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RESEARCH ARTICLE

ENHANCEMENT OF CLINICAL WASTE MANAGEMENT IN KHULNA CITY USING GIS

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ABSTRACT

Healthcare establishments (HCEs) generate a huge quantity of both the hazardous and non-hazardous wastes. There are no proper healthcare waste-management facilities in the government sector in Khulna city or even in the country. There is also lack of available budget to implement the schemes of collection, treatment and disposal of hospital wastes separately. However, a non government organizations (NGO) named Prodipon, Bangladesh, has been handling the heath care wastes management in Khulna city. But yet, they are much far from the achievement of the aimed goals and objectives of proper handling, treatment and disposal of hazardous hospital wastes. From this study the mean total healthcare waste generation rate in Khulna city has been found to be approximately 0.676 kg/bed/day and separately 0.06, 0.12, 0.003 and 0.50 kg per bed per day for Infectious, Plastic, Sharp and Liquid waste respectively. There are a number of treatment and disposal methods like incineration and chemical treatment. But no method is capable of eliminating all risks completely to human health and environment. So management of health care waste is not an easy job in a developing country like Bangladesh without the usages proper technologies and allocation of enough money. Moreover, Geographic Information System (GIS) had been used to assess waste generation, generation variation, collection system and selection of transportation routes and consequently successful management of healthcare wastes in Khulna city can be ensured by the author.

Keywords: Healthcare, waste generation, GIS, decision support, database, waste management, Khulna city.

INTRODUCTION

Under the waste disposal ordinance, clinical waste means waste consisting of any substance, matter or thing generated in connection with a dental, medical, nursing or veterinary practice; any other practice, or establishment (howsoever described), that provides medical care and services for the sick, injured, infirm or those who require medical treatment; dental, medical, nursing, veterinary, pathological or pharmaceutical research; or a dental, medical, veterinary or pathological laboratory practice [1, 2]. Special considerations should be maintained for handling chemical waste arising from medical and dental sources. Certain clinical waste may contain chemical residues which are classified

as chemical waste. In such cases, the chemical residues should be segregated from the clinical waste at source wherever it is practicable. For example, broken thermometer containing mercury should be segregated from other clinical waste. Chemical waste arising from medical and dental sources does not fall within the definition of clinical waste [3]. If the chemical waste contains or is contaminated with any clinical waste, pre-treatment measures should be taken as far as practicable to render the waste non-infectious before it is collected by a licensed chemical waste collector.

The rapid increase of hospitals, clinics, healthcare centre and diagnostic laboratories etc in Khulna city exerts a tremendous impact on human health ecology. More than 150 hospitals, clinics, healthcare centre and diagnostic laboratories exist in the Khulna city (KCC). These facilities generate an estimated 3.6 tons of waste a day. Only a few have the necessary means to dispose the waste safely. It is reported that even body parts are dumped on the streets by these HealthCare Establishments (HCEs) [4]. The prevalence of diseases that may be transmitted by hospital wastes is alarming in Bangladesh. There is evidence of hepatitis B infection among 10 percent of children (5-10 age group) and 30 percent adults. About 5 per cent of the total population in Bangladesh is thought to suffer from chronic hepatitis B infection. Although cases of HIV/AIDS are low in Bangladesh (about 13,000 cases estimated in 2001) in comparison to neighboring countries, nevertheless the numbers are rising. It is noted here that much of the clinical wastes (e.g. syringes, needles, saline drips, discarded food, gauze, vials, and ampoules) are collected by women and children who re-sell it despite of the deadly health risks [5].

Various types of clinical wastes such as food & vegetable wastes, medicine strips, used gauge, cotton, tissue, organs, syringe, saline bags, blades and needles etc. are collected from 44 hospitals/clinics/pathology laboratories of the city. Prodipon provides plastic container of four colors (shown in Figure 1) in the clinics for the storage of wastes. The selected colors are (i) black for kitchen wastes, (ii) gray for general hospital wastes, (iii) yellow for non-sharp or reusable wastes and (iv) red for sharp wastes. The wastes are separated by the users at the source in different categories such as needle & sharp parts, reusable wastes, surgical wastes and food & vegetable wastes by depositing them separately in four bins marked in different colors. Food & vegetable wastes are ultimately disposed with other MSW in the same site of KCC at Rajbandha. Re-useable wastes are shredded and stored for recycling after cleaning; needle & sharp wastes are encapsulated in a 7 ft. deep concrete chamber. Remaining general medical wastes are burned in a locally made burning unit and the residues are then disposed ultimately in a nearby pit [6].

The present practice of improper handling of generated hospital wastes in Khulna city is playing a contributing role in spreading out the Hepatitis and HIV diseases. The liquid and solid wastes containing hazardous materials are simply dumped into the nearest drain or garbage heap respectively where they are prone to contaminate the rag-pickers that sift through the garbage dumps. The chances of infection are very high to the cleaners, concerned people in the HCEs and to the general population. The improvement of waste management for the HCEs in Khulna city will have significant long-term impact on keeping the spread of infectious diseases to a minimum and result in a cleaner and healthy environment. Like other industries and institutes, healthcare facilities generate various kinds of wastes as a result of a variety of medical treatment and research. In the past 10 years, due to the increased number and size of healthcare facilities, medical services, and use of medical disposable products, the generation rate of healthcare wastes has increased rapidly. And so the problem is requiring an urgent attention toward achieving the objectives of safe collection, separation, transportation, treatment and disposal of hazardous hospital wastes [6].

METHODOLODY ADAPTED

Study Design: Map for the study was prepared in ArcGIS using different layers. The Latitudes and Longitudes (LAT-LON) of about 31 hospital/clinic/diagnostic centers at Fulbari, Khalishpur, Boyra, Dackbanglow, Sonadanga (Khulna) area were collected using mobile

Geographical Positioning System (GPS) and layers were made in ArcGIS. For the collection of data and photographs those hospitals were visited. Furthermore surveyed data and information were included in GIS database to prepare various maps.

Mapping: The ground co-ordinates (LAT-LON) of selected HCEs in the study area were collected by field survey with the help of GPS. After that, those positions were shown on a base map of Khulna city.

Spatial Data for GIS Mapping: For spatial analyses and mapping, GIS supporting data were collected during the field survey. The data for spatial analyses were collected from primary and secondary sources such government organizations and NGOs. According to HCEs waste category, 4 plastic containers were provided to the HCEs and collected waste generation quantity of different category and evaluated waste generation rates respectively in Khulna city. The attribute data of map features were imported into the GIS environment.

Black
Kitchen wastes

Gray
General wastes

Yellow
Reusable wastes

Red
Sharp wastes

Figure 1: Container for the storage of clinical wastes in generation point *(after Alamgir et al. 2003)*

DATA MAPPING, ANALYSIS AND DISCUSSIONS

The study has been carried out in Fulbari, Khalishpur, Boyra, Dackbanglow, Sonadanga and nearby areas in Khulna city. The study areas which are mainly residential and commercial areas have developed due to the general public requirements. But hospitals should not be considered as commercial commodity. People are undoubtedly benefited by the modern hospital facilities, but those health care facilities pose a serious health hazard when waste produced in these facilities are not managed with care.

The Figure 2 has been produced by plotting the ground co-ordinates (Latitude and Longitude collected with GPS) on a GIS base map of Khulna city. The map illustrates that most of the health care facilities in the study area have been developed in the crowded areas of Fulbari,

Khalishpur, Boyra, Dackbanglow, Sonadanga and nearby areas. These health care establishments are not environmentally safe for passers-by using the roads as well as for patients taking treatments in these health care facilities.

During study, a questionnaire survey was conducted among the selected HCEs and also supplied waste bin for measured the generation rate of HCs waste and hence discussed in followings. In Figure 3, observation of hazardous waste generation rates of 24 HCEs in Fulbari, Khalishpur, Dackbanglow, Boyra, Sonadanga and nearby areas in Khulna city has been analyzed and compared graphically. Generation rates of different components of hazardous waste in kg per day have been observed separately. The total hazardous waste generation rate for individual hospital has been divided by the number of beds of the same facility to find the waste generation rate in kg per day per bed. Then the waste generation rates of HCEs have been summed out and then the resultant has been divided by 31 to find out the average hazardous waste generation which is 0.676 kg per day per bed.

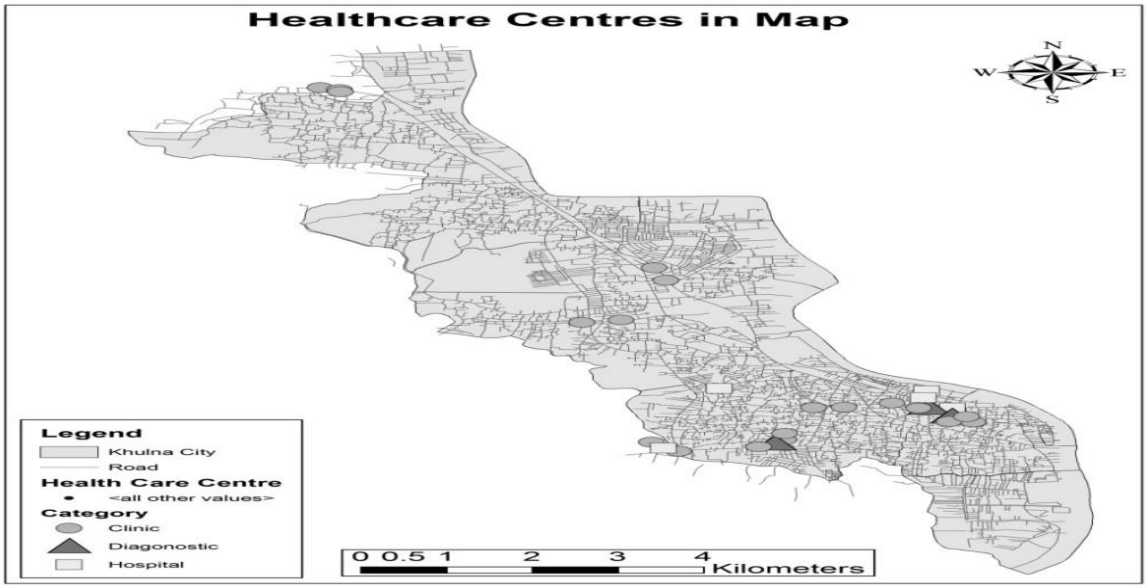

Figure 2: Map of Fulbari, Khalishpur, Boyra, Dackbanglow, Sonadanga and nearby areas (Khulna) showing HCEs

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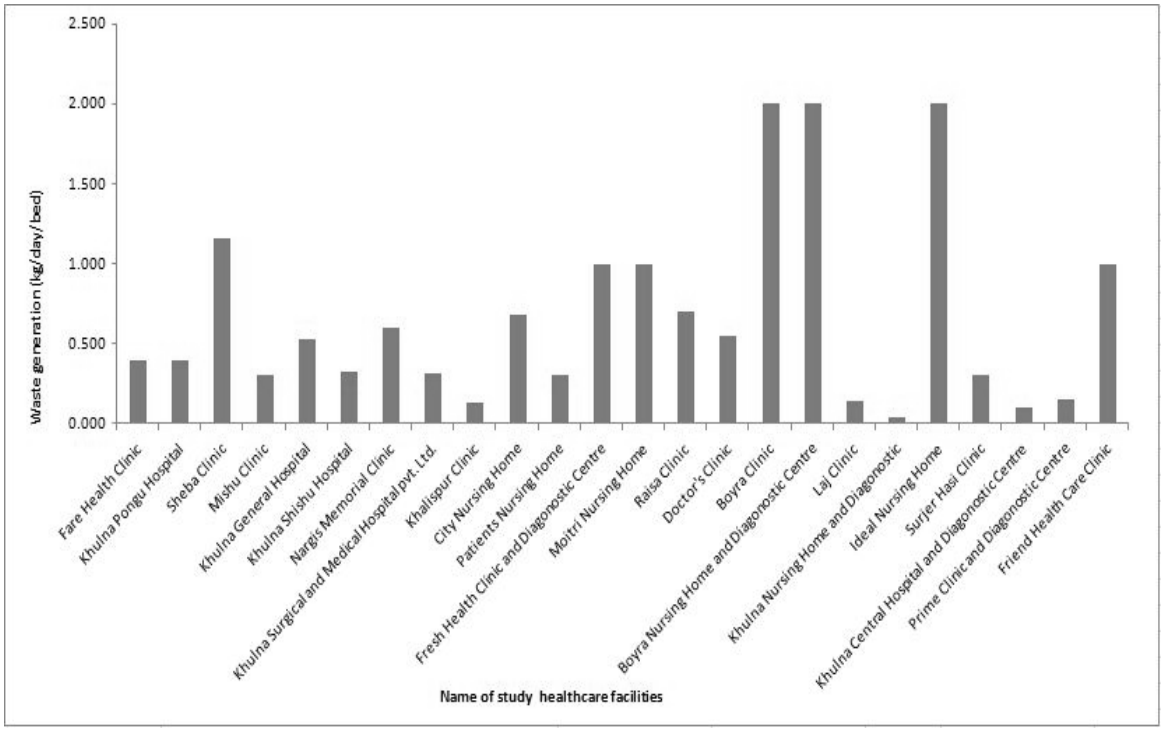

Figure 3: Hazardous waste generation in 24 HCEs in kg/day/bed in Khulna city *(source: study data, 2012).*

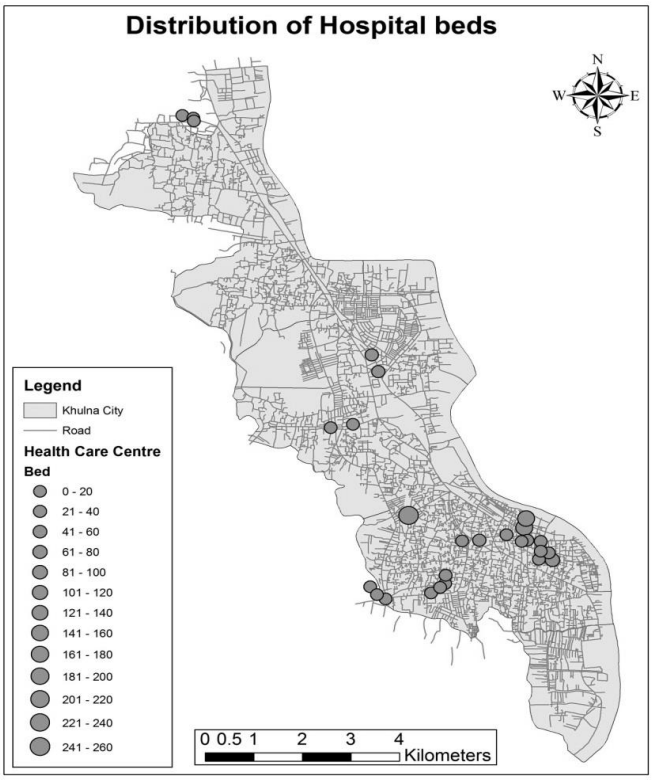

Figure 4: Spatial distribution of hospital beds *(source: field survey, 2012)*

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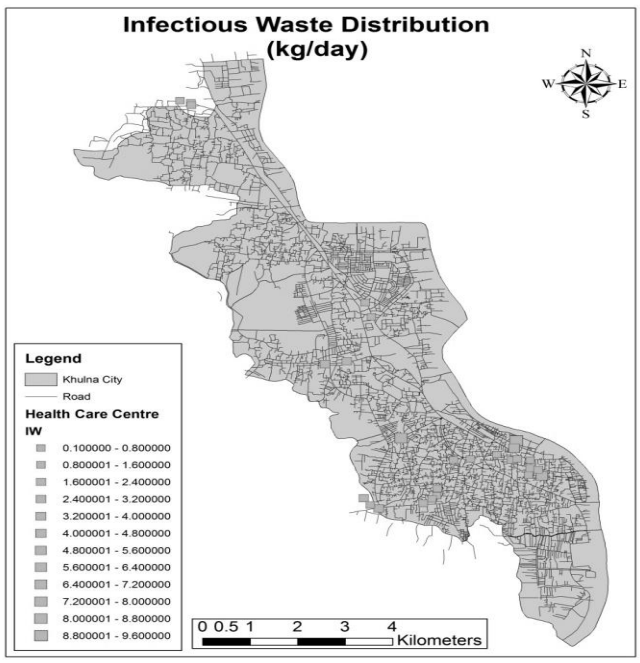

Figure 5: Spatial distribution of infectious waste *(source: study data, 2012)*

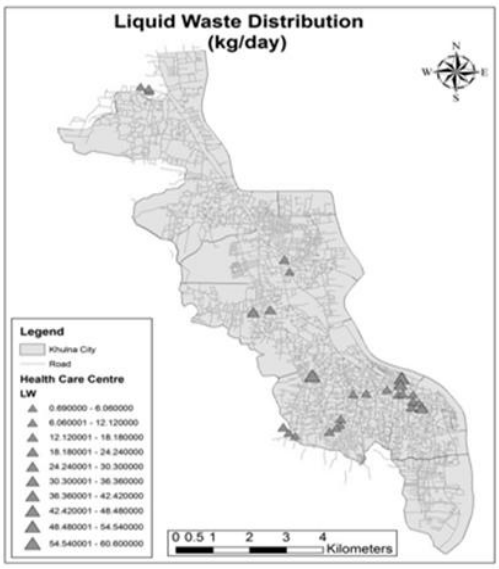

Figure 6: Spatial distribution of liquid waste *(source: study data, 2012)*

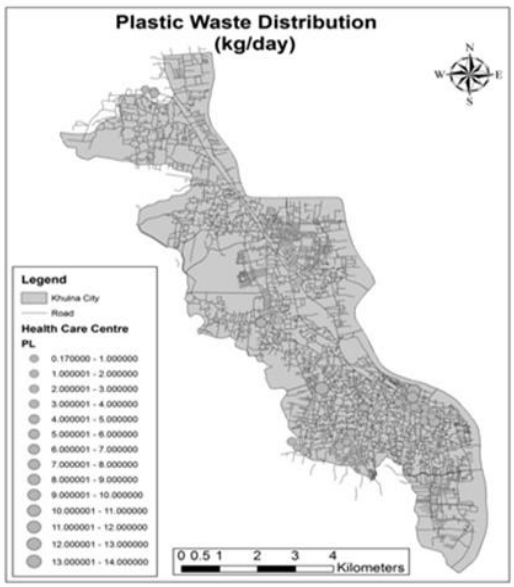

Figure 7: Spatial distribution of plastic waste *(source: study data, 2012)*

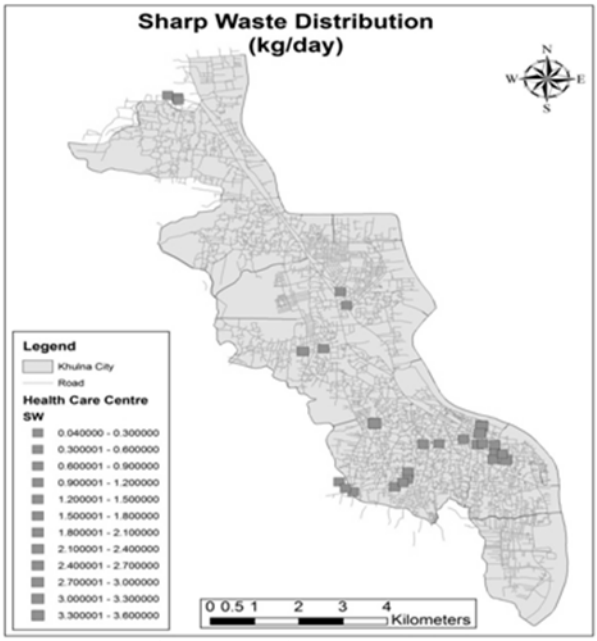

Figure 8: Spatial distribution of sharp waste *(source: study data, 2012)*

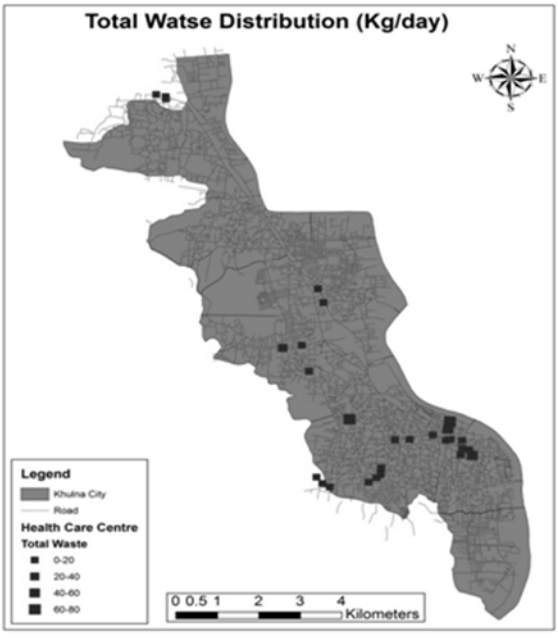

Figure 9: Spatial distribution of total waste *(source: study data, 2012)*

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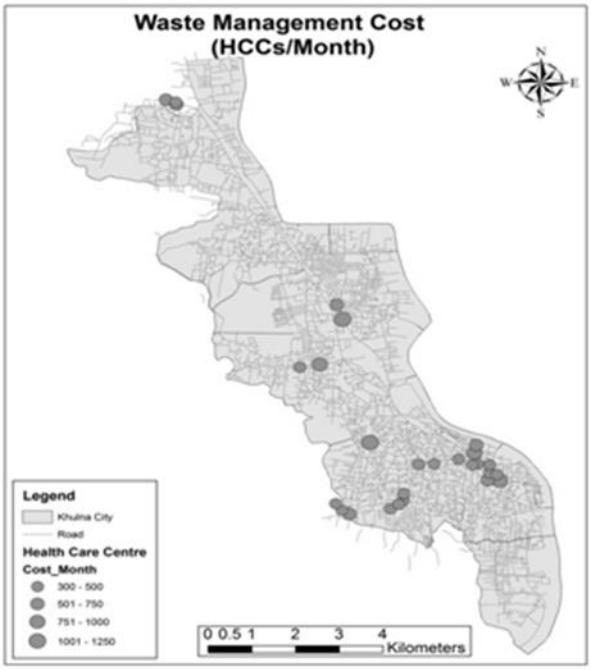

Figure 10: Spatial distribution of waste management costs *(source: study data, 2012)*

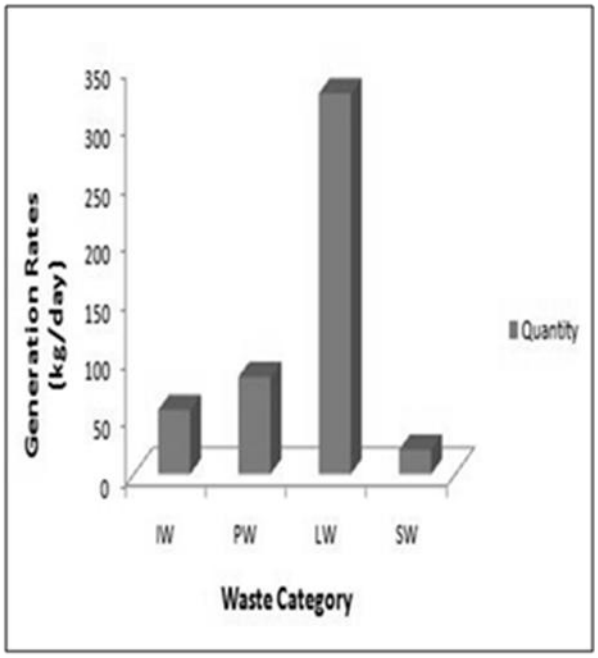

Figure 11: Comparison of component in clinical waste generation (source: study data, 2012).

The Figure 4 is showing spatial distribution of hospital bed in the health care centre. Here the circles are showing number of beds in arrange in ascending format from smaller to larger size. Here most of the hospital's beds are within 0 to 20 ranges. Highest number of beds is 250 in Khulna Surgical and Medical Hospital pvt. Ltd. and lowest is 10 commonly seen in many health care centers. Generally, analysis of bed distribution of HCEs in the study area assists to identify the waste generation rates in kg per day per bed in Khulna City. According to the number of beds in HCEs, it can be assumed the possibility of waste generation in that area and planned a safe system of waste disposal. In contrast, the spatial distribution of Infectious waste in kg per day of the selected health care centre is provided in Figure 5. Here the rectangles are showing the quantity of infectious waste in arrange in ascending format from smaller to larger size. Also, major quantity of infectious waste ranges within 0.1 to 0.8 kg per day. Highest quantity of infectious waste is 9.33 kg per day in Khulna General Hospital, while lowest is 0.1 kg per day commonly seen in many health care centers. Infectious waste can be considered as hazardous waste. Therefore, this figure analyzes the generation of infectious waste in HCEs in Khulna city as it can be determined a suitable treatment option of infectious waste.

The Figure 6 is showing spatial distribution of liquid waste in kg per day in the health care centre. At this point the triangles are showing the quantity of liquid waste in arrange in ascending format from smaller to larger size. Here major quantity of liquid waste ranges within 0.69 to 6.06 kg per day. Highest quantity of liquid waste is 54.67 kg per day in Khulna Surgical and Medical Hospital pvt. Ltd., while lowest is 0.69 kg per day in Khulna Central Hospital and Diagnostics Centre. Liquid waste can be considered as non sharp waste as well as hazardous waste. So, this GIS map in Figure 6 analyzes the generation of liquid waste in HCEs in Khulna city as it can be determined a suitable treatment option of liquid waste.

Here, it is interesting to note that spatial distribution of plastic waste in kg per day of selected health care centre was investigated and provided in Figure 7. Here the circles are showing the quantity of plastic waste in arrange in ascending format from smaller

to larger size. Here major quantity of plastic waste ranges within 0.17 to 1.0 kg per day. Highest quantity of plastic waste is 13.83 kg per day in Khulna Surgical and Medical Hospital pvt. Ltd. and lowest is 0.17 kg per day commonly seen in many health care centers. Plastic waste cannot be considered as hazardous waste. For this it can be collected in a separate plastic container and sometimes it can be made an effort to reuse. Therefore, this GIS in Figure 7 analyzes the generation of plastic waste in HCEs in Khulna city as it can be determined a suitable treatment option of plastic waste. Also, this analysis makes a contribution in waste management cost in HCEs.

The Figure 8 is showing spatial distribution of Sharp waste in kg per day in the health care centre. Here the rectangles are showing the quantity of sharp waste in arrange in ascending format from smaller to larger size. Here major quantity of sharp waste ranges within 0.04 to 0.3 kg per day. Highest quantity of sharp waste is 3.5 kg per day in Khulna General Hospital along with Khulna Surgical and Medical Hospital pvt. Ltd. and lowest is 0.04 kg per day commonly seen in many health care centers. Sharp waste can be considered as hazardous waste and also it can be collected in a separate plastic container for destroying this type of waste fully. So, this GIS map based analysis in Figure 8 illustrates the generation of sharp waste in HCEs in Khulna city as it can be determined a suitable treatment option of sharp waste. Also, this analysis makes a contribution in waste management cost in HCEs.

The Figure 9 is showing spatial distribution of total waste in kg per day in the health care centre. Here the rectangles are showing the quantity of total waste in arrange in ascending format from smaller to larger size. Here major quantity of total waste ranges within 0 to 20 kg per day. Highest quantity of total waste is 80 kg per day in Khulna General Hospital along with Khulna Surgical and Medical Hospital pvt. Ltd. and lowest is 1 kg per day commonly seen in many health care centers. Analysis of total waste distribution indentifies the total quantity of HCEs waste of entire city and separates the different categories of HCEs waste. So, this GIS map based analysis in Figure 9 illustrates the generation of total waste in HCEs in Khulna city as it can be determined a suitable treatment option of HCEs waste. Also, this analysis makes a contribution in waste management cost in HCEs.

The spatial distribution of waste management costs in taka per month in the health care centre provided in Figure 10. Here the circles are showing the quantity of waste management costs in arrange in ascending format from smaller to larger size. Here major amount of waste management costs ranges within 300 to 500 taka per month. Highest amount of waste management costs is 1200 taka per month in Khulna Surgical and Medical Hospital pvt. Ltd. Along with Khalishpur Clinic and lowest is 300 taka per month commonly seen in many health care centers. HCEs waste management costs depends upon the route distance of collection site of HCEs waste and disposal site of waste. Different government or non-government NGO s collects the HCEs waste and they have to be paid a certain amount for waste collection in HCEs. So, this GIS map based analysis can be determined a suitable treatment option of HCEs waste.

The components of clinical waste generation rate are provided in Figure 11. Liquid waste shows the dominant component as 327.47 kg per day, while the minimum is sharp waste presenting 21.13 kg per bed per day on the chart. Others are Plastic waste and Infectious waste showing 83.77 and 55.13 kg per day, respectively.

CONCLUSIONS

Result reveals that total hazardous hospital waste generation rate 0.676 kg per bed per day with component wastes' generation rates were 0.06, 0.12, 0.003 and 0.50 kg per bed per day for infectious, plastic, sharp and liquid waste, respectively. Moreover, liquid waste shows the dominant component as 327.47 kg per day, while the minimum is sharp waste presenting 21.13 kg per bed per day as well as plastic waste and infectious waste showing 83.77 and 55.13 kg per day, respectively. Based on survey, it is very apparent that hospital facilities and waste management in Khulna city is not at all environment friendly, rather degrading the environment with numbers of potential hazards. There is lack of proper laws and regulations which specifically can regulate bio-medical waste management. Every HCEs should

spend a fixed portion of its monthly or annual budget for waste management because this phenomena is not anyhow less important than treatment. Through this study the estimated clinical waste rate can be used to assess the amount of health care waste generated daily in Khulna city and to design the treatment plant. Finally, it can be concluded that GIS can be used to assess waste generation, generation variation, and collection and transportation routes.

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