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A systematic approach to Solid Waste Management in Bangladesh following the Finnish system

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**A systematic approach to Solid Waste Management in
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Nowadays Solid Waste Management (SWM) is recognized worldwide. The World Health Organization (WHO), the European Union, and Environmental Protection Agency (EPA) have emphasized the need to handle and dispose of waste to make a clean and green environment all over the world.

The research objective is to propose a sustainable and integrated solid waste management in Bangladesh by following the Finnish waste management system partially or fully. Finland has already developed an effective method of waste management with some leading companies such as L&T, SOL, ISS and others, and developed an ideal solid waste management system. On the other hand, Bangladesh does not have any effective solid waste management system yet.

As a result, Bangladesh needs to implement an effective waste management system as soon as possible and it is perhaps beneficial to follow a developed country's method. Although, the weather, culture, and society are different in Bangladesh, but they can take some suitable methods from Finnish system and make its own implementation plan.

At present, solid waste in Bangladesh is being handled like any other type of waste and it is placed in concrete enclosures/container or simply dumped on the street. From there it is loaded manually into waste carrying trucks by street sweepers and disposed at the landfill. Both in the street and the landfill, the waste or solid waste is subjected to scavenging. Due to the character of waste, this way of handling may cause health hazards to the people who are involved in the handling, and both the street sweepers and the scavengers cause damage to the environment. In this thesis, existing waste management of Dhaka City will be assessed to clarify the present handling, storage, transport, and treatment and disposal system of waste. Waste generated in Dhaka City is varied in composition and in quantity. It is important to know what type of Waste is generated in Dhaka City to execute proper treatment and disposal of solid waste.

Eventually, the first and most important part of a waste management is to raise awareness about the proper waste management system. How to separate waste at the source place, how to collect for dumping, and all the details can be published in a brochure, and giving information to the public in all possible ways of advertising. Thus, raising awareness will solve the waste generating problem gradually. Afterwards, it will be easier for other companies or the government to handle the rest of the waste properly. Although raising awareness is going to take time, we have to be patient to make fitting laws for the convenient waste management system by this time. Thus, we can hope for a clean and green Bangladesh. Gradually the whole country can come under the umbrella of proper solid waste management.

In this research work different literature, articles, reports, journals were reviewed and analyzed to establish a sustainable framework for solid waste management which complements the objectives of this thesis. Moreover, in the thesis the researchers mostly use a qualitative approach to make a fruitful solution for solid waste management. The research shows that integrated solid waste management can be achieved in Bangladesh by launching sustainable plan, environmental friendly policy, and working together to make a green Bangladesh.

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1 Introduction

According to Environmental Performance Index webpage, Bangladesh is the 169th country out of 178 countries around the world. That means that the overall environmental situation of Bangladesh is in real danger. Among all the categories Bangladesh ranked the worst (178) in air pollution and that has a direct connection with waste. (Environmental performance Index 2014).

Environment pollution is gradually causing severe to normal diseases to humankind. World Health Organization (WHO) has been established that about quarter of the diseases happened to humans due to the long-term effect of environmental pollution. And environment pollution is mostly causing from waste in the environment. (Environmental pollution and impacts of public health no date).

Murtaza (2002) describes that Proper and safe management of Waste is recognized world-wide. Sustainable Waste Management helps for getting rid of waste materials or domestic refuses from the environment. In Bangladesh, by the term 'waste' one largely means city waste because the socio-economic conditions of the villages are such that there is little scope for generation of city type waste from day-to-day domestic activities of village people. (Murtaza 2002).

The thesis starts with the terms that have been used in Waste Management (WM) field at present. By going through those anyone can get a good first impression about the terms. The study area is in Bangladesh, which is a typical Asian country, gradually filling with wastes. More and more people are going to urban areas every day which makes the city more crowded, and as a result more wastes are generating. The authority is being unable to handle, collecting and then throwing those altogether properly. Subsequently, the garbage is thrown then in a landfill which pollutes the surrounding environment.

The lack of proper knowledge of how to put the garbage separately and make the best use of those is still a mystery for common people. A Government agency named as City Corporation is mostly responsible for waste treatment in city areas. In Dhaka city Dhaka City Corporation (DCC) is handling waste treatment. But, without proper waste management system, and not taking the help from projects, seminars which are done by individuals, are making the waste situation worse day by day.

The research has been done by two persons. So, it was a bit challenging to keep contact and write thesis at the same time. In the beginning the theoretical part was done individually and separately. Afterwards the different parts were sent to each other through email, social me-

dia etc. Critical parts for example benchmarking, field research are done together. And the final joining was done by sitting together.

2 Objective of the Study

The main objective is to find out a typical and effective way to reduce, reuse, recycle, and disposal of Municipal Solid Waste (MSW) in Bangladesh. At the same time, make a proposal to reduce the social and environmental costs of waste management in the urban area.

On the other hand it has been designed to explore and identify the types and sources of Waste, determining the impact of waste on the environment, assessing the problems and common drawbacks in solid waste management (SWM). Moreover assessing how the city can be keep clean and healthy, encouraging community people to take initiative in SWM, promoting ideal SWM in all urban areas day by day, by following standard system, and making public awareness. Therefore, to assess the opportunity for minimizing the waste management cost.

Afterward, the Finnish waste management (FWM) system would be implemented partially or as much as possible, in Bangladesh in a small scale. Eventually, if the system is cost effective and becomes successful in aspect of Bangladesh environment, it would be carried out nationwide to get neat and clean environment.

3 Scope of the Study

With the rapid growth of population in Dhaka city, the necessity of safe, clean and proper Waste management (WM) is becoming an important issue. WM is frequently described to be an environmental pollutant as well as presenting a serious health and environmental concern.

Although Bangladesh is predominantly rural, a defining trend for its economy and society is its rapidly growing urban population. Currently, the urban population makes up approximately 20% of the country's population of 160 million. Urbanization is increasing by 5-6% annually, and it is expected that more than 50% of the population in Bangladesh will live in urban areas by the year 2025 (MOHFW, 2005).

The growing urban population has increased the burdens on service delivery in cities, whose resource and management capacities are already over extended. A key challenge for government and development leaders, therefore, is how to cope with growing urbanization and develop service delivery systems that meet public policy goals. So, it is high time to conduct a research to focus on state of the WM in Dhaka city. Simultaneously, it will also recommend some essential suggestions to handle the threat of Waste.

4 Limitations of the Study

In Bangladesh, waste management is carried out by the government organization which is called as City Corporation. For Dhaka city it's called as Dhaka City Corporation. So, working on waste management in city corporation area is quite difficult, because government body does not feel comfort to work with general public because of governmental policy. Thus, getting data and relevant information regarding the research is relatively hard, so that primary data collection is almost impossible. Therefore, to make the research we have to depend on secondary sources of data and information, but that is not also available on solid waste management (SWM) in Bangladesh.

On the other hand, insufficient book, journal, thesis paper, and project report is also another obstacle. As a result, scarcity of current relevant books and journals regarding this topic in the library also made problem to come up with fruitful result. At last, lack of collection of data from field level, and not getting important information for want of technological support is also vital limitation for this research work. However, this thesis work is carried out as faultless as possible and left no stone unturned to improve its quality.

On the other hand, making communication with City Corporation in Bangladesh was another constraint, because even though several times researchers sent e-mail to the authority to get their response regarding waste management, and working with their team members who are involved in waste management, but expecting their response was impossible. Eventually, during field research researchers are intended to making awareness developing program in school or college in Bangladesh, but after knocking several institute, researchers got one head master's response for making successful program in his primary school. Here, it is mentionable that the teacher is involved in social work such as making clean environment through sustainable waste management.

5 Key concepts and terminologies

Waste management was first introduced in 1842 in the United Kingdom. The English government started to keep the wastes away from the rivers. They worked to keep the drinking water clean. They also started to design modern public sanitation as they came to know from the doctors that most of the diseases caused by the germs from the waste. At first, horse drawn cart was introduced to remove waste from houses. Later, in 1917 the garbage truck was invented which took the trashes to the dumping place. (Earth friendly waste management 2009, 10).

Therefore, after 2nd world war, the world itself changed a lot. People moved to cities more than ever. And it was all because of rapid development in science and technology. As a result industries were setting up rapidly. More and more new products inventions were coming every now and then. Disposable products became popular. As a result there were multiplied amount of waste in all the cities. (Earth friendly waste management 2009, 15)

The above mentioned topics are the terms and their definitions frequently used either in the waste industry or specifically by WM.

5.1 Waste

As described in Oxford dictionary waste is “(of a material, substance, or by-product) eliminated or discarded as no longer useful or required after the completion of a process.” (Oxford dictionary 2014). Synonymously the word waste can be depicted as desolation, destruction, expenditure, havoc, loss, ruin, wastage etc. (Thesaurus 2014). The word waste was first used in 1200 century, as devastate, ravage or ruin. Gradually other words added for example, “squander, spend or consume uselessly”, “to kill”, “intoxicated”, “waste water” etc. (Thesaurus 2014).

Waste is very well described by P. Reddy as “any garbage or refuse or other discarded material including solid, liquid, semi liquid, or contained gaseous material arising from domestic, community, industrial, commercial, agricultural or human operations. The sludge from wastewater treatment plant, water supply treatment plant, or air pollutions control facility is also considered as waste.” (Municipal solid waste management 2011, 2).

“The implication that waste is something useless has been troubling. Waste was then described as an unwanted, but not avoided output, hence its creation was not avoided either because it was not possible, or because one failed to avoid it.” (Pongracz 1998) (Herkules 2014).

From ancient times there is trash. In the past people used to reuse, recycle, and burn rest of the trash. As there was no industry so people tried to reuse most of the things they used. Others were thrown out in the street. Gradually the cities in the world getting crowded and waste then started to take a gigantic view. Athens is the first city in the world to start city dump in 500 B.C. (Earth friendly waste management 2009, 8).

The biggest question about waste is from where all these waste come. Every one of us are throwing away a lot of stuffs e.g. foods, packages, papers everything. The most amount of trash is generated by USA alone. The country is producing average of 1.35 billion pound of

waste yearly. The table below shows about how much waste does a person in average produce in different countries. (Earth friendly waste management 2009, 6).

Country	Pound (kg) of trash per person per day
United states	4.5 (2)
Iceland	4.4(2)
Netherlands	3.7(1.7)
United kingdom	3.5(1.6)
France	3.2(1.5)
Japan	2.5(1.1)
Canada	2.1(1)
Mexico	1.9(.9)

Table 1: Amount of trash produce by per person per day (Earth friendly waste management 2009, 6).

From the table we can see the countries which are making the most amounts of trashes per person per day. In the United States, each person is creating a great amount of trash each day. Developed and developing countries are consuming more products and thus creating more trashes.

5.2 Sources of waste

There are three types of waste on the basis of production source such as residential, commercial and Industrial. Amongst three types of waste in cities residential and commercial wastes are disposed of by the city's municipal administration, but industrial waste is discharged into water bodies or dumped near the site where the industry is located. Industrial pollution is today a major environmental threat in many countries including Bangladesh. Although disposal of industrial waste is to be made in a manner that does not constitute a threat to environment, it is frequently not practiced with sufficient stringency. (StEP initiative 2015).

Types of waste source is described below.

Source	Typical Facilities, Activities or located where wastes generated	Types of Waste product
Residential	Single-family & multi-family dwelling	Food wastes, rubbish, ashes
Commercial	Stores, restaurants, markets, office building, hostels, motels, print shop, repair shop, medical and institutions	Food, rubbish, ashes, demolition and construction wastes, hazardous wastes.
Municipal	Same as above	Same as above
Industrial	Construction, fabrication, light and heavy manufacturing, refineries, chemical plants, lumbering, mining, power plants, demolition, etc.	Food, rubbish, ashes, demolition and construction wastes, hazardous wastes.
Open Areas	Streets, alleys, parks, vacant lots, playgrounds, beaches, highways, recreational areas, etc.	Special waste, rubbish
Treatment Plants sites	Water, waste water, and industrial treatment process, etc.	Treatment plants wastes, composed of residual sludge
Agricultural	Field & row crops, orchards, vineyards, dairies, feedlots, farms, etc.	Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes

Table 2: Typical Waste/Solid wastes Generating Facilities, Activities, and Locations associated with source Classification. (eschooltoday 2010).

5.2.1 Household waste

Household waste which is known as domestic waste is generated in houses. Household activities such as cooking, cleaning, repairing, interior decoration make household waste. All used products or materials such as glass, plastic, metal containers, packaging stuffs, clothing, old book, newspaper, and old furniture are also included in this context. There are two types of household wastes such as disposable and non-disposable waste. Basically, household waste contains a lot of different types of wastes such as glass, paper and cardboard, metals, textiles, plastics, vegetable waste, and dust is 10%, 30%, 9%, 3%, 4%, 23%, and 21% respectively, and cinders, and miscellaneous as well. (Household waste no date).

In fact in Bangladesh household waste which has no longer uses and thrown away without taking care of environment, because organic waste containing household waste creates bad smell in the air, and can create harmful effects on human health. Especially organic waste which is thrown away on the street, or into the river, attract flies, mosquitoes, and rats, and allow

them to multiply their breed which may cause of germination of germs. All germs generate diarrheal disease, yellow fever, dengue fever, and bubonic plague. (Solid Waste disposal no date).

5.2.2 Hazardous wastes

Wastes that make immediate danger to human, plant, or animal life for over a period of time is classified as hazardous wastes. A waste is classified as hazardous if it exhibits ignitability, corrosive, reactivity or toxicity. (Solid waste management 2015).

The hazardous wastes are categorized as follow-

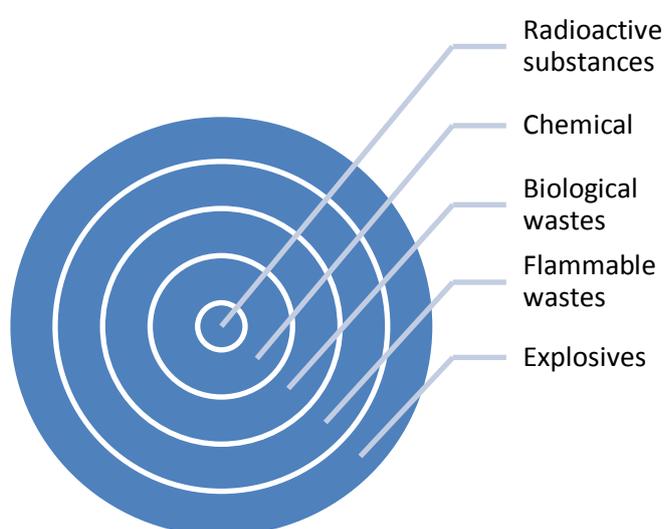


Figure 1: Groups of hazardous wastes

The corrosive, reactive, or toxic substances are included in chemical wastes. On the other hand, biological wastes are mostly generated in hospitals and biological research laboratories which are main biological hazardous wastes. (Solid waste management 2015).

5.2.3 Hospital waste

Hospital waste is a crucial part of solid waste. It is found that, hospitals generate 10%-25% of hazardous wastes and 75%-90% of non-hazardous wastes. So, it should be considered significantly. Waste products that are generated at hospital include paper, plastic, cardboard, food wastes, needles plus miscellaneous other as pathological waste, pharmaceutical waste, and sharps are known as hospital wastes. (WHO no date, 4). It may be hazardous or non-hazardous.

Type	Wt.% of Total
General	50.0
Food	30.0
Infectious	10.0
Cardboard	9.5
Pathological	0.5

Table 3: Type and Quantity of Waste produced by a Hospital (WHO 2015)

The amount of waste generated varies from hospitals. Most trashes have been created in the university hospitals. A breakdown of the types and quantities of the waste produced by a typical hospital facility are shown in table 3.

5.2.4 Construction and Demolition Waste (CDW)

According to eschooltoday, construction and demolition waste are resulting from old buildings that are being demolished. The derris's that are coming from those buildings are demolition waste. Waste items include concrete and bricks, asphalt, metal, rock and stone, soil and sand, package boxes, wood, concrete debris, and plastics. European commission (2014) describes that construction, civil infrastructure; demolition of buildings makes most of the CDW wastes.

For an ecological sustainable and profitable environment, recycling of construction and demolition waste, can save landfill spaces, energy, and the environment by producing less construction materials, can reduce overall building constructing cost by using the old debris. (Environmental Protection Agency 2014).

5.2.5 E-waste

Electronic waste or otherwise known as e-waste are wastes related to electronic and telecommunication products. These products include computer, laptops, televisions, DVD players, mobile phones etc. More and more e-products are adding in this list rapidly by the advancement of science. Much of the e-waste comes from developed countries as more and more electronic products are used vastly. Computer related wastes are growing more in developed countries. Television and DVD related wastes are producing more in developing countries. As these countries are still less advanced in computer related products. (StEP Initiative 2015)

According to UN, between 20 and 50 million tons of e-waste is generated in worldwide every year. Among those 12 million of tons are coming from Asian countries, and the number is increasing every year. Globally computer sales grow around 10% annually. DVD player sales are doubling every year. The lifecycle of a television is 10 years and 2-3 years for a computer. So, these products became waste by this time. As a result, these products are releasing toxins on the environment which is very dangerous for human health as well. Special care is needed for e-waste as these are very hazardous for the environment. (Municipal solid waste management 2011, 9-10).

6 Methodology: Qualitative approaches

According to the research objective that researchers are intended to find out a proper and cost effective way of waste management in Bangladesh as a whole. So, finding the proper and systematic way of solid waste management is depending on a lot of issues such as density of population, socio economic situation, and the fair governance.

First of all it is important to decide about the methods of how the research is being carried out. So, whether it is going to be a qualitative or quantitative research, how to benchmark the research methods, how to get solutions for the proposed problem, how to approach for the problem solutions, and finally presenting the proposed recommendations.

In this thesis researchers are going to concentrate on qualitative research. As waste management is a descriptive issue, so here, qualitative research is preferable than quantitative research. Definition of qualitative research varies. So, simplified definition is “research using methods such as participant observation or case studies which result in a narrative, descriptive account of a setting or practice. Sociologists using these methods typically reject positivism and adopt a form of interpretive sociology.” (Parkinson & Drislane No date).

Qualitative research is more specifically defined by Nkwi, Nyamongo, and Ryan (2001, 1) “Qualitative research involves any research that uses data that do not indicate ordinal values.” Qualitative research includes images, texts, pictures that are used to compare data, gets idea about situation, and other issues. (Guest, Namey & Mitchell 2013, 3).

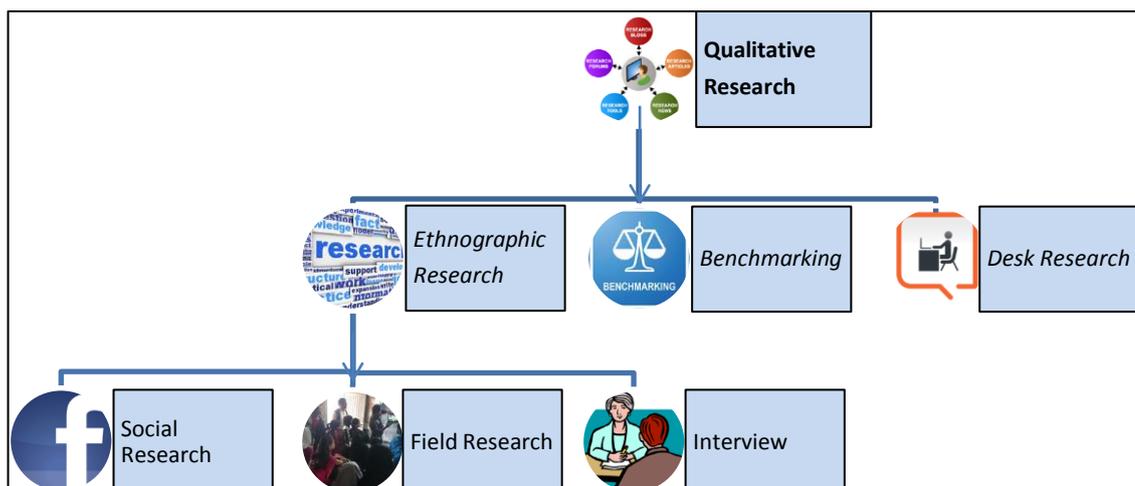


Figure 2: Research method (Qualitative)

From figure 2 it can be seen that the researchers focused on qualitative research. Under qualitative research they did ethnographic research, benchmarking and desk research. Ethnographic research includes social research which includes social media such as Facebook. Field research includes small scale implementation of proposed idea by the researchers. Interview was done in both Bangladesh and in Finland to get ideas about current waste management. All the details can be found below.

In fact, the researchers described the ethnographic research at first, and then social research, field research and interview as they want to focus on ethnographic research more. Later benchmarking and desk research came although those researches got importance as well.

6.1 Ethnographic research

Along with the above-mentioned methods, interviewing of different people who are involved in waste management sector in both countries is taken into consideration for the thesis. In Finland during the thesis-working period researchers visited L&T head office to take interview, and made audio recording regarding Finnish waste management system.

Thus visiting at a recycling point in Finland is also one of the valuable methods; this gives insight information, and making business possibility through waste management. Basically, visiting the recycling point in Finland is vital issue to the researchers, because in Bangladesh there have no central or organized recycling point. So, gathering information regarding business, and environmental aspects, recycling plant introducing cost, and justifying the feasibility

ity to establish such kind of recycling plant in Bangladesh. (Vaisanen 2014, personal communication).

On the other hand, researchers visited Prodipan, an NGO in Bangladesh, is appointed for taking care for hospital and health clinics wastes in Khulna City Corporation. The health clinics have to pay for the service. They also have small scale household waste management which is collecting waste from door to door. And then gathering those in a place mostly in the street or in an open area where it both looks horrible and at the same time create bad smell and spread germs when started rotting.

There are no set rules and regulations for waste sorting. All the wastes altogether go to the landfill which is consuming more places and making the waste situation worse. Scavengers collect bottles, plastics, and other reusable materials from the landfills and reuse them which are unhealthy. According to the interviewees, there is a critical need of a proper way of waste management in Bangladesh immediately.

6.1.1 Social research

Making people aware about waste management system is the most complicated issue, which takes time, money, and effort. So, as a starter of the effort researchers come up with different ideas. For example, Facebook is a very popular, common and easy media by which we can reach people quickly and efficiently. As a lot of people is using Facebook frequently nowadays and the number of users are rising in every second and minute. So, researchers think that it can be a good place to reach mass people quickly.

As a result, researchers have been created a Facebook page by which we are trying to reach to all level of people in Bangladesh. The information about the page can be found from here https://www.facebook.com/pages/WASTE-Management-Bangladesh/1493705990868732?ref=aymt_homepage_panel.



Figure 3: Social media to raise awareness

But only creating the page will not help people to understand about the waste issue. So, we are constantly putting new videos, information, and pictures regarding proper waste disposal system, so that people can get involved to make friendly living environment in Bangladesh.

So far, we have uploaded a lot of information in the page, and we are feeding every now and then to let people know about different aspects of the issue. We started with putting pictures that are depicting what people should do. For example, the picture of reduce, reuse and recycle let people think of the 3Rs once again every time we put any feed. Afterwards we put pictures about separating trashes to let people of Bangladesh to know that separating trashes is an important part of waste management in the beginning. We also shared videos related to proper waste management. The most important document we share is the brochure for separating trashes that we translated into Bengali. That brochure we took as an example from L&T Company from Finland. (Appendices 2).

6.1.2 Field research

Small scale implementation of Finnish waste management system such as sorting of garbage, collection according to segments of waste, disposal of waste in different waste bins, and making awareness among students of primary school (level 1 to 5) are being implemented at West Baniakhmar Government Primary School in Khulna. At the same time the awareness creating tags, sorting manual also distributed among the teachers and students.

In Bangladesh, basically in the school, college, and university level there is no institutional awareness developing system regarding waste management system. So that, during the research work the researchers took initiative to introduce awareness developing program in primary school, and from the primary school the head teacher with other teachers and staffs will take part into dissemination program. Already, the teacher and the staffs have been introduced waste sorting program in the school by making awareness among the students, and in the community. So that, in school program researchers invited community representative and program manager (Silvi Fatima) of Nagorik forum which is working to develop local administration with city people participation to come up with better solution regarding waste management through integrated waste management program.

In the West Baniakhamar Primary school the researchers donated three waste disposable bins to start the waste sorting program, and now the students are taking care of those waste bins, and awareness is developed among the school's catchment area and student's house because of introducing awareness developing program by the researchers, teachers and students even though it is not as much as required.

Below are some pictures to show the implementation process.



Figure 4: Implementation program

On the other hand, another implementation program is introduced in Sonaganga, Khulna. The research area researchers talked with solid waste collector Abdul Hamid about his work. Therefore, he was telling that the vital problem is dwellers do not sort the waste, so that when he collects waste from door to door he is used to get very bad smell regularly. Thus, sometimes he cannot breathe properly. Then, the researchers donated some money to buy plastic bag to give some householders to separate at least Bio waste (fish's waste, chicken waste) from other waste. According to Abdul Hamid's speech fish's waste makes very bad smell than others. So, he will provide plastic bags to those users who do not separate at least fish's waste. Eventually, some dwellers nowadays are using the plastic bags to keep fish's waste separately.

Another important part of implementation is submitting the waste manual to Prodipan. The researchers also made a PowerPoint presentation for the company. The researchers were supposed to give presentation but the projector was not working so they could not be able to give presentation.

6.1.3 Interview

In qualitative research work interview plays vital role, so that researchers choose interview as ethnography research tool. During this research work researchers took interview in Finland as well as in Bangladesh. In Finland researchers made face to face interview in L&T Company with Mirva Vaisanen who is environmental specialist working in L&T, here it is mentionable that L&T is a multinational company which is working on waste management sector since long ago. And in Finland only one sophisticated recycling plant is maintained by L&T. During this part researchers made questionnaire to get in depth information regarding working processes on waste management in Finland, and the questionnaire is in Appendix part with answers.

On the other hand, in Bangladesh researchers took also interview in Prodipan NGO which is working on waste management sector in small scale in Khulna City Corporation area. During this time we took interview by using same questionnaire what is used in Finland as well. In Bangladesh researchers planned to take interview from workers as well who are involved in waste management sector to get proper information and making real scenario of waste management sector of Bangladesh. This interview helps researchers to come up with some valuable recommendation for developing sustainable waste management in Bangladesh. (Appendix)

6.2 Benchmarking

It is a research tool to learn the strategic plans, and successive programs from one's company for adding value to other company. Basically it is a learning process from others. Benchmarking is a vital tool for using other's knowledge, and experiences to make a valuable change in target organization or institute. This tool helps an organization for analyzing the performance of existing programs or projects, and making notes on strengths and weakness of a company, and assessing the strategies what should be done for adding value on products or introducing successful project to eradicate the existing problems. (William No date).

Benchmarking is the process for introducing other's successive skills, and strategies to generate new and fresh ideas. The primary goals of benchmarking are sharing information between benchmarked company and recipient company, and it is evaluated by the receiving company. Generally, benchmarking is the tool for realizing the weaknesses of a company for adding value on the basis of best practices of a company. It is one of the great research elements for

speeding up organization activities, finding more efficient ways of improvements, and bringing corporate approaches in the target company. (William No date)

There are four types of benchmarking such as internal, competitive, process, and generic benchmarking. Internal benchmarking is to follow the own departmental strategy or plan to multiply the different units, for example one company or organization can introduce new unit of them by following their own existing unit. On the other hand competitive benchmarking is that one can perform some strategies or plan by following competitors. Sometimes it is easy to perform, but sometimes it is difficult to introduce by following competitors because of ethical problem. Difficulties might be overcome very easily if the recipient company or country's geographical location is different, for example in this research work the researchers take into consideration the competitive benchmarking to introduce new techniques or strategies on waste management in Bangladesh (in Prodipan organization) by following Finland (L&T). (Vassilis 2000).

Therefore, process benchmarking is another easy tool to introduce same working processes in different organizations. Thus, generic benchmarking is based on technological aspects, basically technological developments and improvements are introduced in different organizations. So, on the basis of vision and mission researcher can select research tool or tools which benchmarking should be followed in the target company. (Vassilis 2000).

On the other hand, during the research work researchers study the working processes of L&T, Finland, and working processes of Prodipan NGO, Bangladesh regarding the waste management. For example, L&T collects sorted waste from the dumping point near to their houses, then they take away to the recycling point, and they sell the recycled products to the manufacturing company, and they make profit as a business. So, this is one of the process benchmarking, and Prodipan NGO can follow the whole processes in Bangladesh, and in this way Bangladesh can get help of process benchmarking. Therefore, in this thesis process benchmarking is playing vital role for developing sustainable solid waste management.

6.3 Desk research

Most of the research is done through desk research. There are a lot of books related to waste management are used during desk research. Researchers got ideas and thoughts from those books, and also took most of the help from the internet as there is a lot of information already pushed into the internet. On the other hand a lot of beneficial, non-beneficial organizations, private companies, and general public were working on waste management. So, researchers used to gather information from them as well. Therefore, scarcity of printed books

based on waste management pushed to get help from online printed books as well. Moreover YouTube videos, journals, business dictionaries also helped a lot to collect information.

Therefore, making an ideal waste management system, researchers create a waste sorting manual in Bengali language following the Finnish manual of HSY - Helsingin Seudun Ympäristöpalvelut-Kuntayhtymä. The waste sorting manual is attached in the Appendix section. This manual is given to Prodipan NGO which is working with Khulna City Corporation in Bangladesh to disseminate among the dwellers.

PRODIPAN an NGO (Non-Government Organization)

PRODIPAN is one of the renowned NGO in Bangladesh which was established in 1983, in the southwestern part of Bangladesh. It has aiming to improve the socio-economic condition of the poor and underprivileged people and build up equity based social structure. Being a development organization, PRODIPAN conducts diversified programs addressing a large community, both in rural and urban areas, of different parts of the country. Prodipan dedicates its program to protect, promote and support sustainable human development. (Prodipan 2013)

The development philosophy of Prodipan is essentially a holistic approach that emphasizes on the human resource development and empowerment of the underprivileged people through facilitating the creation of people's institution. Its programs and interventions are devised with participatory processes for the poor & hardcore poor and their immediate needs with especial commitment to environment friendly development, and initiatives in the context of climate change. Prodipan is sensitized with gender and child concerned issues. (Prodipan 2013)

Prodipan works for ensuring gender equity, empowerment of female in decision making, establishing the fair economic distribution between male and female workers, giving facilities for getting fresh drinking water in the saline based coastal area of Bangladesh. It has great achievement on sustainable livelihood program in the village areas of Bangladesh. On the other hand, it has played a vital role to disseminate awareness on using bio-fertilizer, and awaking the people on harmful effect of chemical fertilizer for farming. (Prodipan 2013)

Therefore, it has been working on Clinical Waste Management (CWM) in Khulna City Corporation of Bangladesh since long ago. It was also working on Solid Waste Management in the same area for many years, and this program achieved fame in the community of Khulna division in Bangladesh. (Prodipan 2013)

7 Background

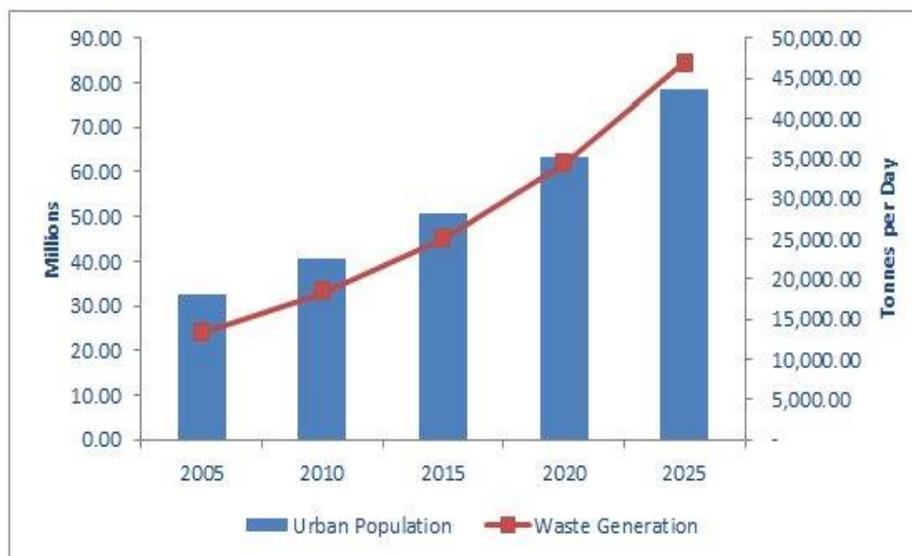
In this part researchers describe about the current waste management situation in Bangladesh and Finland. One important factor about development of any country is related to when the country got its independence. As we know Finland already got its independence in the year 1917, whereas Bangladesh got its independence only in the year 1971. So, Finland got a very long time to formulate and reform the rules and regulations on proper waste management. On the other hand Bangladesh is yet to finalize a draft of its own for waste management.

As with the time, Finland developed the waste management system in a systematic way. For Municipal Solid Waste (MSW), in each and every municipality, there are selected places to throw trash and garbage in allocated places. People, by separating the trashes, throw accordingly in the separated trash boxes. From there other private companies for example L&T collect the trashes in big trucks and send those to recycle points, and the last remaining goes to the landfill. But, in Bangladesh MSW is collected from door to door by small personal initiatives. They then put those in a selected open area. And garbage collecting trucks from Dhaka City Corporation collect and throw the trashes in landfill directly. Below waste management system of Bangladesh and Finland are described broadly and separately.

7.1 Waste management in Bangladesh

Bangladesh is a south-east Asian country bordering most parts with India and Myanmar. On the south there is the Bay of Bengal. The capital of Bangladesh is Dhaka. The total area of Bangladesh is 1, 47,570 square kilometer with over 160 million people. So, it is the 8th most densely populated country in the world. The estimated population of Bangladesh by the year 2030 will be around 185 million. (I look forward to 2010).

This huge amount of people is already became a headache for the government. Although, child birth rate control is a widespread common idea nowadays. Still, numerous numbers of people are adding every day. Hundreds and thousands of people are coming to Dhaka city every day to look for their livelihood. That is how Dhaka is becoming a mega city very rapidly. But this vast amount of people are creating vast amount of problems. One of them is generating more waste. (I look forward to 2010).



Source: World Bank, Waste Concern, and Frost & Sullivan Analysis

Figure 3: Amount of population and trash generated in Bangladesh

Among Asian countries Bangladesh has higher rate of making of waste. From the figure 4 it is mentionable that Bangladesh generated 40 million tons of trashes. The amount of urban population will increase alarmingly. So, the amount of trash will be reached at the peak position which is around 80 million tons by the year 2020. So, it is high time to conduct a research on waste management of Bangladesh.

7.1.1 Research area (Dhaka City Corporation - DCC)

Dhaka is the capital of Bangladesh. It is one of the most populated cities in the world. At present the total population of Dhaka city is 13 million which will rise to 30 million by 2030. But, the area of the city is only 360 square kilometer. Moreover, around one million travelers visit the city every day in search of their livelihood. In Dhaka city the population growth rate is 3.72% per year. In DCC area there are 60% low income houses, 37% middle income and the high-income houses is 3% as well. According to Islam Shafiqul (No date), "There are over 1000 small and large industries including 149 tanneries, about 500 clinics and hospitals in Dhaka Metropolitan Area". (Cities and Sustainable development 2003)

To compare the budget that were spent on waste management in different cities are as follows. The per capita expenditure on SWM in Asian countries is in Bombay 304 taka (around 5 Euro), (tk - Taka - Bangladeshi currency), in Manila 192tk (around 3 euro), in Bangkok 84tk (around 1 euro), and in Bangladesh is 53tk (less than 1 euro). So, the spending of DCC in SWM of Dhaka city is very low. DCC spent only over 15% for SWM annually. In per cubic meter, the management cost is around 313tk (4.50 Euro). Here, it is mentionable that 1Euro = 102Tk,

which gives idea about expenditure internationally. Transportation cost is the most 150.09tk (around 2 Euro) which is 47.90% of the whole spending. Collection cost is 120.54tk (around 1 Euro), (32.75%) and disposal cost is 60.60tk (around .70 Euro), (19.37%). (Cities and Sustainable development 2003, 4).

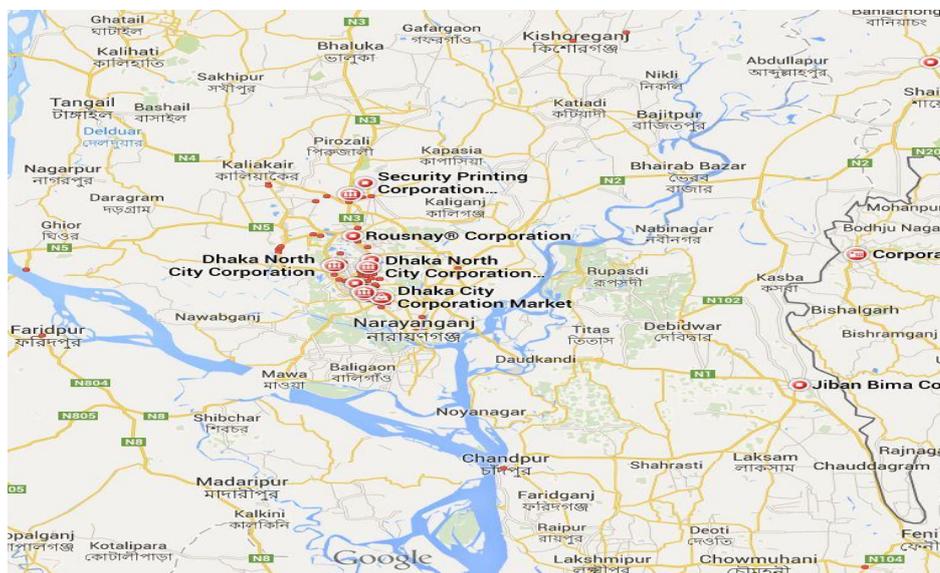


Figure 4: Dhaka City Corporation (Red marked area)

Dhaka city corporation (DCC) is operating by the "Dhaka Municipal Corporation Ordinance XL 1983". The ordinance is quite backdated comparing to the increased amount and different types of waste. That is why there is no specific clause or section for different types of hazardous waste or hospital waste. Moreover there is no mention on how to handle, collect, transport and disposal of waste. Additionally there is no standard rule for punishment on littering. A set of rule has yet to be set by DCC. (Cities and Sustainable development 2003, 7).

7.1.2 Existing Problems of Waste Management

The institutional arrangement, insufficient financial resources, improper disposal, and transportation are the main limitations of solid waste management.

Lack of institutional arrangement

As DCC has no written laws and regulation, the conservancy department has no principle to follow. They also do not have any specialist. The database of labor distribution and transportation has not being updated time to time. The database of waste generation, waste collection and transportation has not been updated. So, there is no recent data on those to do any

project. There is no standard for cleanliness. 'RAJUK', the town planning department, has not yet decide whether or where to put waste bins and container inside the city. (DCC 1999).

Although placing waste bins on the street will create more issues. The improper use of bins, irregular cleaning are some of the issues. Moreover cleaning frequency is zero to slow level. That creates bad smell, flies and unhygienic condition. DCCs open trucks are collecting 43% of the waste. But the effectiveness of these trucks is very slow. (DCC 1999).

Insufficient financial resources

In most developing countries 20 to 40% of budget is used for municipalities, but DCC spend only 14 to 17%, which is very low. As a result the waste situation is getting worse day by day. (UNHSP 2010, 60-61).

According to United Nations Human Settlement program, "Inefficient management of existing manpower, equipment and other resources, unscientific and inefficient collection practices, inefficient management of landfill, Absence of by-laws and standards". (UNHSP 2010, 60-61).

Improper disposal

Improper disposal of waste is the most common issue in most of the developing countries in along with Bangladesh. Most of these countries in company with most African countries have no or a little management system. (Environmental pollution and impacts of public health no date).

Moreover, without any proper regulations the wastes are dispersed wide open in the environment. This then creates long term effective new diseases. Thesis diseases are sometimes hard to cure, and the wastes that are dispersed alone can be infectious, toxic and radioactive. (Environmental pollution and impacts of public health no date).

Transportation problem

There are lacks of transportation comparing to the area DCC has to cover. So, they cannot keep the city clean accordingly. The reason behind lack of transportation is fewer budgets in this sector. As the government has to look after other important sectors such as agriculture, education, and economy, much of the concentration goes to these less important sectors. Although there are some modern vehicles for waste collection but those are not enough. Moreover if the vehicles are inoperative, it takes long time to repair those for the lack of budget. (MMI 1999).

According to DCC (1999), it has 96 open truck (3 & 5 ton pay load) and 100 demountable container carrying vehicles now. Transport department of DCC fixes number of trips of vehicles and schedules. According to MMI (1999), studies show that 25-30% vehicles remained unused for technical problems. Thus lack of transportation means slow waste removal process, which eventually pollutes the environment.

Impact of waste on public health

Today, the city-dwellers seem to have accepted this worsening scenario as an ineluctable reality and become used to living with wastes and waste scattered all over the city. They have become accustomed to living with all the filth, slime and strong stench vitiating their urban habitat and being exposed to health hazards of all conceivable kinds. In most cases, the Waste is made up of perishable food items that rot and create a toxic atmosphere, releasing poisonous gases into the air that is already loaded with automobile and industrial emissions and has earned the dubious distinction of being the most polluted air in the whole world. (MMI 1999).

Waste or Solid waste management (SWM) refers to all activities pertaining to the control, collection, transportation, processing and disposal of waste in accordance with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations. Its scope includes all attendant administrative, financial, legal, planning and engineering functions. (MMI 1999).

Collection and transportation of waste

One important part of waste management is to collect the trashes from different collecting points, and to do the collection properly, there are different systematic ways. These ways of collecting are different in developed and developing countries. Even inside developed and developing countries, the collecting system can differ from region to region. (Municipal solid waste management 2011, 58).

In developing countries like Bangladesh, in general, door to door collection is the most popular. Door to door trash collection means to collect the trashes from every single apartment and every single building from a certain area. Cleaning Workers appointed by the authority to do the door to door collection. They then take the trashes away from the apartments or markets, or from other places in a vehicle mostly small sized for example van run by wheels. They take those trashes to a large place appointed by the authority and throw those trashes randomly. At this point, bigger vehicles like trucks come and collect the trashes and then

take to composting places and/or recycling places or to the landfills. (Municipal solid waste management 2011, 59).

The government itself previously did collection and transportation of wastes. But a lot of problem arises as the government cannot monitor the waste management properly. Afterwards the idea of private companies' involvement generated. It became more successful as there was the question of profitability involved. So, gradually more and more door to door services was given to the private companies. Every family from each apartment has to pay for the service. So the workers started to work seriously. But the mass collection was under the government authority, so it was much easier for the government to handle the mass trash only. (Municipal solid waste management 2011, 59).

The frequency of collecting the wastes is a very important issue. The trashes firstly collected and amassed in central places. But as the trashes are high in amount, so the trashes are kept mostly open under the open sky. The trashes have to be collected daily from homes and or from markets or other places. Collection from the central places takes place usually twice or thrice a day. Trashes are being collected from house or other places, mostly taken to the nearest trash stations. From there, by big trucks, those were taken to the landfills. In the landfills trashes are categorized by some poor workers, most of solid waste goes to the landfills, and some plastic bottles, iron, saline bag goes to recycling plants. (Earth friendly waste management 2009, 18).

7.1.3 Workorder

In Dhaka city corporation SWM is cleaning of drainage, cleaning roads, mosquito removal, clinical waste removal, sanitation activities, keeping of sanctuary clean, special cleaning while religious festivals, removal of dead animals. (Dhaka City Corporation 2014).

DCC is collecting municipal waste in Dhaka city by DCC's bins or containers. DCC has about 7146 cleaners who sweep the streets daily, and they also collect trashes by hand trolley from road side, and open spaces. DCC has 2080 hand trollies, 128 container carrier trucks. It also has 414 container and 242 open trucks to collect municipal waste. (Dhaka City Corporation 2014).

In most areas of Dhaka city door to door waste collection service is being organized by some private companies. Transferring wastes from houses to municipal containers have been done by three wheeler vans along with a driver and a waste collector. 50% of people are using house collection or door to door waste method, and the rest are throwing the waste into roads, drains, and open grounds. (MMI 1999).

In DCC region about 6000 tons of waste has been generated every day. Waste percentage of Dhaka city is domestic 46.8%, street sweeping 21.8%, commercial 19.2%, industrial 12.9% and clinical 0.5%. Collected wastes included 72.50% is food waste, 13.70% polythene, 5.53% of paper and cardboard, and 3.31% of plastic. (MMI 1999).

In the DCC area, about 0.60 kg of waste has been generated by per person per day. Currently DCC has no waste treatment and recycling plant. Poor people, who are living on the street they are collecting 10% of the total waste from different waste gathering points as those collecting points are open mostly. They are recycling those 10%. The rest 26% are being collected by the DCC employees, and thrown to the landfills. (Cities and Sustainable development 2003).

7.1.4 Waste management in private sector

For less job option, a large group of urban poor people of Dhaka City are gradually getting involved in the recovery of waste. Even though they live in such a poor condition that they cannot manage two full meals per day, but they play a vital role in reducing waste by collecting recyclable materials from mixed waste bins. There is 15% of the total solid waste generated to be managed in Dhaka City Corporation by the contribution of poor people who live in 4966 slum areas (Cities and Sustainable development 2003) (World Bank 2007).

On the other hand, about 80% organic waste ironically is managed with the potentials of converting it into economic resource such as compost/organic fertilizer which is collected by these poor people. In 1995, a Non-Government Organization (NGO) which is called 'Waste Concern', started in small-scale, community-based project to convert organic waste into organic fertilizer by using aerobic composting technique. This organization initiates a great job opportunity, and making a new business sector for the poor people in Dhaka urban area. (Cities and Sustainable development 2003).

In January 1996 'Waste Concern composting organization' got a small land which is donated by 'Lions Club' that is concerned about social welfare of Bangladesh. The land is used for composting and the area was only 1000 square meters. In initial stage Waste Concern deployed employees to collect organic waste from DCC and used aerobic composting technique to make organic fertilizer which is nitrogen rich organic manure, and helps for farming near to Dhaka city. This technique is based on waste reduction, separation, and finally making compost. At the same time, Waste Concern also collected some organic waste from the vegetable markets, and from door to door collection of neighboring community. (Cities and Sustainable development 2003), (Composting process and techniques no date).

Since 1996, Waste Concern is performing the composting project, and nowadays one project manager with other informal labors are working for producing the organic fertilizer and marketing it to near farming areas such as in Savar, Gazipur, and near to Mirpur area. This organization is working in Mirpur area, and they get easily poor labor over there because lots of slums are situated in Mirpur under Dhaka North City Corporation. Thus, about 200kg organic fertilizer is produced from one truck of collected solid waste, and more than three hundreds houses are included under the project. Under the project Waste Concern collects waste from house-to-house, and they use modified Rickshaws-vans. The waste is separated and sorted in the composting plant and turned into compost. (Cities and Sustainable development 2003).

Though, Waste Concern is working to make the clean environment by making organic compost from organic waste, so that they got support financially from UNDP and Ministry of Environment and Forest of Bangladesh Government. Therefore, UNDP requested to Waste Concern to replicate their project in five different communities of Dhaka city, and after their continuous advocacy and demonstration, the Dhaka City Corporation came to work with them by providing land for the project and they extended the project in different areas which helps to make clean Dhaka. (Cities and Sustainable development 2003). DCC conducts several projects and reports on Dhaka city time to time. Two of those are described in below case studies.

Below there are two case study examples described. The case studies describe about two different city areas in Dhaka city. The first case study was conducted in a city named Kalabagan, and the second one was conducted in Dhanmondi. The objective of the case study was to show the reader about steps taken to minimize waste in a systematic way. Some private initiatives were taken to make one kind of proper waste management.

Case study 1

Kalabagan is a densely populated and continuously growing area in Dhaka city. Dhaka City Corporation (DCC) was not able to put waste bins in the Kalabagan area for narrow lanes. The environment of the area was contaminated with improper waste littering, and it created bad smell and made the environment even worse. (Cities and Sustainable development 2004).

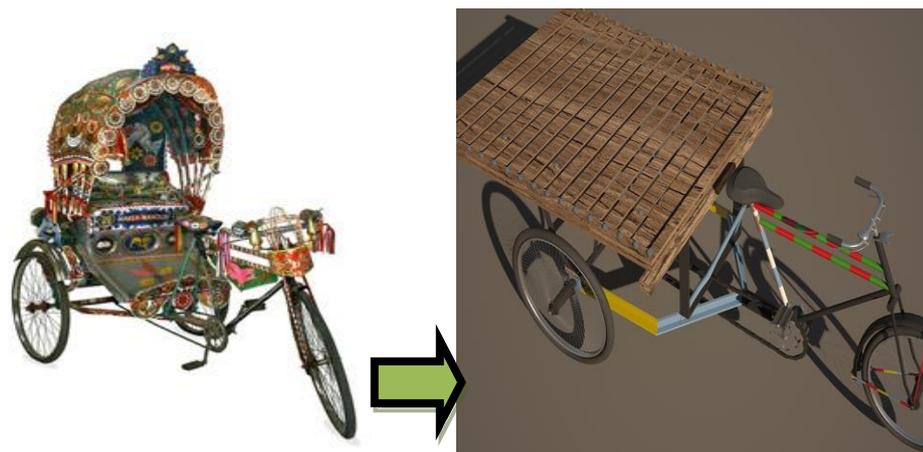


Figure 5: Three wheeler rickshaw transformed to van

Some private initiatives were taken to solve the littering issue. Famous local three wheeler rickshaws were transformed into a new vehicle called as vans. This van can carry a lot of trash altogether. Gradually they were used for collecting wastes from house to house and then transporting those to the DCC community bins. After few years Kalabagan area is cleaned as people expected. The experience of Kalabagan became famous and spread in some other cities as well. (Cities and Sustainable development 2003).

Case study 2

Dhanmondi, another densely populated area, was taken into consideration by DCC for waste treatment in 2002. A private project was planned to cover the whole Dhanmondi area. The main problems that were identified in the project were lack of awareness of waste disposal, at community level there is no awareness, throwing wastes into drains which caused blockage and overflows, roadside bins are often broken and insufficient. (Islam 2011, 19).

To overcome the barriers of clean Dhanmondi every household was provided with a red and a blue colored bin. People were told to separate the organic and non-organic trashes. In the evening DCC employees collect the trashes from the households separately and transport those to the community bins and afterwards to the dumping sites. The community points were looked after by the DCC employees so that scavengers and animals do not scatter the waste. From the dumping sites DCC collects the wastes and put in central dumping station. As a result of the project, now Dhanmondi is a clean area. (Islam 2011, 19).

7.1.5 Waste management process in Bangladesh

The waste management situation of Bangladesh can be well described by the following pictures.



The waste collection process starts with the waste collector going to the apartments in a specific area of the city. And then blows his blow whistle or shout out loud to let people know that its trash collecting time. Then people from the apartments either come and give the trashes or the waste collector went door to door to collect. And bring those altogether and put in the van (picture 1 & 2).



The collector vans bring and put the trashes in specified places shown in picture 3 and open spaces beside the road. From different parts of the city all the vans come and throw their trashes in that place.

Afterwards, heavier and bigger vehicles from the city corporation come to those designated places and collect the trashes from there. Those were then taken directly to the landfill as there are no recycling plants in Bangladesh. (picture 4)

7.1.6 Matuail landfill site

Landfills are place where wastes can be put in lot amount. And it is very expensive to make landfills. But still developed countries like USA, UK and other European countries are making landfills for their own sake as they are the most waste producing countries. Modern landfills are designed simply so that they can hold trash piled up high. Sanitary landfills need to get more importance. Sanitary landfills are made different layers. By digging down deep, at first, there is the first layer of thick mud that can prevent the leachate, to mix up with the ground water. Next there is plastic liner, layer of small rocks, geo-textile liner, gravel layer, sand layer, cell covers and cells of packed waste. (MMI 1999).



Rapid urbanization of Dhaka city and its fast increasing population over the last few decades have created much pressure on its urban services. Alam describes Dhaka City Corporation (DCC) is executing the solid waste disposal as its task. Matuail, located approximately 5 km southwest from the city center is one of the major landfill sites of DCC. Around 3656 tons of

waste is generated every day. 2208 tons of them are collected and dumped into the two dumping stations of DCC. (The Daily star 2009).

The leftover trashes are dumped into drains, rivers, canals, and in open spaces. The total area of the Matuail landfill site is about 40 hectares and a 15 years old open dump is situated on 20 hectares of the land adding that 20 more hectares of land have been developed for landfill in future. According to DCC, present landfill at Matuail operated by DCC was properly designed to protect the environment and the neighborhood from adverse impacts of landfill gas and leachate. (DCC 1999). Although there is no visible sign that the landfill is properly designed as the landfill is wide open and it makes real bad smell around the area.

Major sanitary landfill components introduced were leachate collection and gas venting system, surface drainage improvement, systematic operation of waste by daily coverage, slope reformation, working roads, weighbridge operation and vehicle washing facilities. But nowadays leachate quality deteriorates a lot and the present biological treatment option does not give satisfactory treatment result regarding residual chemical oxygen demand content. So improvement in leachate treatment process is required. (DCC 1999).

7.1.7 Results

After reviewing the overall situation of the waste management scenario of Bangladesh it can be said that the current situation is not acceptable at all. There has been lack of all on everything. The result can be discussed separately below.

First of all, the ultimate truth of overpopulation. Bangladesh is already an overpopulated country. More and more people coming to the city areas are making the situation worse. Due to the overflow of population it is hard to maintain a systematic way of proper waste management.

Secondly, Dhaka city is big enough for DCC alone to keep clean. As a result, DCC was divided into two parts named as Dhaka South and Dhaka North. Still, the areas are big enough for these two parts of DCC. As a result private initiatives come into force and they were bringing good results.

The problems related to waste management is vast. So, to solve all those problems is quite a tough situation yet for the government alone. There are no set rules and regulations for waste management by the government yet. So, people are littering trashes everywhere.

Moreover, lack of employees in DCC, lack of transportation, insufficient budget for waste management, lack of space to put trash, unplanned land filling all these problems altogether creating a mass of problems. And to get rid all of this, is a matter of plan, time and effort.

Although there are bundles of problems, there is still some hope as private sector companies and NGOs are doing their best to keep the environment clean. But as those are small companies, they cannot handle the overall situation. But still these companies are a ray of hope in the midst of sheer darkness.



Figure 6: Waste situation in Bangladesh

7.2 Waste Management in Finland

Finland is a Nordic country bordered with Sweden, Norway, Russia, and Estonia. The capital city is Helsinki. The area of the country is 338424 square kilometer with a population of 5474094 only comparing to Bangladesh. Only 1.4 million people are living in the greater Helsinki region area. So, as there is less population that is why it is still possible to keep the city clean. (Wikipedia 2014).

Waste management system in Finland is used to cover various steps from analyzing to consulting of after sales products and services. It includes steps like problem recognizing, problem solving etc. Next step is to measure plant, collecting and handling trash, collecting trucks. After plant setup, collecting, handling, recycling and disposal are handled by either private or by public companies. (Innovative Waste Management Products 2013, 5).

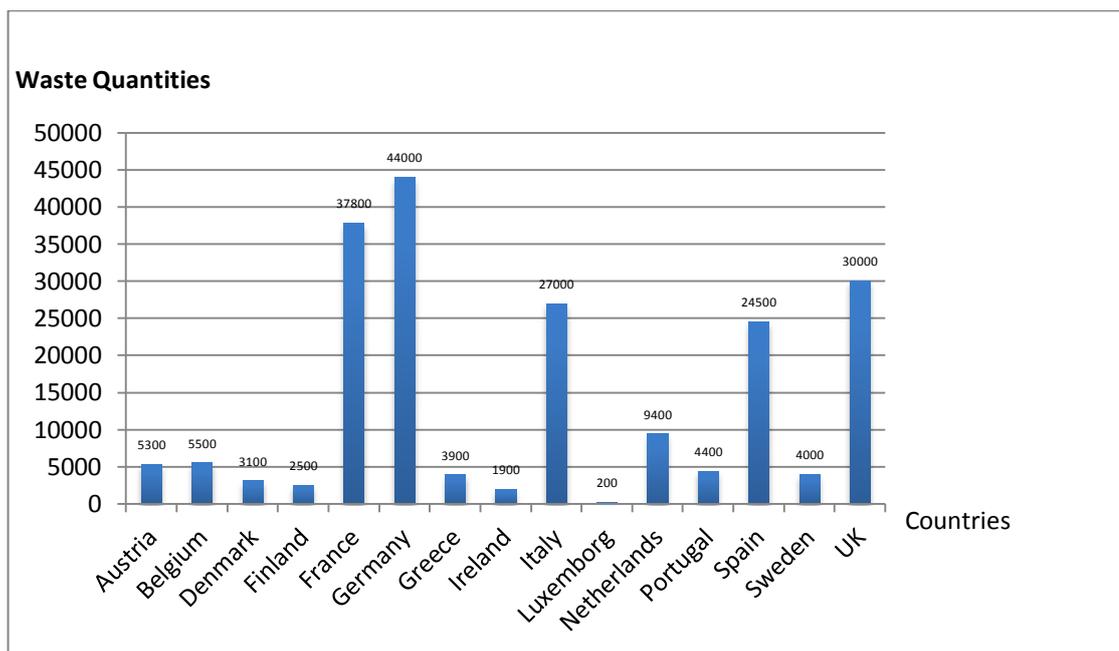


Figure 7: Waste quantities in European countries

Waste generation is based mostly upon the amount of population. The countries with more population create more waste. Therefore EU countries that are producing most wastes are Germany, France, the United Kingdom, Italy and Spain. All other countries in Europe are producing less than 10 million ton of waste per country per year. (Alwaeli 2014, 6).

Finland introduced its first waste legislation in the year 1978. The legislation included waste separation, hazardous waste handling, etc. The legislation was being updated in 1994 and latest in 2012. Finnish waste legislation follows the EU standard properly and in some cases the legislation is harder than EU legislation. (EKOKEM No date)

7.2.1 Waste prevention

According to Christoph Genter, “Waste prevention means to avoid or minimize the production of waste, and is a more favorable solution than waste treatment”. (Innovative waste management products 2013, 17). In USA, in most communities, people pay a set amount of money for trashes. When people have more trash they have to pay more money to collect the trashes by collecting authority. For this reason, people try to make less waste. The less they throw away, the lower the trash bill. (Earth Friendly Waste Management 2009, 18).

Another way of preventing waste is by using biodegradable materials. Biodegradable material is easy to make compost. These materials are mostly made of natural materials. So, the use

of more biodegradable materials can make a big change. By measuring this type of materials from before, it is easy for the cleaning companies to put them in composting section. More use of biodegradable materials can solve waste problem a lot, according to the experts and material suppliers. (Innovative waste management products 2013, 17).

7.2.2 Bio-waste composting in Europe

In Europe, bio-waste composting includes wet waste, mixed solid waste, wastewater sludge and human fecal matter, manure and animal wastes. Wet waste was collected directly from the kitchen in 1970's. But it was given up as bio-waste system thrives. Mixed solid waste contains a lot of mixed waste. Chemical and plastic are to be separated as mixed waste comes from industrial and household wastes. But mixed waste system was not popular as it cannot make marketable recyclables. The final destination for mixed wastes is landfill. (Municipal solid waste management 2011, 88).

Waste water sludge, and human fecal matter are high nitrogen materials that can be composted under certain conditions. Either these can be mixed with chopped wood or paper which are dry. Sludge can be dried to make good fertilizer. Mostly the sludge and human fecal matters include metal and contaminants that creates problem to market the contaminated compost. Special attention has to be paid to these waste plants. Manures and animal wastes are best to compost. Manures are high in nitrogen so it makes very good fertilizer for the agriculture. (Municipal solid waste management 2011, 88).

7.2.3 Finland recycling

Finland is one of the leading countries in the world which is circulating, reusing, and recycling waste at a large scale. Palpa, a company, is responsible for recycling glass bottles, plastic bottles and beverage cans. According to Palpa, 90% of beverage cans, 90% of plastic bottles, and almost 100% glass bottles have been recycled. (Palpa 2014).

According to Finnfacts (2015), Finland tops in the list of bottle recycling countries. One bottle is used for an average of 33 times which saves 33 times of money and new material. Around 6.6 million bottles have been returned each week. The ways bottles are refunded are called deposit-refund system. When a customer buys a product, they have to pay 10-40 cents for the bottle. After using if they return the bottle in reverse vending machine, they can get the money back. One interesting fact is that, the amount of cans that were recycled in 2012 can cover the earth more than three times if the line goes straight. (Finnfacts 2015).

Finland also ranked top at paper recycling. The recycling rate is 93% overall which is very praiseworthy. Although used paper has been collecting is century old process, whereas in some countries it is still a new idea and to some it's far away. Clear information about paper has been provided in infopankki's website. The sorting instruction is also put in everywhere that makes it easier even for a new comer in Finland. (Infopankki no date).

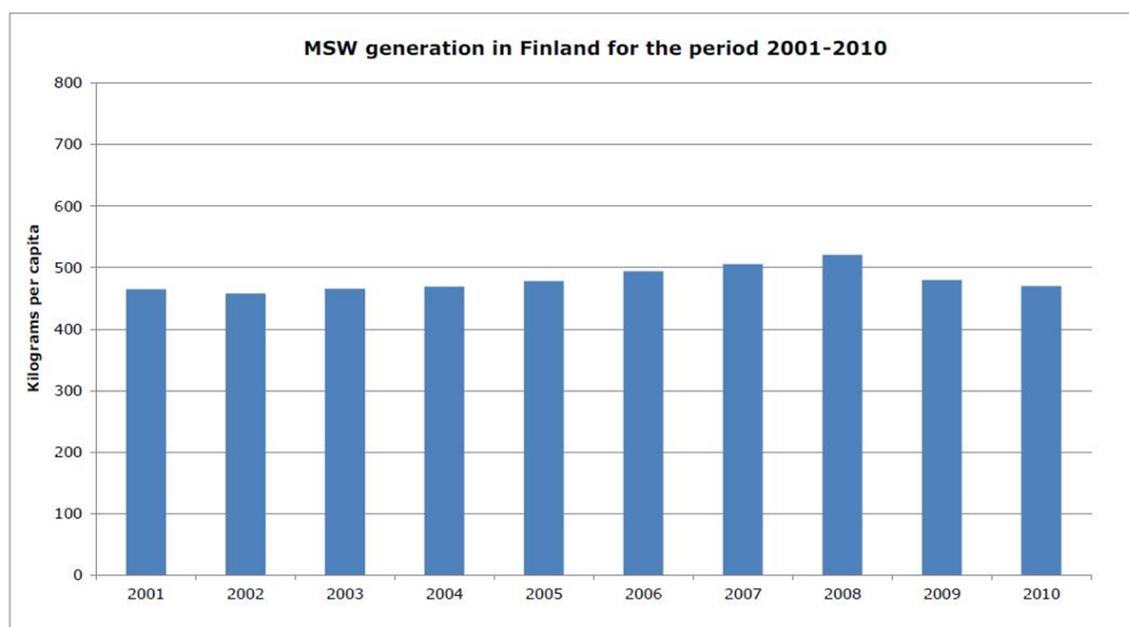


Figure 8: Increasing amount of MSW in Finland (EEA 2010)

From the above figure, we can see that the amount of MSW in Finland is increasing at a slow pace. Municipal solid waste amounted 2.6 million tons, which is 4% of total amount of trash generated in Finland. The recovery rate of MSW increased to 47% compared to an earlier rate of 34%. Overall 40% of the total waste is recovered. (EEA 2010).

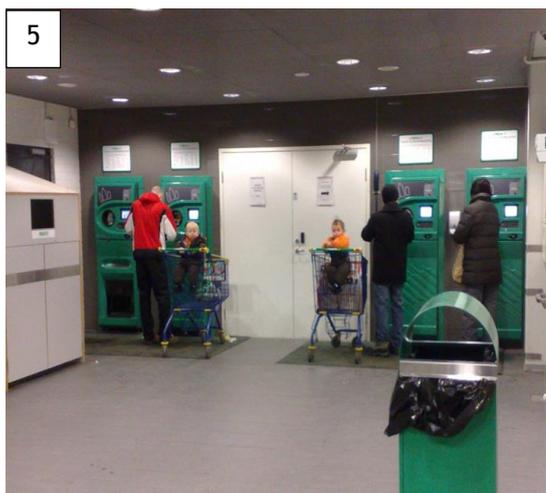
7.2.4 Waste management process in Finland



Waste management process in Finland starts with separating the trashes. First of all people separated the trashes from the house and throw those in separate boxes in the designated place. (Picture 1). The most common boxes for different trashes are the blue box is for paper, the black or grey boxes are for mixed waste, the brown box is for cartons and so on. The color may vary from place to place. So, there is mentioning of names as paper, carton, mixed waste in the boxes as well. It becomes easier even for a newcomer as well.



From picture 4 we can see that when people put the trashes in different boxes then it is easier for the collectors as well. The collectors always come with the modern and expensive vehicles and collect the trashes separately. Newspaper was always taken separately as newspaper is the most recycled product in Finland.



Recycle not always begins after collecting. From picture 5 we can see that bottle; another important waste creator was recycled after consuming at the very beginning. Thus it is not harming the environment. Finland is the topmost recycler of bottles. Reusing is another important factor of waste management. Reusing used products can save money and save the environment by producing fewer products.



Afterwards the mixed waste was transported to the recycle center where the valuable products was separated and collects through a cycling process. Metal, paper and glass was separated and collected for reuse.

In the end the remainder wastes was send to the landfill. In Finland, Ämmässuo landfill in Espoo is the biggest landfill in Nordic countries with 50 hectare of land. The landfill is conducted by HSY. Gas is being produced in the landfill. Heat is also produced there by burning mixed waste. (HSY no date)

7.2.5 Results

From the study regarding Finland's waste management system it can be said that it has already implemented a proper waste management system. The country has a history of proper waste management. Although in the beginning the situation is not like present situation. According to Mirva Vaisanen, it took ages for the government to raise awareness amongst people about proper waste management. (Vaisanen 2014. Personal Communication.)

Leaflets, brochure, advertising all these and most importantly time, raises awareness among people. Generation after generations became used to separate trashes at home and throws to the bin or boxes accordingly. Eventually time and self-consciousness makes people to make a successful waste system. (Vaisanen 2014. Personal Communication.)



Figure 9: Finland waste separation

From figure 9 it can be seen that there are different colored waste boxes. The green box is for all kinds of paper, the grey or the black one is for mixed waste, one box for cartons, and one box for bio waste. The box color can be variable but the name paper, bio waste, mixed waste is also mentioned in the box so that even a newcomer can even easily understand the waste separation process.

7.3 Comparative study: Bangladesh and Finland

Topic	Bangladesh	Finland
Population growth rate	Every year Dhaka's population is rising by 6% while the volume of Waste is increasing by 1.2%. But there is no full-fledged policy on Waste management. The National policy for Water Supply and Sanitation 1998 and DCC website also has a few lines on waste management.	Whereas Finland has a 0.5% of population increase and they are also reducing waste in the beginning. Finland also has a proper policy and legislation and the legislation is being properly followed.
Waste treatment	About 13.5% of the total Waste or solid waste is informally recycled, about 43% is dumped illegally and the remaining 43% is handled by DCC. DCC is paying to four private companies that are managing waste of different parts of Dhaka city.	In Finland, 40% of the total waste was recovered.
Systematic and sustainable waste management programs	Bangladesh has no visible systematic and sustainable waste management programs yet.	Finland has a lot more systematic and sustainable waste management programs.
Organizations for waste management	NGOs are playing important role in waste management. But there is very few of those effective in Bangladesh.	In Finland, L&T, SOL, ISS and other big cleaning companies are playing the most important role in waste management.
Composting	There is only one small composting plant in Dhaka city. But composting plants are more important for Bangladesh.	Although Finland has a very less scope of composting, still HSY is doing the composting.
Marketing compost	Initially, marketing of compost will be a major problem. Press can play a positive role for marketing waste.	Finland has a very small need of compost using. Therefore there is not much visibility of compost marketing.
Awareness among people about trash	Bangladesh people are not aware about the impact of waste dumping.	Finnish people are willingly doing this for quite some time in Finland.

Table 4: Comparison between Bangladesh and Finland

8 Solutions for Bangladesh

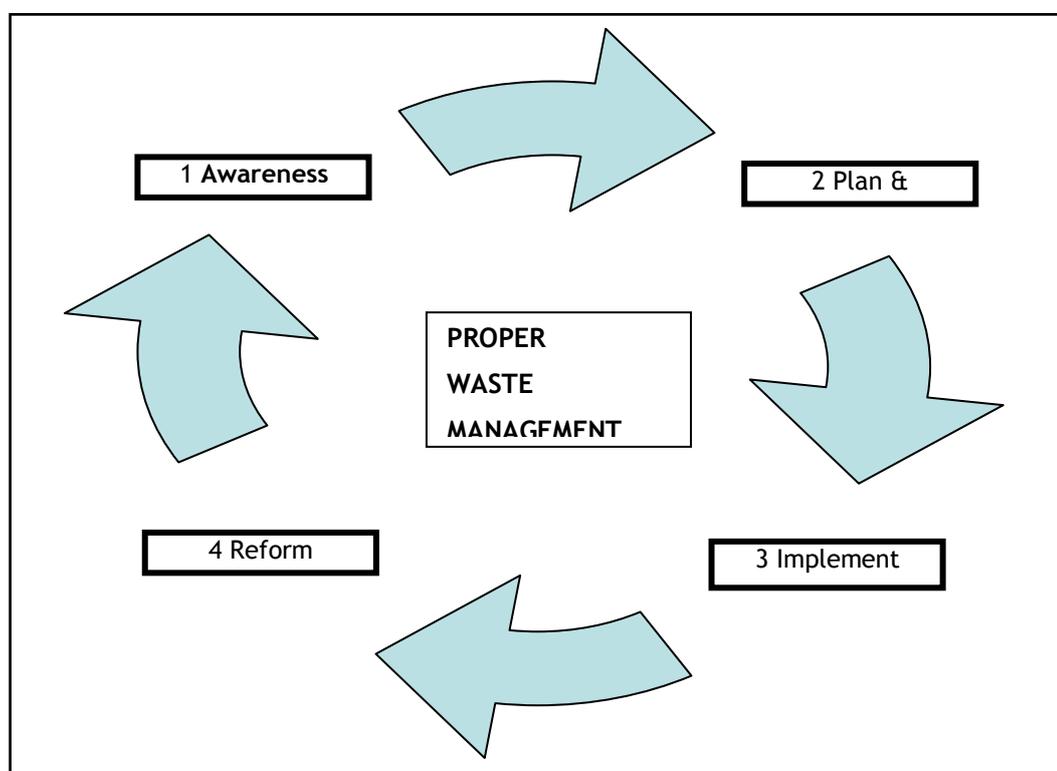


Figure 10: Proper Waste management system (Proposed idea)

After considering all the issues, the most important part at this point that came in front, is the lack of awareness amongst people. People throw trashes on the street, outside from the window, and everywhere, but not on the designated places. So, the first and foremost challenge is to make people aware of what they should do. The brochure that is being followed in Finland can be a perfect example as a starter for Bangladesh people to separate trash from home. (Appendix 2).

Making awareness among people is the fact that they should separate the trashes from their home. If they separate the trashes in the beginning, then it will be much easier for the next steps to be taken. According to Mirva Vaisanen, the environmentalist in L&T, the most important and hardest one is to make people aware. It may take ages. Eventually now people knows how to separate trashes in Finland. And thus the system of Finland becomes fruitful.

The most important challenge for Bangladesh also is to make people aware about waste separation. Although it will take long time but eventually people become aware about these issues. As budget is a big problem for the city corporations, they can make or implement cheap

and easy way for waste separation in the beginning. To show the result of cheap solution, we tried putting small plastic buckets in a school as an experiment. And we found out that it is not expensive and the children over there understood the topic of throwing wastes in separate boxes. If we can put small buckets like that in each and every class room, then the pupils became aware of that. If we do not provide them with solutions, they cannot understand what they have to do.

DCC, with the help of the government can put pressure on households, schools, colleges and universities to put cheap buckets everywhere in the premises. Government can provide funding for the initial implementation. But housing or school authorities have to take initiative as well and continue the good effort until the final goal is reached. Same can be done in households. By selecting areas in each month or each year, DCC can try to implement the above mentioned process.

According to DCC ordinance (1983), rule 83 "Subject to the provisions of this Ordinance and the rules, the Corporation may, and if the Government so directs shall, take such measures for promoting public health, including education in health, as it considers necessary or, as the case may be, the Government directs".

Advertising through publicly announcing, making billboards, TV channels and social media can play an important role in this sector. Social media for example Facebook comes in the beginning. And to make people aware about waste separation, we made a Facebook page where we are constantly putting new pictures, videos, and other documents to let people know of what they should do for separating waste. The more advertising, the more people know. If we can advertise a hundred times, people have to listen once. Then the success story will begin.

8.1 3Rs (Reduce-Reuse-Recycle)

Waste hierarchy is a term accepted by most of the world's countries because this hierarchy is proven to be best. Waste reusing is better than recycling. Likewise reducing is better than reusing. Consume less in the first phase of product is the best practice for waste management. Waste reduction or minimization is the most important part of 3Rs named as reduce, reuse and recycle. Consumers can buy a lot of items altogether to make less waste. Moreover they can choose product that has less packaging and also buy products that can be reused. Thus, in the beginning making less waste saves energy, money and effort. (Chandler No date).

Wieman (no date) says, "Reuse refers to several things. It can mean investing in items that can be reused". A lot of product can be reused. Glass, jars, pots, bottles, wood, clothing, shoes, household items, furniture all can be reused. Reusing is the second most important

factor after reducing usage. "Finding creative ways to turn a used product into a new item of equal or greater value is sometimes called upcycling. Examples of upcycling include turning bottle caps into magnets or using old T-shirts to make a quilt." (Wood 2015).

The final step of waste journey is recycling. United States is the first country to set rules and made laws for waste. The congress of USA passed the first national solid waste law in 1965. In 1970 the congress made laws to encourage recycling. There were different types of booths to return bottles, cans, plastic bottles etc. (Earth friendly waste management 2009, 16).

Recycling is best defined in Mohamed Alwaeli's book Waste and waste management as "the process of collecting certain materials that would otherwise be considered waste - like old metal, paper, wood, or plastic for example and turning them into new reusable products. (30). Recycle process includes four steps, named as collecting, sorting, manufacturing and purchasing of wastes. After collecting the recyclable products from different places in the communities, those are sorted in the facility centers. Afterwards those were cleaned and separated for reuse. In the sorting plant bottles, papers and other wastes becomes separated for recycling.

According to Waste Management and Research Center, there are several steps to take for re-using and recycling construction and demolition waste. Those are planning, identifying materials, develop recycling plan, educate and train personnel, documentation and making adjustments. (Waste Management and Research Center No date).

Advantage of 3Rs

Nowadays more and more products, packaging, are made from recycled products. Even the recycled products can be recycled again. Newspaper, paper, towels, plastic bottles, are all made of recycled objects. Recycling helps to reduce pollution by using the same products again and again. Less new products production means less energy use, instead of the recyclables. We are saving Natural resources like fossil fuel as we are using the recyclables. (Alwaeli 2014, 56).

Recyclables also saves energy a lot, as the readymade products are reusing. To produce a new product, more and more energy needed. But with less energy new products can be produced if used for large scale. As an example, a paper mill uses less than 40% energy than producing new newspapers. More over recycled products costs less money than raw, new product materials. (Alwaeli 2014, 58-59).

Paper, cardboard, plastic, metal, glass and organic materials are good example as recyclable products. (Waste stream 2007, European communities 2003).

8.1.1 Paper

Industrialization is creating forests to disappear from the earth. Also a lot of countries are lacking forests around the globe. Best solution for forest saving is paper recycling. Papers that are recyclable are office white paper, newspaper, magazine, telephone directories, cardboard boxes and cartons, mixed or colored paper, and computer printout papers. (Waste on line 2006).

The reprocessing of paper depends on several issues. One is collected paper and the other is end use. If the collected papers quality is low then those can be used for making new low quality papers such as packaging. Newspapers reuse needs de-inking and then new print again. The overall paper recycling process includes collecting, sorting, grading and pulping of the papers. The pulp is then screened to remove contamination, cleaned, and de-inked through a number of processes until it is suitable for papermaking. Household papers are counted as mixed waste and can be used only for low grade board papers and industrial paper towels. (Alwaeli 2014, 34).

Every tons of paper recycled saves 2.5 barrels of oil, 4100 kWh of electricity, 4 cubic meters of landfill, and 31780 liters of water. Every year around 3.5 million tons of paper and cardboard is used in Australia is enough to fill 160000 large semi-trailers. Almost 90% of waste paper recycled in Australia is used to make packaging and industrial paper. Recycling 1 ton of paper and cardboard saves 13 trees. It takes 2.5 tons of radiate pine to make one ton of newsprint. 17 trees can absorb the carbon dioxide emitted from one car each year, trapping the carbon in the wood and releasing the oxygen back into our atmosphere. (Alwaeli 2014, 36).

8.1.2 Metal

Iron and steel are the world's most recycled and easiest material to reprocess, because, those can be separated magnetically in the sorting plant. By recycling, scrap metal is re-melted in electric furnace to make new top quality steel. Due to high price and good infrastructure, aluminium, another metal, is also most efficient and widely recycled material. Aluminium has been recycled since the beginning of aluminium and one third of aluminium in today's world is recycled aluminium. (Alwaeli 2014, 38).

Aluminium, shredded and grounded in the recycling process into small pieces, is a fairly cheaper process than processing new aluminium. Recycling aluminium saves 95% of energy cost. The reason is, while mined aluminium needs 900 degree Celsius, whereas recycled aluminium needs 600 degree Celsius to melt. Thus significant amount of energy saves by recycling process. Most metals are recycled by melting to scrap metal. (Alwaeli 2014, 38).

Household metals included all kinds of bottled food cans, drink cans, and other metals from different tins. The amount of household metal is estimated 5 to 10 percent of total recycled metal. The recycling level in EU is 6 to 14 kg per capita. The recycling process of metal reduces 76% of water pollution. (Alwaeli 2014, 38).

8.1.3 Plastic

Use of plastics increased ever since it has been created. And it is growing day by day because of its easy and wide range of usability. It has low cost with light weight. It is best for making convenient packaging. But plastic is the worst of all the recyclables. It cannot be re-melted or re-moulded. And thus cannot be recycled. (Alwaeli 2014, 41).

Plastic recycling needs greater processing which increased the cost of recycle process. By using electromagnets metal can be separated but there is no technology for separating plastics. Although energy can be created by burning plastics, but that causes air pollution as well. So, the best solution for plastics should be to produce less plastic and use less plastic. (Alwaeli 2014, 41).

8.1.4 Glass

Glass components come from bottles, broken glasses, light bulbs and other glass items. Glass recycling is the process of making usable products from the wasted bottles. It also saves energy as it takes very low temperature to melt glasses. Moreover producing new glasses consumes more energy than recycling. (Alwaeli 2014, 57).

Although, glasses can be colored, and colored glasses are hard to reuse as colors vary from glass to glass. So, matching same colored glasses can be mixed together to reuse. Also color glass cannot be mixed with white or plain glass. And there is no automatic method of collecting different colored glasses separately. So, colored glasses should be collected separately in the beginning in recycling centers. (Alwaeli, 2014, 43) one best benefit for glass reuse is that it does not produce any CO₂ during the burning process which plastic does a lot. It also uses less amount of fuel. (Glass recycling information sheet 2006).

8.1.5 Waste electrical and electronics equipment

Electric and electronic equipment using is increasing very rapidly all around the world at present and it will increase much more in near future. So, WEEE is a much concern topic now. WEEE includes mobile phones, computer systems and all kinds of home based items. (European Commission 2014).

Recycling WEEE includes reusing the valuable components as well as treating the hazardous wastes properly. In EU electro scrap is the fastest growing waste which is three times faster than average wastes. About 90% of this waste is landfilled. (Alwaeli 2014).

8.2 Composting

According to United States Composting Council, compost is “the product resulting from the controlled biological composition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth”. (The United States Composting Council 2008).

One fourth of all trash around the world is food scraps and yard waste. Another one third is paper and cardboard. Composting could save a lot of space out of the waste. (Earth friendly waste management 2009, 48). Compostable materials are piled up together in bin with the right amount of air and moisture. Bacteria starts to grow which causes the pile to start dwindling, fungi and insects join the pace. Eventually the compost turns into black which takes up to one year to process. (Earth friendly waste management 2009, 49).

Compost can be used in field as fertilizer. It is an excellent replacement of chemical fertilizer. The compost is good supplement for trees, plants, and in gardens. Knowing about the composting process needs some expertise. Compost can be made outside the yard. It can also be made in specific places where people can make compost and collect from there later for their plants. Compost works as soil conditioner, recycles household waste, reduces landfill space and most importantly it is best for the environment. (Eartheasy 2014).

8.3 Integrated solid waste management

Integrated solid waste management (ISWM) is “A framework of developing a sustainable municipal solid waste management system, which has been very successful in various industrialized countries.” ISWM is an essential part of developing countries waste management as solid waste management services are of poor quality and the costs are also higher. Integrated Solid waste management is a mixture of proper technologies, techniques, and management pro-

grams with technical, social, cultural, economic, and environmental aspects. (Municipal solid waste management 2011, 397).

The elements of ISWM are namely waste generation, source generation, collection and transportation of waste, recycling, resource, recovery, existing disposal system and upgradation, and people's participation. (Municipal solid waste management 2011, 398).

Waste to energy (WTE) is the term used by a lot of middle east countries like Kuwait, Qatar, Jordan, Saudi Arabia, Iran, Iraq, Oman, Bahrain and other countries. (The Qatar projects 2014). Sherien Elagroudy, executive director at the Egypt Solid Waste Management Centre of Excellence says, "WTE is an essential component of an overall waste management system because of its ability to divert waste away from landfill," (Waste management raises the agenda 2014).

As shown in figure 5, after collecting waste, those were transferred to waste treatment facility. The wastes then burnt in or over 2500°F to make sure there is no pollution. Steam was produced. Later, steam was converted to energy.



Figure 11: Waste to energy process (ASME No date)

As shown on the Fox news (2014), the municipal solid wastes land filled in 2011 could generate enough electricity to power nearly 14 million homes. (American chemistry council 2014). According to Steve Russel, Vice President of American Chemistry Council, there is couple of ways to turn waste into energy, waste to electricity and plastic to diesel fuel. Plastic to fuel technology is the newest technology that has more potential than waste to electricity. However waste to energy technology is environmentally preferable.

In city climate leadership awards (2013-2014), the challenges, actions and projected outcomes of integrated solid waste management of Dhaka city was described. In 2005, less than half of the waste was collected because of improper waste plan and waste treatment. The integrated actions that were taken by DCC were waste reduction, waste collection and waste disposal. The master plan of DCC to make a cleaner Dhaka is based on small initiatives taken in different small areas. DCC hopes to collect at least 68% of wastes from Dhaka city in near future. (City climate leadership awards 2014).

Familiarizing Universal recycling symbol



Gary Anderson, 23 who was a college student created the design of universal sign of recycling. In 1970 a cardboard recycling company arranged a competition to make the logo of recycling. (Earth friendly waste management 2009, 44). The logo was designed to create awareness among school and college going students. The triangle in the logo means reduce, reuse and recycle. (All recycling facts 2014).

Universal recycle symbol is well known worldwide. But in Bangladesh the symbol is not much familiar to people. The sign is vastly used in a lot of products in Bangladesh. Lack of knowledge amongst people is the reason that people don't know about the sign. To make the symbol famous through advertisements and by letting mass people know that wherever this sign comes, that means, that exact product, packaging, and other product can be recycled. This symbol is very important for recycling. (All recycling facts 2014).

Safety management

Safety management means following safety rules and regulations in compost plants, in waste handling, in dumping stations etc. In Recycling centers there are always scope of contamination. Safety issues include wearing safety boots, safety helmets, earplug, proper clothing, hand gloves, and glasses if needed. Moreover knowing fire control plan, health and safety in emergency cases, use of first aid kit, vaccination, and emergency incident record are also included in safety management. Following the safety rules strictly is a must. Thus contamination will not spread around the working area. And the working environment will be safe and sound. (Medical waste collection, treatment and disposal A11).

In Asian countries like Bangladesh, it is a trend not to follow the safety rules and regulations of proper waste management. Mostly, people tend to find a shortcut on everything and thus not follow the regulations accordingly. It should be made clear that safety rules and regulations should be followed by all employees according to the laws at all times.

9 Recommendations

Local government of Bangladesh has to find appropriate ways to determine the existing recycle situation, regulation, and technical issues, and making appropriate legislation with giving power to authority to give penalty on making environmental pollution by the dwellers. Afterwards, they can follow the success stories of waste management from other countries.

In this study, the researchers followed the Finnish waste management system, and they wanted to implement that in Bangladesh. Awareness campaign for the mass population to understand the importance of waste separation is the most important part. Moreover providing door to door services at the beginning can be helpful, but it could be stopped day by day. Creating a waste recycle center is another option.

Educating and training program for the people to make professional to use special machines. Government has to subsidize campaigns and programs and awareness advertisements.

Setting mission, vision and strategy, and making plan for specific years, for example, 2015-2020, and trying to achieve “raising awareness” by the time frame. Therefore, following ideal plan for waste management, and disseminate among small communities.

Reviewing the plan by higher authority (BUET, Local authority, Government), and putting down the plan in words/documents to make amendment. There could be a specific place/space in each community for waste store.

In every division, making a recycle point, and making a waste sorting manual (Appendix no.2) for public use, and deliver freely amongst the mass population. Putting the brochure everywhere for example in bus station, train station, and other public places is also another way of making people aware.

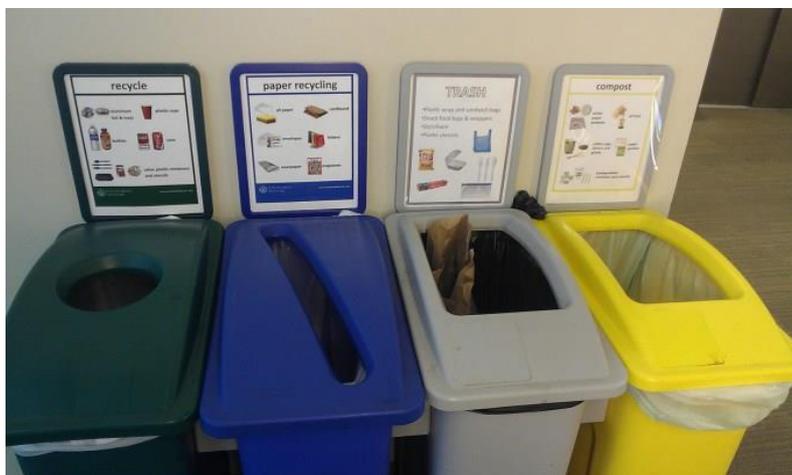


Figure 12: Proposed waste system for Bangladesh

Putting Information in Facebook page; to help people see videos related to keep environment clean and more general information regarding solid waste management. To destroy the final mixed waste, government should make land filling sites at remote areas.

According to the research, in Bangladesh the proper waste management processes could be implemented like Finnish waste management processes such as-

- Waste sorting should be done from the kitchen/ houses/ source places by the users/inhabitants.
- Collecting waste separately from houses/ door to door and putting them separately in the van.
- Making specific and dumping points in the community for the vans to put the trashes
- The vans will bring and put the trashes separately in their designated boxes with proper labeling for example paper, mixed waste, bio waste etc. (Information regarding categories of waste is in Appendix 2).
- City Corporation has to collect the trashes separately as well from the designated places.
- It's the city corporation's duty to reach the trashes to the recycle center.
- City Corporation has to reach the bio waste, newspaper, mixed waste and other trashes to the integrated waste management plant.
- Making electricity from integrated waste management plant to add to national grid of electricity to lessen load shedding problem.
- Establishing entrepreneurship through recycling and introducing new job sectors for the people, because unemployment issue is another vital burden for the Government
- Making large scale bio waste to bio-fertilizer Company because most of the waste in Bangladesh is bio waste.
- Try to landfill trashes as less as possible.

10 Conclusion

Solid Waste Management is a vital issue for the developing countries like Bangladesh. Especially, effective solid waste management in Dhaka city in Bangladesh is significantly important in order to develop living standard, and as well as safe lives. The capital city of Bangladesh is one of the polluted cities in the world according to an UNFPA - the United Nation Population Fund, so it is time demanding concern that authority should have to follow an ideal method to overcome the situation and make a better living environment for the people of Dhaka.

According to the thesis aims, encouraging fruitful practices of integrated sustainable solid waste management in Dhaka city by adopting effective Finnish waste management system. Adaptation of Finnish waste management system could help to make a working framework that will be suitable to Bangladesh, and environmental, social, and economical outcome to be achieved.

On the other hand it is unbelievable that in 2012, waste generation in Bangladesh is around 22.4 million tons per year or 150 kg per year. Additionally, it has been estimated that the waste generation will be increased dramatically within next decade and it could be 47, 064 tons per day. So, it is assumed very clearly that without proper waste management the whole country could be declared as a worst country for living being. But, by following EU (Finland, Sweden, Norway, Denmark, Germany, and UK) waste management system, Bangladesh can make electricity, and recyclable materials for production sectors. It is praise worthy that Bangladesh can eradicate the load shedding by generating power from their abundant unmanaged waste.

Household waste sorting, disposal, and collection system is one of the biggest challenges in Bangladesh. After 1990s, urbanization and industrialization has led to proportional addition of solid waste with existing produced waste in Dhaka city of Bangladesh. There are some people who have negative attitude toward making pleasant living environment is affecting waste management, and careless, lack of awareness of people also could affect on handling waste, and causing lot of diseases and leading to surprising death.

It is scientifically estimated that in 2050 the southern part of Bangladesh could be submerged under water due to environmental pollution. So, Bangladesh government has to take immediate initiative for waste management if Bangladesh could stay in the world map without losing their existence.

Making people aware on waste management like Finnish people, and educating on it following Finnish children who are getting lessons at primary and secondary school is also vital issue for Bangladesh Government. During thesis work researchers were took part to introduce making awareness among students of primary school in Khulna City of Bangladesh as a sample demonstration. So, authority all over the country can adopt the technique to introduce a lesson at primary stage like Finnish Government.

Nowadays, world is working based on technologies, so Bangladesh government take advantages of technologies such as Facebook, twitter, YouTube, and other social medias to make awareness among the people like thesis writers created Facebook page regarding waste management during research work as a sample. To get fruitful result on it, political stability and interest on waste management is another great issue in Bangladesh.

Effective policy making on waste management is key important. In Dhaka City Corporation there is waste management act, but it is not as effective as necessary. Thus, fair governance on waste management is another challenge to make sustainable clean environment in Bangladesh. In Dhaka there are separate industrial act, but it has to be revised according modern era.

Decentralization of industries, government offices, hospital facilities, and involvement of general people in decision making will also help in handling solid waste management. Integrated and sustainable waste management is another main issue to keep the Dhaka city as beauty as required.

At the end of the thesis work, it is mentionable that Bangladesh can learn, adapt, and follow the developed country's rules, regulations, techniques, technologies, expertise, and their experiences to manage solid waste. In developed countries they do not waste their waste; they make business by using this, and recycle it, and generate power to lighten the darkness of a nation, for example Sweden, Finland, and Germany. As a whole, political attention and cooperation among citizens, and Government and all stakeholders should come together to resolve the waste issue once and for all.

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Appendices

Appendix 1

Interview 1

Mirva Vaisanen, Environment Management Specialist, Environmental Services, L&T.

Question - What are the stages for waste travel (from household to apartment)?

Answer - Very small amount goes to landfills. Collection of wastes is done from the particular point near to the apartments. At first all dwellers leave all wastes separately in different colored boxes or containers. So, it's easy to differentiate the waste to reuse and recycle. The color is the instruction for people to understand which color is for what waste. Sorting instructions will be in the boxes/containers. There can be 20 to 30 apartments in one selected area. And one box for each waste type in each point.

Waste truck or vans can come and collect waste from the collecting point/ from the apartments. L&T has own recycling points. The trashes go to the L&T recycling center.

Paper goes to paper industry. Paper industries are buying the papers from L&T. Reusing to make new newspapers. And by selling the newspapers to them L&T is making profit.

Bio-waste goes to other industries or companies to make compost. L&T has to pay other companies for it because it has a very low price in Finland.

By doing Decomposition/De-composting, we can get methane/ energy and electricity.

The last stage is land filling. In landfills, the wastes were put or burnt which needs a lot of space and we cannot get anything from the landfills.

Question: Who are doing the composting?

Answer: In Finland, HSY is the company which is looking after the waste issues in greater Helsinki are that is Helsinki, Espoo and Vantaa. HSY is a government assisted organization.

Bio-waste can be used in two ways, composting and de-composting. Mixed waste can be sent to incineration for burning.

Question: What are the rules for waste management in Finland?

Answer: There are specific rules for waste management in Finland. And people have to follow the rules accordingly. Waste management rules have been studying in Kindergarten from the beginning. So, little pupils learn about sorting and managing waste from their childhood.

Finland has a story of recycling for decades. Paper industries are recycling the newspapers from long before.

Sorting waste from mixed waste is quite hard and expensive. So, it is not recommended. There can be a 10 year plan for implementing waste system.

Question: Does L&T get any money from city or government?

Answer: City Corporation doesn't support companies by itself but government does. HSY plans and deal with companies. They make deals or contracts with companies. Cleaning companies like L&T gets the contract of cleaning from HSY.

Question: Does household pay?

Answer: Yes, they pay for waste bin, transporting and handling of waste.

EKOKEM has incineration process. They also handle hazardous wastes.

Vantaan energiaa also produce energy and heat from waste.

Interview 2

Amir Asraf (Program officer), Abdul Hamid (Worker), Rabiul Islam (Worker), and Jilani Mollik (worker), Prodipan, Bangladesh.

Question - What are the stages for waste travel (from household to apartment)?

Answer - All waste goes to landfills. Waste collection worker goes door to door to collect the waste into the waste collecting van (three wheels), and discard the waste on the street into the open container. Basically, no one sorts the waste. So, all mixed wastes are collected together.

City Corporation takes away the waste container from the street, and dump in the landfill area (Rajbando Landfill, Khulna) in the open air behind the high way which creates very bad smell in the surrounding areas.

Two poor women collect plastic bottles, saline bags, syringe from the landfill area, and sell for recycling. But, the sorting process from the landfill is quite difficult according to the sorting worker's statement.

Rajtik, one bio fertilizer making organization collect bio waste from landfill area, they make bio fertilizer, but small scale bio fertilizer production does not help to protect environmental pollution.

Question: Who are doing the composting?

Answer: Rajtik, one bio fertilizer making organization collect bio waste from landfill area, they make bio fertilizer, but small scale bio fertilizer production does not help to protect environmental pollution.

Question: What are the rules for waste management in Bangladesh?

Answer: In the city corporation area there has no specific rules regulation about sorting, and removal the waste. Basically, most of the dwellers discard the mixed waste on the street, or into the swage drain, but the authority does not take any action against them.

Question: Does Prodipan get any money for the waste collection?

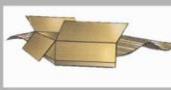
Answer: Nowadays Prodipan is working on clinical waste management. We collect waste from 100 clinics of Khulna City Corporation, and every clinic has to pay for this, but it varies according to the size of the clinic.

Question: Does household pay?

Answer: Every house holder is used to pay for the collection of waste only.

Appendix 2: Waste sorting manual made in Bengali

আবর্জনা পৃথকীকরণ নির্দেশনা

আবর্জনা	হ্যা/না	সংগ্রহের স্থান	ব্যবহার/উপযোগীতা
বিপজ্জনক আবর্জনা 	ফেলা যাবে: ব্যাটারী, টিউবলাইট, ব্যবহৃত তেল, রং, আঠা, ভার্নিশ, খিনার ও অন্যান্য বিষজনিত উপাদানসমূহ।	* আলাদা আলাদাভাবে সংগ্রহ/করতে হবে। * সরকারী ভাবে অথবা বেসরকারীভাবে নির্দিষ্ট পয়েন্টেও জমা দেয়া যাবে।	* প্রজ্জ্বলনের মাধ্যমে অনেক বিপজ্জনক পদার্থই নির্মূল করা যায়। * ব্যবহৃত তেলকে শোধনের মাধ্যমে পুনরায় ব্যবহার করা যায়।
জৈব বর্জ্যপদার্থ ও কম্পোস্ট 	ফেলা যাবে: খাদ্যদ্রব্য, খাদ্য উচ্ছিষ্ট, শাকসজি ও উচ্ছিষ্ট, টিব্যাগ, চাপাতা, কফি, টিস্যু পেপার, বাগানের উচ্ছিষ্ট (পাতা, ঘাস) ইত্যাদি। ফেলা যাবে না: যে কোন ধরনের তরল, ছাই, ঔষধ, সিগারেটের টুকরা, কম্পোস্ট করা যায় না এমন উপাদানসমূহ। নির্দেশনা: জৈব পদার্থসমূহ একটি কাগজের ব্যাগ, অথবা নিউজ পেপার দিয়ে মুড়ে নির্দিষ্ট স্থানে ফেলতে হবে।	* জৈব বর্জ্য পদার্থের জন্য আলাদা স্থানে ফেলতে হবে। * সম্ভব হলে নিজে নিজেই কম্পোস্ট করতে হবে। * বাগানের উচ্ছিষ্টও নির্দিষ্ট স্থানে ফেলতে হবে।	* জৈব বর্জ্যপদার্থ কম্পোস্ট করে বিক্রি করা যাবে। * বাগানের উচ্ছিষ্ট দিয়েও কম্পোস্ট তৈরী করে বিক্রি করা যাবে।
পেপার 	ফেলা যাবে: সব ধরনের কাগজ, নিউজ পেপার, বই, কভার ছাড়া বই ইত্যাদি। ফেলা যাবে না: কার্ডবোর্ড অথবা বাদামী পেপার ব্যাগ, টিস্যু পেপার, র‍্যাপিং পেপার ও প্লাস্টিক। নির্দেশনা: পেপার প্লাস্টিক ব্যাগের মধ্যে ভরে ফেলা যাবে না।	* পেপারের জন্য আলাদা বাক্সে পেপার ফেলতে হবে। * রিসাইক্লিং ও পুনরায় ব্যবহার করতে হবে।	* সংগৃহীত পেপার টিস্যুপেপার ও নিউজপেপার তৈরিতে পুনঃব্যবহার করা যাবে।
কাগজের প্যাকেট ও বাস্ক 	ফেলা যাবে: সবধরনের মোটা কাগজের প্যাকেট ও বাদামী মোটা কাগজের বাস্ক। ফেলা যাবে না: ময়লা ও ভিজা কাগজ অথবা প্লাস্টিক। নির্দেশনা: দুধ ও জুসের প্যাকেট ভেঙ্গে ও ভাজ করে ফেলতে হবে।	* আলাদা সংরক্ষিত স্থানে/বাক্সে ফেলতে হবে। * রিসাইক্লিং সেন্টারে* ফেলতে হবে।	* সংগৃহীত কাগজগুলো পুনরায় কার্ডবোর্ড তৈরীর উপকরণ তৈরীতে ব্যবহার করা যাবে।
কার্ডবোর্ড 	ফেলা যাবে: কার্ডবোর্ড, বাদামী পেপার ব্যাগ। ফেলা যাবে না: কোন ভিজা ও ময়লা কার্ডবোর্ড ও কোন প্লাস্টিক ব্যাগ ফেলা যাবে না। নির্দেশনা: ফেলার পূর্বে ভাজ করে ফেলতে	* সংরক্ষিত স্থানে অথবা বাক্সে ফেলতে হবে। * রিসাইক্লিং সেন্টারে ফেলতে হবে।	* কার্ডবোর্ড পুনরায় কার্ডবোর্ড তৈরীর জন্য কাঁচামাল হিসেবে ব্যবহার করা যাবে।

	হবে।		
<p>গ্লাস</p> 	<p>ফেলা যাবে : গ্লাসের বোতল ও জার। রঙিন ও সাদা গ্লাস আলাদাভাবে ফেলতে হবে। ফেলা যাবে না : জানালা অথবা আয়নার গ্লাস, প্লেট, প্লাস্টিক অথবা লাইট বাল্ব ফেলা যাবে না।</p>	<p>* পুনঃব্যবহারোপযোগী গ্লাস দোকানে ফেরত দিতে হবে। * রিসাইক্লিং সেন্টারে ফেলতে হবে।</p>	<p>* পুনঃউৎপাদনের জন্য গ্লাস তৈরীতে পুনঃব্যবহার করা যায়।</p>
<p>লোহা</p> 	<p>ফেলা যাবে : টিনের ক্যান, এ্যালুমিনিয়াম, রঙের জার, লোহার পন্যসমূহ, সাইকেলের ফ্রেমসহ যাবতীয় লোহাসামগ্রী। ফেলা যাবে না : ইলেক্ট্রিক ও ইলেক্ট্রনিক্স সামগ্রীসমূহ।</p>	<p>* পুনঃব্যবহারোপযোগী গ্লাস দোকানে ফেরত দিতে হবে। * রিসাইক্লিং সেন্টারে ফেলতে হবে।</p>	<p>* পুনঃউৎপাদনের জন্য লোহা গলিয়ে পুনঃব্যবহার করা যায়।</p>
<p>ইলেক্ট্রিক ও ইলেক্ট্রনিক্স সামগ্রী</p> 	<p>ফেলা যাবে : টিভি, রেডিও, ভিডিও, কম্পিউটার, রেফ্রিজারেটর, ফ্রিজ, ওভেন, কফি মেশিন, ভ্যাকুম ক্লিনার, টেলিফোন ইত্যাদি।</p>	<p>* পুনঃব্যবহার সেন্টারে* বিক্রি করা যাবে। * নতুন পণ্য ক্রয়ের সময় পুরাতন পণ্যটি ফেরত দেয়া। * রিসাইক্লিং সেন্টারে ফেলতে হবে।</p>	<p>* ইলেক্ট্রিক ও ইলেক্ট্রনিক্স পণ্যের ভিতরের ভালো পার্টসকে পুনরায় ব্যবহার করা যাবে।</p>
<p>কনস্ট্রাকশনের বর্জ্য</p> 	<p>ফেলা যাবে : কাঠ আলাদাভাবে। সিमेंট/পলি: অ্যাসবেস্টাস ও কাঠ আলাদাভাবে সংরক্ষণ করতে হবে।</p>	<p>* রিসাইক্লিং সেন্টারে ফেলতে হবে।</p>	<p>* যতদূর সম্ভব পুনঃব্যবহার করতে হবে।</p>
<p>বড় দ্রব্যসমূহ</p> 	<p>ফার্নিচার সহ অন্যান্য সামগ্রী।</p>	<p>* রিসাইক্লিং সেন্টারে ফেলতে হবে।</p>	<p>* পুনঃব্যবহার * বিক্রয়</p>
<p>জামা-কাপড়</p> <p>Large Objects</p> 	<p>জামা-কাপড়, জুতা, ফার্নিচার, বই, খেলনা, খেলাধুলাসামগ্রী।</p>	<p>* পুনঃব্যবহার সেন্টারে বিক্রি। * কাপড় ও জুতা রিসাইক্লিং সেন্টারে ফেলতে হবে। ।</p>	<p>* পুনঃব্যবহার।</p>

<p>মিশ্র জৈব পদার্থ Reusable clothes and Items</p> 	<p>ফেলা যাবে : বর্জ্য যা পুনঃব্যবহার করা যায় না, এমন ছেড়া কাপড়, জুতা, টাওয়েল ব্যাগ ইত্যাদি। ফেলা যাবে না : কাগজ, জৈব বর্জ্য পদার্থ অথবা অন্যান্য বর্জ্যসমূহ।</p>	<p>* মিশ্র ময়লার বাক্সে ফেলতে হবে।</p>	<p>* পোড়ানোর মাধ্যমে বিদ্যুৎ উৎপাদন করতে হবে। * ল্যান্ডফিলে* ফেলতে হবে।</p>
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* সাধারণ বর্জ্য বাক্স সমূহ

<p>বাদামী রঙের</p>  <p>জৈব বর্জ্য পদার্থ</p>	<p>নীল রঙের</p>  <p>পেপার</p>	<p>সবুজ রঙের</p>  <p>মোট কাগজ ও কার্ডবোর্ড</p>	<p>কমলা রঙের</p>  <p>এনার্জি বর্জ্য</p>	<p>ছাই রঙের</p>  <p>মিশ্র বর্জ্য</p>
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* স্লোগান

* একজন স্মার্ট ব্যক্তি কম ময়লা তৈরী করে এবং বাকিটা পুনঃব্যবহার করে।

* ল্যান্ডফিল - যেখানে বর্জ্য শেষ আশ্রয় হিসেবে ফেলা হয়। এখানে বর্জ্য পুড়িয়ে ফেলা হয় অথবা মাটির নিচে পুতে ফেলা হয়।

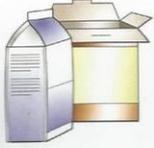
* রিসাইক্লিং সেন্টার - যেখানে বর্জ্য পুনঃব্যবহারের জন্য জমা দেয়া যাবে।

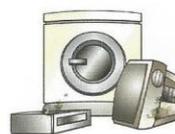
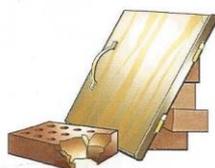
* পুনঃব্যবহার সেন্টার - যেখানে থেকে পুরাতন পণ্য বিনামূল্যে বিতরণ করা যাবে।



Appendix 2: Waste sorting manual in English

Instructions for Sorting Waste

Waste	Yes - No	Collection Points	Utilisation
Hazardous Waste 	<p>Batteries, accumulators, fluorescent light tubes, waste oils, mercury thermometers, paints, glues, varnishes, solvents, other toxic materials</p> <ul style="list-style-type: none"> Medicines and injection needles to the pharmacy Explosives to the police Preferably deliver the hazardous waste to the waste collection in the original packages 	<ul style="list-style-type: none"> HSY's containers for hazardous waste e.g. at several petrol stations Sortti recycling stations or the waste station of Munkinmäki HSY's (springtime) local collection trucks Batteries and small accumulators can also be brought to such stores that sell these products 	<p>A considerable amount of the hazardous waste is made harmless through combustion. This way the energy can be recovered. Additionally e.g. used lubricants are purified for reuse.</p>
Biowaste and Compost 	<p>Food leftovers, fruit and vegetable peels, tea bags, coffee grounds and filters, kitchen paper, gardening waste (twigs, leaves and grass cuttings)</p> <p>No liquids, ashes, cat litter, medicines, cigarette-ends, non-compostable or toxic materials</p> <ul style="list-style-type: none"> Pack your biowaste in a paper bag, in a cereal box or wrap it into an old newspaper or other compostable material 	<ul style="list-style-type: none"> Biowaste container (properties with more than 10 apartments) Your own composting bin (private households) Twigs and leaves into the composting bin or to the Sortti recycling stations or to the waste station of Munkinmäki 	<p>Biowaste is composted at the composting plant.</p> <p>Gardening waste brought to the waste stations is composted and processed into gardening soil.</p> <p>Soil produced in your own composting bin can be used in the garden.</p>
Paper 	<p>All paper received by post, newspapers, magazines, advertisement leaflets, envelopes, books without covers.</p> <p>No cardboard nor any paper or board based packages, brown paper bags, tissue paper or gift wrapping, no wet or dirty paper, no plastic</p> <ul style="list-style-type: none"> Don't put paper packed into plastic bags into the container 	<ul style="list-style-type: none"> Waste paper container at the property Recycling points Sortti recycling stations or the waste station of Munkinmäki 	<p>Collected paper is used as raw material for tissue paper and newspaper.</p>
Paper or Board Based Packages 	<p>All paper and cardboard packages, biscuit and cereal packages, flour bags, egg boxes, milk and juice cartons, corrugated cardboard</p> <p>No dirty or wet cardboard, no plastic bags</p> <ul style="list-style-type: none"> Milk and juice cartons should be rinsed Fold the packages up, before disposing of them 	<ul style="list-style-type: none"> Container for paper or board based packages (properties with more than 20 apartments) Recycling points Sortti recycling stations or the waste station of Munkinmäki 	<p>Cardboard and paper and board based packages are used as raw material for coreboard.</p>
Cardboard 	<p>Cardboard, corrugated cardboard, brown paper bags</p> <p>No wet or dirty cardboard, no plastic or polystyrene</p> <ul style="list-style-type: none"> Fold the packages up, before disposing of them 	<ul style="list-style-type: none"> Container for cardboard or for paper or board based packages (if available) Recycling points Sortti recycling stations or the waste station of Munkinmäki 	<p>Cardboard is also collected separately as it is of higher quality as raw material than paper or board based packages.</p>
Glass 	<p>Glass bottles and jars. Coloured and clear glass separately.</p> <p>No window or mirror glass, no heat-resistant glass, porcelain, plastic, light bulbs</p>	<ul style="list-style-type: none"> Returnable bottles back to the shop Recycling points Sortti recycling stations or the waste station of Munkinmäki 	<p>Glass is utilised as raw material for new glass products and for manufacturing fibreglass and foam glass</p>
Metal 	<p>Tin cans, aluminium trays and foil, empty paint tins, metal</p>	<ul style="list-style-type: none"> Returnable cans back to the shop 	<p>Metal is melted down and</p>

	<p>Objects, bicycle frames</p> <p>No electric or electronic equipment</p>	<p>Small metal objects to recycling points</p> <ul style="list-style-type: none"> Sortti recycling stations or the waste station of Munkinmäki or HSY's (springtime) local collection trucks 	<p>used as raw material for new metal products.</p>	
<p>Electric and Electronic Equipment</p> 	<p>Televisions, radios, videos, computers, refrigerators, freezers, microwaves, vacuum cleaners, coffee machines, telephones etc.</p>	<ul style="list-style-type: none"> Functioning devices to reuse centres Ask if you can return your old one when purchasing a new device Sortti recycling stations or the waste station of Munkinmäki or HSY's (springtime) local collection trucks Other certified reception stations www.kierratys.info 	<p>The life of functioning devices is prolonged when brought to a recycling centre.</p> <p>Electric and electronic equipment are collected separately for recycling of components and materials.</p>	
<p>Energy Waste</p> 	<p>Most plastics such as food casings, plastic foils, detergent flasks, plastic coated papers, polystyrene</p> <p>No PVC (03), no packages consisting of aluminium foil, no food leftovers</p>	<ul style="list-style-type: none"> Container for energy waste (if available) Sortti recycling stations or the waste station of Munkinmäki 	<p>Energy waste can be used as supplementary fuel at power plants or paper mills. There are currently no plants within the metropolitan area that recover energy wastes; therefore this type of waste is currently recovered outside the area.</p>	
<p>Construction Waste</p> 	<p>Demolition waste Wood separately</p> <ul style="list-style-type: none"> Asbestos and impregnated wood are hazardous waste and should be separated from other waste. Max 1m³ of impregnated wood to recycling stations free of charge 	<ul style="list-style-type: none"> Sortti recycling stations or the waste station of Munkinmäki Impregnated wood may also be brought to the recycling containers, provided by building supply stores Truck-loads to treatment centres for construction waste or to the waste treatment centre of HSY Consult the deputy landlord before putting any construction waste into the waste containers of the property Asbestos can only be brought to the Sortti recycling station at Ämmässuo 	<p>A considerable amount can be utilized.</p>	
<p>Large Objects</p> 	<p>Occasional large items such as furniture</p>	<ul style="list-style-type: none"> Sortti recycling stations or the waste station of Munkinmäki Sortti pick-up service for large items can be ordered through customer service for a fee. 	<p>Appropriate treatment.</p>	
<p>Reusable clothes and Items</p> 	<p>Clothes, shoes, furniture, books, toys, sports equipment etc.</p>	<ul style="list-style-type: none"> Reuse centres, charity organisations, flea markets Clothes and shoes to the recycling points 	<p>Reuse.</p>	
<p>Mixed Waste</p> 	<p>Waste which cannot be recycled or reused, china, leather, torn or damaged clothes and shoes, nappies or sanitary towels, bags for vacuum cleaners etc.</p> <p>No paper, biowaste or other recyclable waste</p>	<ul style="list-style-type: none"> Mixed waste container Sortti recycling stations or the waste station of Munkinmäki 	<p>Mixed waste cannot be recycled and it is deposited at the landfill.</p> <p>In the near future the waste-fired power plant of Vantaa Energy will produce electricity and heat from mixed waste</p>	
<p>The usual waste containers, located in the residential areas with blocks of flats, throughout the metropolitan area</p>				
 <p>Biojäte Bioavfall</p> <p>Biowaste</p>	 <p>Paperi Papper</p> <p>Paper</p>	 <p>Kartonki Kartong</p> <p>Paper or Board Based Packages</p>	 <p>Energiajäte Energiavfall</p> <p>Energy Waste</p>	 <p>Sekajäte Blandavfall</p> <p>Mixed Waste</p>



A Smart Person Reduces Waste and Recycles the Remainder

THE SORTING OF WASTE SAVES NATURE AND MONEY

- Sorted waste may be used as raw materials for new products.
- The recycling of waste reduces the demand on new natural resources.
- Unsorted waste is more expensive.
- The regulations set obligations on the sorting of waste.

HAZARDOUS WASTE IS DANGEROUS

- Hazardous waste may be dangerous to people's health and the environment.
- Hazardous waste must not be disposed of in normal garbage bags.
- Hazardous waste may be delivered to the collection points free of charge.

WASTE TREATMENT COSTS MONEY

- The waste management is financed by waste charges, not by the tax-payers' money.

THE BEST WASTE IS NON-GENERATED WASTE

- Avoid disposable products.
- Buy solid and durable products.
- Maintain and repair products.
- Reduce the amount of food, which ends up as waste.
- Tips for reducing waste www.hsy.fi/fiksu
- Jätkä - Waste Search Engine helps you to sort waste www.hsy.fi/jatka (in Finnish only)