$). On the other hand, there was no significant difference among the amount of wastes disposed by the student of 3 halls in each month ($F = 1.555$, df = 9/18, $p > 0.05$).

Other wastes (from veranda, corridor, and in and around the halls' campus)

The wastes, which could not be placed in any one of the above categories, are called other wastes. These included unusable footwear and used pen and pencil. Overall, 5,310 kg of other wastes were disposed during the study period. Among them SN hall produced 201.5 kg wastes (i.e., 3.79%), PL hall 468.5 kg (i.e., 8.82%) and KZ hall

4,640 kg (i.e., 87.38%). It was lowest (285 kg) in amount in the month of August (2012). And in December, it was the highest (727.5 kg).

Overall, each student of three halls produced an average of 2.445 kg of other wastes during the study period i.e., 0.008 kg per day. Each student of SN hall disposed 0.272 kg of other wastes i.e., 0.641 kg per day, PL hall set out 6.629 kg of other wastes i.e., 0.001 kg per day and each student of KZ hall disposed 0.003 kg of other wastes i.e., 0.023 kg per day in that period. There was a significant difference between the amount of others wastes disposed by each student of SN and PL halls ($F = 62.472$ df = 1/9, $p < 0.01$) and among the months ($F = 3.544$, df = 9/9, $p < 0.05$).

Table 3: Anova Table (other wastes)

Source	SS	Df	MS=SS/df	F=MS/error M.S	Table F	P- Value	Comment
Month	0.003	9	0.0003	3.54	3.18 (5%)	P< 0.05	significant
Hall	0.006	1	0.0068	62.47	10.56 (5%)	P< 0.01	significant
Error	0.0009	9	0.0001				

Types of the waste based on physical nature

On the basis of physical nature wastes could be classified into the following categories:

1. Pills of Vegetables: Among all of wastes, on an average 55.26 % pill of vegetables were disposed from 3 halls.

2. Plastic: The students dispose bottle of soybean oil, coconut oil, biscuit packets, shopping bags, polythene, sandals and shoes. Among the all wastes of these three halls; 10.51% plastics were disposed.

3. Paper: There are many types of paper needed in the daily life such as newspapers, magazines, cardboard, writing papers, and colored papers. Among the 3 halls, PL hall disposed the highest amount (13.76%) of papers and SN hall the lowest (9.62%).

4. Clothes: The students disposed their old and useless clothes of cotton, linen and silk and all together it was on an average 3.44%, which are not easily degradable.

5. Metal: Aluminum (mostly discarded cooking pans) and steel cans (mostly soft-drink cans) are the two common metallic waste items that are found in the FS halls. These two waste materials (3.99%) are recyclable.

6. Glass: Different kinds of broken glasses (mostly from broken mug, plate, flower vase and other utensils) were found in waste dumping sites. On an average 10.51% glasses were disposed from these halls.

7. Others: Old useless bags and shoes made up of leathers, rubbers, and bones of animals (fish, chicken and cattle) were found in the waste dumping sites. On an average 4.16% other wastes were found. Mainly after the vacation of Eid-ul-Azha some students throw bones of cattle and offal that emit bad smell.

Waste feeding animals

Seven species of birds and two species of mammals were seen to eat foods from waste dumping sites and two other

Table 4: Category of the wastes, disposed from three ladies' halls of CU campus.

Categories of the wastes	Description of the wastes
Kitchen waste	Pills of vegetable, eggshell, boiled rice, food-waste; packets of biscuit, coffee; polythene; lunch box; broken glass, mug, bucket, bottle; newspapers; and other papers.
Dining and canteen waste	Pills of vegetable, eggshell, boiled rice; and food waste.
Bathroom waste	Sanitary napkin; tissue; hair; packet/bottle of shampoo, packet of soap; and empty containers of face wash and others cosmetics.
Other wastes	Sandals, shoes, clothes, dolls rubbers, used one-time pens, and pencil.

mammals were reported to do so (Table 5), of which crows and mynas were common. Sometimes 1 or 2 pariah dogs and domestic cats were also seen. Security guards of CU informed that sometimes wild boars (*Sus scrofa*) and jackals (*Canis aureus*) come to the waste dumping

site of PL hall at night to eat foods from dumping wastes. Sometimes rock doves (*Columba livia*) were seen at SN hall besides dining hall but they never ate anything from the dumping sites.

Table 5: Mammals and birds seen in the waste dump areas of three ladies' halls of CU campus.

No.	Common name	Scientific name	Observed (O)/Reported (R)
1	Pariah dog	<i>Canis familiaris</i>	O
2	Domestic/Feral cat	<i>Felis catus</i>	O
3	Jackal	<i>Canis aureus</i>	R
4	Wild pig	<i>Sus scrofa</i>	R
5	Jungle crow	<i>Corvus macrorhynchos</i>	O
6	House crow	<i>Corvus splendens</i>	O
7	House sparrow	<i>Passer domesticus</i>	O
8	Blue rock-dove	<i>Columba livia</i>	O
9	Jungle myna	<i>Acridotheres fuscus</i>	O
10	Common myna	<i>Acridotheres tristis</i>	O
11	Pied myna	<i>Sturnus contra</i>	O

Recommendations

The following measures have been suggested for minimizing solid waste disposal systems of these three ladies' halls and as well as others of CU campus:

1. Students should develop their self-awareness to dispose wastes;

2. The cleaners should properly clean the wastes from halls;

3. Biodegradable wastes should be separated and be arranged to convert to organic manure that can be used as fertilizers

4. The wastes like papers, plastics, glasses and metal can

be collected separately and be arranged for reuse through recycling; and

5. Authority of University of Chittagong should develop a waste disposal plan and waste dumping sites, and monitoring system of disposing wastes in the campus.

CONCLUSION

This paper has provided some qualitative and quantitative information about the solid waste disposal scenario of three ladies' halls of CU campus which making them to some extent dirty and they lose their attraction day by day. The students of SN hall throw wastes from upstairs on cemented floor adjacent to their verandas within the hall premises that making the area dirty, slippery due to the accumulation of water and growing mosses, algae and fungi. Most of the students of PL hall complain about solid waste disposal problem and they blame the university authority because the wastes are dumped at about 10 meters from the southern boundary of the Hall. While this study focused only on three ladies' halls, other halls and faculty can also be taken into consideration by using the similar methodology. This research paper will be an effective approach and methodology can be implemented to do future research work on solid waste disposal scenario and management approach also.

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