



The Prospects and Challenges of Plastic Industries in Bangladesh

Pintu MD. Nazmul Hossain

Degree Thesis
Plastics Technology
2016

DEGREE THESIS	
Arcada	
Degree Programme:	Plastics Technology
Identification number:	4320
Author:	Pintu MD. Nazmul Hossain
Title:	The prospects and challenges of plastic industries in Bangladesh
Supervisor (Arcada):	Mirja Andersson
Examiner:	Mariann Holmberg
<p>Abstract:</p> <p>Plastic is one of the most used engineered material in Bangladesh that has come out as important industrial sector during the last few decades. The size of Domestic market is more than thousands of billions euros. The available cheap labor, vast population and fast development of plastics wastes recycling industries have given Bangladesh a huge potential advantages to compete in the global market. Although, plastics sector is one of the most growing markets in Bangladesh, but still it is facing various kinds of challenges. These major challenges faced by plastics industries are mainly institutional arrangements dedicated to the sector and lack of public awareness which are actually possible to overcome by providing supporting services & innovative technology, facilities for quality check & control, consulting service and so on.</p> <p>These all have been focused in this research work. Before heading to the core points of the thesis, it also touches wide ranges of basic of plastics, its history, its different varieties in materials and the different kinds of manufacturing process too to give readers a maximum idea about the fundamental of Plastics science. Later on, the observations, conducted interviews as qualitative studies by experts, recommendations, opinions of Bangladeshi industries have been discussed and finally the research work has ended resulting as a simple guide of its goal for the betterment of plastics sector for Bangladesh as well as for similar developing country.</p>	
Keywords:	History of plastics, manufacturing of plastics, plastic recycling, prospects & faces challenges of plastics industries in Bangladesh.
Number of pages:	61
Language:	English
Date of acceptance:	

Contents

1. Background of Study	7
1.1 Background	7
1.2 Objectives of the Study	7
1.3 Methodology.....	8
1.4. Data collection	8
1.5. Scopes & limitations.....	9
1.6 Outline of the Study.....	9
2. Introduction	10
2.1 The definition of Plastic	12
2.1.1 What is polymers?	14
2.2 History of Plastic	15
2.3 Features of Plastics	16
2.4 Types of Plastics	16
2.4.1 Thermoplastic	16
2.4.2 Thermoset	20
2.4.3 Differences between thermoplastics and thermosets plastics.....	21
2.5 Manufacturing of Plastics	21
2.6 Symbols of Plastics.....	22
2.7 Plastic from petroleum or crude oil.....	23
2.7.1 Petroleum Products from Crude Oil.....	24
2.8 Manufacturing process of plastic.....	24
2.8.1 Injection molding process	24
2.8.2 Extrusion process	25
2.8.3 Blow molding process	25
2.8.4 Injection Blow Molding Process.....	25
2.8.5 Extrusion Blow Molding Process.....	25
3. Plastic Recycling	26
3.1 Overview of plastic recycling	26
3.2 Types of Plastics recycling.....	28
3.3 Stages of Plastics recycling.....	29
Stage 1: collecting and sorting the plastics.....	29
Stage 2: Washing waste plastics	30

Stage 3: Shredding the plastics	30
Stage 4: Identify all plastics according to their classifications	31
Stage 5: Extruding	31
4. Plastic industries in Bangladesh	32
4.1 Country profile [34].....	32
4.2 The history of Plastic industries in Bangladesh.....	32
4.3 Remarkable features of Plastic industries in Bangladesh	33
4.4 Locations distributions of Plastic Industries in Bangladesh	34
4.5 Plastic Products used in Bangladesh.....	35
5. Plastic recycling in Bangladesh	37
5.1 Present situation of plastic recycling	37
5.2 Disposal	38
5.3 Plastics consumption rate in Capital Dhaka region.....	39
5.4 Benefits of Plastics recycling in Bangladesh	40
5.4.1 Economic benefits.....	40
5.4.2 Environmental Benefits.....	40
5.4.3 Social Benefits.....	41
6 Prospects of Plastic industries in Bangladesh	42
6.1 Competitiveness.....	42
6.2 Raw materials of Plastics	43
6.3 Exporting plastics products.....	43
6.4 Future Potential markets in Bangladesh.....	46
6.5 Constraints	46
6.6 Major findings and recent initiatives	46
7 Questionnaire	48
7.1 Interviews.....	48
7.1.1 EREBUS Plastic Industries.....	48
7.1.2 National Polymer Industries group	51
8 Result	55
Finding the plastic's effects.....	56
9 Conclusion.....	57
Limitation of the research.....	57
10 Reference	58

List of Tables

Table 1: Examples of some common Plastics and their monomers	13
Table 2: different kinds of Thermoplastics	19
Table 3: Different types of Thermosets plastics	20
Table 4: The differences between thermoplastics and Thermosets plastics	21
Table 5: Identification Codes & symbols for Plastic Recycling	22
Table 6: Petroleum products from crude oil	24
Table 7: Different types of Plastic recycling	28
Table 8: Plastic's History of Bangladesh	33
Table 9: Plastic Sectors in Bangladesh, Source: UN-ESCAP Report-2009 (Updated)	34
Table 10: Plastic waste recycling and its opportunities in Bangladesh. Waste concern consultants	39
Table 11: Bangladesh Export Statistics (1999-2000 to 2013-2014) by Export Promotion Bureau, www.bbs.gov.bd and author's calculations	44
Table 12: History of EREBUS, Source: http://www.erebusbd.com/	49

LIST OF FIGURES

Figure 1 : EXAMPLES OF NATURAL AND SYNTHETIC POLYMERS	14
Figure 2 : Plastics from Crude Oils	23
Figure 3 : Plastic recycling process Overview	27
Figure 4 : Plastic recycling process	29
Figure 5 : Sorting of Plastics	30
Figure 6 : A Plastic Shredder assembly	31
Figure 7 : the stages of plastic recycling process.....	31
Figure 8 : Bangladesh in world map	32
Figure 9 : FIGURE 8: PLASTIC INDUSTRIES IN DIFFERENT CITIES OF BANGLADESH.....	35
Figure 10 : collection of PE bag for recycling	38
Figure 11 : Plastic Exports in Bangladesh	45
Figure 12 : Growth rate of plastic export.....	45
Figure 13 : PRODUCTS OF SIDDIQUE PLASTIC INDUSTRIES	53

1. Background of Study

1.1 Background

The Author of this thesis as a student of Plastic technology was looking for a very challenging and interesting topic to work on which will be beneficiary in future for many plastic industries and companies of the developed countries as well as of the other developing countries of the world. Bangladesh is a developing country and author has chosen his homeland Bangladesh as a main focus for his this thesis work as a standard country and one of ideal examples of developing world.

The origins of this thesis topic has come from author's recent visit to the country's some well-known established plastics industries and companies in Bangladesh. Although, Bangladesh has observed the fastest growing markets for plastics and plastics related products and it has a big potential markets in the future too, but still those industries and companies are facing many challenges to grow. So, author has chosen this topic to find out those challenges and prospects for Plastics industries in Bangladesh.

1.2 Objectives of the Study

Bangladesh is a very populous country where more than 150 millions people are living. plastics products now a days have made a huge impacts on their daily lives. Compared with the textile and leather industries in Bangladesh, Traditional Plastics relatively a very new. Now a day, plastic industries have big prospects as well as big challenges too in this developing country. As Those industries are making big effects on the total economy of the country too, so it's a very important and matter of facts to find out those challenges as well as prospects too. That's why, this research will focus on some specified points as the main aim of this work which can be classified into below points,

1. To know in details about different kinds of Plastics
2. To describe in details about how they manufacture in Bangladesh
3. Analyzing the system to produce those materials
4. Having a research on Growing market for Plastics
5. The advantages & disadvantages to use of those materials in Bangladesh
6. Finding out the challenges and the prospects of new Plastics industries to grow
7. Finding out the ways to overcoming those obstacles
8. Comparing the past era with the present and estimate the future market for Plastics Industries in Bangladesh

1.3 Methodology

Throughout this research, Qualitative research method has been followed in gathering and the collecting all informations. Qualitative method is one kind of scientific research method under which all data and informations for this research has been collected in particular observation, from online resources and information, in depth interview, by some field works, from email communication and so on.

This research work has been started during author's visit to Bangladesh in last summer on June 2015 and some field works along with companies visit have made during that period of time to acquired information and experiences about the work. Some international articles and reports published by the well-known international organizations regarding this matter have also been observed carefully during this research.

1.4. Data collection

Most of the data related to the plastic product's manufacturing, waste managements and recycling of Plastic industries in Bangladesh have been collected from the site visits, field works and several survey reports of national i.e. Dhaka city corporation (DCC) reports and international org. i.e. European Union regarding this matter. Some recent data have also been collected from the daily local newspapers, journals and from previous research papers done by several org and educational institutes too.

To understand what the professionals and businessmen of Bangladesh think's about the future of plastic industries in Bangladesh, few interviews were taken. Author got some tremendous responses and cooperation from those companies too during this interviews and contacts. Dhaka city corporation (DCC) is one of the most responsible authority in Bangladesh situated in capital region named Dhaka has a total overview and all official information about all plastic industries and companies situated in Dhaka as well as in Bangladesh.

The author has also done his best to gather data, marketing policy, information about facing and challenges in Bangladesh, future goals and so on about other small companies, also a few local NGO's were contacted as well. Moreover, some employers as well as some employees of Plastics companies were contacted via phone, email and author's personal visit where some cooperated friendly and openly. Most of the articles and literatures about those plastics industries are from the private org, consultant farms, from local newspapers and interview conducted. Author has done his best to figure out a whole picture of this research work. The author had attempted to take interviews of several plastic industries in Bangladesh during this research work. Out of those several companies, some interviews were conducted through telephone, some interviews were conducted by email correspondence and rest of the interviews were taken while author had done

his company visit. These all interviews were taken before January 2016. Total manufacturing process also was observed carefully by author when he had done his visitation to those companies during summer of 2015 and all collected data from the interviewers were taken into consideration seriously. Various pictures were taken at that time and also from various websites too.

1.5. Scopes & limitations

This thesis is mainly focused on Plastic industries and companies in Bangladesh where all data and information had been collected from various interviews and online resources that are mainly from private org. There is no updated data available to the government of Bangladesh's website regarding this matter. Author used only those available data done by private sector, NGO and International org. Bangladesh is a very densely populated country. Now a day, almost all people of Bangladesh are totally depending on plastics in many ways. They are using various kinds of products made by plastics. So, plastic has become the part of lives. That's why, the plastic industries are growing very faster and very rapidly in Bangladesh. Author of this thesis work is very optimistic that this research work will help those plastic industries in Bangladesh as well as in other developing countries to find out the challenges, obstacles and also the way to find the solution of those to go ahead, this will help the countries in various ways.

1.6 Outline of the Study

The next two chapters of this thesis work will totally focus about the literature reviews Since the challenges and prospects of Plastic industries in Bangladesh are the main theme to focus for this research work, so chapter three was devoted in discussing about the overview of plastics in Bangladesh where plastic, its classification, manufacturing, its history and so on have been discussed at chapter two. In Chapter four, the whole plastic recycling processes in Bangladesh are discussed.

Chapter four discusses about the prospects plastic industries in Bangladesh, future aims, constraints and potential markets for the industries where challenges of those steps are discussed at chapter six along with the environmental issues and waste management of Plastic in Bangladesh. At the end, some interviews, future markets for those industries in Bangladesh and limitation of these research are discussed and summarized as the findings and conclusion of the work.

2. Introduction

In Modern age, plastic is one of the great miracle material. It is playing a very important role in this era. In fact, plastic has made possible to take aeronautics technology to further forwarded giant steps over past 60 years including the advancements in satellites, aircraft, shuttles, missiles and so on. It now a day plays an important role not only in earth but also for the space exploration. Moreover, plastics are benefitting the constructions works, electronics, the transportation, the packaging and the industries, actually everywhere in our daily life.

Modern Plastic has been first introduced to the world in middle of last century during world war two. During the war, this material was slowly being used as the alternative of other materials such as rubber, iron and woods. Eventually it became the most preferable material on the top than of those materials too. It had been used in airborne radar systems and made a great result as a significant technology because it allowed the waves to pass without creating a big loss.

In fact, Plastic has been used as a substitute of Iron and rubber materials in aerospace technology what has brought a significant advancement in this technology now a day. In this modern stage, plastics are being used in rockets as part of solid fuel boosters and also in space shuttles. This is also one of very usable materials in making of helicopters too because of its rigidity, flexibility and durability. The most important fact about plastic is that it is very lightweight and strong enough what make it an advanced usable materials in the field of aerospace. Now a day, the weight of the aircraft is reduced by using plastic. It has been said that reducing one pound of a jetliner's weight by using plastics can save more than thousand dollars fuel during its lifetime.

Plastics are significantly playing important role in building and construction industries as well. From the past decades, the world saw a significant changes in this industries. In fact plastics has become the 2nd largest materials to consume for the industries, followed only by the packaging industries. Plastic has been used now a day as pipes, valves, decorative elements, doors, windows and so on in the construction industries. It has been commonly found in flooring, siding, gratings, railings, glazing, plumbing fixtures, bathroom units, panels and insulation too. Plastic is a very superior resistant material to corrosion for what it is being used in valves and piping also. On the other hand, because of being lighter than other heavy materials, plastic is very easier to install and easy to use for everything from crude oil to laboratory waste, from saltwater to freshwater. It is also a very cheap material comparing with the others in constructions and building industries.

In packaging industries, plastic is the most usable material even than papers. It is so versatile, rigid and tough what make it a very protective material to use in packaging industries. If the products needs to be protected and if the packaging for the products has to be convenient, then plastic is the essential element to use as it can be used as a variety of packaging purposes.

It can also be used in combination with other materials too. Moreover, plastics can be designed into any desirable shape or size or as transparent material or as any imaginable color what have

made huge advancements in these industries. Plastic packaging helps people and their needs in various ways. It has been used in medical facilities to dispose of needles or any other items that might be contaminated. In a same way, it is protective to use in fragile medical devices which are often shipped in plastic containers what precisely help those not to get damaged during shipping. Various kinds of intravenous bags are also being made by plastics to help the medical staffs to monitor the flow and to intake the important medicines, foods and so on.

Plastic is also being used at home to store a variety of goods. The shatterproof bottles made by plastics are protective from harm if the product should accidentally fall or got rotten. The packaging for child resistance and leak proof are also made out of plastics.

The improvement of various kinds of transportation are one of the main advantages of modern age. Plastic is a very popular choices on making models for transportation because of this various qualities. It has been proved that only the weight of a car has been reduced more than 150 pounds since last century what has saved more than 20 million barrels of oil. Plastic is very corrosion, durable, lightweight and easy to color, for what, it is found in the fenders, trunk lids, bumpers, housings for headlights, sideview mirrors, hoods, wheel covers and doors too.

Many other transports like busses, trains, microbus, subway cars and so on have also taken the advantages of plastics at their best. Plastic has been used in modern designs for windows, door frames, the seating, seat covers, making the carpeting, creating the handles, for the interior panels, even in the polycarbonate windows and so on. Plastics are also the most usable materials now a day for the creation of roller skates, snowboards, skateboards, motorcycles, bicycles, kayaks, surfboards, canoes and even for some athletic shoes too.

Plastics are used with various kinds of electronics devices too for a very wide number of purposes. Plastic has the thermal and insulating properties for that it is an ideal material in house wiring as well as for switches, receptacles and as electrical connector. Now a day, computers, mobiles laptops, cameras, fans, coffee makers, shavers, irons, hair dryers, mixers, microvans and even the refrigerators fully or partly are being made of different kinds of plastics. A very special plastic foam are also being used for insulation purposes in many products such as in freezers. These all products would last about half as long and would waste almost 70% of energy without plastics.

Today's world are unimaginable without computer and computer is unimaginable now days without plastic, it would probably now exist today without plastic. Plastic has made it possible to create smaller and light weighted computers. Different parts of computer such as circuit boards, chips, screen, cover, fan, keyboards etc. are being made and are be able to miniaturize without losing their abilities but improving their performances by plastics. Undoubtedly Plastic deserves a big thanks.

2.1 The definition of Plastic

'Plastic' word is generally being used as a common term for mentioning the wide range of synthetic or semi synthetic materials used and their range of applications. It is one of the most usable products now a day in this modern era. It play a very important vital role everywhere in our daily life. It's unimaginable to life a single day without plastic, that's how, plastic has got engaged with our modern civilization. Plastics are the materials for today and also the choice for the future because they have made it possible to create a balance a modern day needs with the environment concerns.

Plastics are organic. The raw materials of plastics are mainly natural products such as cellulose, coal, natural gas, salt, and of course, the crude oil. Most of the industrial plastics are being mad of petrochemical.

The term 'Plastic' has derived from two Greek words 'Plastikos' and 'Plastos'. Plastikos means 'fit for molding' and Plastos means 'to remain molded'. The derived words of plastics refer to the material's malleability and plasticity during the manufacturing of it that allows to be pressed, cast, or extruded into a variety of shapes such as fibers, plates, tubes, boxes, bottles, films and so on. [1]

Generally plastic can be describes as materials that consists of polymers which contain long chain of carbon and other chemical elements such as Hydrogen, nitrogen, Oxygen, Chlorine and so on. In that sense, plastic is a specific subset of Polymers. So, it is necessary to know about polymers before plastics.

Polymer is a molecule of a large number of small repeating same or complicated subunits. Polymer is derived from two Greek words 'Poly' & 'Mer'. Poly means many and mer mean parts. [2] So polymer means a large molecule or macromolecule consisting of many repeated subunits. A polymer's subunit is called monomer.

For Example:

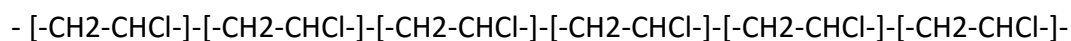
Ethylene is the monomer of Polyethylene where the symbol of Ethylene is $(CH_2=CH_2)$. On the other hand, the symbol of polyethylene is $-(-CH_2-CH_2-)-$.

In the polymerization process, Monomers bonds always break down process and then an open bond is created in the monomer. So, after breaking down, the monomer can join with other to make a new bond or can repeat the same unite to form long chain of the monomers.

Another example:

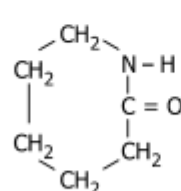
Vinyl chloride is the monomer of PVC or poly vinyl chloride and the symbol of Vinyl chloride is (CH₂=CHCl) and on the other hand, the symbol of PVC is -[CH₂-CHCl]-

Or



Today's some very common Plastics and their monomers have been given into the below table;

TABLE 1: EXAMPLES OF SOME COMMON PLASTICS AND THEIR MONOMERS [3]

	Monomer		Polymer
Ethylene	CH ₂ = CH ₂	Polyethylene (PE)	-[CH ₂ -CH ₂] _n
Propylene	$\begin{array}{c} \text{CH} = \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$	Polypropylene (PP)	-[$\begin{array}{c} \text{CH} - \text{CH}_2 \\ \\ \text{CH}_3 \end{array} $] _n
Vinylchloride	$\text{CH}_2 - \text{C} \begin{array}{l} \text{H} \\ \text{Cl} \end{array}$	Polyvinylchloride (PVC)	-[$\begin{array}{c} \text{CH} - \text{CH}_2 \\ \\ \text{Cl} \end{array} $] _n
Caprolactame		Poly(E-Caprolactame) (PA6)	-[NH-(CH ₂) ₅ -C(=O)] _n
Tetraflourethylene CF ₂ =CF ₂	Polytetraflourethylene (PTFE)	-[CF ₂ -CF ₂]-	-[CF ₂ -CF ₂] _n

2.1.1 What is polymers?

There are mainly two types of polymers;

1. Natural Polymers
2. Synthetic polymers

Natural polymers are the Bio-polymers where the backbone of the polymers are made of Carbone-carbon bonds where the heterochain polymers have other elements such as Oxygen, sulfur, Nitrogen and so on. Glycogen, Cellulose, DNA, RNA, Polypeptides and Proteins etc. are the examples of natural organic Bio polymers. Natural polymers as well as synthetic polymers can also be divided into two more categories such as; Organic polymers and Inorganic polymers.

On the other hand, Synthetic polymers are the human made polymers which can be classified into four main categories. They are;

1. Thermoplastics
2. Thermosets
3. Elastomers
4. Synthetic fibers

Here, Thermoplastics and thermosets are considered as the main two classifications of Plastics.

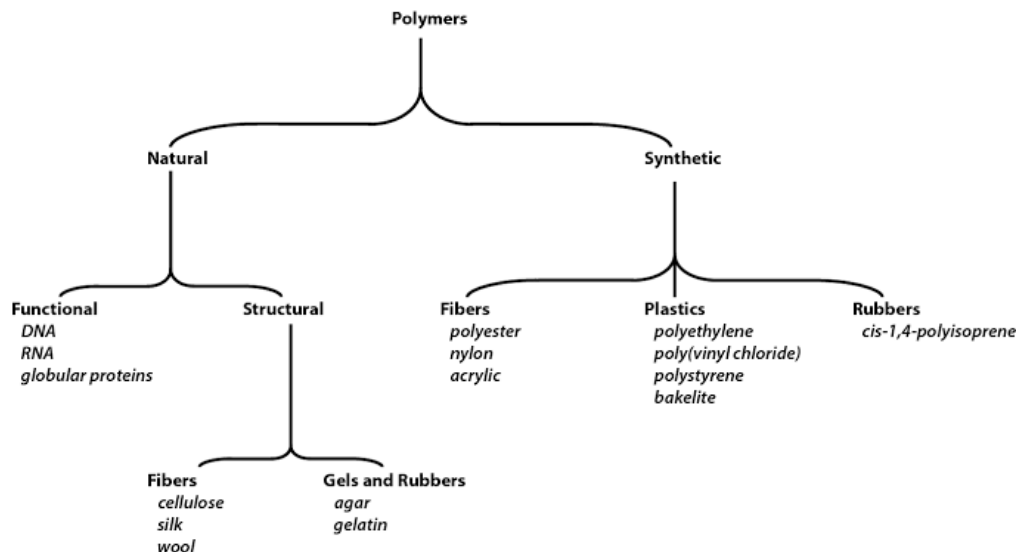


FIGURE 1: EXAMPLES OF NATURAL AND SYNTHETIC POLYMERS [4]

2.2 History of Plastic

In 1860, an offer of ten thousand dollars was given by a U.S. pool and billiard ball company for the designing of the best alternative for natural ivory. [5] Among the competitors, John Wesley Hyatt was one of them who, in fact, was not the winner but developed a cellulose during that time for the competition. Later on in 1869, this product was patented as Celluloid and successfully being used commercially. So, he was the inventor of first synthetic Plastic. [6] Before that, a scientist named Alexander Parks invented a plastic and he declared that in 1962. [7] The material was called Parkestine which can be changed in shape after being heated and remained original when cooled it down. That's why, it has been believed that the development of the plastic was started around 1860.

During the next few decades, more plastics and modified polymers such as rayon were made and introduced. At the very beginning of 20th century, a Belgian American chemist Leo Baekeland developed a complete synthetic plastics for the first time in the history. This Synthetic plastic was named Bakelite. [8]

The years between 1920s and 1930s, are very remarkably known for the development of plastics. The major today's known plastics were invented and designed during that time including nylon, polytetrafluoroethylene known as Teflon, Methyl methacrylate known as Plexiglas and so on.

Wallace H. Carothers of Dupont was the inventor of Nylon [9] and it was developed later on by a chemist named Chemist Julian Hill. [10] In 1938, Teflon was discovered by Roy Plunkett by chance. [11] Also many of the synthetic materials were developed during the World War II including synthetic rubber.

After the war, the advancement of Plastics industries continued their development. In 1953 Polyethylene was developed by a German Chemist Karl Ziegler [12] and the following next year, polypropylene was developed by an Italian chemist Giulio Natta. [13] They were awarded Nobel Prize together in 1963 because of their researches. [14] Polyethylene and Polypropylene are the most commonly used plastics now days. World has been reached in today's position because of the efforts and achievements of 3rd generation during the period of 1978 till 2000.

Still the plastics are being continuously developed and being replaced continuously with the other materials like wood and glass to find out the more advanced plastics and products. Today we are living at the age of polymers and plastics as the new era of modern civilization.

2.3 Features of Plastics

Now a day, Different types of plastic have made our life much easier in different ways than before and even day by day, people are becoming dependent more and more on Plastics. By characteristics, Plastic has durability, versatility, flexibility, inert and so on. Some of the main facts about plastics are;

- ✓ Plastic has high heat combustion
- ✓ Plastics are a very good abrasion resistance
- ✓ Plastic can remain without absorbing much moisture
- ✓ Plastic contains very minimum water than the water content in the biomass.
- ✓ Plastics are available in the local community with attractive colors
- ✓ Plastics are very cheap comparing with other products
- ✓ They can be molded in any shape
- ✓ They very light in weight
- ✓ Plastics are not affected by insects or they do not undergo corrosion.

2.4 Types of Plastics

Generally any type of Synthetic or Semi Synthetic organic Polymer which is consisting of repeating long chains of carbine, hydrogen and other elements is called plastic. Initially plastics can be divided into two basic types of plastics. They are,

1. Thermoplastics
2. Thermosetting plastics.

2.4.1 Thermoplastic

This type of plastics are made of long side chains. The molecules create the bond with each other and make the thermoplastics, but the bond between those molecules are so weak that those can be soften and harden through the given heating and cooling process continuously. But, those chains do not make any kind of changes in chemical structure. This type of plastics can be recycled after using it. The most of the plastics things and products in the earth are made of thermoplastics.

There are different types of Thermoplastics. They have been given below in details;

a. Nylon

It is an anti-ecological cheap substitute which has been used for sild and hemp. This is a very useful plastics for creating fabrics, carpets, musical parts, rope, machineries parts such as screws, power tools and so on.

b. PLA (Poly Lactic Acid)

It is a biodegradable thermoplastic which is derived from renewable and biodegradable resources such as from corn starch, chips, starch, sugarcane or from tapioca roots. It is one of the very important materials for 3D printing with FDM (Fused Deposition Modeling) techniques. [15]

c. Acrylic (Poly Methyl Methacrylate or PMMA)

It has been also knows as Lucite and Plexiglas. It is being used as substitute for glass in motorcycle, aircraft windows, as a replaced of eye lenses and so on.

d. ABS (Acrylonitrile Butadiene Styrene)

It is a polymer which is synthesized from styrene & acrylonitrile in the presence of Polybutadiene. It is used in making many products as examples Toys, telephone etc. [16]

e. PBI (Poly Benz Imidazole)

It is a synthetic fiber which is melted in a very high temperature. This polymer has a very high stability, toughness at high temperature and very good quality of high performance. It has been used to make fabricate for protective apparel, protective gloves for high temperature, aircraft wall fabrics and so on. Very recently It has also been found in fuel cell as membrane. [17]

f. PC (Poly Carbonate)

It is knows as Lexan, Makroclear, Makrolon or as arcoplus. It is very easy to use and easy to mold and also easy to thermoform because of it is easily used in many applications such as as construction materials, as electronic devices. It has also been used as parts of aircraft, data storage components, parts of automotive, security glazing and so on.

g. PES (Poly Sulfone)

It is a specially a engineered thermoplastics with hydrolytic stability and high thermal, good resistance and so on which is a very good elements to aqueous alkalis, salt solutions, mineral acids, oils and greases.

h. PEEK (Polyetherether Ketone)

It has very attractive & good properties such as low flammability, low water absorption, high temperature steam, toxic gases and resistance to radiation. [18]

i. PEI (Poly Etherimide)

It is normally being used in automotive parts, highly performing electrical devices and so on.

j. PE (poly Ethylene)

It is one of the most important and popular plastics to use in various purposes in this modern era. The discovery of this element has made a new starting of a new stage for the development of plastics. High density polyethylene (HDPE) is normally used to make liquid detergent bottles, portable cans, outdoor furniture, water drainage pipes, grocery bags, tubes etc. Medium density polyethylene (MDPE) is being used in packaging, fittings, making gas pipes, sacks and so on. On the other hand, Low density polyethylene (LDPE) is a very flexible plastics which is being used for making milk jug caps, retail stores bags, boxes for transporting & handling goods, household food covering and for many purposes.

k. PPO (Poly Phenylene Oxide)

It is a very high qualified plastics with attractive properties such as impact strength, chemical stability to organic acids and minimum water absorption.

l. PPS (Poly Phenylene Sulfide)

m. PP (Poly Propylene)

It is also a very popular plastic using in our everyday life. It is being used for making of reusable food containers, insulation for electrical cables, safe plastic containers for dishwasher & microwave, sheet for storage bins and stationary folders, for car batteries and also for making many other products too which are being used in our household works. It is also used in medicine as hernia treatments.

n. PS (Poly Styrene)

It is being used for manufacturing of toys, product castings, in making insulation and packaging materials and so on.

o. PVC (Polyvinyl Chloride)

PVC is used in inflatable products such as water beds, pool toys, in construction industries, as roofing sheets, for hoses, tubing, electrical insulation, coats and so on. [19]

p. Rayon

q. Teflon (Polytetrafluoroethylene or PTFE)

Dupont is the brand name for this plastic. It is mostly known as a coating for cookware. It is also used to make containers, pipes, reactive components, as lubricates for sliding parts.

Some Thermoplastics, their examples and properties have been given in below;

TABLE 2: DIFFERENT KINDS OF THERMOPLASTICS [20]

Plastic Name	Products	Properties	
Polyamide (Nylon)		Bearings, gear wheels, casings for power tools, hinges for small cupboards, curtain rail fittings and clothing	Creamy colour, <i>tough</i> , fairly <i>hard</i> , resists wear, <i>self-lubricating</i> , good resistance to chemicals and machines
Polymethyl methacrylate (Acrylic)		Signs, covers of storage boxes, aircraft canopies and windows, covers for car lights, wash basins and baths	Stiff, hard but scratches easily, durable, <i>brittle</i> in small sections, good electrical insulator, machines and polishes well
Polypropylene		Medical equipment, laboratory equipment, containers with built-in hinges, 'plastic' seats, string, rope, kitchen equipment	Light, hard but scratches easily, tough, good resistance to chemicals, resists <i>work fatigue</i>
Polystyrene		Toys, especially model kits, packaging, 'plastic' boxes and containers	Light, hard, stiff, transparent, brittle, with good water resistance
Low density polythene (LDPE)		Packaging, especially bottles, toys, packaging film and bags	Tough, good resistance to chemicals, flexible, fairly soft, good electrical insulator
High density polythene (HDPE)		Plastic bottles, tubing, household equipment	Hard, stiff, able to be sterilised

2.4.2 Thermoset

The bonds between the molecules of thermosets plastics are very strong. This type of plastics is normally formed a cross linked structure during the processing and that's why, these plastics cannot be reshaped or recycled after using.

Different types of thermosetting plastics have been given below;

- a. Bakelite (a phenol formaldehyde resin which have been used in plastic ware and in electrical insulators)
- b. Vulcanized rubber
- c. Polyurethanes (it is used as car parts, print rollers, shoes soles, synthetic fibers, adhesives, mattresses or in coating, flooring and so on)
- d. Polyester Fiberglass
- e. Duroplast (a very strong materials which is used for making car parts)
- f. Epoxy resin (it is used as a materials in many fiber reinforced plastics)
- g. Cyanate Esters (Polycyanurates)
- h. Polyester resins
- i. Urea Formaldehyde
- j. Melamine resin
- k. Diallyl phthalate (DAP)
- l. Polyimides

Several types of Thermosets plastics have been given in below:

TABLE 3: DIFFERENT TYPES OF THERMOSETS PLASTICS [21]

Plastic Name	Products	Properties	
Epoxy resin		Casting and encapsulation, adhesives, bonding of other materials	Good electrical insulator, hard, brittle unless reinforced, resists chemicals well
Melamine formaldehyde		Laminates for work surfaces, electrical insulation, tableware	Stiff, hard, strong, resists some chemicals and stains
Polyester resin		Casting and encapsulation, bonding of other materials	Stiff, hard, brittle unless laminated, good electrical insulator, resists chemicals well
Urea formaldehyde		Electrical fittings, handles and control knobs, adhesives	Stiff, hard, strong, brittle, good electrical insulator

2.4.3 Differences between thermoplastics and thermosets plastics

TABLE 4: THE DIFFERENCES BETWEEN THERMOPLASTICS AND THERMOSETS PLASTICS

<u>Thermoplastics</u>	<u>Thermosets Plastics</u>
They are soften on heating and set on cooling every time	They hardened on heating
The polymer chains are held together by weak force which is called vander waal's force of attraction	The polymer chains are linked by strong chemical bonds
They are soluble in organic solvents	They are insoluble in organic solvents
They expand very much on heating	Their expansion is only marginal due to heat
They are formed by addition polymerization	They are formed by condensation polymerization
they are processed by injection molding	They are processed by compression molding
Scrape can be reused	Scrape can't be reused
It is possible to reshape and recycle	It is not possible to reshape and recycle
Examples: Polythene, PVC, Nylon	Examples: Bakelite, Plaskon, Epoxy Resin

2.5 Manufacturing of Plastics



Plastic is being produced from organic compounds like crude oil, natural gas and so on. During the production of plastics, some toxic chemicals such as acetone, methylene, chloride, styrene, benzene, sulfur oxides, nitrogen oxides, methanol etc. and also some volatile organic compounds are frequently released. These toxic acids cause serious environmental pollution during the time.

As an example, during the production of PET (Polyethylene terephthalate), the air Pollutants nearly 100 times more than by the productions of same quantities of glass bottles. The using of other chemicals during the productions cause also the toxicity of mercury, lead, cadmium and so on. Various kinds of plasticizers, heat stabilizers, barrier resins, colorants and antioxidants are mainly being used during these productions. Burning 1kg of oil creates about 3 kg of carbon dioxide during the production. Following this equation, only for the consumption in USA, the production of bottle requires more than 17 million barrel of oil excluding the energy and transportation. These bottling water production produces more than 2 million tons of carbon dioxide and also it needs 3liters of water to produce 1 liter of bottled water.

2.6 Symbols of Plastics

Plastic has become the parts of one's daily life. Many kinds of plastics in many ways have been used daily. So, it is very important to know the plastics accurately. To identify different kinds of plastics, different kinds of symbols are being used. Some of those plastics are recyclable and some of them are automatically recycled. So when someone knows about the symbol and the numbers of plastic separately which is on the products in every item, it will be very much easy to keep that plastic in right place. So, the symbol of plastics has been given below;

Table 5: Identification Codes & symbols for Plastic Recycling [22]

Symbol	Acronym	Full name and uses
	PET	Polyethylene terephthalate - Fizzy drink bottles and frozen ready meal packages.
	HDPE	High-density polyethylene - Milk and washing-up liquid bottles
	PVC	Polyvinyl chloride - Food trays, cling film, bottles for squash, mineral water and shampoo.
	LDPE	Low density polyethylene - Carrier bags and bin liners.
	PP	Polypropylene - Margarine tubs, microwavable meal trays.
	PS	Polystyrene - Yoghurt pots, foam meat or fish trays, hamburger boxes and egg cartons, vending cups, plastic cutlery, protective packaging for electronic goods and toys.
	Other	Any other plastics that do not fall into any of the above categories. For example melamine, often used in plastic plates and cups.

2.7 Plastic from petroleum or crude oil

It has been mentioned before that Plastics are made of Petroleum based organic compounds such as from natural gas, petroleum oil or from crude oil and so on. Every compounds consist of polymers and the each subunits of polymers is called monomers which is consisting of carbon-carbon bonds with other molecules such as Hydrogen, Oxygen, nitrogen, chlorine, phosphorus etc. “How plastics are produced from crude oil” is being described shortly below;

- Crude oil is refined into ethane, Propane and other petrochemical products such as diesel, fuel gasoline and so on in the refinery industry.
- By applying 760° C temperature, ethane and propane are cracked into ethylene and propylene
- These ethylene and propylene are separated from the other hydrocarbon of petroleum products.
- During the process for further more reaction, these hydrocarbons are mixed with catalyst and form long polymer chain which is called plastic in a polymerization reactor.

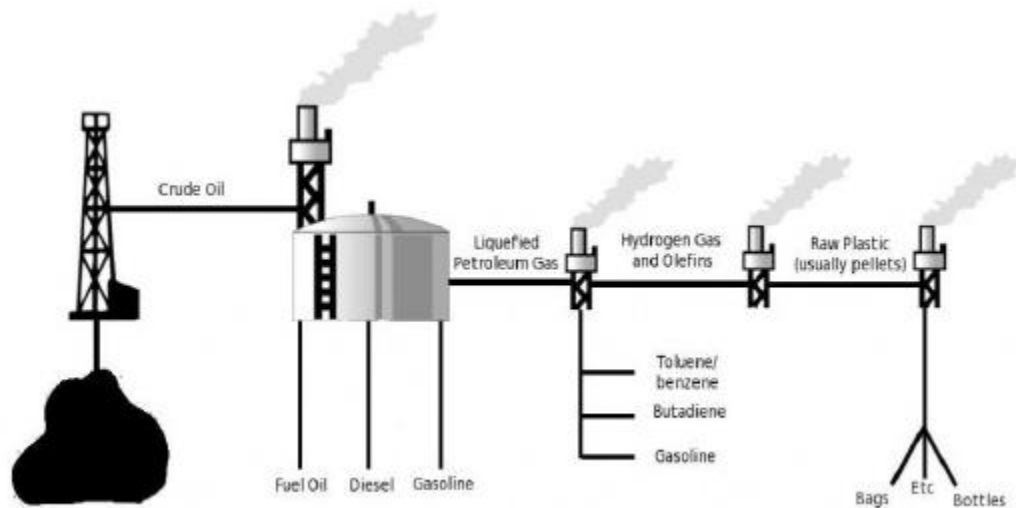


FIGURE 2 : PLASTICS FROM CRUDE OILS [23]

2.7.1 Petroleum Products from Crude Oil

Plastics are long chain of hydrocarbon components. After being heated, they have been melted down and their hydrocarbon bonds are broken into smallest numbers. Below there are some level of hydrocarbons i.e. petroleum products that are produced from plastics or from crude oil in different stages and at different temperatures;

TABLE 6: PETROLEUM PRODUCTS FROM CRUDE OIL

Hydrocarbon level	Products
C 1-4	Gas. Boiling temperature below 0.
C 5-7	It is Very light petroleum products, that's why it is so easily vaporized. These clear liquid is called naphtha. Used as solvent. Dry cleaning fluids, paint solvent, quick drying products are made from these liquids.
C 7-11	Gasoline. Vaporized below boiling point of water.
C 12-15	Kerosene
C 16-18	Lubricating oil. Does not vaporize at normal temperature level.
C 18 <	Solid

2.8 Manufacturing process of plastic

There are many kinds of process to produce plastics. Injection molding process, Extrusion process, Blow molding process, injection blow molding process and extrusion blow molding process are the main five plastic manufacturing processes. These all processes are being described shortly below:

2.8.1 Injection molding process

Injection molding process is one of the most important popular manufacturing processes for producing plastic products in Plastic industries. Plastics products are produced from almost all kinds of Thermoplastics and thermosets plastics by this process. It is the process where high pressure and certain temperatures are used to heat the polymers into a mold cavity and then solidifies there. This is the most popular plastic manufacturing process, even more than extrusion process because of the possibilities of making complex and more cross sectioned products in this process well as producing. By this process, it is also possible to make the products with little part by part variation. For many complicated parts such as the medical injection tubes, injection molding process is the one & only process to produce those. Injection unit, Mold, Clamping are the major

three unit of an injection molding machine. [24] Bottle caps, packaging, pocket combs, Wire spools etc. can be made by this process.

2.8.2 Extrusion process

Extrusion process is the one of another popular manufacturing process of plastics. This process can be done mainly in below two ways,

1. extrusion can be used to shape the parts directly after the mixing
2. An extruder can be used as a melting device into the system which is coupled with others shaping processes.

Normally in the direct method, an extruder is placed at the end of the extruder machine. The basic idea of extrusion process always remains same. It is always pushing the molten plastics by the pressure in heated barrel through the dies to the desirable shape. After that the molten plastic is cooled down by the air or water pots to solidify and cut into small units as required. Pellet, films, sheet and tubes can be produced by this process. [25]

2.8.3 Blow molding process

Blow molding process is a plastic forming process mainly 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 desirable shape

2.8.4 Injection Blow Molding Process

In this process, the parison (Molten plastic) is injected around a core pin by an injection-molding machine. Then the formed parison is transferred to another machine named 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. [26]

2.8.5 Extrusion Blow Molding Process

The molten plastics are formed by forcing the plastic through an extrusion die by this process. After that, the two-part mold closes on it. Then the parison (molten plastic) is pinched off at the top and bottom and then 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. [27]

3. Plastic Recycling

3.1 Overview of plastic recycling

Plastic can be used for multiple uses in multiple times. Thousands billions of plastics have been being produced every day in the world. It is very easy to throw all those plastics products to the garbage or trash without having a 2nd thought, but human are the most responsible creations in the history for the nature. Everyone should be very careful to take care of this beautiful planet for themselves & for the future generations too.

Plastics have been discovered and being products by human for their own uses, so this is a very compulsory and necessary fact for human to have clear monitoring system on this issue so that any other creations or creatures can't be harmed because of those. Unfortunately planet is suffering a lot because of wastes of plastics and because of lack of proper recycling systems of each plastic. So, this is very important to have an ideal process for plastic recycling.

Plastic recycling is the process of reusing waste, unused or damaged plastics by reprocessing the materials into useful products or to something else which can sometimes be completely different from their original state. This is the process of using previous materials in producing new materials which might be similar, semi-similar or totally different from its original shapes, values or states.

Plastics recycling is gaining popularity day by day because of its advantages in this modern societies,

- Recycling of Plastics can save more than 750 kg of Oil
- It reduced the consumptions of energy
- It also reduces the amounts of solid waste from mixing with landfill
- It reduces the emissions of Carbon dioxides (CO₂), nitrogen oxide (NO_x) and sulfur dioxide (SO₂).
- More than 8% of the world's oil production is used to produce the non-renewable fossil fuels plastics. Plastic recycling process is helping to reduce this production too.
- It inspires the process to protect the environment from being polluted.
- Hundreds of millions sea creatures are killed every year because of throwing plastics bags and other plastics garbage into the ocean apart from recycling.
- It keeps society clean and safe



FIGURE 3 : PLASTIC RECYCLING PROCESS OVERVIEW [28]

The most popular plastics products for recycling are PET (polyethylene terephthalate) bottles and HDPE (high-density polyethylene) jugs. The percentages of plastics recycling process has been increased every year since 1990.

Even, only in USA, the total plastics wastes were at least 33/6 million tons where only 6.5% were recycled, 7.7% which is 2.6 million tons were burned form energy and rent of 85.5% (28.9 million tons) were thrown away. [29]

So, the world now a day is unimaginable without plastics as well as without the plastics recycling continuous process. It is and it has to be popular in this modern era undoubtedly.

3.2 Types of Plastics recycling

There are 4 types of plastic recycling:

1. Primary plastic recycling
2. Secondary Plastic recycling
3. Tertiary Plastic recycling
4. Quaternary Plastic recycling

The primary plastic recycling is happened for those plastics which is normally products. When consumers don't need to use any plastics products anymore, if it can be used then its recycling as a product. By constructing those by different color, it is possible to make this product's life durable too.

The secondary plastics recycling are that kind of plastic recycling where plastics can be used as raw materials for making new plastics or as substitutes of wood, iron or other materials. Tertiary process is that kind of plastic recycling process which is normally involving producing basic chemicals & fuels from plastics.

The final process of plastic recycling is Quaternary plastic recycling process which is used rapidly now days. Primarily, energy is produced by this process from plastics by burning. It is presently a widely used process because of having high heat content in most plastics. More than 900 degree temperatures is used in this process to make energy. By Quaternary plastic recycling process, more than 75% in weight and more than 85% in volume of waste can be reduced and rest of materials can be dumped in landfills.

TABLE 7: DIFFERENT TYPES OF PLASTIC RECYCLING [30]

Terminology used in different types of plastics recycling and recovery.		
Definitions	Equivalent ISO definitions	Other equivalent terms
Primary recycling	Mechanical recycling	Closed-loop recycling
Secondary recycling	Mechanical recycling	Downgrading
Tertiary recycling	Chemical recycling	Feedstock recycling
Quaternary recycling	Energy recovery	Valorization

3.3 Stages of Plastics recycling

The whole recycling process can be divided into below five stages:

- Stage 1: Collecting & sorting the plastics
- Stage 2: Washing waste plastics (cleaning and drying)
- Stage 3: Shredding the plastics
- Stage 4: Identify all plastics according to their classifications
- Stage 5: Extruding

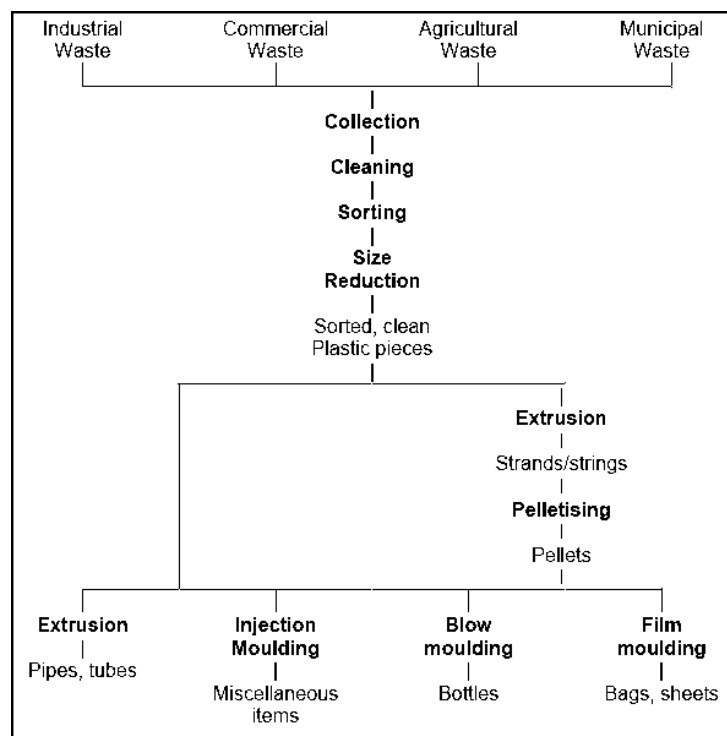


FIGURE 4 : PLASTIC RECYCLING PROCESS [31]

Stage 1: collecting and sorting the plastics

This is very important to know all kinds of plastics according to their codes and to sort those separately according to their symbols. This is the first stage of recycling process. This process has mainly need to be previously done by consumers which is actually the initial starting point of the whole process. For that, they have to learn the correct disposal procedures for their trashes and do all necessary presorting. For examples, all bottles, caps have to be collected and sorted to make the process easier for machinery.



FIGURE 5 : SORTING OF PLASTICS [32]

All plastics wastes need to be collected by the companies of the city who are actually responsible for recycling. After arriving plastics at the recycling plant, all plastics have to be sorted again. Plastics recycling process is normally complicated process than any other materials recycling process such as Metal or glass recycling because of the mixture of different types of plastics. Moreover, mixed plastics can't be used in manufacturing at the same time. So, therefore, that's why, all plastics recycling companies has to go through this stage carefully. Through this sorting method, plastic wastes are separated into different categories before going to the next stage in recycling process.

Stage 2: Washing waste plastics

After the sorting and the selection of plastics waste separately, the cleaning process can start. At this stage, all paper labels, adhesives, labels on plastics bottles, containers need to be removed completely by washing, otherwise those will lower the quality of the finished recycling plastics products.

Stage 3: Shredding the plastics

After washing all those plastics, plastic wastes are taken, loaded and put together to a conveyor plant or directly to a big hoppers which is rotating towards metal teeth that cut and rip those plastic waste into small pieces and pellets which are afterwards ready for testing.

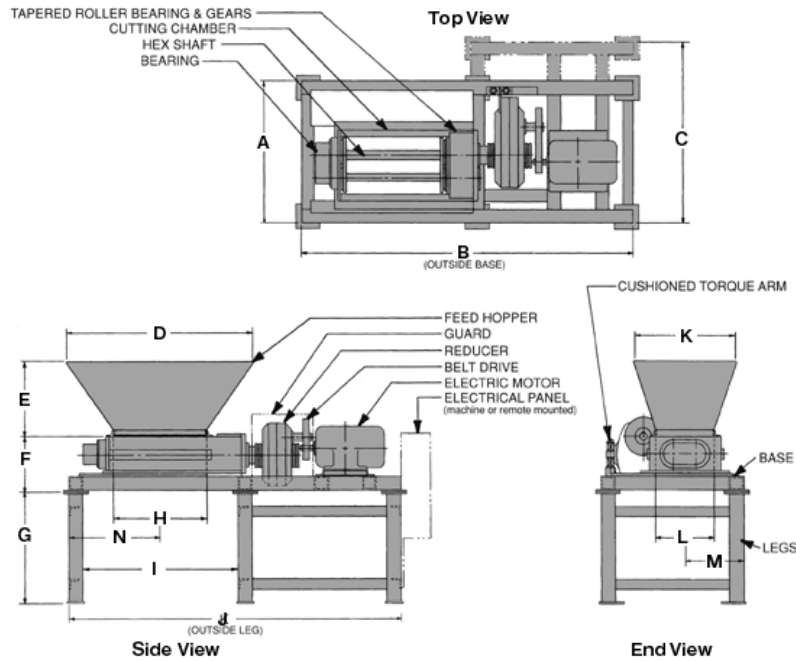


FIGURE 6 : A PLASTIC SHREDDER ASSEMBLY [33]

Stage 4: Identify all plastics according to their classifications

After stage 4, it is time to have chemical test for those plastic waste and labelled those as their specification. At this stage, those grade of plastic can also be used to add to a mix of virgin plastics in the manufacturing or those plastics can be further recycled.

Stage 5: Extruding

The last and final stage of plastic recycling process is the extruding. At this stage, the clean shredded plastics is melted and extruded into the form of pellets. After the melting and extruding, it is then go to the production and the manufacturing of the next lot of plastics products.

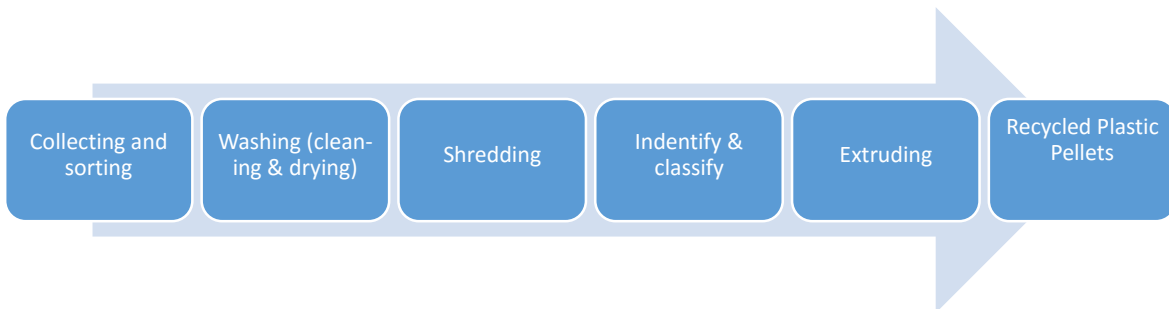


FIGURE 7: THE STAGES OF PLASTIC RECYCLING PROCESS

4. Plastic industries in Bangladesh

4.1 Country profile ^[34]

Country name: The people's republic of Bangladesh

Capital: Dhaka

Location: North-east south Asia

Area: 147,570 square km.

Climate: Tropical

Time zone: GMT +6

Population: 156.6 million (2013)

Religion: Islam, Hindu, Buddhist, Christian and others

Language: 95% Bangla, English is widely spoken.

Political situation: Democratic

GDP per capita: 3581 dollar

Currency: Taka. 100 Taka ~ 1 Euro



FIGURE 8: BANGLADESH IN WORLD MAP [35]

4.2 The history of Plastic industries in Bangladesh

The history of Plastics in Bangladesh is not so old. Alike with the part of the world, Bangladeshis are now a day involved with products made by plastic in many ways. In that way, plastics are playing a great and important role in our life from morning alarm clock to dinner food tables, from food plate to Laptop or desktop PC, from Rickshaw to airplane and so on. Plastics are used everywhere in everyone's life in this modern era which is one the biggest beauty and easiness of life of this modern civilization. Even, day by day, all people are becoming dependent on the use of plastics because of the characteristics of plastics such as its durability, flexibility, versatility, inert and so on.

The plastic industries in Bangladesh are relatively very new comparing with the other industries like Textile and leather industries. Plastic industry has begun its journey like a small industry in 1960's. Bangladeshi people observed a milestone and rapid development of plastics industry in Bangladesh since then i.e. after 1990's. The development of plastic industries in Bangladesh have been showed in below Table – 1;

Table 8: Plastic's History of Bangladesh [36]

Year	Technology and Products
1960's	Small products such as toys, bangles and photo frame where made using handmade molds. Plastic spare parts for jute mills.
1970's	Automatic machines were installed to manufacture household utensils such as plastic jugs and plate.
1980's	Film blowing machines to manufacture plastic bags.
1991's	Plastic accessories especially hangers for exportable garments.
2000's	Molded plastic chairs and tables. Water tank made by rotation molding. Locally developed machines (shredder, extruder, and pelletizer) for recycling plastic wastes.

4.3 Remarkable features of Plastic industries in Bangladesh

Plastics are kind of engineered materials which are produced as very widely type of products to meet the domestic need in Bangladesh. They have already being played a very important role in Bangladeshi industries sectors during last two decades. And still the growth of plastics industries in Bangladesh are like mashroom because of ongoing local, national and international demands. Bangladeshi plastics industries are normally importing polymer granules.

During the period of 1960 to 2009, the import of polymer increased from few thousand tons to three hundreds thousands tons per year. At the present, the consumption of imported polymers & recycled polymers in total is more than 750 000 tons. In that case, the consumption of per capita plastics in Bangladesh is 5kg per year against the world (average 30 kg per year) where the per capita consumptions in India and Asian countries are respectively more than 8kg and 17 kg.

There are about more than 3000 manufacturing units in Plastic sector which are almost more than 97% belongs to the SMEs (Small & Medium Enterprises). The plastic sectors are contributing almost more than 1% of total country's Gross Domestic Product (GDP) and have created employments for more than half a million people. In the below table, more information on Plastic sectors in Bangladesh has been shown;

TABLE 9: PLASTIC SECTORS IN BANGLADESH, SOURCE: UN-ESCAP REPORT-2009 (UPDATED) [37]

Domestic Markets	Tk. 7,000 Crore (US \$950 million)
Per Capita Plastic Consumption	About more than 5 kg/Year
Direct Export Earning	Tk. 500 Crore (US \$69 million)
Deem Export: RMG Accessories	Tk. 2000 Crore (US\$286 million)
Manufacturing Units	medium and large plastic manufacturing units operate across the country
Recycling Sector	There are 300 small units in Dhaka City which recycle about 138 tonnes/day
Growth	20 percent per annum During 1990's
Employment	Half a million workers are got employed in the sector

4.4 Locations distributions of Plastic Industries in Bangladesh

There are more than 3000 plastics in the country now a day. Out of them, 1967 factories are small, 981 factories are medium where the rest of 52 factories are large companies which are dealing with the international market as well.

There are 64 districts in Bangladesh and Dhaka is the capital of the country. So, most of those plastics companies (65%) are based on the capital region. On the other hand, some few plastic industries have also been situated in port region like Chittagong (20%) and in industrial city named Narayangang (10%), a large trade center of the country which is very close city to the capital Dhaka as well. There are also some plastic industries (5%) situated in other cities of the country such as in Khulna, Sylhet and so on.

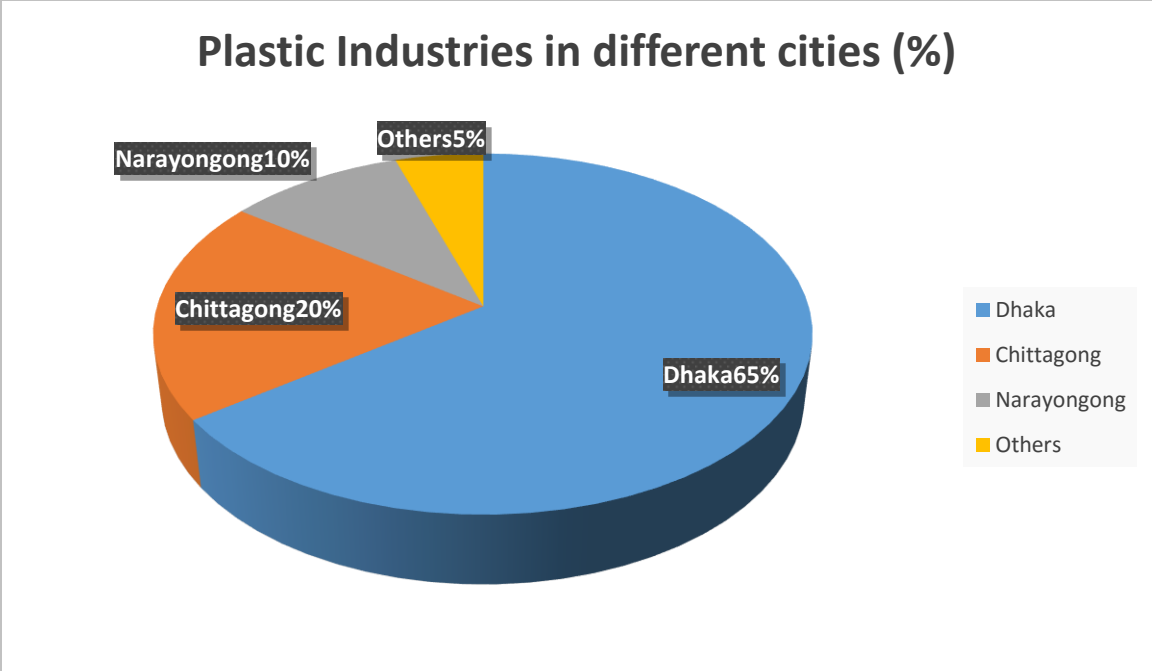


FIGURE 9 : FIGURE 8: PLASTIC INDUSTRIES IN DIFFERENT CITIES OF BANGLADESH

4.5 Plastic Products used in Bangladesh

Plastic are being used in Bangladesh for different kinds of purposes. Now a day, the utilization of plastics ranges from sports items to various kinds of vehicles, from household’s items to office accessories, from soft drink bottles to refrigerators, from cellphone-recorders-various devices to television sets and so on.

Bangladesh is a riverine and agricultural country. Agriculture is the single largest economy of the country where now various kinds of plastic tools are being used in this purpose too. On the other hand, the highest users of plastics in the country are industries related to packaging, water managements and infrastructure.

Plastics are essential materials for our daily life now days which are used in varieties of applications, such as:

- Household Applications
 - Bucket
 - Jug, plate
 - Plastics pouches
 - Wraps refrigerators dishwashers
 - Dishes
 - Glasses

- Electronics and electrical equipment
 - Irons
 - Tea or coffee makers
 - Mixers
 - Cookers, rice cookers
 - Microwave ovens
 - Food processors
 - Electric switches
 - Wires, electrical cables
 - Connectors
 - Regulators
 - Laptop, desktop, PC
 - Computer accessories
 - Telecommunication equipment

- Accessories for RMG (Resource Management Groups)
 - Bags
 - Hangers
 - Packaging materials

- Packaging
 - Various kinds of products packaging
 - Rigid plastics which are used in protection of the products
 - Flexible plastics are chosen for convenient paramount

- Healthcare
 - Toiletries such as soap cash, tooth brush and so on
 - Medical accessories such as blood bag, saline bag, injection, medicine container

- Building and Construction
 - Plastics pipes
 - Doors
 - Toilet flush, bathroom units
 - Insulation
 - Plumbing
 - Siding, flooring

- Fixtures
 - Glazing
 - Various kinds of Tools for the constructions
- Agricultural Products
- Plastics pipers for the irrigation
 - Plastics films for shedding crops
 - Different kinds of tools for irrigation
- Industrial Applications
- Engineering parts
 - Office accessories
- Furniture ware
- Chair, tables, tools
- Tableware and kitchenware

5. Plastic recycling in Bangladesh

5.1 Present situation of plastic recycling

Plastic recycling process in Bangladesh is relatively sound environmentally. Manufacturing of plastics waste is a very challenging problems now days for every country as well as for Bangladesh too. Polyethylene's (PE) products are the most popular plastics products in Bangladesh. During the production of plastic products of PE, carbon monoxide is released which is caused serious harm in environment. The plastic waste management of PE bags has been a serious environmental issues for Bangladesh. These plastics products had created an unmanageable serious situation throughout the country in 2002 due to lack of proper management and recycling process because of what the parliaments of the country passed a bill banning the products. Even after these several years, still Bangladesh is facing the same problems in a greater face.



FIGURE 10: COLLECTION OF PE BAG FOR RECYCLING [38]

At these present days, Lack of proper management of this thin plastic products has created a huge negative image on overall plastics industries in the country. Moreover, this causes a serious effect on exporting plastics products and goods too because of the questioning on the standard and the quality of Plastics products as well as the plastic waste management systems of plastic industries in Bangladesh.

Interestingly plastic recycling has also developed into a significant and sizeable way of the plastics industries in and around Dhaka. Availabilities of river water and very low of transportation costs have made the whole recycling units and process in biggest Dhaka region very economically attractive and development oriented. More than 400 small units are recycling around 150 metric tons of wastes a day in this region.

5.2 Disposal

Basically the Pollution that occurs in the disposal stage when plastic wastes fail to reach landfills. Burning of plastics releases many harmful toxic gases such as chlorine, sulfur, phosphorus substances, heavy metals and emits noxious gases like furans & dioxins which cause of serious cell damages, health problems including the damage of reproductive and nerve systems, difficulties and even cancer.

Recovery of cans is the best alternative for disposal. Plastic disposal has many negative impacts on the nature too. For that recovery and recycling is the best option to prevent that. So, by realizing these facts, the importance and public awareness of plastic recycling in Bangladesh is increasing day by day.

5.3 Plastics consumption rate in Capital Dhaka region

TABLE 10: PLASTIC WASTE RECYCLING AND ITS OPPORTUNITIES IN BANGLADESH. WASTE CONCERN CONSULTANTS [39]

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 total consumption for Dhaka city region is more than fifty thousand tons per year of which more than 33000 tons (almost 66% of total consumptions) recycled per year. Traditional plastics are non-biodegradable plastics consisting of different kinds of polymers such as carbon, hydrogen, chlorine, nitrogen and some other elements too. Because of this elements, it takes hundreds of years to get degraded and needs big landfill to dispose.

Now there are more than 35 million people living in Dhaka City. So disposal of Plastics is increasing day by day. By Dhaka City Corporation, it has been showed that the total consumption of plastics in that region only is more than 3500 tons which is on average 4.15% of the total. [40] There is not so many ways available to recycle all of it. So, parts of those waste is recycled in some very selective process when the rest goes here and there. Almost more than 50 500 tons/year plastics waste have been collected for recycling when almost 35000 tones/year is soiled or goes here and there which is almost 7% of total.

5.4 Benefits of Plastics recycling in Bangladesh

A country can be benefited by plastic recycling process in many ways which have been described shortly before. Bangladesh is a densely populated country and more than 150 million people are living in this country what has made this country the eighth most densely populous country in the world. Bangladesh has more than 336000 tons plastics waste available each year for recycling where only 69% of total waste is recycled. So, a proper plastic recycling process can bring huge benefits for Bangladesh. The benefits of plastic recycling in Bangladesh can be described in below three sections:

5.4.1 Economic benefits

The plastic industries and companies of Bangladesh are mainly producing Plastic products from raw materials and they need to import most of those raw materials from abroad. So, if those industries are starting to reuse plastics and make more emphasize on making plastic recycling process stronger and modern, then of course, they can save huge amount of money yearly. At the same time, the price of the products will be more reduced and the product of plastics will be increased. So, eventually customers can buy more plastics products, the companies will get more customers and will make more money. At the same money, more job opportunities will be available for the people of Bangladesh. By that way, it can also reduce the unemployment rate of Bangladesh tremendously. People can earn their livelihood without being so much educated about this very easily.

5.4.2 Environmental Benefits

It has been mentioned before that Bangladesh is the eighth most densely populated country of the world. At the same time, Bangladesh is naturally a most beautiful country and it is called the riverine country of the world. . It has very fertile lands. So, the environmental issues are very important key factors for Bangladesh.

Now a day, using of traditional plastics i.e. non-biodegradable wastes are making big impacts on this fertile lands, Bangladesh is losing its fertility because of using these plastics without having a proper plastic recycling process alarmingly. There are many kinds of wastes which can be turned and used as composts. These composts can be used as viable sources of energy in Bangladesh.

On the other hands, plastics like PET, PE bottles etc. are non-biodegradable which can cause many effects on environments and must have to be recycled properly.

Petroleum or crude oils with many other adhesive are used to produce plastics. So, the energy for the production of virgin plastics is much more than the energy used to make plastics from recycling. At the same time, the products of virgin plastics causes bigger amounts to carbon dioxides emissions in the environment than the productions of recycled plastics. The emission of carbon dioxides is one of the big reason of global warming.

As Bangladesh is the riverine country, so it is very important to take necessaries steps to prevent the water pollution. Plastic recycling process is one of great steps to prevent this pollution too. Recycling also help to increase the fertility of the land. Using of adhesives and chemical in the production of virgin plastics can also be reduced or prevented by increasing the productions of recycled plastics. The polymers of plastics can leach those chemicals both the surface & under surface of water and decrease of the fertility of Soil which can be protected by plastic recycling too.

5.4.3 Social Benefits

People of Bangladesh are depending on plastics in many ways. So, plastic recycling process is one the most prioritized things to focus on. This is very common scenario that people of the country are using plastics and throwing those on the rood or dustbin which later litter the streets, block-age the sewerage systems and also bind the water removal system in the drain that cause more mosquitos and flies. So, the raising awareness among the people and a proper plastics recycling process are mandatory for Bangladesh to keep society clean, beautiful, healthy and place to live.

6 Prospects of Plastic industries in Bangladesh

6.1 Competitiveness

Comparing with the paper, jute and iron industries in Bangladesh, Plastics industries are totally new. Within these past decades, plastics have made their own huge markets in Bangladesh and also remarkable effects on other's industries too. At this point, there is the highest on a per capita basis plastic's consumption in the country.

Bangladesh has a very competitive benefits and advantages for plastic industries because of cheap labor, its big population i.e. huge markets and well transportations to carry. Some prospects are given below:

- More than 150 million people are living in Bangladesh and plastics have become a very popular, daily most usable and important products for all of them. Even, at this present situation, the demanding of plastics are increasing at the same time with the increasing of population in very alarming rate. So, the prospects of Plastics industries in Bangladesh are very high.
- Undoubtedly Business related to plastics are very profitable business in Bangladesh if it can run according to the demands of all classes people living in the society.
- Bangladesh is a riverine country which has made the country a favorable business environment and deemed competitive for plastic sectors.
- Bangladesh is a developing country whose economy is a growing economy. Bangladesh has also taken a place in N 11 (Next eleven countries of the world) list which has showed the economic strength and growth of the country too. Plastic industries are making a big effect on this too.
- Plastics now are very popular products among all classes of people living in the society. Now a day, it has very high demand among the people of high, middle and lower classes in the society. For this reason, some developed countries like Japanese and Chinese plastic companies have huge opportunities and interest on doing business in Bangladesh too.
- The consumption of plastics rate in Bangladesh is more than 5kg/year where the world has average of 20 kg. This comprising is showing a huge potentiality for the growth of Plastic industries.
- Bangladesh is also very famous in the international markets for its cheap labor and sometimes cheap materials costs too. It is also experiencing the fastest growing and development of recycling industries for plastic wastes. These are some of the main reasons for Bangladesh to have brighter future for Plastic industries. It shows that Bangladesh are potentially having and have to take these advantages to provide competitiveness in the global markets.

Now those industries in Bangladesh just need to focus on the high standard qualities on making plastic related products and also to maintain a proper plastic wastes recycling system in order to be more competitive in the global market.

6.2 Raw materials of Plastics

Different kinds of Polymers are the main elements of plastics. Although the plastic industries and companies are flourishing in Bangladesh day by day, but there is no product of polymers in the country. The domestic plastic industries are mainly using imported raw materials of polymers granules. Nearly more than 0.75 million tons of Plastic raw materials which is now as Resin is used for plastic industries and companies in Bangladesh. India, Saudi Arabia, Malaysia and some parts of Asia are the main exporter for these materials to Bangladesh.

So, it's very important now for Bangladesh to get dependent on producing raw materials for fulfilling own demands so that those plastics industries can be self-sufficient to produce plastic products without depending on others or never need to import raw materials from outside of the country in near future.

6.3 Exporting plastics products

Undoubtedly, one can say that Bangladesh has a huge big opportunity to export plastic products after fulfilling domestic needs. In that way, Bangladesh can earn more foreign currency to strengthen its national economy. It has been mentioned before that the big plastic industries are now days exporting plastic products to abroad and in that sense, Bangladesh is doing very well in trade plastic products.

Bangladeshi plastics industries are producing different kinds of plastics product, among which, Chair, tables, hanger, toothbrush, jug, glass, toys, switch, wardrobe, baskets, Ball points pen body, Sofa set, electronics, garments related oven, garments related products accessories, plastic bags, various kinds of industrial plastics products etc. are being exported from Bangladesh with high international quality and demands.

United States of America, United Kingdom, Many EU countries and Malaysia are the main Exporter countries of Plastic products from Bangladesh. On the other hand, various kind of plastic products are also exported to SAARC members' countries such as India, Nepal, Sri-Lanka, Maldives, Pakistan, Afghanistan and also Bhutan. [41]

As per export Promotion Bureau (EPB), in 2013-2014 Bangladesh has earned around \$85.70 million by exporting plastic products. The amount was \$84.50 million in 2012-2013 and in 2011-2012 it was little over than \$88.69 million.

The following table represent the trend of plastic export earnings, its share to total export and its export growth from 1999-2000 to 2014-15 at latest.

TABLE 11: BANGLADESH EXPORT STATISTICS (1999-2000 TO 2013-2014) BY EXPORT PROMOTION BUREAU, WWW.BBS.GOV.BD\\ AND AUTHOR'S CALCULATIONS [42]

Year	GDP (Million US \$)	Plastic Export Earnings (million US \$)	Share of Export (%)	Growth of Export (%)
1999-2000	30224.125	25.48	0.44	
2000-2001	32322.580	18.81	0.29	-26.2
2001-2002	34828.186	11.36	0.19	-39.61
2002-2003	38318.526	12.34	0.19	8.7
2003-2004	42448.047	21.43	0.28	73.7
2004-2005	47258.437	40.58	0.47	89.33
2005-2006	52934.569	46.71	0.44	15.10
2006-2007	60232.514	46.42	0.38	-0.6
2007-2008	59579.883	52.36	0.37	12.8
2008-2009	78565.573	52.39	0.34	0.06
2009-2010	88265.799	50.63	0.31	-3.36
2010-2011	100395.703	68.76	0.29	35.80
2011-2012	134519.425	88.69	0.36	28.99
2012-2013	152841.023	84.51	0.31	-4.3
2013-2014	172217.917	85.70	0.28	1.41

For each and every of the country of the world, Gross Domestic Profit (GDP) increases from year to year. Although the previous years it was observed a very slow growth but it is increasing rapidly in recent years. It has been showed from the above table that, the GDP of 2013-2014 is more than \$172 billion which is a very high figure comparing with the amount of 1999-2000 which was little more than \$30 billion. So, by observing each data of the above table, it can be said that the plastics products, its waste and quality have a very significant impact on total GDP of Bangladesh.

The following figure represent the trend of plastic export earnings and export growth from 1999-2000 to 2014-15 at latest.

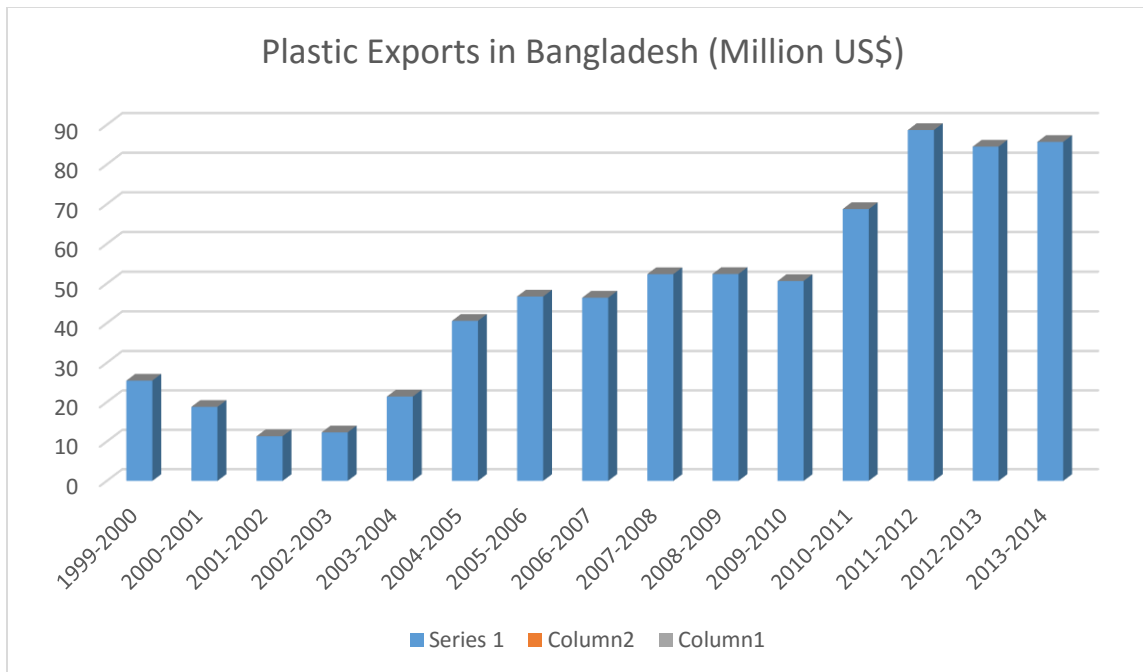


FIGURE 11 : PLASTIC EXPORTS IN BANGLADESH (MILLION US\$)

The above bar chart has given an idea about the trend of plastic export earnings about the last 15 years. It shows that the earning was highest in 2011-2012 which was more than USD88 million and lowest amount was in 2001-2002 which was less than USD 11.5 million. The overall data has given a total view about the upward trend of export earnings.

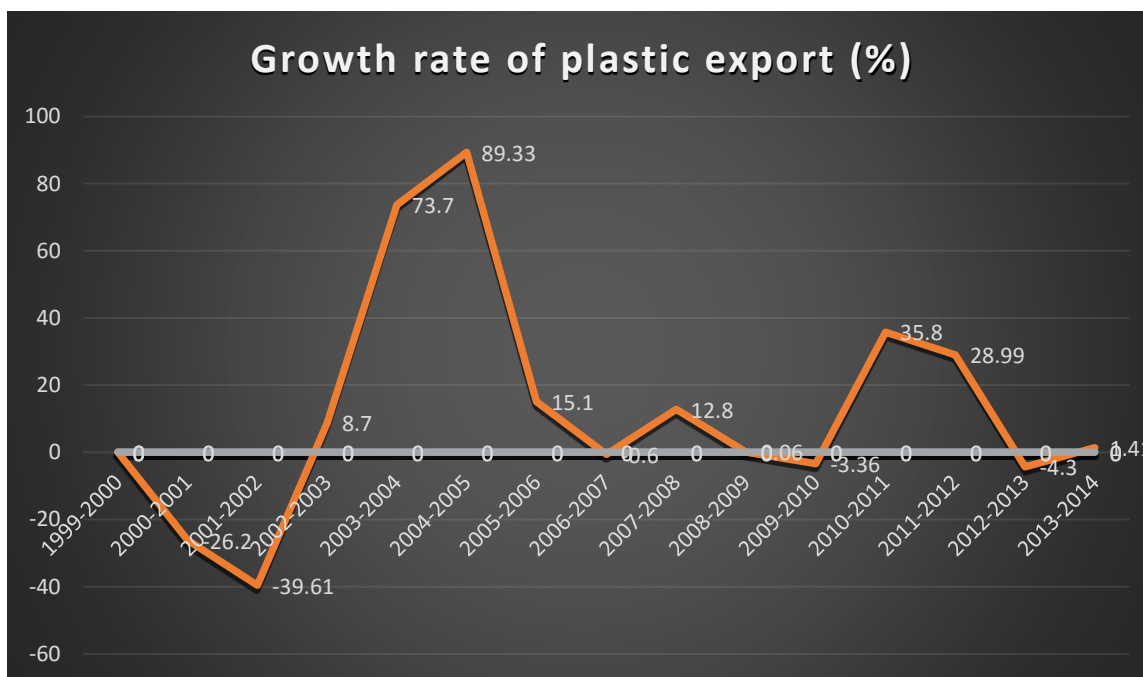


FIGURE 12 : GROWTH RATE OF PLASTIC EXPORT

6.4 Future Potential markets in Bangladesh

In 1990, the consumptions of Plastics in Bangladesh was around 15000 tons and it took more than 20 years now to reach an increase of 50 times which is now 750 000 tons. As it has been mentioned before that present the per capita consumption of plastics in Bangladesh is 5kg/year as compared with the world on average of 20kg. By observing this 25 years of survey from past till present, it can be easily said that there is a huge potential market and growth of Plastic industry in the country.

6.5 Constraints

There is no doubt that plastics industries are growing in Bangladesh positively. At the mean times, they also have some constraints. The major constraints for plastics industries in Bangladesh mainly occur because of the lack of institutional arrangements to the plastics sectors. As a result, there is almost no supportive services are available for the following:

- ❖ Specific Mold design as well as mold making for specific plastic products
- ❖ Development of skilled manpower
- ❖ Proper management and ideal system of plastics wastes
- ❖ Consultancy services for technical supports
- ❖ Negative environmental images for plastic industries
- ❖ Testing services for quality control services
- ❖ Trouble shooting for the operation of processing machine
- ❖ Proper quality of infrastructure

Those above mentioned constraints are considered as the major constraints for plastic industries and sectors in Bangladesh. Those need government policies supports and proper systematic intervention.

6.6 Major findings and recent initiatives

- Bangladesh has saved more than 1 billion US dollar only in 2014 from using of 70% of plastic recycled wastes by avoiding the importation of virgin resin which is even growing each year.

- Government of Bangladesh is providing 10% cash incentive on exporting PET which is encouraging recycle industries to export Plastics wastes such as PET bottles and products from Bangladesh and this is worth more than 200 million US dollars.
- Traditional plastics are non-biodegradable. So, it is essential to promote recycling of plastic waste and to reach 100% recycling rate leaving no amount of plastic waste to be land filled which cause serious damages of environment.
- The recycling of the Poly Ethylene Terephthalate or PET products such as bottles have grown into industries in Bangladesh over past several years. Street children in the country forage the used packaging for food products, beverages and edible oils sell them to factory owners.
- The flakes made into fibers are used as base material for clothing, carpets, pillows and polyester sheets. Now a day, these are also exported to many countries such as China, Vietnam, South Korea and Thailand etc. and were earned more than US208 million only in 2014.
- PET flakes are also being used to produce geotextile in local industries which is being used as dams at river banks and also to prevent land erosion.
- Bangladesh has launched The National 3Rs (reduce, reuse and recycling) Strategy on Waste Management in 2010. [43]
- In 2012, the Department of Environment of the Government of Bangladesh has initiated a pilot source segregation of waste project by adopting the concept of 3Rs (Reduce, Reuse and Recycling) that is operating in Dhaka and Chittagong by using the Climate Change Trust Fund. [44]
- Plastic Waste Recycling Plants including the Bangladesh Bank's Green Banking are refi-nancing scheme to promote Green Projects and Products in the country.
- Bangladesh has taken necessary steps to improve the relation between NGO's and Policy makers for Plastic sectors who were against the usage of plastics.
- Bangladesh has recently formed a waste management foundation and is also planning to set up a plastic industrial park.
- Necessary steps have also been taken to raise the public positive awareness about plastics and also arranging continuous dialogue with major media and regulatory bodies to promote the positive image of plastic industries.

7 Questionnaire

A questionnaire has been made for several companies to get overall ideas on the plastic industries and companies in Bangladesh. Almost 5 companies have been contacted by author. Among them, some companies were very much co-operative with the author and some of them just gave some ideas on this subjects. Five questions were made for this questioner and were asked all those companies for the better understanding the real picture and situation of Plastics industries in Bangladesh. Same procedures have been followed almost for all of those companies and author got proper interest and replying from 3 of those contacted companies.

7.1Interviews

Author got some clear concepts and ideas about those companies from their website first. Since, there isn't too much public information regarding those questioners, so it was necessary to contact with the companies in some other ways such as by phones, emailing and also by visiting. 5 questions were made because of these interviews where all of those companies were asked the same questions. Those questions for the interviews were:

- a. What are you using as raw materials of Plastics
- b. What do you do with the waste of plastics
- c. What are the customer's opinions about the recycled plastics and raw plastics?
- d. What are the challenges that plastic industries are facing now a day?
- e. What are the future market for plastic industries in Bangladesh?

The whole interviews were conducted in Bengali where author has translated those into English. These three companies are:

1. EREBUS Plastic Industries
2. National Polymer Industries group
3. Siddique Plastic Industries LTD

7.1.1 EREBUS Plastic Industries

Name of the company	EREBUS Plastic Industries LTD
Address	57/B, Road – 5, Dohs, Banani
City	Dhaka
Country	Bangladesh
Description	Plastic industries
Company's website	www.erebusbd.com


Overview of companies

This Plastic industries is one of the leading plastic manufacturing companies in Bangladesh. The company is producing rigid plastic packaging and supplies products by using the plastic manufacturing of conversion processes such as blow molding, injection molding and injection blow molding. This company has 2 factories in the heart of Bangladesh Dhaka and more than 4,000 people are working in the company.

History of EREBUS

TABLE 12: HISTORY OF EREBUS, SOURCE: [HTTP://WWW.EREBUSBD.COM/](http://www.erebusbd.com/) [45]

2004	<ul style="list-style-type: none">• Inception of the idea• Formation of the company; started up manufacturing in a rented shed with one blow molding machine• Set up outsourcing partner for paint buckets
2006	<ul style="list-style-type: none">• Yearly revenue crossed US\$1 million• Number of blow molding machines increased to 3• Number of factory workers crossed 100
2007	<ul style="list-style-type: none">• Full fledged own factory with captive power generation facilities started up• Certified as A class vendor for key client Marico• Business volume reached US\$3mln
2009	<ul style="list-style-type: none">• Start up of the second factory dedicated primarily for injection molding under the name Horizon plastic• Started up business with Uni Lever• Business volume reached US\$ 4mln
2011	<ul style="list-style-type: none">• Started up business with GSK• Business volume reached US\$ 5mln
2012	<ul style="list-style-type: none">• First consignment of export done• Business volume reached US\$ 7mln



Products of the industry

EREBUS plastic industries limited produces plastic bottles, jars and so on made of polyethylene terephthalate (PET) and high-density polyethylene (HDPE). The company is also producing pre-forms and bottles from PLA (polymerized lactic acid) which is corn-based resin. Most of the products that made are for the pharmaceutical, personal care, nutritional supplement, and niche food and beverage markets. Company's capabilities include high quality of injection as well as some extrusion blow molding process.

In addition to manufacturing, EREBUS also offers engineering services in-house design, tools for manufacturing various types of plastic products and also to develop the shapes of existed plastic products.

Consumers of the industries

EREBUS has multinational customers operating in Bangladesh- namely GSK, UNILEVER, and BERGER Paints, MARICO. These companies are the number 1 popular Bangladeshi companies in their respective categories. The industry has particularly strong positions in the food & beverage market, the beauty and personal care sector, the paints & chemicals containers too.

Interview

The questions which author has asked to the company during interview:

- a. What are you using as raw materials of Plastics

Answer: Mainly virgin raw material and others are from return broken product are being used as the raw materials for our products. We are very carefully on maintaining the products quality as most of our consumers are the top class companies in their respective fields.

- b. What do you do with the waste of plastics?

Answer: we are using those depending on customer's demands. Normally we are reusing those as industrial products or in recycling to produce recycled products.

- c. What are the customer's opinions about the recycled plastics and raw plastics?

Answer: As we have mentioned before that we have top class Bangladeshi companies as our consumers, so most of them are preferring raw products. We are selling and using recycled products to some specific customers depending on their needs and demands.

- d. What are the challenges that plastic industries are facing now a day?

Answer: we have to agree that the lack of proper awareness, negative thought and knowledge about the recycled products among the consumers, we can't reuse most of our waste of plastics in further productions. We are always using those by the permissions of the consumer or by the special contract i.e. agreements with the customers.

- e. What are the future market for plastic industries in Bangladesh?

Answer: Bangladesh is a very densely populated country and capital Dhaka is the most populated region of the country. Although we are focusing on the top class consumers, but generally consumers from different classes are interested to buy plastic products because of their cheap price comparing with other materials, usability and different designs. That's why consumers like to buy those products.

As the consuming rate is high in Bangladesh, So the waste plastic rate is getting higher and higher day by day 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 without any doubt.

7.1.2 National Polymer Industries group

Name of the company	National Polymer Industries Group
Address	House#15(1st Floor), Road#24 CNW(C), Gulshan-2
City	Dhaka - 1212
Country	Bangladesh
Description	Plastic industries
Company's website	www.nationalpolymer.net

Overview of companies

National Polymer Industries Ltd. (NPIL) is a leading PVC pipes manufacturing industry in Bangladesh. The Company was officially established in June 1987 as a public listed Company. From the very beginning of manufacturing, the company is using the modern machinery and technics of European origin in its manufacturing process to break new grounds for premium quality uPVC products. Over the decades, the Company has owned a strong position in the market and has been known as one of the best manufacturers in its arena.

Applications of the company

The company is offering complete pipe system solutions in three marketing segments:

- a. Building segment including applications for water, soil and waste products and sanitary purpose.
- b. Civil segment including pipe systems for sewer, drainage and irrigation management.
- c. Utilities segment including water and cable duct for telecommunications.

The Company's abilities, experiences and portfolio give the flexibility to offer complete solutions to specific consumer by their demands needs. The Company is always very careful on maintaining and on monitoring high standards of qualities and is able to guarantee highly professional service to meet the customers' needs. Since October 2003, quality management system certification ISO 9001:2000 have always been followed for ensuring the Company's product quality.

Interview

The questions which author has asked to the company during interview:

- a. What are you using as raw materials of Plastics?

Answer: as it has been mentioned before that the company is not compromising with the quality of the products and doing their best to fulfill the consumer's needs and demands. So mainly the company is using virgin exported raw materials (90%) and sometimes the waste of plastics (10%) as the raw materials of Plastics. The Company get their waste plastic from their own factory. During the production some products do not found according to their customers destruction. On the other hand, some defects are seen in some production due to faulty instructions or operating

system. In this case the company does not supply this defects products to market. These defect products are being used as their raw materials for the next production line. The company is always collecting its own defect products from market those are damaged or lose its original quality during handling in market. This Plastic industry is one of the largest PVC pipes manufacturing company in Bangladesh. Company needs in total thousands of tons raw materials in a month and most of those raw materials are imported from abroad.

b. What do you do with the waste of plastics?

Answer: company is using the waste of plastics as 10% of raw materials for the next production line. As it has been mentioned that company is collecting the defective products from market or from the production system which are being used or just produced. Also the products which haven't produced according to the expected designs or haven't reached to the standard quality or are damaged by the workers are used to recycle to use it again.

c. What are the customer's opinions about the recycled plastics and raw plastics?

Answer: we have some consumers who are happy to use recycled products because of its cheaper price than the raw products. We are always monitoring the quality and slandered of our products. We are using virgin materials as 90% of raw materials which are mainly imported from abroad what make the product little costly than the recycled products. As we are always maintaining high quality of all products, so consumers are also happy to take recycled products.

d. What are the challenges that plastic industries are facing?

Answer: we, the people of Bangladesh now-a-days use plastic materials everywhere in our daily life. Plastic products are comparably cheaper than others, so people use plastic products such as plastic chair, jars, plates, various kinds of devices, table, doors, fans, computer, pot, parts of electric devices, pot for food grain and bottle for different beverages etc. in our country. Basically a huge numbers of popular companies use original raw materials. But there are some local factories also who are mainly using the recycling materials for their productions. Although their products do not meet the standard quality but their products are cheaper than many other companies. As those products are not expensive, people throw these products after one time use. So everyday a lot of waste plastic products are found in everywhere. So, this is very important to have systematic way for recycling of plastics wastes what actually has become the actual challenges for plastic industries in Bangladesh.

e. What are the future market for plastic industries in Bangladesh?

Answer: it can be easily said that the future market for plastics industries in Bangladesh is brighter if we can maintain the international high slandered in production, quality of the products and be succeeded fulfilling those challenges too.

7.1.3 Siddique Plastic Industries LTD

Name of the company	Siddique Plastic Industries LTD
Address	9/3, Noorbagh, Kamrangir Char
City	Dhaka - 1211
Country	Bangladesh
Description	Plastic industries
Company's website	www.siddiqueplastic.com

Overview of companies

Siddique Plastic Industries Ltd, is a private Plastic Manufacturer which is specializing in producing Pharmaceutical plastic products. The company was founded in 1978. The slogan of the company's is "quality first and client gratification" that has clearly spoken about the goals and aims of the company. The Company has an area of 6500 square meters as factory situated in the capital region Dhaka.

The factory of the company situated in Dhaka is producing all kinds of plastic containers, bottles, caps and closers, jars, droppers, cosmetic, PET bottles, Polythene, disposable products and especially Pharmaceuticals plastics products.



FIGURE 13 : PRODUCTS OF SIDDIQUE PLASTIC INDUSTRIES [46]

Interview

- What are you using as raw materials of Plastics?

Answer: pharmaceutical plastics products are the most sensitive and health hazards types of products. So, Siddique Plastic Industries Ltd. is following all mandatory steps to produce high qualities & standard products. In that case, we are using virgin raw materials most of what are imported mainly from abroad.

b. What do you do with the waste of plastics?

Answer: it is not possible for us to reuse the waste of plastics for the production of pharmaceutical products fully. But of course, we are using the broken plastic's parts, plastics waste and damaged plastics for the productions of another kinds of plastics products such as various types of bottles, caps and closers and food jars etc.

c. What's the consumer's reaction about the recycled products and raw products?

Answer: Customer's satisfaction is our no 1 priority. Our slogan for the company is "quality first and client gratification". A Client concentric organization, we have addressed completely our attempts towards endlessly providing clients with superior quality of injection and blow molding plastic products. This helps us in collecting high degree of satisfaction of our clients. Most of our big consumers are selecting plastics products which are produced from imported virgin raw materials. At the same time, we have also many customers who are preferring recycled plastics products such as caps & closers, food jars, Pet bottles etc. which are not mainly pharmaceutical products because of their low prices.

d. What are the challenges that plastic industries are facing?

it is important to take necessary steps by the government of the country as well as by the plastic industries too such as patronizing recycling plastic industries for being development, ensuring the level of standard of the product's quality, strictly maintaining the facilities for workers including wages and holidays, ensuring the sound environment of factories and so on. On the other hands, necessary steps should be taken into consideration about proper management of waste plastics and Mass awareness should be increased by the government as well as by the media too.

Actually those above points are the challenges and constraints that the plastics industries in Bangladesh are facing now a days. If it's possible to ensure above needs about waste of plastics, then the future of plastics industries in Bangladesh will be brighter.

e. What are the future market for plastic industries in Bangladesh?

Bangladesh is the eighth largest populated country of the world with more than 150 million people. Bangladesh is a developing country where a significant number of people are living below the poverty line. As recycled plastics products are cheaper than virgin one, so most of those people will be happy to use recycled plastics and in that sense, plastic industries and products in Bangladesh have bright future.

8 Result

The result that author has got from the questionnaire are in the following section:

All those above companies were asked five similar questions at the same time. Among those companies, two companies were interested on exporting their products to abroad and another one is just focusing on the domestic market. One company do not collect external waste plastic materials. On the other hand, more or less, other two companies are directly involved in plastics recycling and manufacturing plastic products from them. They are also directly involved on exporting their goods.

All those companies are not focusing and selling their products to all classes of consumers in a same way. They have their own class of customers. One company among those are having top classes manufacturing companies of the country in their respected fields as customers and another one company is focusing to all people of customers from low class to the top class. One out of those three companies are also selling their products to all classes of people but through online too.

All companies have their own factories where two of them have their factories in the capital region and another one has its factory situated outside of the capital region. One company out of those is so big and occupying big consumers that it has its own 2 big factories in capital region and working with one sister company too where one out of two companies is having middle type of factory and another one has its own small size factory.

All companies representative have said that although most of them are focusing producing plastic products from virgin raw materials, but the recycled products are much cheaper than that. Although some of them are directly or indirectly involving on recycling the waste of plastics, but they demand and feel the absence of advanced technology and scientific method for recycling process in Bangladesh. They have agreed that the highest authority of the country i.e. the government should take necessary steps as well as all plastics industries in Bangladesh for recycling the plastics wastes and for a systematic advanced waste management throughout the country.

On the other hands, some workers also have been interviewed by author and they all have said that to have increased of salaries as their wages are very low. They also have said that workers of the plastics industries in the country will be happier to engage in the sectors if they get enough supports, rightful wages, safety, opportunity to gain experiences and education. They are also very optimistic that the government as well as the companies will give focus on them and will take necessary mandatory steps to enforce and to improve them.

On the other hand, raising the awareness among the people of the country about plastics, their uses and about the waste managements from their side are also necessary. People should be aware, educated and given enough supports in managing the plastic wastes.

Finding the plastic's effects

- I. It is possible to reduce a huge amount of plastic wastes from the environment by which environment, water and other natural elements can be protect from pollution.
- II. This the development of this sector, Plastic waste manage and advance recycling systems can create lot of job opportunities in Bangladesh where unemployment rate is very high in the country.
- III. Plastic industries of Bangladesh as well as the country can earn huge foreign currencies from exporting plastics goods and recycled plastics.
- IV. Bangladesh is one of the most densely populated country in the world. The monthly amount of many country's wastes is even less than the amount of day's plastics wastes of Bangladesh. So, the proper plastic wastes recycling process can bring a huge opportunities for the people of the country as well as for the domestic economy.

Plastics has and can cause many positive impacts in our society of course as well as negative effects on the environments too.

Plastic is totally non-biodegradable materials. It's one of the responsible elements for losing the fertility of the soil. It also causes the drain blockage, mosquitos, flies as well as the emissions of toxic gases such as carbon mono oxides which cause even cancer, inhaling and so on. It is also sometimes responsible for flood in the urban area because of the blockage of the sewerage systems

The government of Bangladesh has taken many necessities steps to promote plastics positively and raise awareness among the people of the society. There is no doubt that plastics industries and plastic waste managements have great future in Bangladesh. To get the max benefit out of it, it is necessary to work hand by hand. The government of the country, trade authority, law enforcement authority and plastics industries etc. have to work together.

Bangladesh is a developing country and many people in this country are living below the poverty line. The natural beauty of the country is also got effected because of the unappropriated unhealthy processing of plastic recycling. So, Plastics and its related sectors positively can bring huge economic changes among the people of the country as well as for the national economic too. A healthy process and proper waste manage systems can also positively bring changes on the environments.

9 Conclusion

The aim of the study was to focus, document and gather information about the prospects and challenges of Plastic industries in Bangladesh. The result of the study is that the research work has been done to find out a set of suggestions and has also pointed the present situation and current state of plastic industries in Bangladesh.

It is very difficult to find out alternative of plastics at this present era because of the dependence on plastics. Plastic's demands are increasing every day as well as their waste too. It can easily be said that if the use of plastics wastes is increased, the waste management will search more advanced ways to find out to collect and process them.

The early chapters of this thesis on the elementary principles of plastics sciences provided information as a guide throughout the research work. For more advanced research the interviews and works have suggested that big plastics company's ad factories in the country are still not very active in starting their own recycling operations as the waste management in Bangladesh is still quite manually done. On the other hand, the small companies are quite the opposite than the large companies as their business model is based on recycled plastics.

The implementation of this thesis work can help to find out so many opportunities in the country. It can be a guide of advices and recommendations to control waste plastic and develop a new ideas. Bangladesh is such a country where this kind of project could be very promising and effective in the near future as well as challenging too for all of us.

Limitation of the research

Alike to others research structures, this research work is not totally free of weakness. For more deeply discussion, many more points could have been added from a general point of view. The lack of time, scopes and constraints left them in research manner.

Moreover five questions were aimed to ask to discuss through the interviews of more than three companies. But, the research had to be finalized and concluded statistically because of non-responsiveness of some companies. Three interviews are not enough to conclude a huge concepts about such a densely populated country like Bangladesh where more than 150 million people are living and using plastics hugely every day. Author has done to find out and finish the work as his best.

10 Reference

1. What is Plastic? Published on Plasticseurope.org (Access on 12 January 2016)
(<http://www.plasticseurope.org/what-is-plastic.aspx>).
2. Polymer, Available at: Wikipedia, (Access on 13 January 2016)
(<https://en.wikipedia.org/wiki/Polymer>)
3. Klein, Rolf. Laser Welding of Plastics. Weinheim: Wiley-VCH, 2012. Page 4. Print.
4. Polymer Synthesis. Available at: Chemistry 105 Lab (Access on 13 January 2016)
<https://sites.google.com/a/wellesley.edu/chem-105-online-lab-manual/labs/07-polymer-synthesis>
5. The History and Future of Plastics: The First Synthetic Plastic. Published on Conflicts in Chemistry. (Access on 13 January 2016)
<http://www.chemheritage.org/discover/online-resources/conflicts-in-chemistry/the-case-of-plastics/all-history-of-plastics.aspx>
6. HISTORY OF EARLY PLASTICS: Celluloid, Published on Ebay (Access on 13 January 2016)
<http://www.ebay.com/gds/EARLY-JEWELRY-PLASTICS-Testing-for-Bakelite-/10000000000747861/g.html>
7. Mary Bellis. The History of Plastics: The First Man-Made Plastic - Parkesine. Published on About Money (Access on 13 January 2016).
<http://inventors.about.com/od/pstartinventions/a/plastics.htm>
8. The History of Plastic, Published on Actforlibraries.org (Access on 13 January 2016)
<http://www.actforlibraries.org/the-history-of-plastic/>
9. Wallace Carothers - History of Nylon. Available at: About Money (Access on 13 January 2016).
<http://inventors.about.com/od/nstartinventions/a/nylon.htm>
10. Julian W. Hill; DuPont Chemist Helped Develop Nylon. Published on Los Angeles Times (Access on 14 January 2016).
http://articles.latimes.com/1996-02-02/news/mn-31620_1_julian-werner-hill
11. Daven Hiskey. TEFLON WAS INVENTED BY ACCIDENT. Published on Today I found out (Access on 14 January 2016)
<http://www.todayifoundout.com/index.php/2011/08/teflon-was-invented-by-accident/>

12. Karl Ziegler and Giulio Natta. Published on Chemical Heritage Foundation (Access on 14 January 2016).

<http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/petrochemistry-and-synthetic-polymers/synthetic-polymers/ziegler-and-natta.aspx>

13. Karl Ziegler and Giulio Natta. Published on Chemical Heritage Foundation (Access on 14 January 2016).

<http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/petrochemistry-and-synthetic-polymers/synthetic-polymers/ziegler-and-natta.aspx>

14. Karl Ziegler and Giulio Natta. Published on Chemical Heritage Foundation (Access on 14 January 2016).

<http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/petrochemistry-and-synthetic-polymers/synthetic-polymers/ziegler-and-natta.aspx>

15. Polylactic acid. Available at: Wikipedia (Access on 14 January 2016)

https://en.wikipedia.org/wiki/Polylactic_acid

16. Thermoplastic. Available at : wikipedia (Access on 14 January 2016)

<https://en.wikipedia.org/wiki/Thermoplastic>

17. Polybenzimidazole fiber. Available at : Wikipedia (Access on 14 January 2016)

https://en.wikipedia.org/wiki/Polybenzimidazole_fiber

18. Thermoplastic. Available at : wikipedia (Access on 14 January 2016)

<https://en.wikipedia.org/wiki/Thermoplastic>

19. Thermoplastic. Available at : wikipedia (Access on 14 January 2016)

<https://en.wikipedia.org/wiki/Thermoplastic>

20. Common Thermoplastics & Thermosetting and there uses. Access on 15 January 2016

<http://www.stephensinjectionmoulding.co.uk/thermoplastics/>

21. Common Thermoplastics & Thermosetting and there uses. Access on 15 January 2016

<http://www.stephensinjectionmoulding.co.uk/thermoplastics/>

22. Healthy Natalie. Are PLASTIC BOTTLES POISONING US? What Do Those Recycling Symbols and Codes at The Bottom Mean? Published on Cool Healthy Recipes. (Access on 15 January 2016)

<http://www.coolhealthyrecipes.com/are-plastic-bottles-poisoning-us-what-do-those-recycling-symbols-and-codes-at-the-bottom-mean/>

23. How Plastic is made. (Access on 15 January)

Available at <http://ecologiquedesign.wordpress.com/2011/03/10/how-plastic-is-made/>

24. Strong, A. Brent. *Plastics: Materials and Processing*. 3rd Edition. Upper Saddle River, NJ: Pearson/Prentice Hall, 2006. Page 434. Print.

25. Strong, A. Brent. *Plastics: Materials and Processing*. 3rd Edition. Upper Saddle River, NJ: Pearson/Prentice Hall, 2006. Page 363. Print.

26. Strong, A. Brent. *Plastics: Materials and Processing*. 3rd Edition. Upper Saddle River, NJ: Pearson/Prentice Hall, 2006. Page 509. Print.

27. Strong, A. Brent. *Plastics: Materials and Processing*. 3rd Edition. Upper Saddle River, NJ: Pearson/Prentice Hall, 2006. Page 503. Print.

28. Plastic recycling. available at : Pinterest (Access on 16 January 2016)

<https://fi.pinterest.com/bakenbread/recycling/>

29. Weigel, Margaret. "Energy and Economic Value of Plastics and Municipal Solid Wastes - Journalist's Resource." *Journalists Resource*. 17 Nov. 2011.

30. Hussain, Anwar. "Recycling Presentation." *Recycling Presentation*. 03 Feb. 2015. (web Access on 16 January 2016).

<http://www.slideshare.net/anuladak/recycling-presentation-44203428>

31. "How to Recycle Plastics." *Howtopedia English RSS*. (Access on 16 January 2016).

http://en.howtopedia.org/wiki/How_to_Recycle_Plastics

32. Bauers, Sandy. "What to Recycle: Hints for the Perplexed." *Philly.com*. 14 Apr. 2011. (Web access on 17 January 2016).

<http://www.philly.com/philly/blogs/greenliving/What-to-recycle-Hints-for-the-unsure.html>

33. "Plastic Shredder." *Plastic Shredder*. (Access on 17 Jan. 2016).

<http://www.plasticshredder.com/>

34. "Bangladesh." *Wikipedia*. Wikimedia Foundation. (Web access 18 Jan. 2016).

<https://en.wikipedia.org/wiki/Bangladesh>

35. "Bangladesh Google Map." *Bangladesh Satellite Map*. (Web Access on 18 January 2016).

<http://www.mapsofworld.com/bangladesh/google-map.html>

36. Ahamed, Mansur, Ph. D. "A Report on Plastic Industry of Bangladesh. Research Department, JBBC Corporation. (Web access on 18 Jan. 2016).

<http://jbbc.co.jp/wp-content/uploads/2014/08/A-Report-on-Plastic-Industry-of-Bangladesh.pdf>

37. Islam, M. Serajul, Former Associate Professor of Chemical Engineering, BUET, Dhaka. "PROSPECTS AND CHALLENGES OF PLASTIC INDUSTRIES IN BANGLADESH." Journal of Chemical Engineering, IEB, 1 Dec. 2011. (Web access on 18 Jan. 2016).

www.banglajol.info/index.php/JCE/article/download/10176/7531

38. SHIMO, MD. HYAT ULLAH. "PLASTIC RECYCLING IN BANGLADESH,WHAT NEEDS TO BE DONE?" Arcada, 2014.

39. SHIMO, MD. HYAT ULLAH. "PLASTIC RECYCLING IN BANGLADESH,WHAT NEEDS TO BE DONE?" Arcada, 2014.

40. "Plastic Waste Recycling and Its Opportunities in Bangladesh." n. pag. Waste Concern Consultants, May 2006. (Access on 19 Jan. 2016).

41. SAARC Member Countries." SAARC Countries. (Web access 20 Jan. 2016).

<http://www.mapsofworld.com/saarc-member-countries.htm>

42. Afrin, Sazia, and Kiptia Akhter. "AN ANALYSIS OF THE CURRENT TREND OF EXPORT EARNINGS FROM PLASTIC PRODUCTS: A CASE STUDY OF BANGLADESH." Asian Journal of Empirical Research (2015): Asian Economic and Social Society, 2015. (Web access 20 Jan. 2016).

[http://www.aessweb.com/pdf-files/1-138-5\(4\)2015-AJER-52-58.pdf](http://www.aessweb.com/pdf-files/1-138-5(4)2015-AJER-52-58.pdf).

43. Reza, Arif, and Tariq Bin Yousuf, Dr. "3R (Reduce, Reuse and Recycle) Action Plan for the City Corporations in Bangladesh: Paradigm Shift of Waste Management to Resource Management." Academia.edu, 12 Feb. 2013. (Web access on 15 Feb. 2016).

http://www.academia.edu/7860677/3R_Reduce_Reuse_and_Recycle_Action_Plan_for_the_City_Corporations_in_Bangladesh_Paradigm_shift_of_Waste_Management_to_Resource_Management>.

44. Huq, Syed Tahsin. "Environmental Challenges of Plastics Waste in Bangladesh." (2015). 6 Feb. 2015. (Web access on 16 Feb. 2016).

<http://www.mpma.org.my/Documents/Bangladesh.pdf>

45. History of EREBUS Plastic industries. Web access on 20 February 2016.

<http://www.erebusbd.com/history.php>

46. Products of Siddique Plastic Industries. Web access on 21 February 2016.

<http://www.siddiqueplastic.com/>