Quantification and Physical Composition of Household Municipal Solid Waste and People's Attitudes towards its Final Disposal – Chuadanga Municipality, Khulna

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I. Introduction

Simply Solid waste (SW) or Municipal Solid Waste (MSW) is considered as one of the most immediate and serious environmental disputes in-the-vicinity of its generation and disposal confronting urban local governments in emergent nations. This is the main outcome of rapid growth of population and haphazard urbanization in developing countries (Bartone, 1990). However, MSW is consists of discarded bulk of the households, dead animals, trade, commercial, agricultural, and industrial waste wherein other immense scale waste alike debris from construction site, furniture etc.(Cunningham and Saigo, 1999). A great deal of MSW generation demands extra infra-structure, financial support, technology and manpower etc. So, large volume of wastes generation and its disposal causes the degradation of environment in developing countries (Asraf, 1994) due to dearth-of-disposal capacity while industrially developed nations produce a huge quantity of wastes but it's no problem for them. Contrary, developing countries generate less MSW per capita because of their lower purchasing capacity and the consequent lesser consumption (Cairncross and Feachem, 1993). Besides, municipal solid waste management (MSWM) is a multidimensional challenge faced by urban authorities, especially in developing nations suchlike Bangladesh (Sujauddin et al., 2008). Ever growing MSW is aforethought to be one of the most burning and serious environmental obstacles hereto (Alam et al., 2002). One of the precisely agnate consequences of population growth and economic development is the increase of waste piles. The total MSW contribution from such increasing population is huge ample to bring environmental dilemma (Salequzzaman et al., 2001). In Bangladesh, MSW generation in urban areas is expanding proportionately with the growth of its population, economy and living standard of citizens. If the wastes are not fitly handled, stored, collected and disposed of, that it can fabricate a hazardous venture to the environment and human health. Typically one to two-thirds of the generated MSW is not collected in most of the developing countries (WRI, 1996). Consequently, the uncollected waste which is often also accumulated with human and animal excreta is dumped indiscriminately in the streets and in drains, so contributing to flash flooding, breeding of insects and rodent vectors and the spread of germs or diseases (USEPA, 1995). However, MSWM encompasses all demeanors relevant to waste generation, on-site handling and storage, collection, transportation, reuse and recycling and final disposal. Now-a-days, it is a multi-disciplinary approach based on engineering principles and also involves economics, urban and regional planning, social sciences, and other disciplines. Due to dearth of financial resources, institutional weakness, ill-timed choice of technology and want of public awareness about MSWM, it has rendered unsatisfactory services in Bangladesh. Therefore, a considerable chunk of work has been accomplished on MSWM in Bangladesh (Rashid, 1996; Sarker et al., 2006; Sarker, 2001; Akhter et al., 1999; Rahman, 2000; Bhide, 1990;Hoq and Lechner, 1994)wherein a little attention has been paid to perform study on residential MSWM (Sujauddin et al., 2008; Rahman et al., 2013; Salam et al., 2012). As a result, household solid waste (HSW) management has

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emerged as one of the supreme mission, especially in cities and municipalities of Bangladesh. Besides, mass people perceptions of wastes management and informal recycling related works is very limited (Ivy et al., 2015; Matter et al., 2013). So, the present investigation is an attempt to explore the volume of MSW generation, its physical composition, and overall management system Chuadanga Municipality (CM).

Chuadanga district is one of the smallest districts in Bangladesh but its population size is increasing day-to-day. With the growth of population, MSW generation and management has become a major urban concern in CM. But there is no study has been done yet concluding this important issue. Where in, a major fraction of generated MSW comes from household activities. So, we conducted this study on HSW to explore generation rate, physical composition and its management system in CM. This study shows that on an average 1.015 kg/household/day and 0.22 kg/person/day MSWs generate from households in the study area. Amidst the various types of wastes it was discovered that, food wastes (vegetables) were the highest (76%). In addition, findings of this study will support to compare with big cities as well as it will give significant information to policy makers about increasing rate of MSW in small and new cities in Bangladesh.

II. Methodology

a) Selection Of The Study Area

The experiment was accomplished in Chuadanga Municipality of Bangladesh. It resides of 9 wards amidstMukti Para, Court Para and Puraton Hospital Para under ward No. 3; and Gulshan Para, Cinema Hall Para and Thana Council Para under ward No. 9 were chosen randomly (details are shown in Fig.1) for conducted this study. And from each para 5 households were selected randomly for surveying.

b) Literature Review

For gathering sufficient knowledge about conducted study on MSW in Bangladesh, an extensive survey was done on the available and relevant literature (both published and unpublished) to capture better sensitive information to design more efficient experiment. Aside from, a depth enquiry into miscellaneous documents, reports, journals and publication have also been wrapped-up to obtain required propaganda link with MSW generation, quantification, physical composition and their disposal and associated impacts on environment.

c) Identification And Categorization Of MSW

All the gathered MSWs were segregated and carefully noticed to find out the physical compositions. It was found that MSWs has various constituents which were categorized into 9 groups in CM zone on the basis of their physical features. These were – (1) vegetable and food waste; (2) paper, book and printed material; (3) packaging materials; (4) plastic, rubber and polythene; (5) textile, rags and jute; (6) glass and ceramic; (7) can, jar, tin and metals; (8) wood, leaves; and (9) miscellaneous (dirt, stone).

d) Reconnaissance Survey

At first, a reconnaissance field scrutiny was performed in-order-to investigate the up-to-date process of MSW disposal system in the study area and to diagnose the manifold problems originated due to the absence of appropriate MSW collection and disposal systems. Based on the surveillance survey, the whole experimental area was classified into three distinct socioeconomic groups on the substructure of the household's monthly earning: Low socioeconomic group (LSEG) (monthly income < Tk. 15000), Middle socioeconomic group (MSEG) (monthly income between Tk. 15,000 and Tk. 30,000), Upper socioeconomic group (USEG) (monthly income above Tk. 30,000).

e) Questionnaire Survey

Based on gathered knowledge and experiences from surveillance scrutiny, we framed a semi-structured questionnaire. It was designed with the reference to people's attitudes about existing MSWM program and how it is besmirching environment, their gauge of awareness, nature and caliber of disputes, they encounter problems due to the absence of systematic MSW collection frequency and disposal including their suggestions for upgrading a sustainable MSWM model for CM to resolve current problems.

f) Data Collection

For data collection, 15 households were selected at random from each of the targeted area. Thus a total of 30 households were surveyed in the study area. From each household, data on daily MSWs generation was collected. In the interim the questionnaire scrutiny, 5 similar size polythene bags were supplied to each household to store their produced wastes of different 5 days. Aggregated wastes from each poly bags were weighed and recorded. Then the wastes within each bag were segregated into several types which were weighed distinctly and recorded too. The same task was accomplished for each of the five days for each of the 30 households. In addition, the questionnaires were included a number of attitudinal questions aimed at examining household awareness and attitudes toward the urban MSWM and final disposal scheme.

g) Data Processing And Analysis

All the data collected from miscellaneous sources above mentioned was carefully sorted and then only the decisive and required propaganda were set aside for compilation and analysis to avoid unexpected bulk of the paper. Intensive care was taken with respect to the applicability, reliability and validity of information.

After sorting and compilation, the data were analyzed by utilizing MS-excel sheet version: 2007, SigmaPlot12 and SPSS software version: 18.

Fig. 1 : Study area location map - Chuadanga Municipal (Banglapedia, 2008).

III. RESULTS AND DISCUSSION

a) Fundamental Info Of Chuadanga Municipal

Chuadanga (Sadar) Municipal is tiny municipal in size in Bangladesh which is placed in Chuadanda District of Khulna division. It was settled in 1984 and covers 289.59 sq km areas along a population size of 278,726. The increasing trend of population is very fast and current density is 962 per sq km (BBS, 2011). As a result, the ongoing MSW generation rate is 61.32 ton/day which will be doubled after 10 years seeing eminent pressure of population. The municipal has its own MSW management department which is not sufficient to handle such an ever growing immense quantity of wastes dearth of proper technology and sufficient fund. Likewise, there is no availability of skilled manpower too. Again, from (table 1), it is detected that in our experimental area, the apical percentage was marked in the family which consists of member ranging between 3 and 4 and its allotment is (50%) and the lowest percentage was identified in the family which formed of member limits between 1 and 2 and its chunk is almost (3%). The size of family member accommodating 5 to 6 is almost (37%) that is almost 4 times higher than the family encompassing member 7 to 8 that constitutes of (10%) only.

Table 1: Waste generation rate (WGR) in kg/household (hh)/day with respect to family size.

Family size	No. of families	Percentage (%)	WGR(kg/hh/day)
1 – 2	1	3.3	0.65
3 – 4	15	50	o.95
5 – 6	11	36.7	1.17
7 – 8	3	10	1.29
Total	30	100	4.06 (avg. =1.015)

Further, from (table 2) it is crystal clear that the contribution of average family age which ranges 31 to 40 is almost (57%) that is about two times superior to than the age ranges 41to 50 constituting about (27%). The class of the average family age ranging 20 to 30 is (10%) and the age ranging 51 to 60 is (6.6%). Thus, waste generation rate varies in-relation- to the age of the people.

Table 2 : Waste generation rate in kg/hh/day with regarding to the average age of the family members

Average age	No. of families	Percentage (%)	WGR (kg/hh/day)
20 – 30	3	10	1.16
31 – 40	17	56.7	1.24
41 – 50	8	26.7	0.97
51 – 60	2	6.6	0.69
Total	30	100	4.06(avg. 1.015)

b) Household Solid Waste (Hsw) Generation

The average waste generation by the family size 7 to 8 is 1.29 kg/day, the family size 5 to 6 is 1.17 kg/day, the family range 3 to 4 is 0.95 kg/day and the family dimensions 1 to 2 is 0.65 kg/day (table 1). It is very luminous that the extensive no. of family, the huge magnitude of waste production. Infinitely the waste generation varies with relation to the family size. But waste generation rate (kg/hh/day) is highest in those household having average age 31 to 40 is 1.24 kg/day, second highest is 1.16 kg/day propagated by those family having average age 20 to 30. Besides, family having average age 41 to 50 generates 0.97 kg/day and the minor generation rate is 0.69 kg/day in those family having average age 51 to 60 (table 2). So, it is crystal clear that the waste generation rate varies with reference to the age of the inhabitants and number of family members. Thus MSW generation rate and volume not only depends on economic growth rather it also depend family size.

Contrary, (Fig. 2) reveals that the MSW generation rate per household per day increase from lower socio-economic group to upper socio-economic group in a sequential stratification. The figure displays that MSW generation rate is lesser in lower socio-economic group and supreme in upper socio-economic group figuring out 0.77 kg/hh/day and 1.21 kg/hh/day proportionately wherein in middle socio-economic group 1.07 kg/hh/day. However, the average MSW generation rate is 1.015 kg/hh/day. Therefore, it is transparent that the MSW generation rate varies with the economic status or solvency and living standards of family. From table (1, 2, 3) it is clear that MSW generation rate from households in the urban areas mainly depends on family size, age of family members and economic status of family including living standards or style.

Table 3 : MSW generated by an individual family per day in different households in CM

Socio-economic group	No. of person studied	WGR(kg/person/day)
Lower socio-economic group	35	0.19
Middle socio economic group	43	0.21
Higher socio economic group	59	0.26
Total	137	0.66 (Avg. =0.22)

Both of the (table 3) and (fig. 2) represents that the MSW generation rate in kg/person/day is rising up gradually from lower socio-economic group to upper socio-economic group. Further, it is observed that MSW generation rate is maximum in upper socio-economic group and minor in lower socio-economic group, figuring out 0.26 kg/person/day and 0.19 kg/person/day respectively. Contrary, the waste generation rate in middle socio-economic group is 0.21 kg/person/day. So, it is stark clear that the MSW generation rate differs with the livelihood of the people. Finally, it is realized from the study that per person and per family waste generation quota per day verify depending on the age of family members, family size and economic condition.
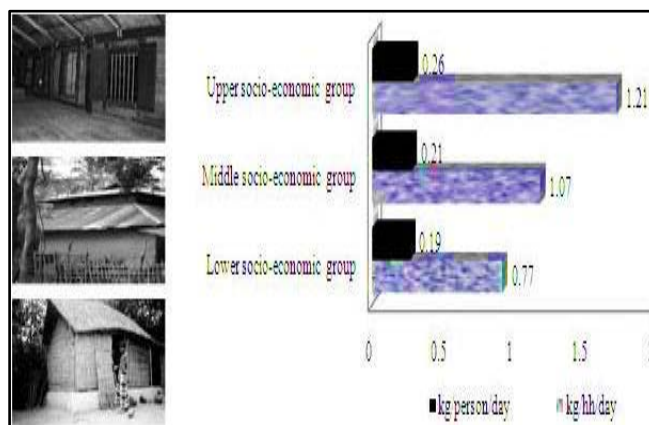
Fig. 2 : MSW generation rate in different socio-economic group in kg/hh/day and kg/person/day.

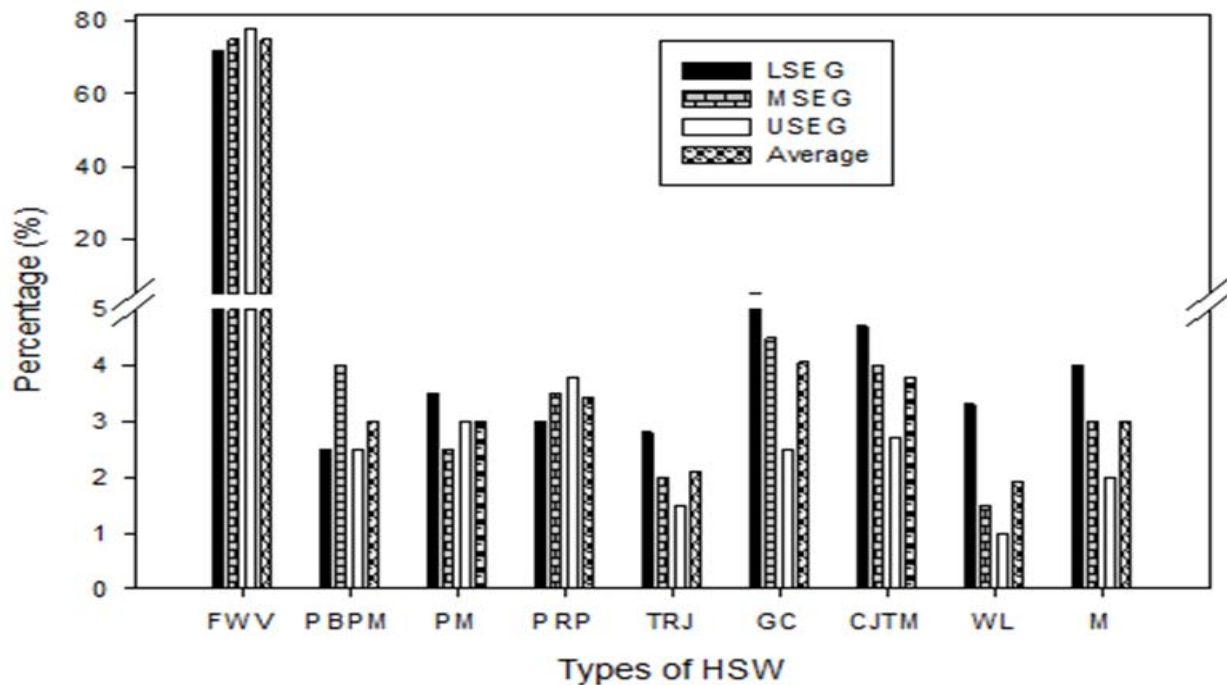*c) Physical Composition of HSW*

From (Fig. 3) it is seen that lower socio-economic group (LSEG) discharges 72% vegetable waste, the the second, third and fourth highest volume of waste is glass/ceramic (5.2%), can/jar/tin (4.7%) and miscellaneous (dirt, stone) (4%) respectively. It also represents that the bulk of packaging materials, wood/ leaves, plastics/ rubber/ polythene, textile/ jutes/ rags

and paper/book/printed material are 3.5, 3.3, 3, 2.8, and 2.5 (%) in each types subsequently. Once more from (figure 3), it is found that 75% the maximum volume of waste germinated by middle socio-economic group (MSEG) is vegetable/food waste that is higher than LSEG. And the second highest is glass/ceramic but differ in quantity (4.5%). Likewise the generation rate of other categories of waste varies between (1%) and (1.5%). In addition, (figure 3) discloses that upper socio-economic group (USEG) produces (78%) the apical bulk of vegetable/food waste and that is the highest quantity compared to LSEG and MSEG. But the second major amount of waste germinated by USEG differs from other two types and is plastics/rubber/polythene (3.8%). And other categories of wastes vary from its composition

between (1%) and (1.5%) too but comparing to LSEG is more. These tiers of wastes is multi-fold lesser than the composition of vegetable/food waste.

Amid from (Fig. 3), it is stark clear that in case of average HHSW generation the apical quantity of waste generated by household is vegetable/food waste (75%) compared to the rest types of waste. Likewise, the second highest waste is glass/ceramic (4.07%). And the third and fourth supreme waste quantity is can/jar/tin metals and plastics/rubber/polythene (3.8%)and (3.43%) subsequently. From the rest tiers, packaging materials; paper/book/printed materials and miscellaneous (dirt, stone) waste represent 3%. Latter the minor volume of waste is (2.1%) and (1.93%) from textile/rags/jute and wood/leaves correspondingly produced.

(FWV=Food waste, vegetables; PBPM=Paper, books, printed materials; PM=Packaging materials; PRP=Plastic, rubber, polythene; TRJ=Textile, rags, jutes; GC=Glass, ceramic; CJTM=Can, jar, tin, metals; WL=Wood, leaves; M=Miscellaneous)

Fig. 3 : Physical composition of HSW generated from different socioeconomic groups and average.

d) City Dwellers Attitude towards Final Disposal of HSW

(Table 4) reveals that most of the people about (33%) dump their waste close to open place that is 2 times higher than dumping to the waste collector which is almost (17%). Very nearly (27%) of people discharge their generated waste in covered dustbin and almost (17%) of people release their waste in the vicinity of the drain side that is the same percent of people who supply their waste to the waste collector (scavengers/waste pickers/tokai). And minor percent of people dump their waste to the lagoon/lake side is

about (8%). It is transparent that the tendency of throwing waste towards the open lands is higher than that of any other disposal channels. Waste dispose to waste collector and in covered dustbin is inferior than that of disposing close to open field is the consequent of unfair management of municipality. More dustbins and man powers are required in the municipal zone aimed to regular collection and secured disposal. At least one bin is needed in per half km area. Then it will provide more facilities to discharge wastes into dustbins as well as to increase collection efficiency.

Table 4 : Frequency and cumulative frequency in (%) with respect to MSW disposal system

Disposal system	No. of family	Frequency (%)	Cumulative F. (%)
Open dump	10	33.3	33.3
To waste collector	5	16.7	50
Throwing into drain	5	16.7	66.7
Throwing beside pond	2	6.7	73.4
Covered dustbin	8	26.6	100

Besides, (table 5) indicates that (55%) of people are unsatisfied and (25%) of people are satisfied with the MSW management service providing by municipal authority. Wherein about (15%) of people's view is to the MSW management as poor and only (5%) people diagnose it as a good service. From this investigation, it can be said that conspicuously the present condition of MSWM system in our study region is poor. As a result, it is unavoidable to upgrade the current management system as quick as possible of municipal area for ensuring sound health of people as well as for the better environment. About (79%) people consider this tough task lies on municipal solely. But municipal is not capable to handle such ever growing waste volume because it has to lead some other task at the same time. So, municipal can't pay much attention and investment on wastes management. Therefore, introduce of a private initiative the foremost demand for appropriate management of MSW.

Table 5 : Satisfactory rating about the MSW management by householders

Satisfaction level	Frequency	(%)	Cumulative F. (%)
Good	0	5	5
Poor	9	15	20
Satisfied	9	25	45
Unsatisfied	12	55	100

From the (table 6), it is stark clear that (46.66%) of the people face bad odor from scattered MSW and that is the highest percentage. The second big problem, people encounter the presence of disease vector that is about (26.67%). Likewise (16.67%) of the people face the dispute of blockage of drainage flow and a minor quantity (10%) of the people face the problem that the waste in the vicinity of road. This study reveals that majority (%) of people face problems due to the exiting MSW management system.

Table 6 : People's view about the problems occurred from scattered MSW management system

Problems	No. of family	Percentage	Cumulative (%)
Bad odor	14	46.66	46.66
Waste beside road	3	10	56.66
Blockage of drain	5	16.67	73.33
Disease vector	8	26.67	100

From the study, it is clear that most of the inhabitants in our investigation area suffer from bad odor and presence of disease vector dilemma that is threatened to their sound health. Further, people face the obstacles of blockage of drainage flow which is responsible for flash flood and waste beside the road in as-much-as dearth of dustbin and overall MSW management system in municipal area. Consequently, to ensure sound health and better environment for the people of municipal area, the municipal authority should upgrade the current management process.

Table 7: Frequency of HSW collection by municipal authority

Collection day	Frequency	Percentage (%)	Cumulative (%)
Daily	2	6.67	6.67
Alternative day	5	16.67	23.34
Every two day	8	26.67	50.01
Irregular	15	50	100.01

(Table 7), reveals that about half (50%) collection of waste is performed on irregular basis by the municipal authority. Nevertheless, daily basis is hardly found which (6.67%). Worthwhile every two days collection frequency is (26.67%) whereas alternative day

collection level is only (16.67%). Amid the findings, it is crystal clear that the current management system with-

e) Recycling Potentiality Of Generated HSW And Employment Opportunity

(Fig. 4) shows that in our study area, (79.93%) wastes is consists of non-recyclable waste which is about 4 times higher than recyclable waste consisting of (20.7%). This huge large volume of non-recyclable wastes requires fair collection and disposal procedures. In contrary, a significant quantity of recyclable wastes is needed to recycle for the better environment. In

regarding-to the collection of MSW is very unfair by municipal authority.

recyclable waste, shown in (figure 4) the highest quantity is seen as glass/ceramic and the lowest value is found as textile/rags/jute figuring out, (4.07%) and (2.1%) accordingly. On the other hand, in non-recyclable waste comprising of (75%) vegetable/food waste is the prime level of waste. Meanwhile, a little quantity of waste is wood/leaves and miscellaneous (dirt/stone) that figured out (1.93%) and (3%) subsequently (fig. 4).
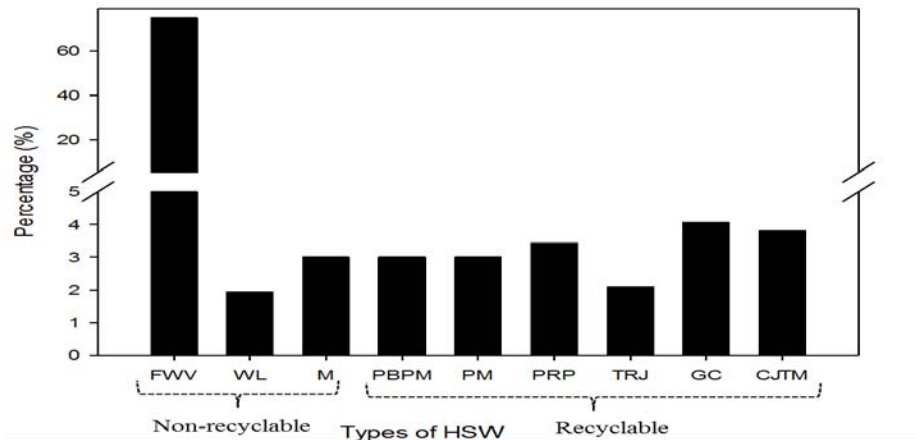

Fig. 4 : Percentage (%) of physical composition of recyclable and non-recyclable MSW.

Nevertheless (fig. 5) reflects that degradable waste is almost 6 times inferior to non-degradable wastes figuring out, (86.50%) and (13.50%) respectively. The degradable wastes that are degraded in natural process which is not concerned, it demands only fair disposal. But a bit amount of non-degradable waste is in highly concerned with the environment. Therefore, it is highly needed to recycle for reuse as-far-as possible. In non-degradable waste, the supreme part is glass/ceramic which comprised of (4.07%). And the quantity of can/jar/tin metals and plastic/rubber/polythene is (3.8%) and (3.43%) in sequence (fig. 5). Furthermore, (fig. 5) displays that in degradable waste, the maximum volume of waste is vegetable/food waste which consists of (75%) which is multi-fold than the other types of wastes varies between (1%) and (2%). These types of waste represent almost similar value in case of organic and non-organic MSW too (fig. 6).
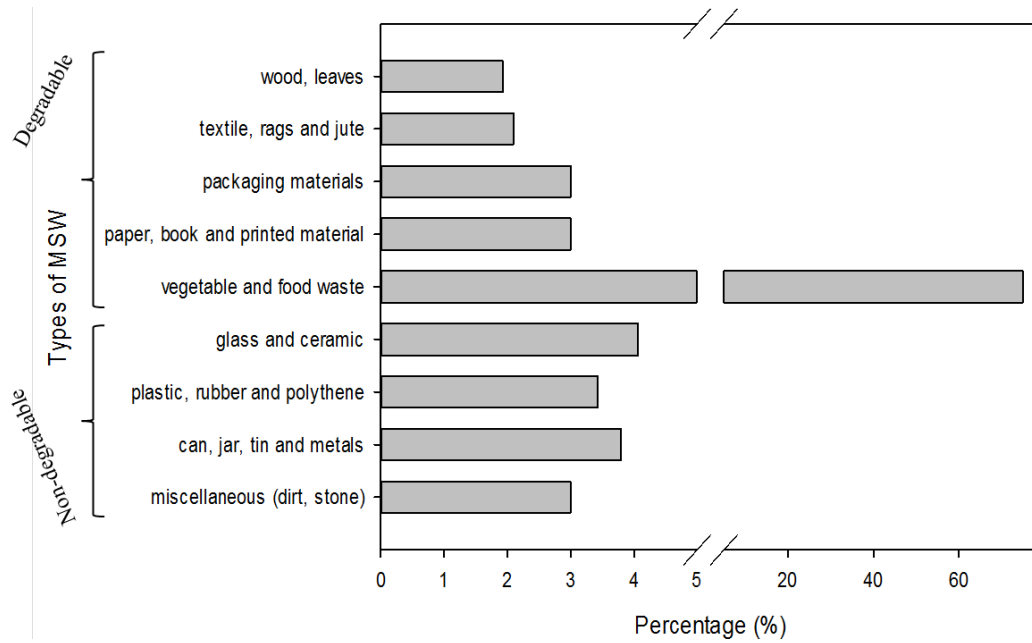
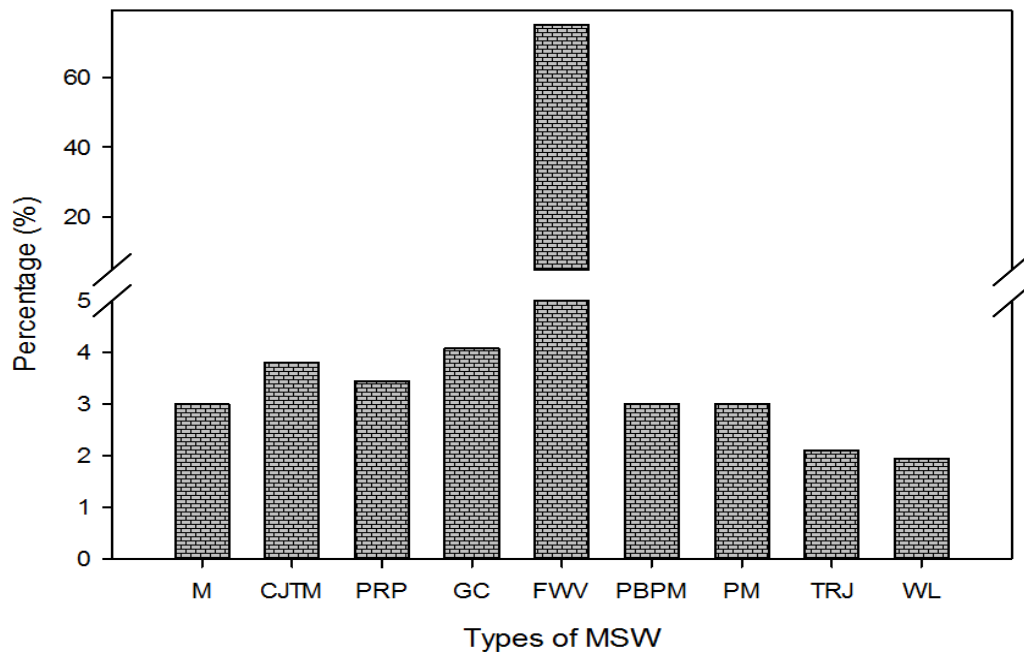*Fig. 5 :* Percentage (%) of physical constituents of degradable and non-degradable MSW.

Fig. 6 : Percentage (%) of physical elements of inorganic and organic MSW.

Finally, from (fig. 6) it is crystal clear that consisting (85.7%) of organic waste is almost 6 times than inorganic waste which is comprised of (14.3%). Organic wastes can be converted into organic manure by composting which is viable to environment. So it is needed to convert organic waste into organic manure for better and sustainable environment. But on the other hand, the inorganic wastes can't be converted to such products. It only can be recycled to other products or raw materials. So, it is compulsory to recycle the inorganic waste to ensure friendly environment and to save cost. In inorganic waste, consisting of (4.07%) the apical value of waste is glass/ceramic waste. And the other types of wastes can/jar/tin metals, plastic/rubber/polythene and miscellaneous are consisted of (3.8%), (3.43%) and (3%) subsequently (figure 6).

IV. DISCUSSION

Bangladesh is a tiny country in size but it possesses a myriad number of populations. As a result of high pressure of more population, its natural

resources availability is reducing rapidly and it has become urgent to diagnose alternate way of goods supply (Bhuiyan, 2010; Huda et al., 2014). Meanwhile,MSW generation quantity is rising up. Akin such scenarios are also found in every cities of the world but it is no matter for first world countries because they possess sufficient amount of fund and technology including skilled manpower. But in emergent nations like Bangladesh has neither fund nor technology even lack of skilled man power. Consequently, we aren't affording to manage such ever growing waste and so it is liable to degrade or pollute our city environment. However, this study reveals that on an average (20.7%)of the generated MSW is recyclable by utilizing this quantity; we can produce products and can reduce pressure on acquisition of raw materials from natural sources. In Bangladesh, there are a lot of floating people and by employing them with low wages; we can recycle this valuable MSW. Likewise, it will create an employment opportunity and supply of raw materials won't be stopped. In addition, through biological process about (75%) vegetable/food waste, we can convert into fertilizer, gas, electricity and fish feed (Moqsud et al., 2011; Zurbr¨ugg et al., 2005; Hasan et al., 2012; Huda et al., 2014). It is also good solution for MSW management because products made from wastes is cheap and it remains under buying capacity of poor people. A few pilot projects have already been implemented in Bangladesh on recycling of MSW but none of them have become fruitful yet dearth of fund and technology.

In case of large-scale municipal or city manifold experiments have been accomplished by native and foreign researchers. Meanwhile, a few pilot projects have also been implemented by national and international NGO but none in such municipal still. Hardly found a few studies of such municipals in Bangladesh which are not sufficient for taking proper steps and formulating policy (Ahmed and Huq-Hussain, 2011; Majumder, 2012; Moqsud et al., 2011). In that case our study can help the regarding authority or organizations. Likewise, recycling business of MSW is not so strong in such category of cities in Bangladesh. Even most of the generated wastes are disposed in unclosed land which is liable for environmental contamination. Apart from, we are losing a great deal of resources dearth of awareness and profuse fund along with technology. Therefore, to confirm appropriate utilization of such ever growing pile of wastes resources, growing awareness amid mass people is very significant. Otherwise, we will fail to reassure resource extraction from these wastes. Likewise, the government should introduce a source segregation system which is mandatory for every wastes generator. Contemporarily, in some big cities this has already commenced partially but not strictly up-to-date. Hence it has become unfruitful.

V. CONCLUSION

Bangladesh is one of the densely populated countries of the world. Moreover, the population is increasing day-to-day. With the increase of population the SW generation rate is also rising up which is the major concern for sustainable environment. Most of the cities and towns areas are threatened to ever growing such uncontrolled volume of MSW. CM is one of the smallest towns in Bangladesh where a significant quantity of MSW generates by the sundry population increasing day by day. Most of the people dump their generated waste towards the open places whereas a few numbers of people dump their waste in dustbin properly. During the household survey, most of the householders complain about existing MSW disposal problem and they blame that the Municipal authority have no responsibility and there is no fixed dumping sites where they can dump their waste. A little number of dustbins is fixed in CM area that is not in appropriate location for maximum householders to dump. As a result, they discharge their generated waste on nearby open place, road side or drain side that is now going to be a potential threat of environmental pollution. Likewise, a few number of the householders who can empty their waste in dustbin that is not collected regularly by Municipal authority, as a result people face problem paradigm bad odor, presence of disease vector that is threatened to the people's health as well as the sound environment. So, it is crying need to consider about the MSW disposal and overall management system of CM area.

The recycling of MSW is very important concept about the MSW management program for the up-to-date aspect of CM since the extensive segment of total household waste is recyclable. This recyclable waste is not degradable through natural process that is deadly harmful for the environment. So, to recycle such types of waste is more necessary for sustainable environment. There is no recycling factory in CM area but some people or boys namely 'Tokai' and 'Scavenger' collect this valuable MSW and sell to the scrap shop or vhangary (the person who trades in waste) and finally this sorted waste is supplied to big factories in Dhaka for recycling or exporting.

VI. ACKNOWLEDGEMENT

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