



# **PLASTIC RECYCLING IN BANGLADESH,WHAT NEEDS TO BE DONE?**

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<p><b>Abstract:</b></p> <p>Although the core of this thesis deals with plastic waste management in Bangladesh, before going there it touches issues ranging from the basic chemistry of plastics, different types of the material and the manufacturing process to give readers an idea with fundamentals of plastic science. Then it finally moves on to the discipline of plastics waste management. This research first provides a theoretical framework on the aforementioned topics by discussing relevant materials. Then it moves on to the empirical part where a qualitative approach had been undertaken. The qualitative study is based on three expert interviews. After that, by comparing the theoretical framework with expert opinions the research results were drawn, where a list of observations and recommendations were presented. As for limitations, the small interview size could be mentioned, since the research area was the plastics waste management of whole Bangladesh the three interviews is too narrow for a broad conclusion. Finally, this research can serve basic guide for waste managers to better manage the plastic scraps.</p>	
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# **1. BACKGROUND OF STUDY**

## **1.1 Background**

As a student of Plastics Technology the author was looking for an interesting and challenging topic to work on. Since plastic recycling is a big part of the plastic sector overall and because there is a lot of work to be done in author's native country of Bangladesh this topic was chosen.

The origin of this topic came from the author's work placement done in Bangladesh and saw there is a very small amount of work going on about recycling of plastic. There are huge amounts of plastic wastes and no systematic process is present to recycle that. The author thought that if there is a systematical way to recycle that waste plastic and manufacture different kinds of products it will create more job opportunity and that it can also help the national economy.

## **1.2 Research Objectives**

Since plastic is a non-biodegradable product and cannot be dumped in the ground, plastic recycling is a very important issue in protecting the nature. In Europe or Asia, so many countries are doing plastic recycling, but in Bangladesh plastic industries don't usually want to do that.

The main objective of this thesis work is to provide a description of manufacturing of plastic and plastic recycling in Bangladesh. In order to achieve this the system of plastic recycling in Bangladesh is described and the overall prospects and challenges of plastic industry in Bangladesh are also talked about.

To be specific the research would go along remembering these questions:

- 1) What is plastic recycling?
- 2) Types of recycling.
- 3) How can plastic be recycled?
- 4) How to differ one kind of plastic from another?
- 5) What we have to do with recycled plastics?

### **1.3 Description of Methods**

In gathering information qualitative research method was followed. Data have been collected from online sources, email correspondence and so on. Some fieldwork and company visits have made it possible to acquire information and as well as first degree experience.

To get what plastic industry of Bangladesh think about plastic recycling some interview was taken and some companies cooperated with the author and some didn't

More on the research method has been described on chapter 4.1.

### **1.4 Scopes and limitation**

This thesis is mainly focused on plastic recycling in Bangladesh and for that the author interviewed some companies and some of them didn't cooperate. There is no data regarding the plastic wastes by the government of Bangladesh. Some NGO did research about the plastic wastes and author used that data for this thesis. Bangladesh is a densely populated country. Every day a big amount of wastes can be collected from people and if the recycling takes place there, that will help the country in various ways.

### **1.5 Outline of the Study**

The literature review section consists of the next two chapters. Since plastic recycling is the main theme of this thesis, chapter two was devoted in discussing the term manufacture of plastic and chapter three was discussed about plastic recycling in general.

Chapter four discusses plastic recycling system in Bangladesh, plastic consumption rate in Dhaka, the capital of Bangladesh. Then three companies interviewed were discussed focusing on the present condition of plastic recycling in Bangladesh. Then research methodology was discussed in detail and from the data collected from different sources and interviews from the companies, the research findings were discussed and summarized.



## 2 INTRODUCTION

Residential, commercial and industrial activities will always result in the generation of waste. Now-a-days people have become conscious about environment and ecological sites. So they always want to make sure that their environment is free of pollution. The ideal approach to reduce that pollution in a plastic site is to recycle the wastes. The recycling of plastic may take several processes.

Plastic is made from synthetic and semi synthetic materials. 'The term "plastic" includes materials composed of various elements such as carbon, hydrogen, oxygen, nitrogen, chlorine and sulfur.' Plastics have high molecular weight which means in a plastic product there is some polymers that has molecules which contains thousands of atom bonds together. [1]

Recycling means the reprocessing and refabricating of a material that has been used and discarded by a consumer and that otherwise would be destined as solid waste. This type of recycle is called post-consumer recycle, as opposed to recycle that is created as a normal part of scrap from a manufacturing process. The reprocessing of plastic materials into useful products needs several steps such as collection, sorting, cleaning and refabricating. [2]

The amount of plastic is increasing day by day. The thought of plastics first came in the late 1950s and early 1960s. The idea of plastic recycling on the other hand began to take shape in the 1990s in United States and elsewhere. At that time this process was run only to destroy the plastic wastes. Now-a-days many products are coming out of recycling including automobiles.

## 2.1 WHAT IS PLASTIC?

The word plastic is derived from two Greek words “Plastikos” and “plastos”. Plastikos means fit for molding and plastos means to remain molded.

To make a plastic material synthetic or semi-synthetic organic material is used which are moldable. Normally the raw materials of plastic are found in nature such as cellulose, coal, natural gas, salt, crude oil; and most industrial plastic is made from petrochemicals. The main thing of plastic is it can be cast, pressed and extruded in variety of shapes such as films, fibers, plates, tubes, bottles and much more.(3)

In general plastic consists of polymers which contain long chains of carbon and other chemical elements. For example:

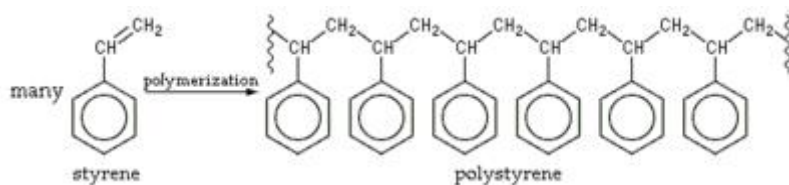


Figure 1: Alkene polymerization. (4)

Here styrene is the monomer of polystyrene.

The process where some monomers in a chemical reaction reacting together to form a monomer chains and then an open bond created by which monomer can join with another molecule or repeat the same process to form a long chain is known as polymerization process.

Such as

Vinyl chloride ( $\text{CH}_2=\text{CHCl}$ ) is the monomer of PVC or poly vinyl chloride -  $[-\text{CH}_2 - \text{CHCl}-]$  –

Or

-  $[-\text{CH}_2-\text{CHCl}-][-\text{CH}_2-\text{CHCl}-][-\text{CH}_2-\text{CHCl}-][-\text{CH}_2-\text{CHCl}-][-\text{CH}_2-\text{CHCl}-][-\text{CH}_2-\text{CHCl}-]$ -

## 2.2 History of plastic

The idea of plastic first came at 1860 when Phelan and Celluloid, a US Pool and Billiard Company declared prize for the substitute of natural ivory. (5) And John Wesley Hyatt invented the first synthetic plastic in 1869. (6) But before that in 1862 a scientist named Alexander Parks created another plastic and he declared that in 1862 at the Great International Exhibition in London. The materials called Parkestine which can change its shape when heated and remain original when cooled. (7) After that John Wesley Hyatt invented celluloid which is derived from cellulose and alcoholized camphor. He created celluloid in a strip format for movie film. Then in 1907 Leo Baekeland invented Bakelite, the first fully synthetic plastic. From 1978 to 2000 plastic had reached today's position because of the third generation of plastic. (8)

## 2.3 How Plastics are made

The production of plastic can be divided into four categories

1. Acquiring raw material
2. Synthesizing the polymers
3. Compounding the polymers into materials
4. Molding(9)

### 2.3.1 Raw materials

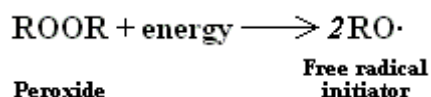
Normally raw materials are natural resources, mostly resins which we can get from vegetable oil. But now-a-days petrochemicals are used industrially to make plastics because it is easy to get and cheaper than other raw materials.

However the supply of oil is exhaustible. Researchers are trying to investigate new raw materials such as coal gasification. (10)

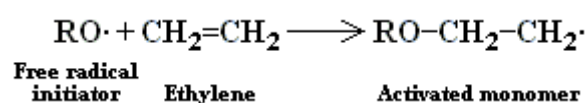


There are also three steps for the additional polymerization

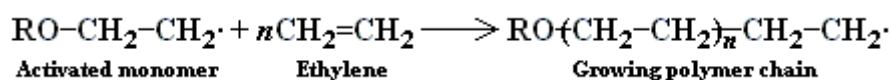
1. **Initiation** It begins by the initiator which decomposes a free radical in the presence of monomer and the active center of the radicals get one electrons from the carbon-carbon double bond and make one unpaired electron.



In this reaction light and heat can provide if needed and peroxide monomers break into 2 free radicals and that 2 free radicals get attracted with a monomer molecule and make one activated free radical.



2. **Propagation** After initiation, propagation process begins where the electron transfer and the motion of the active center which joins down the chain proceeds. Normally the entire propagation takes place in fraction of a second. In this process the newly formed activated radical attaches with double bond of another monomer molecule.



Here n stands for the number of molecule.

3. **Termination** Termination occurs in two ways, combination where the free radicals get another electron and form a single chain.  
Disproportionation when free radicals get a hydrogen atom. (14)

### 2.3.3 Compounding the polymers into materials

Chemical additive can be used to get certain characteristics:

- From degradation by ozone antioxidants is used.
- Protect from weathering ultraviolet stabilizer
- Increase polymer flexibility plasticizer
- Flame retardants and etc. (15)

### 2.3.4 Molding

After that plastics can be made by the size and shape required.

## **2.4 Types of plastic**

Plastics can be divided into two major categories:

### **2.4.1 Thermosets**

It's normally long chain plastic, which is made by cross-linked of another long chains polymers. It cannot be re-melted or re-shaped after its getting one shape. For example Epoxy resin, polyester resin, carbon fiber plastics are thermosetting plastic.

### **2.4.2. Thermoplastics**

This kind of plastic can be re-melted or re-shaped easily. This is soft and moldable on cooling. This kind of plastic hardens when it gets cold. Such as HDPE, LDPE, PVC, Polypropylene, polystyrene are thermoplastics.

Since various kinds of plastics can be recycled SPI identification methods has been introduced with many other methods. The SPI identification system is developed by the packaging industries and consists of a tri-angular shaped arrows and a number between 1 and 7. It's easy to identify what plastic is that and easy to recycle by knowing the plastic types.

There are various kinds of plastic. The most important plastics are:

Polyethylene (PE)

High Density Polyethylene (HDPE)

Low Density Polyethylene (LDPE)

Polystyrene (PS)

Poly vinyl chloride (PVC)

Nylon

Epoxy Resin

Cellulose Acetate

Acrylic acid

Polypropylene

ABS

**PE**

There are two kinds of PE, one is HDPE and another is LDPE.

**HDPE**

HDPE is tough, waxy. It is resistant to chemicals. HDPE is known for its large strength to density ratio. It is mostly used for blow molding and injection molding process. Bottle, bucket and container can be made by HDPE.

**LDPE**

LDPE is a thermoplastic made from the monomer ethylene. It is not reactive at room temperature. LDPE contains chemical element carbons and hydrogen.

**Polyvinyl chloride**

It is rigid and water resistant. It is mainly used in glass frames and drain pipes. It is often used in extrusion processes.

**Polystyrene**

It is soft, lightweight and good insulator. General purpose Polystyrene is clear, hard and brittle. It is also a thermoplastic polymer. It is widely used in packaging industry and also in insulate buildings.

**Nylon**

Nylon is designated from polyamides. It is a silky material, hard, rigid, self-lubricant and resistant to petrochemicals. It is used for gear wheels, film, clothing and packaging.

**Cellulose acetate**

It is hard, tough and flexible. It is used as a film base in photography, as a component in some adhesives and as a frame material for eyeglasses.

**Acrylic acid**

It is stiff, hard and brittle and scratches easily. It is noted for its transparency and resistance to breakage. It is used for bath, sign lighting, windows and display stands.

**Polypropylene**

It is a thermoplastic polymer used in a wide variety of applications in packaging and labeling, textiles, plastic parts and reusable components. It is rigid, good fatigue resistance and good chemical resistant.

**Acrylonitrile Butadiene Styrene**

It is strong and tough, chemical resistant. ABS is mostly used for injection moulding process.

**Epoxy resin**








It is also known as poly-epoxides and is a class of reactive pre-polymers and polymers which contain epoxy groups. A wide range of epoxy is produced in the industry. It is strong and clear. Epoxy Resin is normally used as an adhesive of a liquid for casting.



## 2.5 Symbols of plastic

There are many kinds of plastics. Some of them are recyclable and some of them are automatically recycled. So when someone knows about the symbol and the number which is on the products in every item s/he can keep that plastic in right place because there are a variety of boxes for that. Kerbside collection system is known for the automatically recycled plastic collection. (16)

**Table 1: Table of SPI Resin Identification Codes for Plastic Packaging Recycling:**

Recycling Number	Image	Polymer Name	Polymer Abbreviation
1	 (PDF - 11KB)	Polyethylene Terephthalate	PETE or PET
2	 (PDF - 11KB)	High Density Polyethylene	HDPE
3	 (PDF - 10KB)	Polyvinyl Chloride	PVC
4	 (PDF - 11KB)	Low Density Polyethylene	LDPE
5	 (PDF - 10KB)	Polypropylene	PP
6	 (PDF - 10KB)	Polystyrene	PS
7	 (PDF - 10KB)	Other plastics, including acrylic, acrylonitrile butadiene styrene, fiberglass, nylon, polycarbonate, and polylactic acid	Other

## **2.6 Manufacturing process of plastic**

Most of the plastics can be processed in various ways. Here is the short overview of the techniques used for plastic manufacturing; extrusion process, injection-molding process, blow molding process, extrusion blow molding process and injection blow molding process. Below is a short description of the process:

### **Extrusion Process**

The word extrusion derives from a Greek word 'roots' that means to 'push out' which is a pump that supplies continuous stream of material to a shaping tool.

'Extrusion process can be done by two different ways, one is, extrusion can be used to shape the part directly after the mixing or an extruder can be used as the melting device that is coupled with other shaping processes. In the direct method an extruder is placed at the end of the extrusion machine. (17)

The basic idea of extrusion process is pushing the molten plastics in a heated barrel through the dies (one or more) which is aided by pressure to the required shape. After that the molten plastic is cooled by the air or water drum to solidify and cut into units as required. The extrusion process can produce sheet, tube, film or pellet.

### **Injection Molding Process**

Injection molding process is one of the most important manufacturing processes in plastic industry. It is the process where polymer is heated under high pressure into a mold cavity and then it solidifies there. Almost all thermoplastics and thermosets can be injection molded. (18) Injection molding process is more popular than extrusion process because of making complex and more cross section products and the part can be made with little part-by-part variation. For some complex part like the medical injection tube, injection-molding process is the only option. In an injection-molding machine there are three major units; Injection unit, Mold, Clamping (19).

Wire spools, packaging, bottle caps can be made by this process.

## **Blow Molding Process**

Blow molding process is a plastic forming process mainly for hollow parts like bottles. It can be explained in three simple steps:

- 1) Melting the resin
- 2) Forming a preform tube
- 3) Blowing the tube into the shape desired.

There are two methods that are used to form the parison (molten Plastic).

### **Extrusion Blow Molding Process**

In this process the parison is formed by forcing the plastic through an extrusion die. At the process the two-part mold closes on it. Then the parison is pinched off at the top and bottom and the tube is inflated to take the shape of the cavity. When it gets the shape the mold is opened to remove the part and solidify. (20)

### **Injection Blow Molding Process**

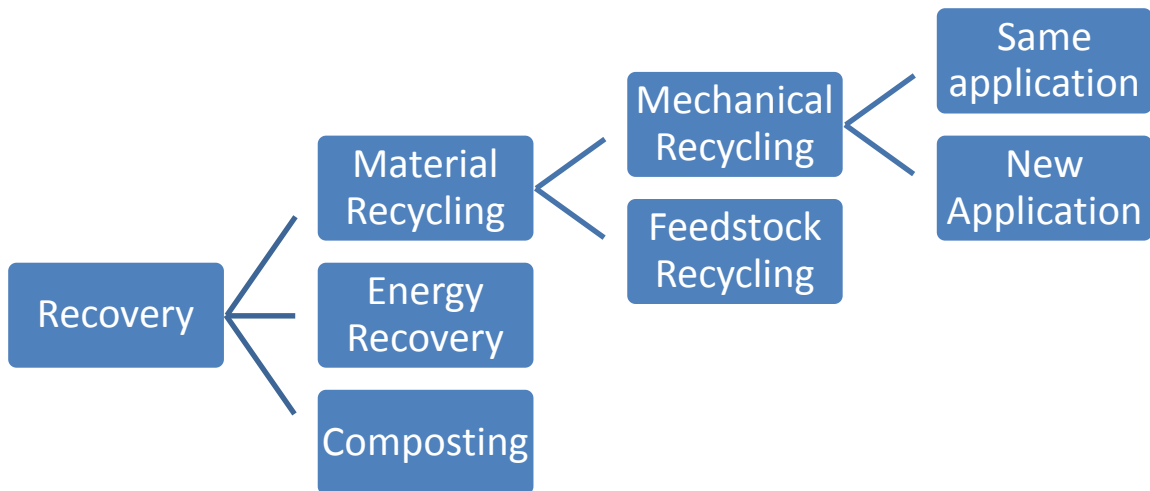
In this process the parison is injected around a core pin by an injection-molding machine. Then the formed parison is transferred to another machine, blow molding machine when the parison is still soften. A pressurized air is inflated through the parison to get the shape and it cools by the wall of the mold to solidify. Then the mold is open to remove the product. (21)

### 3 PLASTIC RECYCLING

Recycling is the reprocessing of used materials to a new form from its original state or sometimes destined for disposal of solid state. This is called post-consumer recycle and another type of recycling process which is created as normal part of the scarp from a manufacturing process is plant recycle.

Plastic recycling is getting popular day by day. An overall 10% increase of recycling in five years whereas in 1990s the percentage was 24% of all waste in USA. Aluminum soda cans have been recycling for many years and almost 50% are recycled. The most popular products of recycling is PET soda bottles and HDPE milk jugs. Because Pet and HDPE is as convenient to recycle as aluminum cans, their recycle percentages of total production 57% of HDPE and 31% of Pet bottles already approach those of aluminum cans. (22)

Recovery of cans is the best alternative for disposal. Plastic disposal has many negative impacts on the nature. For that recovery and recycling is the best option to prevent that. Below a scheme for recovery options is presented.



## **Composting**

This is an organic matter which is decomposed as a fertilizer and mostly applicable for biological application. (23)



Figure 4: Compost

Source: <http://en.wikipedia.org/wiki/Compost#mediaviewer/File:Compost-dirt.jpg>

## **Energy recovery**

The basic idea of energy recovery is that plastic is made from crude oil and can be used as fuel.

## **Material recycling**

There are two types of material recycling process, one is feed-stock recycling and another is mechanical recycling.

### **Feedstock recycling**

There are some products which contain different materials which is hard to separate. In the recycling process, first they are broken down into basic compounds and then it can be used as raw materials such as gas and oil. (24)

The basic idea of feedstock recycling is breaking down a polymer into molecule and that molecule used as raw material lately.

### **Mechanical recycling**

It is the method by which materials are recycled by mechanical process. In a mechanical recycling process there are some steps like grinding, washing, separating, drying, pelletizing of flakes and compounding. (25)

## **3.1 Recycling Systems**

### **3.1.1 Technical consideration**

Almost every people in the world are using plastics now-a-days. People are threatened by the limited natural resources like gas or oil. If recycling takes place in every sector then it will be a salvation for the natural resources. (26)

Plastic which is considered as waste by the consumer can be categorized as below:

#### **Single-grade production and processing scarp and surplus raw material**

Mainly household used plastic wastes which has more possibility to recycle. (26)

#### **Single-grade post-consumer commercial waste**

It's already recycled plastic but by checking its contamination and history of plastics it can be used for the same application or for a new application. (26)

### **Mixed grade post-consumer commercial waste**

Most of this types of plastics can be recycled but they have to be separated into their different polymer types. The best recycling option is feedstock recycling or energy recovery. (26)

### **Household waste and agricultural plastic waste**

The process for this kind of plastics is to mainly dump them in an organized landfill. (26)

## **3.1.2 Economic consideration**

When it's about plastic recycling, economic benefits play an important role. A company that recycles plastic has to follow the market rule, and has to find the consumers for their products. And for that they have to face some challenges like:

- Are they getting enough recycled raw materials for their products?
- Are they able to keep the quality of the products compared to the virgin one?
- Are they able to follow the plastic products standards?
- Public attitude about recycled products.

## **3.1.3 Ecological Consideration**

Plastic waste's impact on the environment can be divided into two parts, one is visible part which is destroying the scenic beauty and the second part is potential risk which may occur in the long term and cause deeper environmental problems. This is because plastic has its own steady chemical structure which can't be destroyed by microbes and is non-biodegradable.

## **3.2 Types of Plastic Recycling**

There are four types of plastic recycling:

(1)Primary

(2)Secondary

(3)Tertiary

(4)Quaternary

The primary way of recycling plastic is as a product. By using product second hand or when someone don't need that. If it can be used then it's recycling as a product. Or by reconstructing a plastic like by making some paintings by colouring, we can make the product life durable.

Secondary way of recycling plastic is that plastic used as fencepost and as sub products that can be used as a substitution to wood. Plastics can also be use as raw materials for making new plastic.

Tertiary process is that which involves producing basic chemicals and fuels from plastic.

Final process of recycling is quaternary. It is used rapidly now-a-days. This process uses the energy from plastic by burning. It is widely used because of high heat content of most plastics. For this process incinerator can reach temperatures as high as 900-1000 degrees Celsius. In total 80% in weight and 90% in volume of incoming waste can be reduced by using the incineration and rest of the materials dumped in landfills. (27)

## **4 PLASTIC RECYCLING IN BANGLADESH**

### **4.1 Methods of the study**



To understand what the Bangladeshi plastic industry professional's thinks about plastic recycling a few interviews were taken and some companies cooperated with the author while some didn't.

Since plastic industries in Bangladesh don't want to engage in plastic recycling in a broad sense, there is not much data available about plastic recycling. Dhaka City Corporation (DCC), which is the responsible authority for the waste recycling of Dhaka the capital city, has a total overview of the collection of wastes but that's not exclusive to plastic waste.

The author tried to get the data and the process of plastic recycling which is being followed by some small companies, also a few NGO's were contacted, and some plastic industry managers. Most of the literatures of the plastic recycling in Bangladesh are from waste concern consultants, articles from local newspapers and the interviews conducted. Author tried to gather the whole picture and there are no updated data available from the year 2008 and so on. Most of the information is prior to that.

The author of this thesis had attempted to interview 5 plastic companies in Bangladesh on how they collect the plastic wastes, what they do with these wastes, and how they do the whole recycling process. Out of the five companies three companies replied, two did not. Among the conducted interview two were conducted through telephone communication, and the remaining one thorough email correspondence and these interviews were took place in November, 2014.

Legislation and directives were taken from Ministry of environment and forests under the government of Bangladesh.

Total plastic waste recycling process was observed by the author when he had done his work placement in January, 2014 and with that data collected from the interviewers were taken into account. Most of the photographs were taken at that time and some of them were collected from various websites.

## **4.2 Plastics Background in Bangladesh**

Plastic is an engineered material which is manufactured as a wide variety of products to meet the domestic demand in Bangladesh. In recent times the size of the plastic industry is growing day by day. It played an important role in Bangladeshi industries sector during the last two decades. First plastic industry in Bangladesh started their journey in 1960's by making plastic toys, photo frame and plastic spare parts for the jute mills. They used handmade mould to make those products. Soon after, automatic manufacturing machines were introduced to make plastic jugs and plates in the 1970's. In 1980's the companies started making plastic bags by film blowing machines. From the 2000's plastic recycling takes place through locally developed machines such as shredder, extruder and the companies started making plastic chairs, tables and water tank by rotation moulding machine. Now-a-days there are 2997 plastic factories in the country. Out of them 1965 factories are small, 980 are medium and rest 52 are large companies which deal internationally.

There are 64 districts in Bangladesh but most of the plastic industry is based on the capital, Dhaka and some in major port city Chittagong, while a few are in Narayan gang a city close to the capital and a large trade centre. (28)

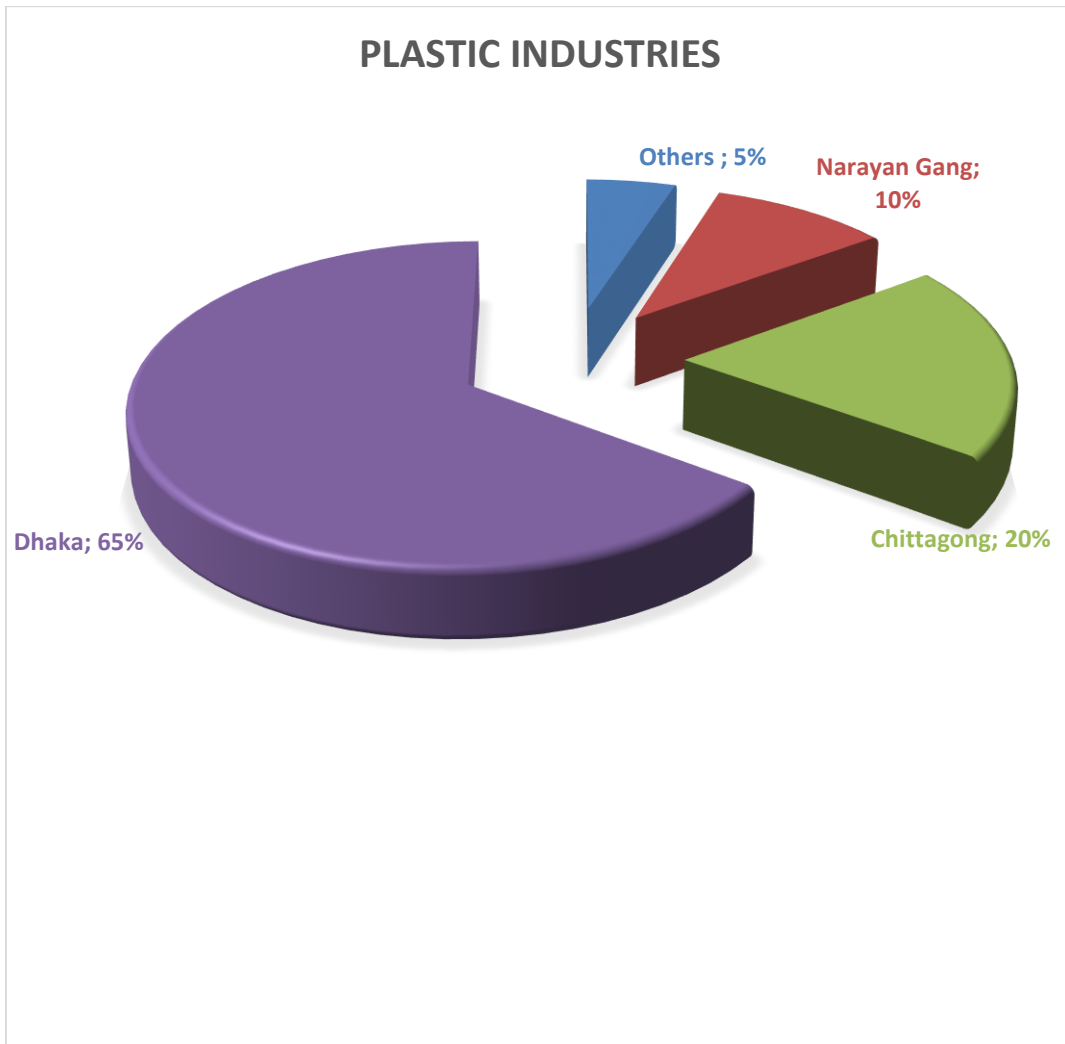


Figure 5: Plastic Industries of Bangladesh

### 4.3 Plastic Consumption Rate in Dhaka City Corporation (DCC)

Plastic is getting popular in Bangladesh since the last decade. Plastic factories started importing polymer granules and since then different kinds of plastic products were available. From 1987-2007, the amount of imported polymer was 287,000 tons per year. Before that it was 10,000 tons per year. At present total consumption of plastic and recycled plastic products are 750,000 tons per year which is 5 kg per capita per year against the world average of 30 kg per capita per year. At present the companies have started to export their products to India, Sri Lanka, and Nepal.

Because there was no previous data for the consumption of plastic in Bangladesh, an organization named waste concern consultants did a field survey assuming the amount of plastic disposed or sold is equal to the amount of plastic consumed. Based on the income group, the disposal rate of plastic waste by households the estimated per capita per year is shown in the table below:

Table 2: Plastic consumption rate in DCC (2006)

Income group	Consumption of plastic( kg/cap/year)	Population in DCC	Average ( kg/cap/year)
Low	5.235	55%	9
Middle	12.73	40%	
High	14.03	5%	

The growth of plastic waste is also increasing day by day related to the population growth. Now- a days there are 30 million people living in Dhaka city. So each and every day the disposal of plastic is also increasing. By DCC total solid waste generation per capita per day is 3315 tons/day and on average 4.15% of the total solid waste is plastic waste. (29)

From the source of waste data base of Bangladesh which is published by Waste concern consultants 50,213 tons/year plastic products have been collected for recycling and 34,646 tons/ year is soiled which is 69% of the total plastic available for recycling. (29)

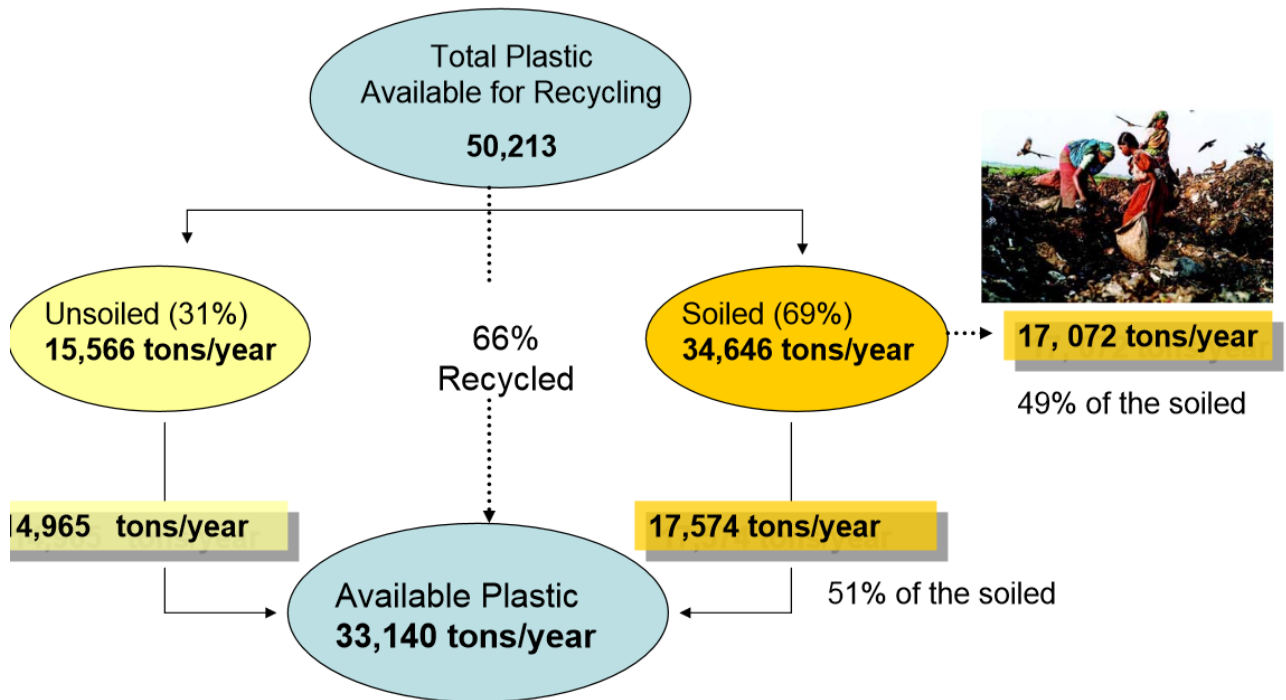


Figure 6: Plastic waste recycling In Dhaka.

Source: waste Database of Bangladesh, Waste concern consultants.

#### 4.4 Legislation and Directives

Laws and directives are needed in waste management to treat the waste systematically and in an environment friendly way. The laws of waste management in Bangladesh are usually made by the Ministry of Environment and Forests department under Bangladesh government and the department is the responsible to generate awareness among the people about the rules.

Ministry of Environment and Forests have some strategy, policy and plan for the waste management. Bangladesh Government has banned use of polybag in 2002 because of the huge usage of polybags and an absence of a proper management system.

The Ministry of Environment and Forests recent activity about waste management system is “National 3R strategy for waste Management” where 3R means Reduce, Re-use and

Recycle. Waste minimization can be achieved in an efficient way by following the 3Rs, reduce followed by reuse and then recycle.

There is no specific policy or rules for waste management but several rules and policies are being drafted for specific types of wastes. Some of those rules are

Bangladesh Environmental Conservation Act (ECA) of 1997 which recommends waste disposal standards for mainly industrial wastes.

Draft national Solid Waste management Handling Rule of 2005 where 3R principle has been used.

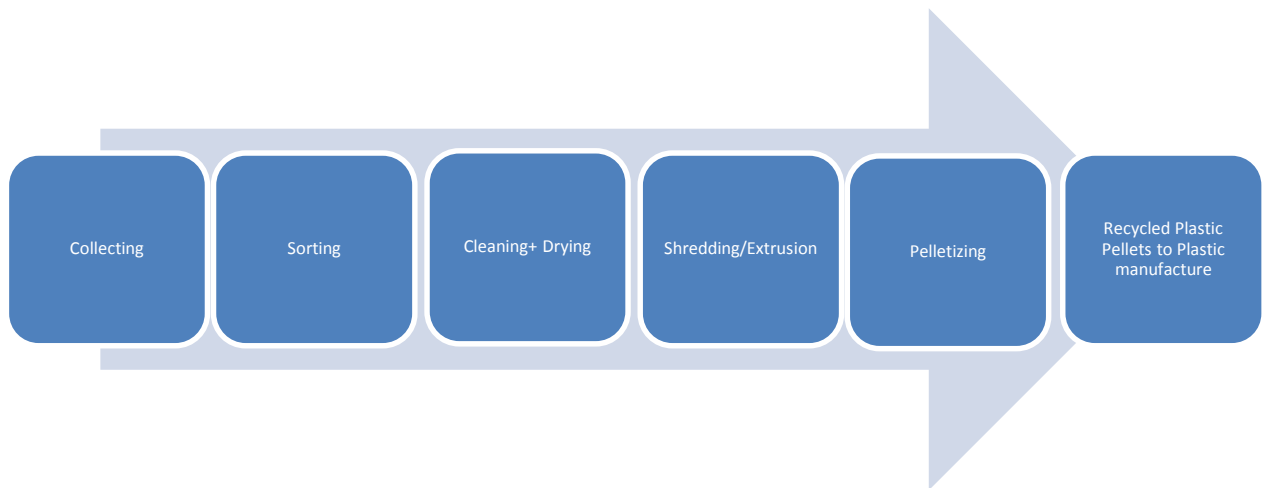
Lead Acid battery Recycling and management Rules of 2006, under this rules collection and recycling have been improved.

Biomedical waste management rules of 2008 recommends source separation of hospital waste as well as separate collection, transportation and treatment and disposal of all kinds of hospital and clinical wastes. (30)

## **4.5 Plastic Waste Recycling Process**

Plastic recycling is not very popular in Bangladesh. Very few plastic industries have recycling machines like shredder or extruder. Collecting, cleaning, sorting is done manually. Labor cost is very low there so the owner of the companies likes to do that manually. For example one labor gets 200 BDT taka (1 euro = 100 taka) per day.

Total recycling process of Bangladesh can be shown in some simple steps. Below is the flow diagram of the recycling process followed in Bangladesh



### 4.5.1 Collecting

Bangladesh doesn't have the system to collect waste products. The consumer throw that away in anywhere and the collector called '*Tokai*' collect that from streets, river, drain or dustbin and sell the waste plastic to the plastic waste collectors at a cheap price. Some collectors have their own workers who collect the plastic wastes from streets or some also has the contract with the households. They keep the plastic wastes and the worker collects that. Dhaka City Corporation is the responsible authority for the collection of wastes and by their database only 42% solid wastes have been collected only in Dhaka city in 2007. Uncollected wastes is deposited in open spaces. A large group of street children always search for saleable and recyclable plastic materials in the dirt, garbage and sell them to some mid-level shops and after that they transfer that plastic to the recycling places. In Dhaka city waste plastics or wastes collectors consists of two categories, primary waste collector and secondary waste collector. Resident's households and Tokai are the primary waste collectors. DCC is responsible for the secondary waste collection. They collect that waste from dustbin and take that waste to the final disposal area or the companies who take the waste plastics. (31)

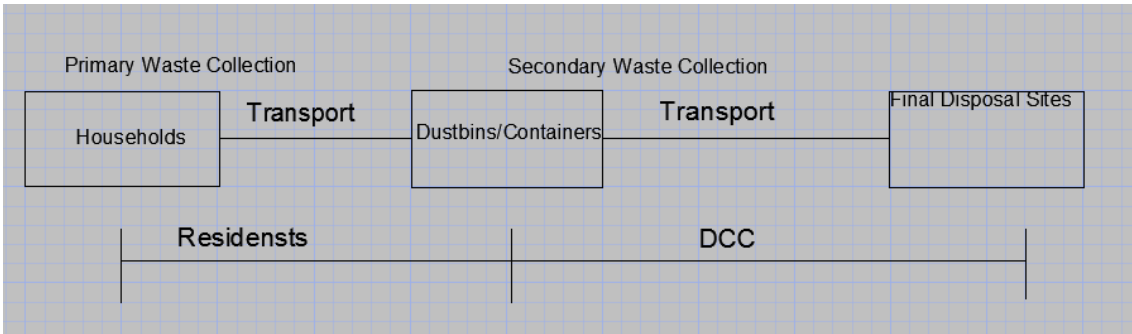


Figure 7: Waste Collection System in Dhaka City

Here are some pictures of plastics collection in Bangladesh.



Figure 8: Tokai; collecting plastic wastes Taken by B, M Mahibul Islam Sabab Accessed on 19.11.2014





Figure 9: Collecting Plastic wastes (Demotix.com, accessed on 19.11.2014)

#### **4.5.2 Sorting**

After collecting the waste plastics the small buyers of waste recycles sorted the plastics by their types and colors. Normally in Bangladesh the companies don't use any machine to sort the plastics. . The whole sorting process is done manually. The workers only know the basic of plastics like which number is for which kind of plastics. Plastic wastes can be sorted by maintaining plastic codes for example 3 is for PVC and 1 is for PET.



Figure 10: Sorting of plastic (Shimo, 2014)



Figure 10: Sorting of plastic (Shimo, 2014)



### 4.5.3 Cleaning and Drying

After sorting plastic wastes the most critical thing in the recycling process is cleaning the plastics. Because the plastic is already contaminated with lots of dirt, grease or oil, it is really important to use the surfactants (detergents) and water to remove the contaminants from the plastic materials. Here, in Bangladesh all cleaning process is done manually, normally in river or pond and dry that wet materials in sunlight.



Figure 11: Cleaning the Flakes (Martin, R (2014). Plastic recycling workers in Bangladesh, Ranak Martin blog, 17.11.2014)



Figure 12: Drying the flakes (Martin, R (2014). Plastic recycling workers in Bangladesh, Ranak Martin blog, 17.11.2014)

#### 4.5.4 Shredding

Then the sorted and clean plastic wastes are sent to the shredder to be cut into plastic flakes. It is important to cut the big plastic bottles into small ones which is called size reduction before putting it into the chipper or shredder. The shredder is incorporated with a rotating blade that cut the plastics into the small pieces and these go through a passage with small holes into flakes collector. The companies in Bangladesh use some locally made shredder machine to make the flakes. There is also a blade to cut the plastics and collect that plastic flakes in a bin or bucket.



Figure 13: Plastic flakes (Shimo, 2014)

### **4.5.5 Pelletizing**

The plastic flakes are put into an extruder where the extruder melts the flakes. The melted flakes then extruded through a small die hole.

Raw and recycled plastics are reprocessed and the reprocessed plastics are converted into pellets because pellets are easy to handle and transport. After melting the reprocessed plastics the liquid mixture is shot into molds or extruded to make a new plastic products.

## **4.6 Benefits of Recycled Plastics**

Recycling of plastic has many benefits for the country if the recycling is done systematically. The whole benefit of the recycling process can be figured in three sector, social, economic and environmental. The three beneficial sectors described below:

### **4.6.1 Social Benefits**

To make a society clean, beautiful and healthy place to live recycling is one of the most important things to focus on. People throw their wastes on the rood or dustbin and plastic wastes litter the streets and bind the water removal system in the drain which causes mosquitos and flies. As Bangladesh is a densely populated country there is not much suitable land for disposal and not any secured place for disposal of hazardous waste. To have a clean and safe place to live, recycling of wastes is the best option. Modeling examples from other nations our leaders want to apply the systematic way of developing the country and in the process make it more beautiful. Better management of wastes is an important part of it.

### **4.6.2 Environmental benefits**

Modern waste management reduces the environmental impact and will save resources. Bangladesh used to have very fertile lands in the world but because of non-biodegradable wastes it is losing its fertility. There are some kind of wastes which can be turned into composts, a viable source of energy but the plastic wastes like polyethylene, PET bottle are non-biodegradable and can cause many impacts on the environment.

Plastic is manufactured from crude oil and the energy used for recycling is less than the energy use of the production of virgin products. And producing virgin plastics cause the emission of carbon-di-oxide and sulfur-di-oxide in the atmosphere where the recycling of plastic can decrease the emission and protect global warming.

Recycling also protects water from pollution, as plastic is non-biodegradable, since the wastes which is made by polymer can leach chemical both the surface and under water and decrease the fertility of soil, recycling can protect that.

### **4.6.3 Economic benefits**

Most of the companies manufacture plastic from raw materials in Bangladesh. If they start using recycle plastic that can save their money and the price of the products will be less than the virgin products. So the companies will eventually get more consumers and the consumer also can afford to buy more plastic products which are necessary. And by starting recycling plastic companies can create more job opportunities than before. They don't need much education for recycling and can earn their livelihood easily.



## 4.7 Plastic Products in Bangladesh

Applications of plastic products are used mainly in packaging, medical, household sector in Bangladesh. Garbage bag, toothbrushes, plastic doors, chairs, tables, bed, PVC pipes, electric switches, toys, buckets are some of the products that the plastic industry are manufacturing now-a-days in Bangladesh. Although plastic industry in Bangladesh has made a remarkable progress over the years but still they need a well-designed plan to be more reliable to the consumers.

Table 3: Plastic products and its application in Bangladesh

Applications	Products
Household	Chair, Table, Sofa, Bucket, strainer, Bowl,  Tableware, bath ware
Accessories for RMG	Packaging material. Bags, hanger
Construction	Plastic pipe, door, toilet flush
Agricultural products	Plastic pipes for irrigation and plastic films for shedding crops
Healthcare and Electrical	Blood bag, saline bag, injection medicine container, Electric cables and wires covers, switches

The companies in Bangladesh don't make any products with the recycled plastic flakes. They export the flakes. So it will be a good opportunity to start an industry only for the recycled plastic flakes.

There are some companies who are directly involved with plastic recycling but they recycle only PET bottles and they export the chips (flakes and scrap) to china. In 2013, in a TV interview the president of PET flakes exporter association told that around 500,000

metric ton per year of flakes have been exported and they earn around 1500-2000 million dollar in a year. (32)

## **4.8 Prospects of the Plastic Industry**

Manufacturing is a sunset industry in west. Because of the low costs it could be quite rewarding to start a plastic recycling factory in Bangladesh. The main prospects are below:

- ❖ Affordability of the labor cost and the fast developing recycling industry of post-consumer plastic wastes in Bangladesh are the great advantages to compete in the global market.
- ❖ The consumption rate of plastic in Bangladesh is 5kg/year as compared of world consumption rate 30kg/year, there is a huge potential for the domestic growth of the plastic industry in Bangladesh
- ❖ The population growth in Bangladesh is high and therefore the consumption rate will increase and if the plastic industry can take the consumers of lower & middle class, the business should be profitable.

## **5 Questionnaire**

To get an overall look at the situation right now with the plastic recycling in Bangladesh a questionnaire was made for some companies. Some of the companies co-operated with the author, some of them did not. There were six questions to better understand the overall plastic recycling system in Bangladesh. Almost every company have the same process and two companies have no interest to manufacture products with recycled materials, they do recycle only with their own damaged plastic materials.



## 5.1 Interviews

Since there isn't too much public information and facts considering plastic recycling in Bangladesh it was necessary to get information in some other way. For this purpose interviewing with some companies was a suitable method. Author made six questions for the companies and took interview of three different companies. The whole interview was conducted in Bengali, author translated that to English.

The interviewees were from:

- Bengal Plastic Industries Ltd.
- N. Mohammad Plastic Industries Ltd.
- Fatema Plastics and Industries

### 5.1.1 Bengal Plastic Industries Ltd

**Company Name** Bengal Plastic Industries Ltd

**Address** Bengal House, 75 Gulshan Avenue, Gulshan-1, Dhaka, 1212, Bangladesh

The point of taking interview with Bengal Plastic Industries Ltd was to find out how they are doing plastic recycling. Also Bengal Plastics is one of the most popular and the oldest plastic company in Bangladesh. They started their business in 1969 with a single hand operated injection molding machine and from 1978 started their business in a wide range. Today they process more than 3000 metric ton raw materials per month and they export most of their products to India, Nepal, Sri-Lanka, Italy and Spain. They don't manufacture plastic from the recycled materials; they just recycle some of their own materials which are damaged or somehow broken and some products which cannot satisfy the consumers.

They question which author asked to the company are:

- 1) Where do you get the waste plastics?

**Answer** Maximum of our raw materials is virgin raw material and others are from return broken product.

- 2) What do you do with the waste plastics?

**Answer** We reuse it in industrial products or customize product as customer demand.

- 3) What's the consumer's reaction about the recycled products and raw products?

**Answer** We use recycle product with the special customer's permission and if they satisfy with the products then we sell that to them.

- 4) What's the future of plastic recycling in Bangladesh?

**Answer** Bangladesh is a densely populated country and people are interested to buy plastic products. That is cheap and useable and different design that's why consumers like to buy the products. As the consuming rate is high the waste plastic rate is getting high and if some companies use that waste plastic and recycled that and manufacture products with that, the future of plastic recycling will be very bright in Bangladesh.

- 5) How would you improve plastic recycling?

**Answer** Basically we don't manufacture with recycled materials in this industry, we only use the broken products which is made in this industry.

- 6) What do you think about plastic recycling in general?

**Answer** Most of this companies products export to another country and the company doesn't manufacture products with the recycled materials because the quality of the recycled products is almost 50% less than the virgin products and the company doesn't like to lose their popularity for that.

## 5.1.2 N. Mohammad Plastic Industries Ltd

**Company Name** N. Mohammad Plastic Industries Ltd.

**Address** 179/A, CDA Avenue, Muradpur, Chittagong-4212, Bangladesh

N Mohammed Plastic industry is one of the most popular plastic companies in Bangladesh located in the port city of Chittagong. They started their business in 1987 and the name and fame of the company spread over the country within a short time because of its quality, service, design and reasonable pricing.

1) Where do you get the waste plastics?

**Answer** The Company get their waste plastic from their own factory. During the production some products do not found according to their customers destruction. Due to faulty instructions or operating system defects are seen in some production. In this case they do not supply this defects products to market. They use these defect products as their raw materials by recycling. They also collect their defect products from market those are damaged or lose its original quality during handling in market. N. Mohammad Plastic industry is one of the largest plastic company in Bangladesh. Every month they need in total 112 metric ton raw materials. Most of the raw materials are imported. In the production system they use 90% original raw materials and 10% recycling materials. According to their average calculation they need 3.8 metric ton raw materials for their production. Among them 0.38 metric ton recycling materials they use daily.

2) What do you do with the waste plastics?

**Answer** They collect the defective products from market and defective products from their production system. When the engineer have noticed that the produced products are not according to the design and its quality is not as required, they take these to recycle. Sometimes the worker destroy some products during production, these also take to recycling to use it again. Then they take these plastic materials in shredder machine. In shredder machine the waste plastic turn into small granules. These granules can be directly used as raw materials.

3) What's the consumer's reaction about the recycled products and raw products?

**Answer** Almost all plastic products of this industry made from raw materials. Raw materials are produced from chemical combination. When these raw materials are used in producing new products they have to make the raw materials in to liquid form by giving high heat. During processing raw materials lose their original quality. Here the chemical loses their initial quality. When the raw materials are used their quality decrease about 50%. When the waste plastics are recycled its original quality does not present. If these raw materials are used for production the quality of the products are not standard. The products those are produced from recycling waste raw materials are less bright and their durability decrease. Most often these products lose its 50% quality value after one time use. If those are further used in recycling they lose their quality again and again. One of the most harmful sides of recycling raw materials are if these products are used in keeping food materials they emit one type of bad smell and chemicals there. In this case the company loses their name and fame about their products in market. The consumers are now very careful about the quality value of plastic. In plastic raw materials, different chemicals are used those are harmful for our health.

4) What's the future of plastic recycling in Bangladesh?

**Answer** Now-a-days we use plastic materials everywhere in our daily uses. Plastic products are comparably cheaper than others, so people use plastic products most of the time. Plastic chair, table, doors and pot for food grain and bottle for different beverages are common use of plastics in our country. Large and popular companies use original raw materials. But there are some local factories mainly use the recycling materials for producing plastic products. Their products do not meet the standard quality but their products are cheaper than the brand companies. They sell their products in local market and in village sides. So everyday a lot of waste plastic products are found in everywhere. As the plastic products are not expensive, people throw these products after one time use. The hawker and street boys collect that and sell to the local agent at very low price. There are some agents who buy that from them. They collect all these waste plastics and sell to the recycling factory. In Chittagong there are about 20 factories where waste plastics are recycled.

5) How would you improve plastic recycling?

**Answer** We know our total resources are limited, so we have to optimize the sustainable uses of our resources. As plastic is a cheaper materials, most of the time we do not care about its use. Every day we use a lots of plastic utensils. After using them we throw the plastic materials easily. We rarely use these again. Every day a lot of waste plastics are collected for recycle. But here in Bangladesh the factory who is responsible for the recycling, they do not follow the advanced or scientific process. Moreover during recycling a lots of chemical materials remain in the granules and the new plastic products produced by these recycled materials are not pure. They become contaminated. When these plastic materials are used their usual quality decreases. They spread bad smell. They lose their usual durability. So the renowned company like N. Mohammad plastic industry are not interested to use recycled materials in the production. If systematic recycling process can be done and make the waste plastic pure, then it would be more effective and contaminated free.

6) What do you think about plastic recycling in general?

**Answer** Actually in Bangladesh recycling waste plastic raw materials are used by some local company. The brand and large company use the recycled materials rarely. Because they think that if they use the recycling waste materials in production they can lose their standard in market and the consumer will be dissatisfied to their products. If recycling materials are used in the production, the production will be minimized. In this case the products will be cheaper than the original one. For this the local company use recycling raw materials and their products are cheap. But their quality is not as good as the original one. So recycling plastic materials will be affective if the quality of the products can be maintained.

### 5.1.3 Fatema Plastics and Industries

**Company Name** Fatema plastics and industries

**Address** 35/4, East Islam bag, Posta, Lalbag, Dhaka-Bangladesh

Fatema plastics and industries is a local plastic company in Dhaka. They collect the waste materials from the collector and recycle that waste plastics and most of the times they sell that granules to the plastic companies and export to India & China.

1) Where do you get the waste plastics?

**Answer** Waste plastics are collected in various streets, river, and dustbin by street boys. They called locally Tokai. Tokai sells it in scrap shops. Scrap businessmen sell it another agent, they are called cutting businessmen. Cutting men collect it. They wash it properly. After that they cut it into so small pieces by locally made shredder. Then they sell it to another agent who is called Dhana (like seeds) businessmen. Various companies buy the plastic granules from there. After that Industries produce various products according to demand.

On the other hand, there are some plastics industries here. They collect waste plastics from bottom level of the country and all processes are executed by industries. Finally such companies supply products in the market.

2) What do you do with the waste plastics?

**Answer** Basically we get it from Dhana (seeds businessmen). These waste plastics come to industry by handling various ways like Tokai, scrap shop, cutting shop, dhana shop. Various companies order us to produce different kinds of products according to their demand. Normally we produce different plastic items like body hanger, miter board, bucket, Vessel, ewer, bowls, cupboard, sandals.

3) What's the Consumer's reaction about the recycled products and raw products?

**Answer** The consumers reaction about the recycled plastic and raw plastic is observed here in somewhat. Consumers want always cheaper products. As recycled products are cheaper than raw products, consumers are always interested buying more recycled products. They don't care about quality. They think the price and is

that useable or not? Even they do not want to know from sellers which products are recycled and which one is virgin plastic in some cases. Although recycled products are less durable than raw products.

4) What's the future of plastic recycling in Bangladesh?

**Answer** Bangladesh is covered a huge population around 160 million and most of them are not solvent in economy. As recycled plastics products are cheaper than virgin one, plastic recycling in Bangladesh have a bright future. But for that the companies and government should take some steps like

- ✓ Government has to patronize in recycling plastic industries for being development.
- ✓ Facilities of workers must be ensured in standard level.
- ✓ Sound environment of factories must be ensured.
- ✓ Proper vacation of workers must be ensured.
- ✓ Collection process of waste plastic should be more conducive to plastic industries.
- ✓ Government should take step about proper management of waste plastics.
- ✓ Mass awareness should be increased.
- ✓ Advanced and scientific method should be used for recycling.

If we ensure above requirements about waste plastics, the future of plastics recycling of Bangladesh will be bright.

5) How would you improve plastic recycling?

**Answer** The author has visited in some plastic industries before on collecting information about relevant issue. Workers of plastic industries think that their salary is too low. They cannot enjoy any holyday and don't get any accommodation facilities.

Mohammad Zaved, Machine operator of Fatema plastics and Industries says that "I have been working here for 10 years but still now I get only 10,000 BDT taka per month

(1 euro= 100 BDT taka) and there is no accommodation facility.” So it is clearly understood that some reformative steps should take for improving plastic recycling sector in Bangladesh. Some of them described below:

- ✓ Increase seriousness about recycling.
- ✓ People do not have the idea that plastic can be recycle and that’s why they just throw the products after using them. SO it must be expended among the population of the country.
- ✓ Patronizing of state must be ensured.
- ✓ Definite rules and regulations must be provided by the state about recycling industry.
- ✓ Workers facility and safe environment must be ensured.
- ✓ Awareness must be increased among the consumers of recycling products.

Overall it is told that proper planning of recycled products will be improved.

6) What do you think about plastic recycling in general?

**Answer** Plastic recycling is the best way to save the environment pollution and it is contributing in national economy also. Proper planning and awareness of the people can make this plastic recycling sector, the most beneficial sector in Bangladesh. Also the recycling companies should follow the advanced process to recycle the plastic wastes.



Figure 14: Recycled granules in Dhana (seeds businessmen) shop. (Shimo, 2014)



## 6 Results

Results from the questionnaire are described in the following section.

There were total six questions to three different companies and two companies do not collect external waste plastic materials and another company directly involved in plastic recycling and manufacturing products by them but the company which is directly involved to the plastic recycling does not export their products. They sell them to the local market and to the lower class people whereas two another companies are involved in exporting their products.

All companies representative have said that recycled product are much cheaper than virgin products and there should be advanced and scientific method for recycling process and to remove the contaminants.

To improve the plastic recycling sector in Bangladesh government should take some step and DCC should collect waste systematically. Workers of the plastic industry in Bangladesh have said that if they get increased salary and if there is a rule for the minimum salary in plastic industry then people should be more interested to work in this sector. On the other hand generating awareness amongst the people is also necessary in properly managing the plastic wastes.

And from the objectives of this thesis work the following findings came out:

Management of Plastic waste and identifying them:

People throw the waste in the dustbin or on the street and city corporation workers take them to a selected place and the only destination of this is a landfill. There should be a systematic way to dispose the wastes. Solid wastes were not sorted to separate metals, glass and plastic from each other.

Identify the types of plastic materials in the waste:

The author was in Bangladesh and visited some disposal landfills and did found the following types of plastic materials generated by the people

- Polyethylene (PE)
- PVC

- Polystyrene ( PS)
- Polypropylene(PP)
- Polyethylene terephthalate (PET)

#### Findings of the effect plastic bring to environment:

Plastic is non-biodegradable and because of that land is losing its fertility and for the plastic wastes in the drain create the barrier and which causes mosquitos, flies which are harmful, that can also be responsible for the flood also.

The burning of the plastic wastes as a way to dispose them produce toxins such as carbon monoxide, carbon dioxide which causes cancer, inhaling.

The following plastic recycling processes was described during the thesis work which can be used in Bangladesh also:

Mechanical recycling,

Energy recovery

Feedstock recycling

#### Findings regarding the benefits of recycling plastic wastes:

Recycling would reduce the amount of plastic wastes on the environment which can protect environment pollution. Job opportunities can be a great plus point in the country where many educated people are looking for a job to survive and recycling plastic wastes can also bring foreign currency to the national economy. Bangladesh is one of the most densely populated country in the world and the amount of plastic wastes in a day is much more than the amount of plastic wastes in a month of some country. If the plastic recycling takes places and people are conscious about the effects of plastic wastes then recycling would be a good option for the employment as well as for the national economy.

## **7 Conclusion**

### **Summary**

The aim of this study was to document and assess the plastic wastes management state in Bangladesh. The result is that this study has produced a set of suggestions and pointed observations regarding the current state of plastic industry in Bangladesh.

The early chapters on the elementary principles of plastics sciences served as a guide throughout the research. That is because since the plastic waste management in Bangladesh is still quite manually done, the basic principles were enough to make sense out of them.

For the empirical research the interviews suggest that large companies are still not very active in starting their own recycling operations whereas the smaller ones are quite the opposite- their business model is based on recycled plastics.

### **Research Limitations**

Similar to other research bodies this research is not free of weakness. From a general point of view, there could have been more in-depth discussion to some of the elementary concepts such as Synthesis of Polymers or the plastic manufacturing process. Time constraint left them in a reserved manner.

Secondly, the interview population sample can also be mentioned here: Originally it was aimed to have six interviews. Because of non-responsiveness of some companies the researcher had to be satisfied with three. Bangladesh a nation of 160 million people that produces an ample amount of plastic wastes these three interviews are not enough to reach an objective conclusion.

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