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A Study Based on the Elimination of the Packaging Materials with Low Utile Value and Sustainable Packaging in the Oral Care Industry of Bangladesh

B.Sc. Engineering (Civil & Environmental) Thesis

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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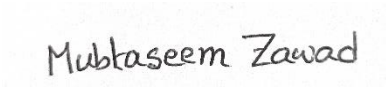

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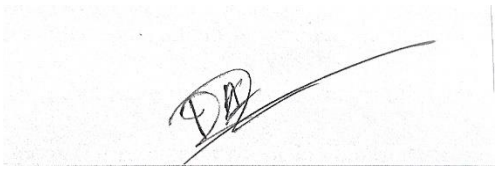

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Abstract

Packaging used to be thought of as a way to secure a commodity through delivery, transport, or storage; however, it has evolved into more than a logistic role to protect and maintain a product during its shipment in the supply chain, and it now must fulfill many marketing roles before meeting its ultimate customer to be competitive. In the other hand, it is a reflection of the evolution of different types of self-service transactions as well as the increasing market appetite for knowledge as a result of increased dietary awareness. Due to the competition between leading brands, packaging are constantly changing and being updated the the latest fashions to satisfy customer needs and marketing policy. Most of the changes being made to the packages are deemed unnecessary from the environmental perspective. As these extra layer of packages aren't always needed for the protection of the products, rather for the product to be eye catching to the consumers i.e. to increase sell. But the effect of these packages to the environment is perilous and has been ignored for long. This paper identifies packaging that have minimum customer utility value of fast moving consumer goods, quantifies potential reduction of packaging material and conservation of energy resources analyzing the characteristics of packaging materials. The products with low utile value packagings were identified through customer involvement via Google questnnaire survey. The packaging with the lowest utile value (i.e toothpaste) has been studied upon & the primary data's were collected from various brands of the Bangladeshi Market. After obtaining the secondary data through anonymous sources the possible reduction amount of earthly resources and energy used to produce the unnecessary layer of packaging has been quantified. Study results show that vast amount of material and energy resources along with waste management cost can be conserved through eliminating

unnecessary packaging. Alternatives with less environmental effect has been suggested analyzing the existing packages. Through this study, it has been found that 19.68 Million Liters of water and 858072.55 KWh electricity can be conserved if the alternative measures be taken. Generation of 1402.79 Tons of paper waste can be avoided and save nearly 34.40 crore TK. The waste management department can extricate upto 1430 waste truck trips and 13 lakhs of waste management cost annually.

Acknowledgements

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We also place on record, our gratitude to one and all, who directly or indirectly, have lent their hand in this venture.

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1 Introduction

1.1 Solid Waste Present Status in Bangladesh

Solid waste management has become a serious issue as a result of rapid urbanization. Bangladesh's metropolitan area produces approximately 16,015 tons of waste per day, totaling over 5.84 million tons per year. By 2025, it is expected that this volume will have increased to 47,000 tons a day, or close to 17.16 million tons a year, due to population growth and a rise in per capita waste generation. Waste collection performance in different urban areas ranges from 37 percent to 77 percent, with an average of 55 percent, according to existing waste management infrastructure. The current state of waste disposal is dissatisfactory. Uncollected waste, a significant proportion of which is organic, creates a nuisance and quickly pollutes the local environment. Solid waste disposal is a bigger issue because it causes land contamination if it's discarded freely, water pollution if it's dumped in low-lying areas, and air pollution if it's burned. Due to unrecovered waste management on streets and other public areas, clogged drainage systems from extrajudicially dumped wastes, and pollution of water supplies near unregulated dumping sites, Dhaka, Bangladesh's capital city, is facing significant environmental degradation and public-health danger.

In Dhaka, per capita solid waste generation is low; however, due to the city's size and density, the waste management problem in Dhaka is extreme when compared to many other developing countries' cities. Solid waste generation in Dhaka City exceeds 4000 metric tons per day. A combination of hazardous materials, radioactive elements, and pathological substances make up the 200 metric tons of hospital and clinical waste. 15 to 20% of clinical

waste are extremely hazardous to human life. When these wastes are deposited in the open with other urban wastes, they pose a significant health risk to urban residents.

Solid waste is evolving over time and as a result of growth. Plastic and polyethylene products are among the solid wastes that pose a danger to human health, the climate, and the drainage system. These items are plentiful and cheap in markets. Users are uninterested in reusing them. They prefer to throw these items out the window and door. According to the Inception Report on Control and Management of Polyethylene Bags in Bangladesh, Dhaka residents alone used 600 million bags every day. Rain water did not flow smoothly during floods for a variety of reasons, one of which was the use of polyethylene in the sewage system. Plastic and polyethylene products are not biodegradable. They will not decompose naturally. Polyethylene persists in the soil, disrupting the flow of nutrients and obstructing the entry of sunlight. Compaction kills the beneficial bacteria in the soil. In the long run, it damaged the foundations of physical infrastructures on the plastic dumpsite, if any exist. This problem has been solved owing to successful legislation preventing the use of polyethylene bags. (Bahauddin & Uddin, 2012)

1.2 Role of Packaging Waste

Packaging is important in preserving and maintaining products as they travel across the supply chain to the end user. Packaging materials, design, and labeling advances open up new possibilities for increasing the valuable product's performance.

1.3 3R Strategy of Waste

Owing to the depletion of natural resources and increased pollution levels in the atmosphere, the 3Rs theory has recently gained more popularity. By focusing on waste reduction, reuse, and recycling, the 3Rs strategy will help to encourage resource efficiency while also balancing environmental and economic concerns.

FIGURE 1.1: 3R

1.3.1 Background of 3R initiative

Many global policies and action plans reiterate the value of 3R. Changes in consumption and production trends are illustrated in Agenda 21 for sustainable growth. To accelerate global sustainable economic growth, the Johannesburg Plan of Implementation (JPOI) adopted at the 2002 World Summit on Sustainable Development stated that all countries should promote sustainable consumption and production. It has placed a strong focus on improving waste treatment programs, with waste reduction and alleviation, reuse and recycling, and eco sustainable disposal facilities receiving top priority. The 30th G8 Summit in Sea Island, Georgia (June 2004) and the subsequent 3R Ministerial Meeting in Tokyo (April 2005) both stressed the crucial need for realigning output and consumer preferences through successful execution of 3R principles. The G8 countries agreed to

launch the 3R Project in 2004 in order to eliminate obstacles to the global movement of products and resources for recycling and retrofitting, as well as to create capacity for the 3Rs in developed nations, at the G8 summit. At the 3R Ministerial Meeting in Tokyo, the 3R Initiative for a "Sound Material Cycle Society" was officially unveiled. China has been implementing a "Circular Economy Policy" since the late 1990s, with a transition in environmental protection policies from end-of-pipe to comprehensive monitoring and management. In Asia, the 3R Initiative held a number of inter-governmental and expert consultations, culminating in the implementation of "The Kobe Action Plan." In the national growth agenda, the Kobe action plan has placed a strong focus on the 3Rs. With the sponsorship of the Environment agency of European union and The united States Centre for Regional Implementation, the National 3R Strategic Planning Project was launched in 2009 as a joint capacity development initiative in six Asian countries, including Bangladesh (UNCRD).

1.3.2 Review of the National 3R (Reduce, Reuse and Recycling) strategy for waste management

The Bangladeshi government's National 3R (Reduce, Reuse, and Recycle) policy was established after a set of regional discussion meetings with concerned ministries and other possible stakeholders. The strategy was launched in order to address the challenges posed by the continuous increase in waste generation and resource demand. It aims to raise the priority of environmentally sound waste management and resource efficiency while also increasing institutional capacity. This plan has been approved by the Government of Bangladesh (GOB) in 2010. By 2015, the policy sets a target of waste diversion, reuse, and

recycling, as well as reducing waste disposal in open dumps, wetlands, flood zones, and landfills. It further facilitates waste recycling by enforcing compulsory waste segregation at source, establishing a demand for recycled goods, and providing incentives for recycling programs.

- It considers wastes and encourages waste isolation at the source.
- The plan promotes the use of emission-reducing technologies and the use of CDM provisions.
- It fosters private-sector spending.
- It advances the concept that "polluters pay," and also cleaner manufacturing and an Environmental Management System (EMS).
- It encourages input from the informal sector, which recycles a variety of products.

The plan suggests:

- Raising public consciousness,
- Leveraging suitable technologies,
- Creating a 3R secretary general at the Department of Environment (DoE),
- Engaging all stakeholder groups through Public-Private Partnership (PPP),
- Financing through the Clean Growth Process to support 3R values (CDM)
- Waste separation at the source, as well as additional handling for hazardous waste.

It further establishes the positions of government officials, individuals, private sector organisations, non-governmental organizations, and the media.

The National 3R policy guides the local government bodies to create their respective implementation plan with establishing of quantifiable goals and seek organic waste recycling by composting, bio-gas and rejected derived electricity.(Yousuf & Reza, 2013)

1.4 Relevancy of the study according to local and global scenario (SDG)

SDG Goal 12: Responsible Consumption and Production

Targets

- Implement the 10-year system of programs on sustainability issues and productivity, with developed nations leading the charge and emerging countries taking into account their growth and capabilities.
- By 2030, accomplish balanced natural resource utilization and productive use.
- By 2030, significantly minimize generation of waste by avoidance, diversion, recycling, and reuse at the retail and wholesale levels, as well as reduce food losses in distribution and supply chains, particularly post-harvest failures.
- Assist developed countries in improving their science and technical capabilities in order to transition to more productive demand and production practices. (Franco & Newey, 2020)

1.4.1 Global Scenario

TABLE 1.1: AMOUNT OF MUNICIPAL WASTE GENERATION GLOBALLY (*TRENDS IN SOLID WASTE MANAGEMENT*, N.D.)

Parameter	**Information**
Annual Municipal Waste Generation	2.01 Billion Tons
Unmanaged Waste	33%
Average Per Capita Waste Generation	0.74 kg/person/day (range 0.11-4.54 kg/person/day)

From **table 1**, it can be stated that a significant percentage of waste remain unmanaged in an environmentally safe manner.

TABLE 1.2: PACKAGING WASTE GENERATION & CORRELATION WITH MUNICIPAL SOLID WASTE IN INDIVIDUAL COUNTRIES (ROBERTSON, 2020)

Country	**Packaging Waste (Million Tons)**	**PW/MSW (%)**	**PW Per Capita (kg)**
USA	56.8	27	210
Japan	20.0	41	163
United Kingdom	7.7	44	134
France	10.0	159	181
Germany	10.0	49	181
Italy	12.0	68	188
Total	**116.5**	**-**	**1,057**

From **table 2**, total amount of packaging waste produced from those countries is 116.5 million tons which is a huge mass. Among these countries, USA is responsible for producing maximum packaging waste which is 56.8 Million Tons.

1.4.1.1 Break Free From Plastic

Break Free From Plastic (BFFP) is one of most well-known environmental campaigns aiming to create a world free of plastic waste. After its inception in September 2016, almost 1,500 entities from all over the world have signed up to demand drastic decreases in single-use plastics and long-term approaches to the plastic waste crisis.(*About | Break Free From Plastic*, n.d.)

1.4.1.2 The EU Single-Use Plastics Directive

Plastic contamination has long been a top priority for the European Union. The European Union released its Plastics in a Financial Inclusion Strategy in January 2018, and the EU decided in December 2018 to pioneer new regulations to minimize the overall effects of such plastic goods, known as the Single-Use Plastics Regulation.

Cotton bud sticks, cutlery, bowls, straws, stirrers, balloon sticks, and also cups, foodservice containers made of extended polystyrene, and all products produced of oxo-degradable plastic, are among the single-use plastic products for which consumer substitutes exist. Steps to minimize the use of plastic food packaging and drinking cups, as well as clear package branding and labeling. (Robertson, 2020)

1.4.2 Local Scenario

12.1 - Ensure 100% industries install and operate waste management system Indicators

NPI 31: Ensure 100% industries install and operate waste management system

Bangladesh is also a long way from achieving SDG Goal-12's aim level.

SDG Goal -12 would be aided by the work of this study.

TABLE 1.3 : AMOUNT OF WASTE GENERATION, TOTAL BUDGET DISCERNED FOR BOTH CITY CORPORATION IN DHAKA (ALAMGIR & AHSAN, 2007) (KABIR, 2015) (DNCC, 2016)

Name	Year	Corporataion	Data	Unit
Total Waste Generated	2012	-	22.40	Million Ton
Total Revenue Budget	2013-2014	DSCC	183.80	BDT in Crores
Total Development Budget	2013-2014	DSCC	419.75	BDT in Crores
Total Revenue Budget	2013-2014	DNCC	190.96	BDT in Crores
Total Development Budget	2013-2014	DNCC	352.75	BDT in Crores
Total Waste Collected	2015-2016	DNCC	683,174	Tons
Total Waste Collected	2016-2017	DNCC	852,391	Tons
Projected Waste Generation	2025	-	47,064	Tons/day

From **table 3**, in 2013-2014, revenue budget for DNCC is slightly higher than DSCC whereas development budget is higher in DSCC.

2 Objective

This study looks at some of the ways that improved packaging can help to eliminate or recycle packaging waste. Product safety is the main target of packaging sustainability, and this often necessitates packaging-waste trade-offs.

- Examine market, resource, and lifestyle patterns that are most likely to affect waste production in Bangladesh's urban and regional areas; and
- Identify main, secondary, and tertiary packaging perspectives to further reduce waste production across the distribution chain.
- Identify packaging that have minimum customer utility value of fast moving consumer goods
- Analyze characteristics of packaging materials
- Quantify potential packaging material reduction from the waste stream selected
- Quantify possible conservation of energy resources
- Proposing alternative to the existing packaging system

This report is interesting in that it focuses on packaging insights that may further minimize packaging waste. There seems to be little work into the function of packaging in product protection and shelf life extension at any point of the supply chain. These vital roles are often ignored in discussions around product safety and pollution. While this study looks at packaging waste throughout the supply chain, it focuses on packaging waste that happens before it is used.

3 Literature Review

3.1Types of packaging

Clay retains its artistic appeal despite the fact that it is no longer widely used as a packaging medium. (Cooper, 1972)

Metal, glass, wood, paper or pulp-based materials, plastics, ceramics, or composites of multiple materials are now used for packaging applications. They're used in three different types of packaging:

I. Primary packaging

II. Secondary packaging

III. Tertiary packaging

Primary Packaging

Primary packaging is the final piece of packaging between the product and the end user. It looks like the wrapper on a cracker box or the lid of a soda can. It is almost always intended to remain on the package until the product is purchased by the end consumer, and it is rarely removed until the product is used. The box containing a batch of paper clips, the aspirin bottle, and a number of other products are examples.

Both utility and design should be emphasized in primary packaging solutions. Since faulty packaging can directly affect the end user's ability to use your product, utility is critical. In the case of food items, consumers will almost always be forced to discard items with

damaged primary packaging. Even with non-perishable goods, faulty primary packaging can result in product loss or harm, restricting the user's ability to use the product.

If the primary packaging is of low quality, the company will suffer the consequences. Clients will begin to look at other competitors to see if they are better able to produce their goods without the failure or harm that may occur when primary packaging is inadequate. As a result, it's important to ensure that primary packaging strategies have a quality standard.

Aside from securing the product before it hits its final destination, primary packaging may also play a significant role. It's an important spot to put the logo, slogan, and other details that will help people recognize and trust the brand.Consider the efforts of soda producers, who advertise their goods by showing this detail on the primary packaging. It may be common to see promotional materials for other items printed on soda cans, but it is often common to see the product's brand. Soda producers have tapped into a significant marketing opportunity by using primary packaging as an advertisement, using ad space where a consumer's eye is likely to fail.

FIGURE 3.1: PRIMARY PACKAGING

Secondary packaging

The packaging that keeps a product's individual units together is referred to as secondary packaging. It is designed to distribute mass amounts of the good to the point of sale or end

user, rather than to carry the good (which is the task of the primary packaging). The item's secondary packaging may be removed without altering the item's quality or characteristics.

Plastic rings holding a six-pack of cans together or a cardboard box holding a case of cans together are also examples of secondary packaging. A large box of goods intended for individual sale, for example, or a box containing smaller boxes of batteries. The aim of secondary packaging is to make it easier to transport a product from the manufacturer to the end consumer. However, it is often overlooked by the product's final user. As a result, secondary packaging's ideal qualities are more strategic than decorative or advertisement. Secondary packaging should be durable enough to secure the item while still being simple enough to open so that restocking workers can get to it without damaging it.

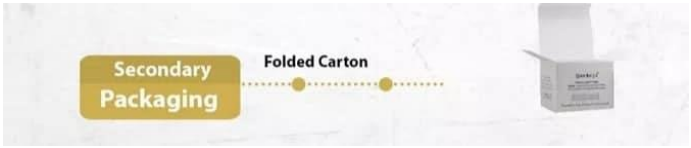

FIGURE 3.2: SECONDARY PACKAGING

Tertiary Packaging

Tertiary wrapping makes it easier to secure, manage, and transport a set of sales units or secondary packaging so that it can be organized into containerized cargo during shipping. The buyer seldom sees this form of packaging.

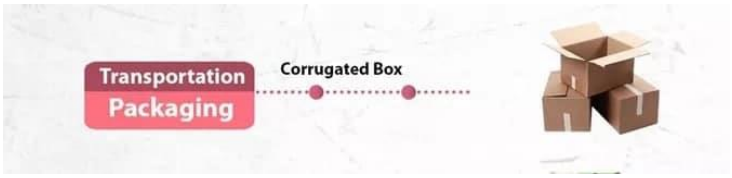

FIGURE 3.3: TERTIARY OR TRANSPORTATION PACKAGING

3.2 Packaging Materials, Waste Generation & Impacts

3.2.1 Packaging Materials

Paper/board

In the production of paper, cellulose fibers form bonds with one another. Carton boxes are a flexible and efficient packaging medium that protects against damage and deformation. It's easy to print on, collect into secondary packages, and stack on store shelves. Carton is completely recyclable after use and is often used as a raw material in the production of wrapping papers and boards. Corrugated board is made up of many layers of paper, the inner layers of which are known as fluting. The cardboard box is a commonly used and flexible packaging medium. It is the most widely used secondary packaging material. Forest management that is done correctly will ensure a steady supply of wood for paper and other uses. The majority of trees used to produce paper are specifically planted for that purpose. As a result, less paper is used, resulting in less trees being planted by industrial excavators. Furthermore, tree harvesting and planting can have other environmental advantages. Carbon dioxide is consumed by trees in vast quantities. If forests were grown in the United States, they could absorb as much carbon dioxide as the nation emits. Mature

forest habitats, which are made up of a blend of living and dead trees, emit as much carbon dioxide as they eat. (Scarlett, 1995)

Glass

Glass is indeed one of the traditional packaging products, with a long history of use. Glass is nonporous and impermeable; it is chemically inert and does not decay. This ensures that it is built to shield its contents from oxygen and moisture, ensuring that they remain in good condition. This is one of the key reasons why many cosmetics are wrapped in glass. (Pharma tutor)

Glass is mostly made up of silica, with varying amounts of metal oxides, soda-ash, limestone, and cullet thrown in for good measure. Sand is almost pure silica, soda-ash is sodium carbonate, and limestone is calcium carbonate. (Jenke, 2002)

3.83 percent of the Earth's crust is made up of calcium. Glass is used for packaging to the tune of 70% of overall glass intake. (Selke, 1990)

Plastic

Plastics have proven useful in packaging for a variety of reasons, including the ease with which they can be shaped, their high quality, and the design flexibility they offer. Plastic containers are highly break resistant, ensuring customer protection while also reducing breakage losses at all stages of delivery and use.Polyethylene, polymethyl methacrylate, polyethylene terephthalate, polyethylene terephthalate, polytrifluoroethylene, amino formaldehydes, and polyamides are the most common polymers used in pharmaceutical containers. (FDA guideline for drug Master files , 1989)

Foils (up to 0.2 mm thick) and sheets of plastic are used for packaging (above 1 mm). Foils are used for flexible wall packages like bags, and sheets are used for rigid wall packages like boxes. (Rockstroh, 1972)

Containers, milk and detergent bottles, bags, and industrial packaging are all made of high-density polyethylene (HDPE). Pallet and agricultural film, bags, coatings, and containers are all made of low-density polyethylene (LDPE). Film, crates, and microwavable containers are all made of polypropylene. PET is used in bottles, films, and other food-packaging technologies, while polystyrene is used in jewel cases, trays, and foam insulation. (Dunn, 2002)

Steel

Metals like copper, iron, and tin came of age at the same time as pottery making, but it wasn't until recently that they started to play a unique role in packaging. Metal containers have proven to be both stronger and stiffer than other components in many situations. (Knauth, 1974)

Aluminum

During WWII, tin and steel cans are commonly accepted. As a result of the increasing demand, tin plate prices rose, forcing can manufacturers to search for a more cost-effective alternative. According to the Adolph Coors Company's website, the Adolph Coors Company became the first American brewer to package beer in aluminum cans in 1959.

For various packaging uses, different alloys and pressure sensors of aluminum foil are used, with most metals containing up to about a 3% mix of iron, silicon, and manganese, with tiny amounts of copper added for additional support. For various packaging uses, different

alloys and pressure sensors of aluminum foil are used, with most metals containing up to about a 3% mix of iron, silicon, and manganese, with tiny amounts of copper added for additional support. (Waste Prevention)

Composites

Composites are made up of a variety of materials that are used to improve content security. Two or more different layers of materials, most commonly paper or board and aluminum foil or plastics, are joined. Combinations have benefits from both a technical and economic standpoint. Their usage is often the only technologically feasible choice. Coating, lamination, and co-extrusion are the processes used to make flexible and semi-rigid-wall packaging materials. The following are the most widely used combined packaging materials. (Rockstroh, 1972)

Wood

Crates and pallets are usually made of wood as a packing material for transportation. Pallets are an integral component of commodity transportation. According to reports, solid wood packaging accounts for 40% of all hardwood lumber manufactured in the United States. For the manufacture of 400 to 500 million solid wood pallets per year, the pallet manufacturer requires approximately 1.4 billion board feet of solid wood lumber and 2.1 billion board feet of softwood lumber. While the number of new wood pallets produced increases significantly, the proportion of hardwood used decreases and pallet recovery rises at the same time. (J. Bejune, 2002)

3.2.2 Waste Generation & Impacts

PVC

Exposure to the carcinogenic vinyl chloride monomer in the workplace and dioxin contamination in wastewater may have serious consequences. Accidental exposure to vinylchloride, chlorine, or hydrogen chloride, heavy metals, phosgene, and dioxins, as well as exposure to vinylchloride, chlorine, or hydrogen chloride, heavy metals, phosgene, and dioxins, as well as exposed to vinylchloride, chlorine, or hydrogen chloride, as well as exposure to vinylchloride, chlorine, or hydrogen chloride, as well as exposure to vinylchloride, chlorine, or hydrogen. The composting of PVC-containing waste releases hydrogen chloride, dioxins, and heavy metals into the environment, as well as contaminating excavator ash and filter residues. (K. Christiansen, 1991)

EPDM (Ethylene Propylene Diene Monomer)

Usage of halogen-based harmful chemicals in specialty goods, as well as potential exposure to neurotoxic n-hexane and cancer causing benzene throughout manufacturing and processing. (K. Christiansen, 1991)

Impregnated wood

Unintentional releases of tributyotin (wood preservatives) pose a significant risk to the aquatic environment, and processing entails high exposure to wood dust, which is expected to be toxic to humans. (K. Christiansen, 1991)

Paper

Sulphate-mass waxing and, in some regions, chlorine-based bleaching dominate manufacturing, resulting in waste water strained with oxygen-consuming contaminants and chloroorganics, such as dioxins. (K. Christiansen, 1991)

Aluminum

The processing of virgin aluminum requires a lot of resources, and the work environment has a lot of highly toxic polyaromatic hydrocarbons (PAHs). Just about a fifth of the raw material is used in the final product, resulting in significant quantities of solid waste and silt to be disposed of. (K. Christiansen, 1991)

Synthetic rubbers, chloroprene

Involve harmful compounds in the manufacturing and processing system.(vulcanisation). (K. Christiansen, 1991)

3.2.3 Environmental Impacts

Foodservice availability is primarily determined by their appearance. Advances in packaging materials have made it possible to preserve and ship food products all over the world. With improved packaging, product shelf life has risen. Furthermore, the demand for high-quality food has prompted packaging creativity, which has aided in the development of new food categories as well as quality indicators. (Risch, 2009). Packaging's primary role is not restricted to merely containing the product. As people's habits shift, they demand higher-quality foods that can be stored for extended amounts of time. Packaging has developed into a multipurpose method. Defending the item from toxic gases, blocking light to shield foods' nutrients, color, and texture, and preserving the product by ensuring precise atmospheric conditions around the food within a jar are all part of the process. (Risch, 2009). Since foods were stored by drying, smoking, salting, or pickling, original packaging materials made from natural materials along with skins, bark, leaves, and woven twigs only worked moderately well. Due to shortcomings in these products, textile, wood, ceramic, and glass containers were created, but they all have limitations in terms of adequately

protecting food. The emergence of limited printing and the introduction of labels coincided with the development of lithography in 1798. Around the time of the American Civil War, canned tomatoes were launched. In the early 1800s, heat sterilisation of perishable foods in glass and steel containers was implemented. This was a significant move forward in the field of packaging. A generation ago, food products in paperboard packages were made, retaining the nutrition, taste, and usability of perishables throughout the year. Steel cans were used during the Industrialization to shield pulverized cigarettes from ambient moisture. (Risch, 2009). Later, Nicholas Appert came up with the concept of preserving food for the French army by using cans. Metal cans finally took the place of glass bottles. When metal cans were used instead of glass, the amount of heat processing was increased. Individual packaging was used for biscuits in the 1890s. Biscuits were previously sold in large containers, with consumers filling their pockets with biscuits to take home. The biscuits were covered from moisture by liners within the bags. When customised packaging for a product was invented, it was a major move in the history of packaging. William Painter invented the metal cork in 1892 to ensure a strong seal on glass bottles. It decreased the amount of oxygen that reached the bottle. The evolution of how consumers shopped affected the packaging of food products as well. (Verghese K, 2011). The first supermarket was founded in the United States in 1920. Goods in containers were an important necessity for the production of packaging and stores at the time. In 1907, the “economy store” idea was launched in New York, and it was a financial success. The first supermarket, called Piggly Wiggly, opened in Memphis, Tennessee, USA, in 1916 as a result of this achievement. Customers might buy items that were kept on shelves in aisles in this type of store. Clients in Houston were given trolleys (shopping carts) by another firm.(Lewis,

2011). During World War II, the production of new distribution and packaging techniques accelerated. Polycarbonate films and thin metal foils and sheets are among the innovations. Polyethylene was the most widely used packaging in the mid-nineteenth decade. Imperial Chemical Companies patented the production of ethylene packaging material. The operation entailed squeezing and heating ethylene gas to a high temperature. Single-use package boxes were brought into the industry in the mid-twentieth decade to partially replace refillable containers. This development altered the dynamics of the distribution chain. (Verghese K, 2011). Today, a wide range of packaging materials, such as bottles, cellophane, cartons, plastics, cans, and so on, are available; but, as new boxes are created, the problem of waste management has risen. The use of packaging materials is skyrocketing in almost every country on the planet. The production, service, shipping, and recycling of packaging materials have various environmental implications. The packaging industry contributes significantly to pollution of land, air, soil, and water. As a result, in order to move toward a more sustainable future, it is important to examine the environmental effects of packaging materials. It's because packaging products cannot be eliminated from everyday life because they've become an integral part of all aspects of human activity; however, their environmental damage can be significantly reduced. This can be achieved by analyzing the environmental effects of packaging products using quantitative methods that measure environmental indicators.

3.2.4 Chemical Impacts on the Atmosphere for Pulp Industry

Pulp and paper are made from wood or recycled fibre in the pulp and paper industry. At the pulping and bleaching stages, pulp and paper mills use and produce products that can

pollute the air, water, and soil. Initial drying, cleaning, and bleaching are all steps in the pulping operation. Pulping removes the cellulose component from the lignin component, reducing the wood to a fibrous mat. It may be categorized as organic, mechanical, or semi-chemical, with the kraft and sulfite processes being the most commonly used chemical pulping methods. In a digester, wood is roasted, mechanically ground, or a mixture of both. The embedded lignin and additives are then removed by high-temperature cleaning, releasing exhaust gases containing toxic air contaminants.(Rosenfeld & Feng, 2011)

3.2.4.1 Chemical Emission Sources in the Pulp and Paper Industry

- Chemical wood pulping:
    - Kraft
    - Sulfite
    - Neutral sulfite
    - Semi-chemical
    - Soda

- Bleaching
- Log processing equipment
- Digesters
- Stock washers

- Evaporators
- Lime kilns
- Power boilers
- Recovery furnaces
- Smelt tanks
- Paper machines
- Storage tanks and vessels
- Effluent treatment systems
- Coal and coke handling systems. (Rosenfeld & Feng, 2011)

3.2.4.2 Chemicals Emitted in the Pulp and Paper Industry

- Criteria air pollutants:
    - Particulate matter (PM)
    - Ground-level ozone
    - Carbon monoxide
    - Sulfur oxides (SOx)
    - Nitrogen oxides (NOx)
    - Lead

- Other air pollutants:
    - Ammonia
    - Carbon dioxide
    - Carbonyl sulfide
    - Chlorine and chlorine dioxide
    - Chloroform
    - Dioxins and furans
    - Hydrogen chloride (as part of PM)
    - Methanol
    - Phenols
    - Total reduced sulfur compounds
    - Volatile organic compounds (VOCs)
- Liquid and solid pollutants:
    - Adsorbable organic halides (AOXs)
    - Pulping liquors
    - Bleaching effluents (chlorinated dioxins and furans, chloroform, etc.).

Particulate Matter (PM)

Constituted of materials such as timber, lime, road soil, or carbon-based oxidizing agents, metallic oxides and salts, acids, or oils PM is usually produced in the production of paper by the rebound boiler, lime kiln, smelt disintegrating tank, steam boilers, wood chip yard, and landfill debris.

Nitrous Oxides (NOx)

NO2, N2O4, N2O3, and N2O5 are among the compounds in this group. The lime kiln, recovery boiler, power boiler, gas turbines, and brown stock washers all emit them. Smog, ground-level ozone, small particulates, and acid rain are all caused by NOx, a toxic air contaminant. It has been found to be detrimental to human health and plant growth. NOx has been linked to asthma, emphysema, bronchitis, and premature death in humans, as well as aggravating heart disease and lowering lung function.

Sulfur Oxides (SOx)

SO2, SO3, and solid sulfates are among the highly reactive gases in this category. When sulfur-containing compounds are burnt, such as in the recovery boiler, lime kiln, power boilers, brown stock washers, and chip bins, these gases are emitted. SOx are irritants to the skin and lungs, causing a host of breathing conditions such as bronchoconstriction and asthma flare-ups.

Carbon Monoxide (CO)

The kraft process has a negative effect on the respiratory system, including the power boiler and lime kilns, will emit these gases. CO is a radioactive gas that has harmful effects

on the cardiovascular, nervous, and respiratory systems. CO is important because it has a human visual effect at 50 parts per million for one hour, mortality at 750 parts per million, and vegetation impact at higher speeds.

Volatile Organic Compounds (VOCs)

Terpenes, alcohols, phenols, methanol, acetone, and chloroform are examples of compounds that are released as gases from such solids or liquids. Chip digesters, liquor evaporation, and pulp drying all emit VOCs in pulp and paper mills (in non-integrated mills).

Total Reduced Sulfur (TRS)

It's been linked to noxious odors from pulp and paper factories. It's made up of hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide, which are all reduced sulfur gases. Wood chip digestion, black liquor evaporation, and the chemical recovery boiler process all release these compounds.

Chloroform

A human carcinogen with the ability to cause cancer Short-term exposure can adversely affect the central nervous system and cause dizziness and headaches, whereas long-term exposure can affect the liver and cause hepatitis and jaundice. Vents in the pulp bleaching process and the bleach plant release chloroform.

Dioxins and Furans

Skin defects, tumors, and fertility effects, as well as immune system dysfunction, are also possible side effects. Unfortunately, the combination of chemicals in waste steam from

pulp and paper mill bleaching processes may contain dioxins and furans. (Rosenfeld & Feng, 2011)

3.3 Waste Management from Packaging Materials in Developed and Developing Countries

In the last three decades, a trend known as urbanization has seen the growth of urban areas over rural areas. The rate of urbanization in developing countries is much higher than in developed countries. The truth is that increased urbanization does not necessarily imply better living conditions. The quantity and complexity of produced wastes and overburdens, including municipal solid wastes, increases as a result of this unplanned development (MSW). MSW is made up of food packaging, such as cans and bottles. Differences in MSW produced in low and high income countries are expressed by the percentage composition of MSW constituents (developed and most developing countries). There, people's lifestyles decisively characterize the percentage composition, with organic waste stream and overburden accounting for more than half of all MSW produced. In high-income nations, on the other hand, the lifestyle encourages less home cooking and a reliance on ready-made backed produce. This is expressed in the data, which show that the percentage of organic waste stream does not surpass an average of 30% of total produced waste and that the MSW contains more packaging material.

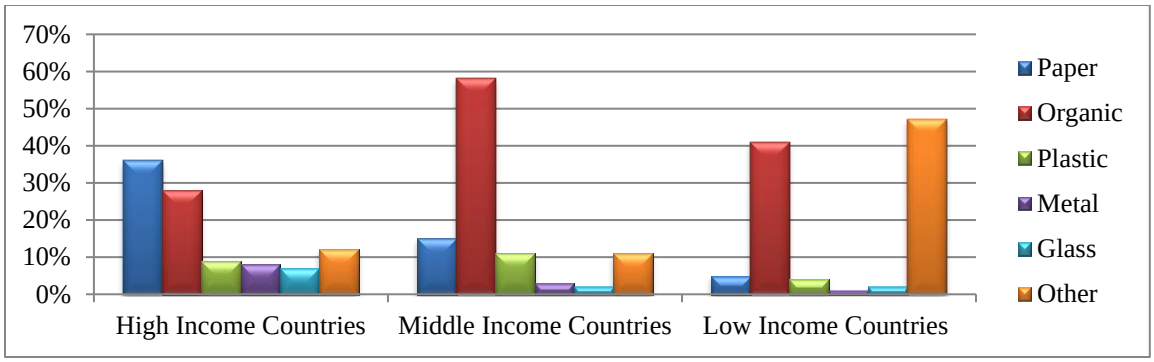

FIGURE 3.4: CHARACTERISTICS OF MSW STREAMS DEPENDING ON INCOME (KHATIB, 2011)

The variations in MSW parentage distributions among high-income countries (developed and developing), medium-income countries (most developing), and low-income countries are represented in this graph (some developing and least developed countries).

MSW is stored and discarded in landfill sites that do not meet the standards in most developing and least developed countries' urban areas. Such disposal necessitates the collection, transportation, and drainage of waste into a nearby open space field. MSW is discarded in water sources or burned in other countries. These acts have negative implications for the environment (public health problem, ecology). According to studies undertaken in many developed countries during the past decade, the same old non-environmentally sound techniques are still in use. While many attempts have been made in many developing countries over the past few decades, with technological and financial assistance from developed countries and international organisations, major changes in the management of MSW have yet to be completed. This is because the models recommended were largely similar to those used in developed countries, but without taking into account the socioeconomic disparities between developed and developing countries.

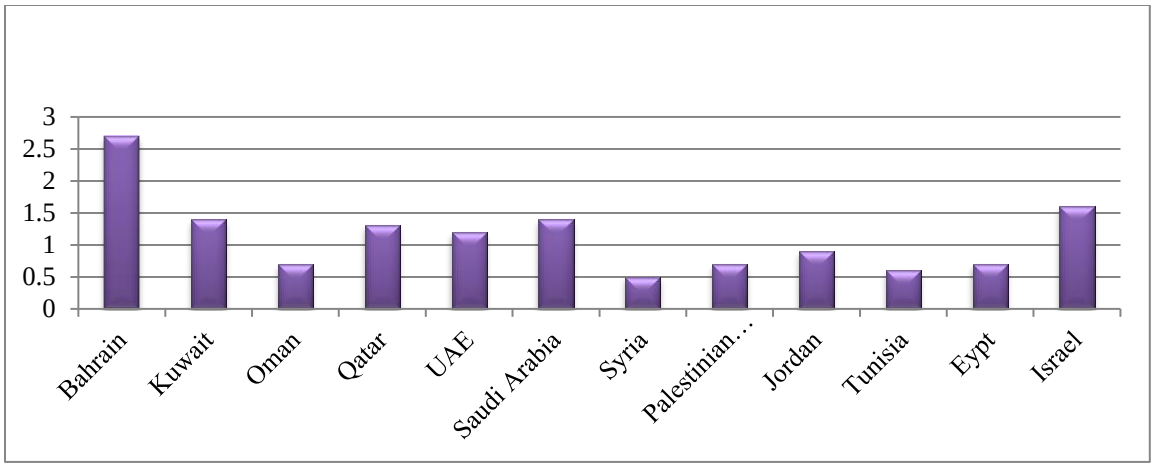

FIGURE 3.5: MSW GENERATION RATES (KG/CAPITA/DAY) IN COUNTRIES IN THE MIDDLE EAST (KHATIB, 2011)

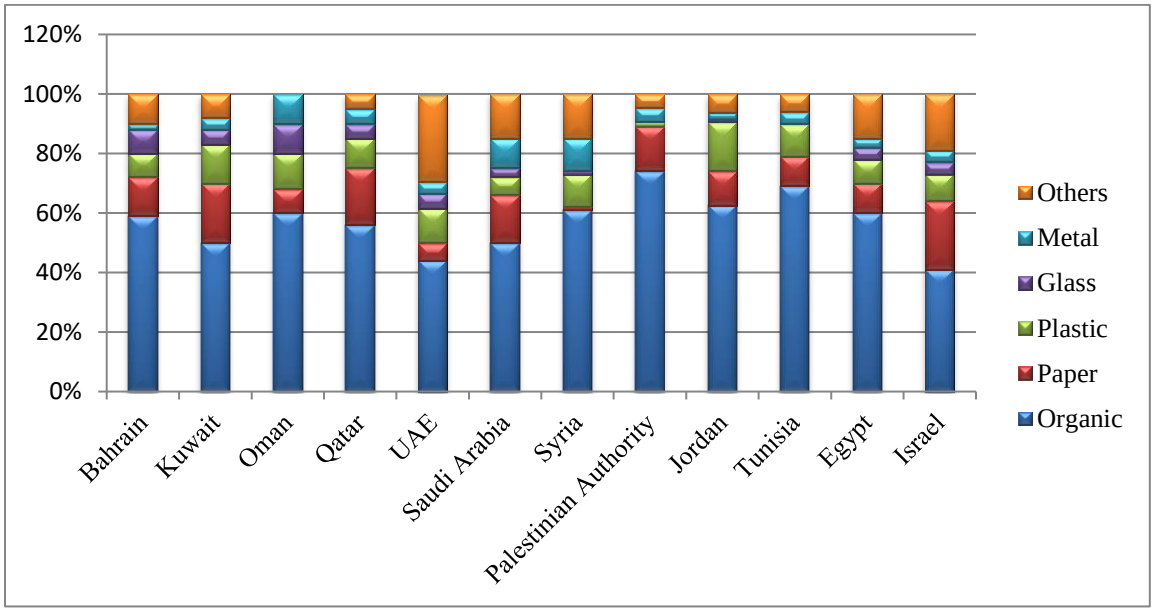

FIGURE 3.6: PERCENTAGE COMPOSITION OF MSW IN SOME MIDDLE EAST COUNTRIES (KHATIB, 2011)

Figure 3.5 shows the per capita rate of generated MSW, which is very varied but represents the country's income level. However, based on the percentage composition of MSW constituencies seen in **Figure 3.6**, it is clear that the bulk of MSW in Arab Middle Eastern

countries is organic. This is attributable to the fact that these nations have identical lifestyles and dietary patterns. In Southeast Asia, countries of medium and low income produce comparable volumes of MSW per capita, but the percentage composition of produced MSW sources varies.

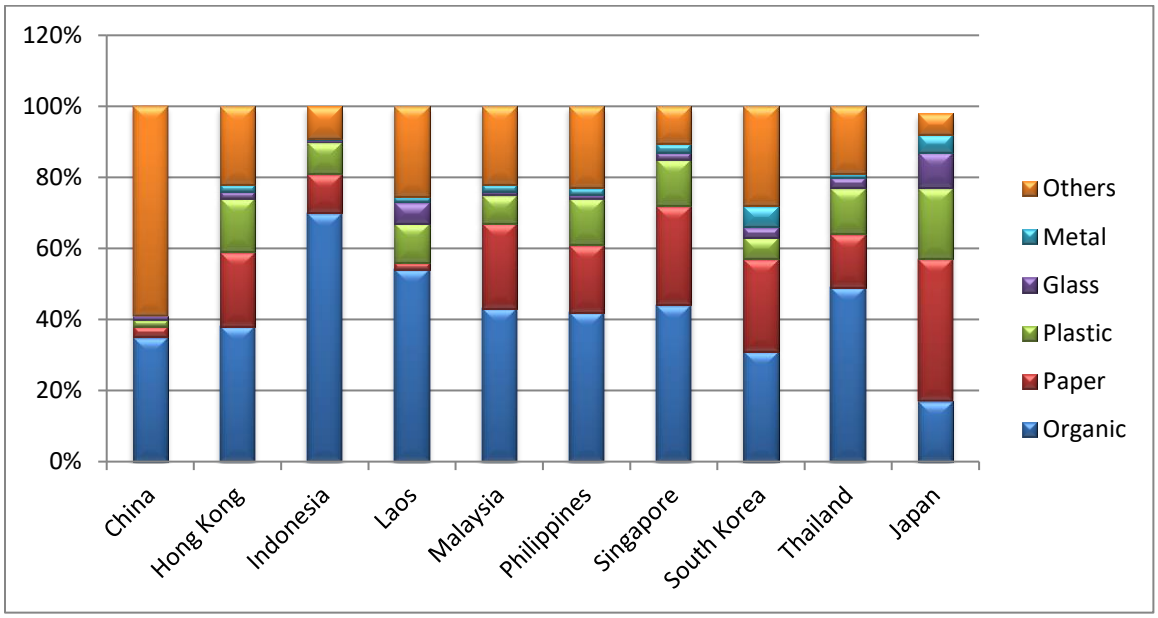

FIGURE 3.7: PERCENTAGE COMPOSITION OF MSW IN SOME ASIAN COUNTRIES (KHATIB, 2011)

In most Asian countries, organic overburden dominates the MSW diversity structure, as seen in this diagram.

As a result, it is clear that the majority of MSW produced in most developing countries is decomposable and recyclable. If properly handled, such MSW may provide substantial opportunities for countries' socioeconomic growth. However, the reality is that the MSW continues to be a socioeconomic hotspot with numerous issues.

In various developed countries, there are a variety of MSW management solutions. In Egypt, a country in Africa's Middle East, 75 percent of MSW is produced in urban areas.

Based on 2001 results, gross forecast MSW for 2025 is projected to exceed 33 million tons, reflecting a 3.2 percent rise. Only about 30% in urban and rural areas have collection systems, making the remainder disadvantaged. A portion of the total collected MSW is sent to a compost facility, but the remainder is dumped in open spaces throughout the world, posing a significant risk to public health and the climate.

Many emerging and least developed countries in the area, such as Syria, Jordan, and the Palestinian Authority, as well as countries in Southeast Asia, Africa, and Latin America, are in a similar condition. On the other hand, Israel produced approximately 6 million tons of MSW and industrial waste in 2006 from both urban and rural areas. Solid waste facilities are available in virtually every part of the world. There are over 15 state-of-the-art landfills located across the country, as well as a recycling plant where 23 percent of total waste produced (1.4 million tons) is recycled. Some 25% of MSW produced in Dubai, Abu Dhabi, and Sharjeh is redirected to compost plants in the Gulf Arab countries, particularly in the UAE. MSW is gathered and sent to dumpsites in other UAE emirates. More than 60% of the generated methane is retrieved, notably in Dubai.

Another common issue is the lack of clear and robust regulatory structures regulating the solid waste industry, as well as ineffective compliance processes that are almost as relevant as the laws themselves. Such weaknesses in MSW management build chasms and escalate the issues. Standards and norms are also important for the enforcement of statutory mechanisms, notably those relating to the establishment, construction, and operation of landfills, as well as the handling of potentially hazardous and healthcare wastes. Human and corporate capabilities are both lacking in many developed countries with sufficient financial capital.Donors have invested a large amount of money in the Pakistani

Government to restore deteriorated infrastructure and provide facilities for the storage, distribution, and recycling of solid waste, but they have failed to develop the requisite structural and human capacities and increase public awareness. This culminated in a dilemma that was only recently fixed. (Khatib, 2011)

Various nations have taken different approaches to implementing waste management schemes for packaging. Four of the five countries studied have opted for a system that holds farmers accountable. In some countries, all packaging waste is used in the scheme, while in others, commercial waste is the primary concern. In general, the systems contain a range of initiatives aimed specifically at raising recovery and recycling, with actions on packaging waste reduction obviously lacking. (Agency, 2005)

Between 1997 and 2001, packaging waste rose in ten of the fifteen EU countries, and by 7% in the EU as a whole. Prior to the directive's approval in 1994, Austria had a framework in effect. Their packaging waste producer responsibility scheme (ARA) was founded in 1993. It has achieved very high rate of regeneration and recycling, far exceeding the directive's requirements, and has also met the amended directive's goals for 2008. ARA is a full-cost scheme, which ensures it bears more of the costs of processing, sorting, and recovery than the other countries surveyed. As a result, it is relatively pricey. Local governments in Denmark are in charge of implementing the appropriate collection and recycling systems. One of the cornerstones of waste management is the deposit-return scheme for soda packaging. Recycling standards were still well on their way to achieving the directive's goals when it went into effect. To satisfy the new commitments, it was agreed to concentrate on transportation packaging rather than domestic packaging, and the 2001 goals were fulfilled with the exception of 15% plastics waste recycling, which was

exceeded by 1%. Repak, Ireland's key reform measure, is a producer obligation mechanism.

Ireland is excluded from the directive's recycling and recovery goals, which must be met by 2005, with a required recovery rate of 25% by 2001. Packaging waste per capita (214 kg) is higher than in any other EU region, and it is the at a faster rate than GDP. With such a high reliance on landfills, recycling is the only existing means of regeneration, and it has achieved the 25 percent goal set in 2001. The construction of household waste management infrastructure and the effect of the landfill directive are expected to have a substantial impact in the coming years on Ireland's packaging waste management scheme. The CONAI producer-responsibility system is Italy's key tool for achieving the directive's goals. CONAI reimburses city governments for the extra costs incurred as a result of increased packaging collection. Around 1997 and 2001, the total amount of packaging waste rose by 19%. In 2001, the directive's recovery and recycling targets were reached, with recovery rates exceeding 50% and recycling rates reaching 46%. In northern and southern Italy, there are significant variations in the volume of packaging waste obtained separately for recycling and recovery. In the United Kingdom, the producer-responsibility system is the most critical indicator (Packaging Waste Recovery Notes). This focuses on commercial waste, with the goal of achieving the directive's goals in a cost-effective and competitive way. Along the packaging chain, businesses are required to take responsibility for a certain volume of packaging based on their operations. According to recent statistics, the amount of packaging is growing. In 2001, the recycling rate was 42 percent, exceeding the directive's targets; however, the 50 percent recovery goal was missed by 2%. Due to PRN (Packaging Recovery Notes) price volatility, the funding requirement varies greatly from

year to year. The device seems to have met its aim of hitting the goals at the lowest possible expense to industry as measured per ton packaging recovered. However, since the PRN system's turnover only represents a fraction of overall costs, it's unknown if the system is running at the lowest possible cost to society. Despite its competitiveness, this industry-driven approach has resulted in a lack of public engagement and recognition of the packaging waste problem. (Agency, 2005)

Bangladesh faces various waste management problems as a result of its dense population. With the increase in population, the quality, amount, and composition of wastes changes. According to a UNFPA survey, Dhaka is currently one of the world's most contaminated cities, with one of the issues being the handling of municipal waste. (Bhuiya, 2007). Bangladesh's Urban Waste Development Trends In 2003, waste production was projected to be 5,650 tons a day. Regular and annual production will hit 15,110 tons a day and 5.52 million tons a year by 2021. (Islam, 2016). By 2025, the amount of waste production would have risen to 47, 064 tons per day. (Ahsan., 2007) However, in major Bangladeshi cities such as Dhaka, the overall waste collection rate is just 37%. (Sinha, 2005).

To solve this issue, proper waste management is needed. Wastes should be regarded as a resource rather than a concern. When renewable resources get scarcer and waste generation increases, the 3R concept has gained momentum as a way of ensuring waste diversion, reuse, and recycling. Bangladesh's Department of Environment has developed a National 3R strategy to prioritize environmentally sound waste management and resource utilization while also building institutional capability. In 2010, the Government of Bangladesh (GOB) approved this strategy. The below are the objectives of this strategy:

- By 2015, eliminating, reusing, and recycling waste while reducing waste disposal
- Promoting waste recycling by compulsory waste segregation at source
- Encouraging emission-reducing technologies
- Promoting the "polluter pays" concept
- Supporting the inclusion of the informal recycling industry

Recycling can help save money by allowing items that are already manufactured to be produced domestically. Recycling is mostly conducted in the unorganized sector in Bangladesh. Some companies use local technology to recycle plastic, aluminum, glass, and paper. However, these sectors lack adequate facilities as well as a safe working climate. Poverty, solid waste disposal, and recycling are all intertwined. For many unemployed people, recycling is a means of money. Waste management includes a substantial number of women and children. In Bangladesh, there are three stages of recovery and recycling. The waste generators detach waste with higher market value, such as newspaper, glass, and plastic containers, and sell them to street hawkers in the first process. The scavengers gather recyclable items of low market value, such as broken bottles, containers, and polythene, in the second process. The waste pickers directly after unloading at dumpsites gather recyclable materials from the waste vehicles in the final process. In no part of Bangladesh is root segregation a scheduled practice. Scavengers, rag pickers, and waste generators are the ones that perform the most of the sorting. Since they prefer to segregate only certain waste materials that have a relatively higher economic return in the recycling industry, segregation efficiency is very poor. And all of this segregation and sorting takes place in a very dangerous and insecure setting. Food waste, which makes up the bulk of the waste stream, is often discarded rather than isolated and composted. However, owing

to the high demand for compost and its economic feasibility, several composting plants have been shut down. Furthermore, there are insufficient funds to help waste separation and recycling. (Tariq Bin Yousuf).

It is impossible for the municipality to offer effective and sufficient waste collection and recycling facilities to the entire community due to insufficient financial and operational resources. DCC's waste disposal includes regular sweeping of highways and waterways, accumulating waste along the roadside, gathering and transporting waste to the closest container, dumping at depots, and dressing with bulldozers and tire dozers, among other things. (Islam, 2016)

3.4 Packaging and Promotion: How Does Packaging Affect Marketing Strategy?

The product packaging system (i.e. primary, secondary, and tertiary packages and accessories) is extremely significant in the supply chain, and its significance is increasing as a result of the need to cut costs, minimize environmental impact, and improve web operations (i.e. electronic commerce).

A traditional supply chain is an end-to-end network that focuses on commodity manufacturing, storage, and distribution. It refers to the natural flow of goods from the supplier to the producer, dealer, retailer, and finally to the end user. Since all goods are shipped in containers, understanding physical logistics flows and the function of packaging is crucial for the description and design of manufacturing processes, as well as improving layout and increasing company performance.

Companies have begun to view packaging as a crucial concern in recent years. In order to enhance company efficiency and reduce costs, it is important to evaluate package characteristics (e.g. shape, components, transportation, etc.). Packaging encompasses all aspects of a company's operations, from the acquisition of raw materials to the manufacture and selling of finished goods, as well as transportation and distribution. (Regattieri & Santarelli, 2013)

According to experts, the most defining characteristics of packaging should be included in the concept of packaging:

- Safety of a commodity during packaging, transportation, and use, and perhaps even, in certain cases, environmental protection from the product's potentially harmful effects.
- Processing, transportation, and selling of goods, as well as their use, are all being simplified.
- Information about a product that is needed by law, especially information about its consumer utility.
- Through the proper presentation of a product, one can have a psychological effect on a potential consumer. (Wyrwa & Barska, 2017)

3.4.1 Packaging as a Means of Product Information from the Producer's Perspective

The purpose of packaging and its responsibilities are dynamic categories that change over time, influenced primarily by shifts in market dynamics and the needs of consumers that are closely connected to them. Packaging has become an important component of any

marketing campaign as a result of rising customer needs, the increase of self-service modes of selling, the population income, improved packaging efficiency, and the opportunity to make quick improvements. The nature of the product for which it is manufactured, as well as the type of choice taken by a consumer while purchasing the product, determine the role of packaging as a marketing tool. Packaging has historically been presented in a number of marketing contexts:

- Packaging as a tool in the marketing mix
- Packaging, cost, delivery, and marketing in relation to a product
- The features and ideals of packaging in relation to the needs and preferences of consumers
- The role of packaging in a good's marketing
- Packaging as part of marketing campaign
- Consumers' feelings and experiences are influenced by packaging and its nature.
- Consumers may use packaging as a source of knowledge and education. (Wyrwa & Barska, 2017)

The communication factor, which involves providing prospective customers detailed details about a product and its vendor designed to motivate them to purchase it, is one of the most important packaging marketing features. Both influencing, educating, and promoting a commodity can be referred to as "contact." In this sense, the coordinating position is mostly concerned with individual packaging; however, it is clear that it is increasingly evolving to include group packaging as a result of the emergence of "Cash & Carry" distribution networks.

The aesthetics, visual appeal, and appropriate details on packaging are generally associated with the communication role of packaging. This data should primarily shape customer desires, draw their attention, and pique their interest in purchasing a product.

The interpretation of information on packages is a number of co mechanism that includes sharing information (the analytical phase), evoking emotions (the affective phase), and taking action (the behavioral phase) (the behavioral phase). These stages are supposed to put the item in a hierarchy of alternative goods based on its consistency, price, and market name, as well as pique interest in buying and buying it.(Wyrwa & Barska, 2017)

Two groups of attributes make up the packaging's information function. The first is semantic, while the second is non-semantic.

The initial one is:

- The presence and readability of essential details from a consumer's perspective (including mandatory information);
- The readability of essential data such as the product's nam e or intent
- The existance of warnings about using the product in an unhealthy manner.

The second category includes the following:

- Use of acceptable and contrast colors for easy reading of details
- Ability to express the product's function through the packaging's graphic surface (colors added, fonts, or packaging shape)
- Using alert colors for dangerous products

Labeling on packaging, labels, or collective packaging refers to placing details on the packaging, labels, or collective packaging that pertains to the product packaged. This

knowledge is presented in the form of words, letters, logos, photographs, figures, or symbols, and it can pertain to the product's shelf life, preparation methods, use, nutritive worth, or all other business considerations. Labeling is intended to protect the interests of consumers. It also plays an important role in trade, acting as a source of information for both customers and other logistics chain participants. The requisite details can be printed on the packaging or on labels. Labeling is an important part of ensuring food protection, which includes health and sensory consistency as well as nutritional value. To guarantee that a manufacturer's statement on packages does not deceive customers, it must be reviewed and approved by competent authority in charge of oversight. As a result, labeling entails providing data about the good and the producer, along with nutritional information.

Packaging separates and defines items in the assortment through its information feature. It is a transporter of product description, terms of use, ingredients, schedules of feasibility for purchase, or other promotional information aimed at persuading customers to purchase a product from a particular manufacturer or company. According to C.F. Hales, the prime objective of packaging is to raise awareness for those who come into touch with packaging and its products (consumers and workers at different levels of the distribution channel) about how to handle the packaged product (during shipping, use, and after consumption), its composition, and the choices available.The information function means above all:

- Having the information needed to make a buying decision
- Increasing trust in the adequacy of decisions that are made
- Growing understanding of the benefits of purchasing
- Providing feedback on new technologies and services (Wyrwa & Barska, 2017)

3.4.2 Information Aspects of Product Packaging from the Consumer's Perspective

New product production patterns are influenced by evolving customer needs and desires, which are influenced by a variety of factors, including global population shifts, higher rates of diet-related disorders, the growth of e-commerce, and increased environmental consciousness. As a consequence of all of this, customer preferences for multiple packaging features, including the knowledge function, are growing. The packaging industry's growth is influenced by consumer dynamics, which is why it's important to look into the issues.

In October and November 2015, observational experiments using survey methodology and a structured questionnaire were performed on a group of adult consumers living in the Lubusz Voivodeship. The Cronbach's alpha test has proved the accuracy of the measurement tool's scale. The survey was restricted to 372 respondents due to the checking of the analytical material and insufficient evidence in the questionnaires. Pilot experiments were conducted prior to the field studies to ensure that the measurement instruments were accurate. The sample's respondent allocation criterion took into account the population's representativeness in the voivodeship, and the selection was quota-style, taking gender and place of residence into account. Women made up 52% of the respondents, while residents of rural areas made up 36%.

According to the results of the study, the most significant roles of food product packaging are protection (23.8 percent) and information (23.8 percent). Utility (22.8%), ecological (13.8%), aesthetic (7.5%), and distinguishing functions were also listed (2.5 percent). The age of respondents can be used as a distinguishing factor within demographic variables.

Young people were also more likely to mention packaging's ecological functions, such as environmental protection and recyclability.

More and more customers in this community are interested in packaging that is biodegradable and does not deplete the ozone layer. Consumers aged 50 and up dominated the category of respondents who ranked the knowledge feature as the most important. Many abuses in food processing and distribution, as well as the widespread use of pesticides with uncertain long-term consequences, have resulted in packaging taking on a greater informational function. Given the increasing demands of consumers in terms of transparency, the value of labeling, which helps to protect consumers' rights, including their lives and wellbeing, is growing. (Wyrwa & Barska, 2017)

3.4.3 Packaging Contributes to Business Success

Packaging has been an effective selling tactic due to a variety of reasons. The primary role that corporations have historically attributed to packaging has been to secure goods during the delivery process from a manufacturer to a final customer. New consumer demands, on the other hand, have sparked a rethinking of product design and a production process that includes the logistical, commercial, and environmental roles of packaging. The logistic role covers how a product moves from a source to a customer, as well as the physical specifications that packaging must fulfill within the supply chain. The commercial role is concerned with various marketing contact criteria, as well as required user information (e.g., about the content; how to use the product), and awareness of customer demand and its possible effect on the purchasing decision process. The environmental feature is concerned with the re-use, recycling, and reduction of packaging materials, as well as

environmental consciousness in general. The business climate, which includes customer, innovation, and regulatory conditions, is also included in this feature.

Product and material distribution has become a much more critical feature of our culture today. We wouldn't be able to sell or supply goods over long distances without packaging. “The packing content costs for Fast Moving Consumer Goods (FMCG) can be as much as 20% of the purchase price,” according to Innventia (2011), a Swedish research agency. Every day, a buyer is confronted by – and treats – 20-30 packages, some of which are handled several times.” Even though packaging has become a well-known marketing technique, there have been very few studies in the marketing literature dedicated to analytical work. (Rundh, 2013)

3.4.4 Packaging innovation

According to previous surveys, the US industry introduces over 15,000 new items per year, all of which necessitate new packaging technologies, even though the contents are just line extensions. Innovative packaging will clearly have significant benefits to consumers while still generating sales for manufacturers. New materials and special features, such as resealable materials and new ways of opening a box, can be used to develop creative solutions. (Rundh, 2013)

3.4.5 Competitive advantage through packaging

Competitive advantage can be obtained in any area of a company's operations. A increasing interest in and use of packaging for distinction and competitive advantage has been

attributed to a number of factors. To do so, packaging must be analyzed and created as an innovative marketing technique, not only as a part of a product plan. From the construction of a box to its re-cycling by the end-consumer, manufacturing and the packaging process include all of the actions that various players conduct to add value in a supply chain.

The primary packaging for an item, the secondary package, and the transport or shipping package are all examples of this. A well-designed box can serve as the silent sales agent, contributing to the selling of the product, and it can be the first interaction a prospective customer has with a product in a store or supermarket. Previous research has also stressed the value of the package's communicative and brand-building features. Packaging can also affect customers' future encounters with a product by encouraging them to reuse the box for other purposes. Clearly, a growing use of packaging for marketing purposes may be attributed to a number of reasons. One of these reasons is the growing value of self-service, in which a successful kit would execute many of the promotional activities, such as gaining interest, explaining the contents of the box, and describing the product's functionality. Given that 50 to 70% of all purchasing decisions are taken in stores, the packaging design must both inspire customer trust and provide a favorable overall image of the package's contents. (Rundh, 2013)

3.4.6 Packaging as a Marketing Tool

Packaging has evolved from its original roles of security and delivery to becoming a medium for a variety of other marketing purposes. Another vital role is for networking purposes, such as name and product identification. A package's other important functions include supplying price and ingredient detail to consumers, as well as guidance about how

to manage and use the product. A kit must be able to draw and hold the interest of the buyer in order to be successful in ads. This can be accomplished by the package's format, color, scale, and shape. According to previous studies, a mild change in product design could be the best option for attracting interest and creating a favorable impression of a package. Wansink's (1996) observations from five experiments indicate that large packages of well-known branded goods promote greater use than small packages. Wide box sizes consistently improved commodity usage volume in these trials. Larger packages are considered to be less costly per unit than smaller packages with the same items, which is one reason why customers may use more from them. Wansink (1996) also claims that “it is necessary to note that packaging affects customer behavior long after it influences purchase” from a managerial standpoint. Bloch (1995) looked into the form of the box, and Raghubir and Greenleaf (2006) looked into the impact of package proportional ratios in another analysis. Consumer reactions to rectangular package types can affect buying intentions and preferences, according to their study, but this is also linked to marketplace demand. The outcomes of their analysis back up Bloch's claim that product type should be included in marketing strategy (1995). Kauppinen has looked at the use of color to draw consumers' interest (2004). Consumers' decision-making at the point of purchase was found to be influenced by the colors on labels for low-involvement purchases. According to Kauppinen's (2004) research, colors play three roles. Colors on packages draw focus, serve as an artistic feature, and convey detail. The results also show that when the roles of colors on packages complement each other, an "additive effect" can be achieved. Underwood and Klein (2002) investigated the communicative value of packaging (2003). They looked at the communicative influence of packaging in terms of building and expressing brand

identity in these studies. This study backs up the idea that for goods that aren't purchased in their finished state, "consumers frequently rely more on the packaging than other means of marketing contact to create an understanding of the commodity in its prepared state." (Rundh, 2013)

3.4.7 Packaging in Marketing Strategy

Due to the intense competition, packaging can be used as an integrative tactic in marketing strategies. New package concept can be used as a marketing strategy to achieve marketing targets and fulfill customer preferences. This can be done by integrating the package's decorative and practical features. The form and size of a box, as well as the content, color, writing, and graphics, are both aesthetic factors. Packaging design is important not only for branding purposes, but also for the package's function. Many modern re-sealable, tamperproof, and more easy to use containers, such as for take-away products, have been developed thanks to technology. These advancements also resulted in packaging that is easier to handle, open, and store at home 1551 as a result of these advances. Packaging, on the other hand, would work in tandem with other elements of the marketing mix, such as pricing, advertisement, and other facets of marketing policy. Packaging and labeling should be viewed as a part of the product plan in a conventional marketing campaign. Such critical facets of the product plan that often occur on a box are warranties and promises. From a commercial standpoint, packaging must meet a variety of targets as part of a marketing strategy:

- Use of cutting-edge architecture to increase consumer interest.
- The desire to recognise a brand.
- Disseminating descriptive and persuasive results.
- Streamlining commodity transportation and maintaining material security.
- Assisting in at-home storage.
- It's easy to open and close.
- Promoting product consumption;
- clever dispensing and recyclability; and
- raising environmental awareness.
- Any manufacturing company's marketing plan should clearly include the value of clean and simple packaging solutions.

Well-designed packages will help to create a brand and boost sales, and they've clearly been a central component in increasing consumer satisfaction and maintaining a competitive edge.(Rundh, 2013)

3.4.8 Marketing Tactics

Marketing managers formulate plans and approaches aimed at delivering loyalty by bringing value to consumers through the implementation of a marketing campaign. This must be achieved in light of the current competitive environment, and the different factors, or components, must be combined into a marketing combination which is appropriate (controllable variables). At the retail level, packaging has been an essential component of product differentiation and creativity. Lauterborn's (1990) four Cs – consumer comfort,

customer satisfaction and rewards, customer expense and contact including customer relationships – are one way to define the required variables.(Rundh, 2013)

4 Methodolgy

4.1 Selection of Potential Secondary Packaging Waste

There are three types of packaging (Primary, Secondary and Tertiary) that are used for packaging the products in the market. Primary packaging is in direct contact with the product itself. The main purpose of primary packaging is to contain, protect and/or preserve the finished product, particularly against contamination. Secondary packaging is the exterior packaging of the primary packaging. Tertiary packaging facilitates the protection, handling and transportation of a series of sales units or secondary packaging in order to group everything into unit loads during transit. The secondary package among these is mostly used to give the product an aesthetic view and for marketing purpose rather than protecting the product itself.

Economic utility refers to the usefulness or value that consumers experience from a product or service and can be judged based on the form, time, place and possession. These factors help in assessing the purchase decisions and the drivers behind those decisions.

4.1.1 Survey Analysis

To know the utility of secondary packaging layer for various products, a questionnaire survey was conducted (Appendix 1). The survey was conducted through google form. Through the questionnaire survey, a sum amount of 129 people of various sectors such as students, service holders, businessmen etc could be reached.

The objective of the survey was to understand the utility of the packaging of various categories of products like skin care, dry food, toothpaste, dairy products, bundle offer products etc. The respondents were asked to share the utilities if there was any to them.

The consumers were asked to choose between some products if they would buy those even without the extra layer of packaging. Depending on the opinions of the consumers, one product was chosen to be studied upon.

4.2 Field Observation

To perceive the whole market share of that chosen product in Bangladesh, a field observation had been conducted.

4.3 Data Collection

To study upon the chosen product various data's were analyzed. Some of the data's were procured from confidential sources and some were obtained through laboratory tests.

4.3.1 Primary Data

Factors like unit weight, Secondary Packaging Paper Gram Per Square Meter (GSM), costing of the packaging per unit, resource requirement (water, energy, raw materials), annual production and manufacturing process flow of the secondary packaging were obtained from a packaging manufacturer company (subcontractors).

4.3.2 Seconadary Data

To proceed with the study, some data's were required which are not always open to the public. A set of data was obtained through anonymous source under a non-disclosable condition. Waste management data and paper packaging production emission data were obtained through the data set.

4.4 Measurement

The gathered data allowed us to measure and quantify various parameters and aspects of the products that we selected. The primary data helped to quantify the unit value of the environmental impact and the annual impact was quantified through the secondary data.

4.4.1 Generation

The waste that is generated from the secondary packaging is basically paper waste. The primary data that has been collected from the laboratory test led to the quantification of the amount of paper waste generated.

4.4.2 Composition

The manufacturing process of the packaging was attained through analyzing the packages. This showed the elements and chemicals used to bring the package into existence.

4.4.3 Resource Requirement & Cost Conservation

The various resources like materials, water and energy resources were quantified from the primary data collected. The resources were then multiplied with the annual demand which allowed the study to quantify the resources and the cost behind that would be saved if secondary packaging is removed.

Here,

Annual Production Units = P

Unit Weight of Paper Packaging = Q

Costing (TK per Unit) = X

Water Consumption (Litre per Unit) = Y

Electricity Consumption (KWh per Unit Package) = Z

So,

Weight of Annual Paper Produced (gm) = P*Q

Annual Production Cost (TK) = P*X

Annual Water Consumption (Litre) = P*Y

Annual Electricity Consumption (KWh) = P*Z

4.4.4 Volume of Waste Generation

After adding the sum total weights of annual paper packaging produced for those brands available in the market, the amount is multiplied by the density of paper waste. Therefore, total volume of waste generated by this paper packaging is procured.

If,

Total Weight of Paper Waste (Kg) = A

Density of Paper Waste (Kg/m^3) = B = 81.7

So,

Volume of Total Paper Waste Generated (m^3) = U =A/B

4.4.5 Waste Management

The obtained total waste volume was multiplied by compaction factor. The resultant is the compacted volume of total paper waste for transportation. This compacted volume is then divided by the capacity of a garbage truck to obtain the number of trips needed to transport that amount of paper waste.

Next the amount of compacted volume is multiplied by paper waste density. The resultant is the weight of the total compacted waste. Then by multiplying with per ton Solid Management Cost (SWM), total management cost was obtained.

Here,

Compaction Factor = K =1.5

Capacity of a Garbage Truck (m^3) = C = 8

SWM Cost (TK/ton) = E = 930

So,

Volume of Total Paper Waste for Transportation (m^3) = V = U/K

Total Trip Needed for this Compacted Waste = V/C

Total Management Cost for Paper Waste (TK) = A*E

4.4.6 Probable Chemical Emission

Total amount of pulp produced was multiplied with the unit chemical emission per ton pulp. The amount of pulp was calculated through a paper pulp ratio.

4.5 Suggesting Possible Alterative Packaging

Possible alternative to the existing packaging methods was suggested after proper research upon the topic.

5 Result

5.1 Survey Analysis

Question 1: The survey was done to know the perspective of general people regarding secondary packaging. This inspection data was performed among the different ages of people shown in **Figure 5.1**.

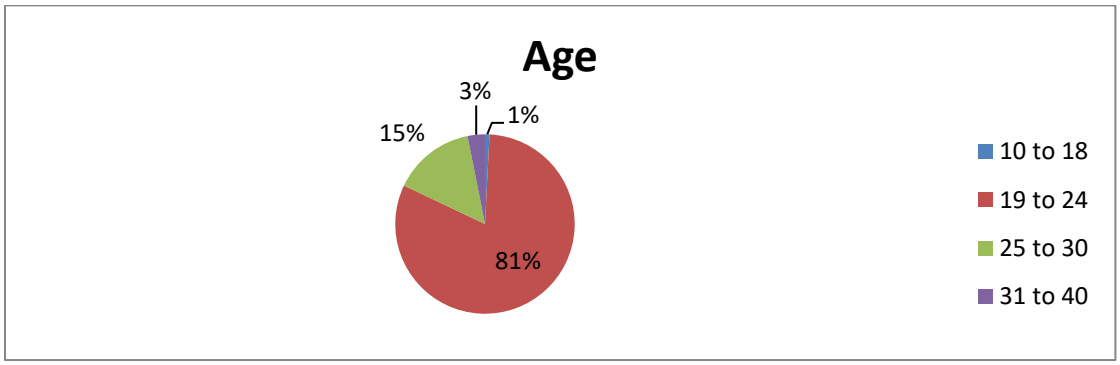

FIGURE 5.1: AGE RANGE OF THE PEOPLE PARTICIPATED IN THE SURVEY

19-24 aged people were contributed most in this study in the percentage of 81.

Question 2: To study upon the packaging system of various products the survey was done. From the **Figure 5.2** a sum of 129 people could be reached through the survey; among which 85% were students, 13% were service holder and rest of them are businessmen and home makers.

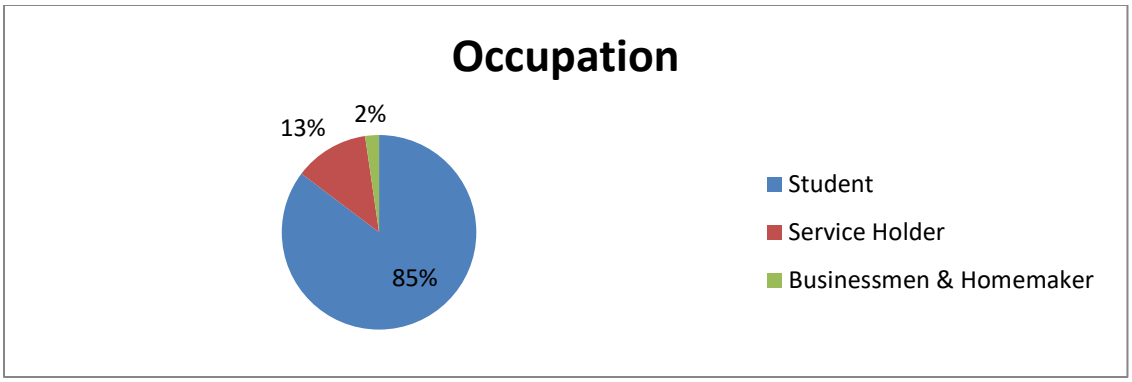

FIGURE 5.2: PROFESSIONS OF THE PEOPLE PARTICIPATED IN THE SURVEY

Question 3: They were asked the utility of secondary packaging after buying any goods and 96.6% of people answered that the secondary packages don't fulfill any purpose to them. The result is given through the **Figure 5.3**.

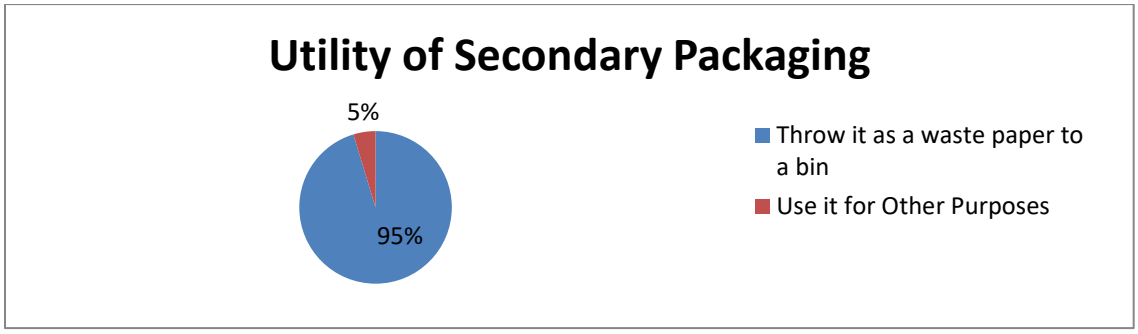

FIGURE 5.3: UTILITY OF SECONDARY PACKAGING

From the **Figure 5.3**, it can be stated that most of the consumers ind no utility of secondary packaging. A small percentage of people use this packaging for different purposes which is negligible.

Question 4: They were also asked for the congeniality of buying consumer goods like toothpaste, face cream etc. with just a plastic tube rather than in a paper packet. Most of

them said that they would still purchase the products even if paper packaging is not there, but the tube should be sealed. The result is shown in **Figure 5.4**.

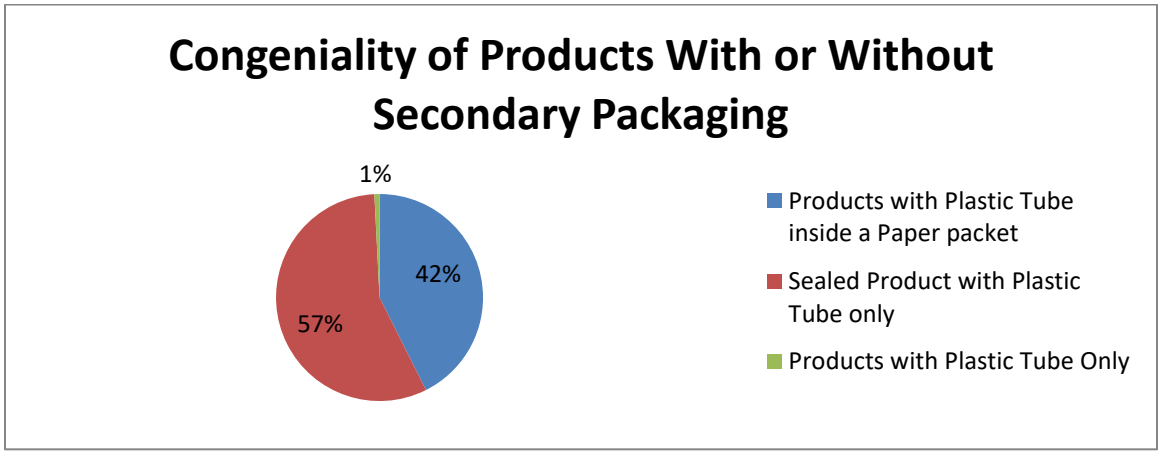

FIGURE 5.4: CONGENIALITY OF PRODUCTS WITH OR WITHOUT SECONDARY PACKAGING

From the **Figure 5.4**, it can be stated that most of the consumers don't fine any necessity of secondary packaging if the product inside is sealed properly.

Question 5: Then they were asked about the utility of the board used to pack dry food items (with a plastic wrapper inside). Majority of the people admitted that the board is of no use to them.

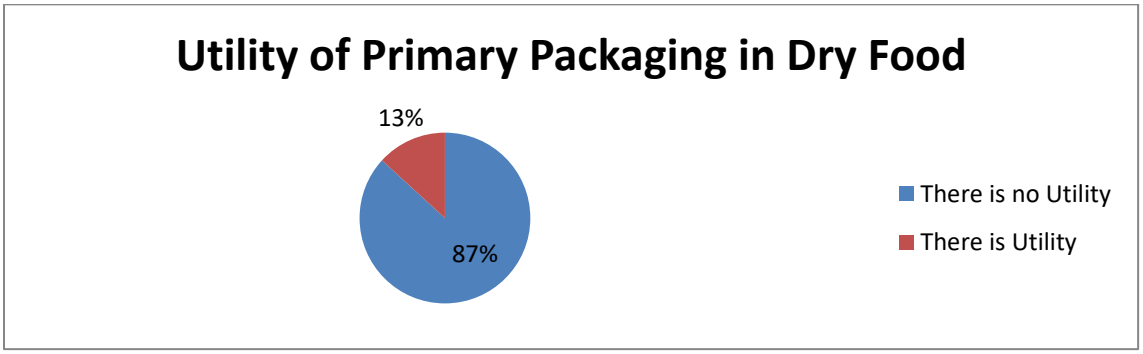

FIGURE 5.5: UTILITY OF PRIMARY PACKAGING IN DRY FOOD

From the **Figure 5.5**, only 13% said that they use the primary packaging for crafting or as storage unit but the percentage is very low compared to the percentage who don't find any utility of this primary packaging.

Question 6: The consumers had different statements about checking the printed information on the secondary packaging during the purchase. The result is shown in **Figure 14**.

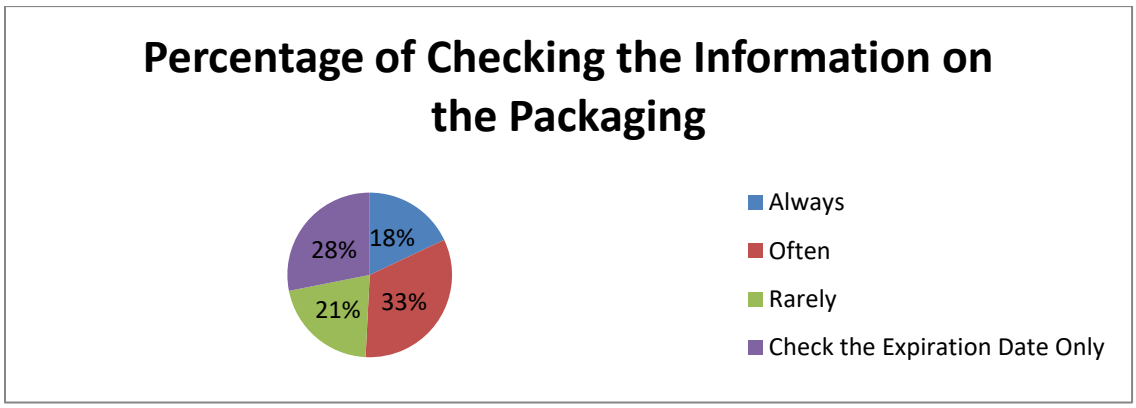

FIGURE 5.6: PERCENTAGE OF CHECKING THE INFORMATION ON THE PACKAGING

From the figure, it can be stated that a very small portion of consumers always check the information printed on the packaging. A significant percentage of consumers check the expiry date only.

Question 7: Through the survey, it is got to know that most consumers prefer 'ecofriendly', 'minimum waste' and 'less resource used' type environmental branding.

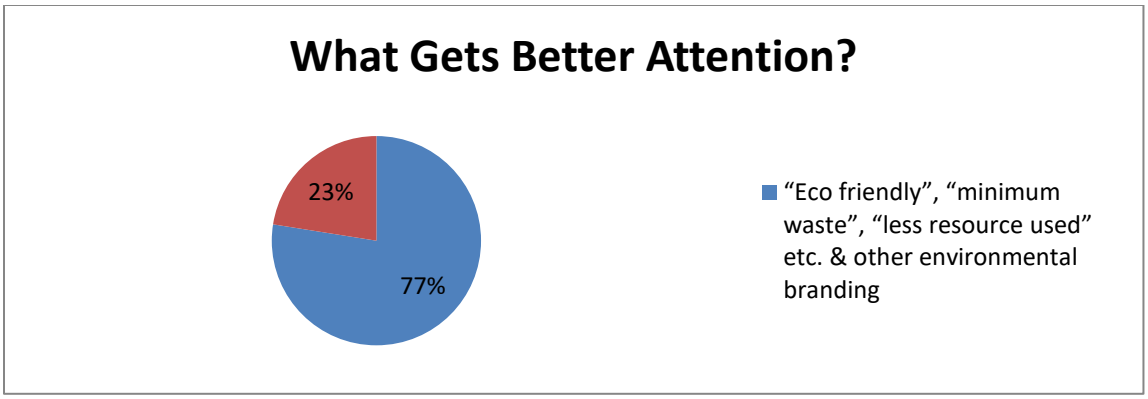

FIGURE 5.7: WHAT GETS BETTER ATTENTION ACCORDING TO THE CONSUMERS

From this figure above, it can be stated that consumers are more environment conscious now. They prefer to buy products which are environment friendly and don't lessen the resources of the environment.

Question 8: The consumers were asked their preferable products between products producing less waste and excessive waste. A significant percentage of consumers don't think of it before purchasing.

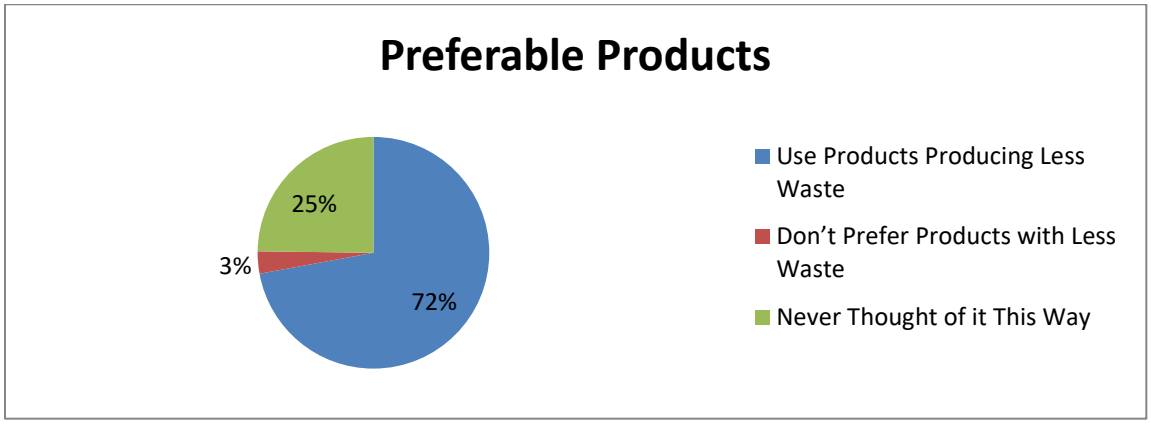

FIGURE 5.8: PREFERABLE PRODUCTS IN TERMS OF WASTE PRODUCTION

From **Figure 5.8**, most of the consumers (72%) prefer using products those produce less waste. Only 3% people don't prefer products with less waste.

Question 9: The consumers were provided some specific products types to know whether they would purchase those or not (if the secondary packaging is eliminated). The result is shown below:

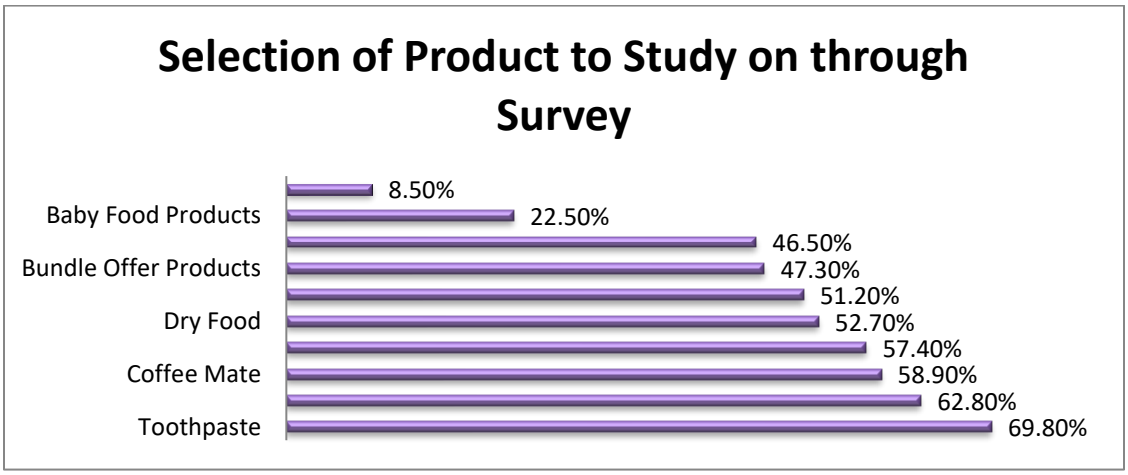

FIGURE 5.9: PRODUCTION SELECTION TO STUDY ON THROUGH SURVEY

So the majority of the people (69.8%) agreed to the point that the secondary packaging of toothpaste can be eliminated. So the study was continued with this product.

5.2 Field Observation

The market share of various brand of Bangladesh was obtained through field observations and data source.

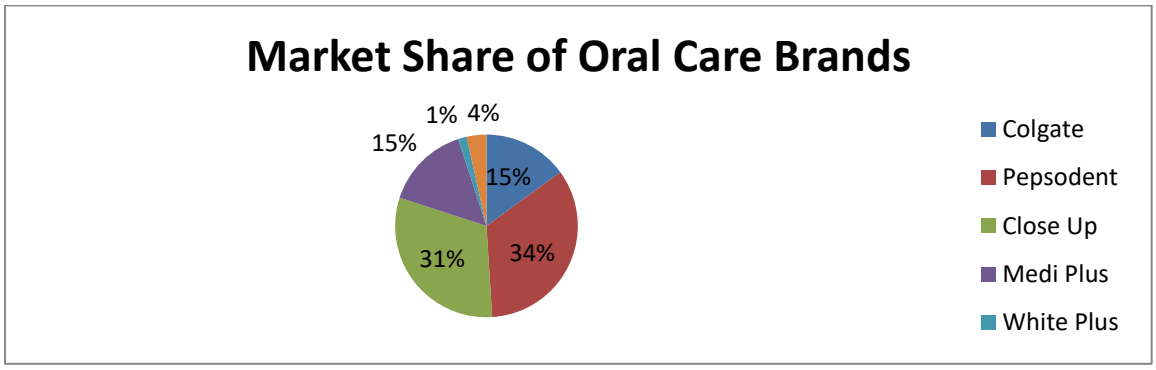

FIGURE 5.10: MARKET SHARE OF ORAL CARE PRODUCTS

In the the above figure, it can be said that the brand that holds the lagest market share of the toothpaste market of Bangladesh is Pepsodent (34%). The rest are Colgate (15%), Close Up (31%), Medi Plus (15%), White Plus (1.5%) and others (3.5%).

5.3 Data and Calculation

The primary data's for the study were procured from five leading toothpaste brands of Bangladesh. Those data's were further used to quantify various components in the study. The resultants are given below:

5.3.1 Brand 01

TABLE 5.1: UNIT WEIGHT AND RESOURCE CONSUMPTION PER UNIT OF PACKAGING (BRAND 01)

Pack Size (gm)	GSM	Unit Weight	Costing (TK per Unit)	Water Consumption (Litre per Unit)	Electricity Consumption (KWh per Unit Package)
15	300	3.80	1.27	0.10	0.00436
50	300	6.13	1.55	0.10	0.00436
100	350	9.31	2.07	0.10	0.00436
150	350	12.48	2.50	0.10	0.00436
200	350	15.71	2.97	0.10	0.00436
300	350	19.13	3.69	0.10	0.00436

TABLE 5.2: ANNUAL PRODUCTION OF PAPER & CONSUMPTION OF RESOURCES (BRAND 01)

Pack Size (gm)	Annual Production Units	Weight of Annual Paper Produced (gm)	Annual Production Cost (TK)	Annual Water Consumption (Litre)	Annual Electricity Consumption (KWh)
15	38814400	147494720	49294288	3881440.00	169230.78
50	10089000	61845570	15637950	1008900.00	43988.04
100	10873600	101233216	22508352	1087360.00	47408.90
150	6691400	83508672	16728500	669140.00	29174.50
200	6187150	97200126	18375835.50	618715.00	26975.97
300	4752700	90919151	17537463	475270.00	20721.77
Total	77408250	582201455.50	140082388.50	7740825.00	337499.97

From these two tables, it is perceived that consumers tend to buy the toothpaste which has the pack size of 15gm (the smallest pack size) most as it has the highest production value. Half of the total water consumption is used to manufacture this package annually. And the largest size which is 300gm, has the lowest production value so far. It is seen that the specific brand has an annual production rate of 7.75 million pack unit producing 582.20 tons of paper. The production process of the paper consumes 7.75 Megalitre water and 337.5 MWh electricity annually with an overall costing of 14.1 million TK annually.

5.3.2 Brand 02

TABLE 5.3: UNIT WEIGHT AND RESOURCE CONSUMPTION PER UNIT OF PACKAGING (BRAND 02)

Pack Size (gm)	GSM	Unit Weight	Costing (TK per Unit)	Water Consumption (Litre per Unit)	Electricity Consumption (KWh per Unit Package)
10	300	3.59	1.18	0.10	0.00436
25	300	4.47	1.35	0.10	0.00436
50	300	6.16	1.59	0.10	0.00436
80	300	8.01	1.86	0.10	0.00436
100	350	9.34	2.11	0.10	0.00436
125	350	10.91	2.37	0.10	0.00436
145	350	12.23	2.58	0.10	0.00436
160	350	13.19	2.73	0.10	0.00436

TABLE 5.4: ANNUAL PRODUCTION OF PAPER & CONSUMPTION OF RESOURCES (BRAND 02)

Pack Size (gm)	Annual Production Units	Weight of Annual Paper Produced (gm)	Annual Production Cost (TK)	Annual Water Consumption (Litre)	Annual Electricity Consumption (KWh)
10	14155800	50819322	16703844	1415580.	61719.29
25	21233800	94915086	28665630	2123380	92579.37
50	9198800	56664608	14626092	919880	40106.77
80	1288980	10324729	2397502.80	128898	5619.95
100	9914200	92598628	20918962	991420	43225.91
125	3660600	39937146	8675622	366060	15960.22
145	2440400	29846092	6296232	244040	10640.14
160	5641200	74407428	15400476	564120	24595.63
Total	67533780	449513039.8	113684360.80	6753378	294447.28

From the tables above, it is perceived that consumers tend to buy the toothpaste which has a pack size of 25gm, most as it has the highest production value. 32% of total water consumption is used to manufacture this package. Toothpaste which has a pack size of 80gm has the lowest production value. It is seen that the specific brand has an annual production rate of 6.7 million pack unit producing 495.5 tons of paper. The production process of the paper consumes 6.75 Megalitre water and 294.5 MWh electricity annually with an overall costing of 11.4 million TK annually.

5.3.3 Brand 03

TABLE 5.5: UNIT WEIGHT AND RESOURCE CONSUMPTION PER UNIT OF PACKAGING (BRAND 03)

Pack Size (gm)	GSM	Unit Weight	Costing (TK per Unit)	Water Consumption (Litre per Unit)	Electricity Consumption (KWh per Unit Package)
15	300	3.83	1.23	0.10	0.00436
50	300	6.10	1.54	0.10	0.00436
80	300	7.97	1.81	0.10	0.00436
100	350	9.27	2.01	0.10	0.00436
150	350	12.45	2.47	0.10	0.00436
200	350	15.63	2.93	0.10	0.00436

TABLE 5.6: ANNUAL PRODUCTION OF PAPER & CONSUMPTION OF RESOURCES (BRAND 03)

Pack Size (gm)	Annual Production Units	Weight of Annual Paper Produced (gm)	Annual Production Cost (TK)	Annual Water Consumption (Litre)	Annual Electricity Consumption (KWh)
15	17124000	65584920	21062520	1712400	74660.64
50	4451000	27151100	6854540	445100	19406.36
80	623700	4970889	1128897	62370	2719.33
100	4797200	44470044	9642372	479720	20915.79
150	2952100	36753645	7291687	295210	12871.16
200	2729600	42663648	7997728	272960	11901.06
Total	32677600	221594246	53977744	3267760	142474.34

From these two tables, it is perceived that consumers tend to buy the toothpaste which has the pack size of 15gm (the smallest pack size) most as it has the highest production value. More than half (52%) of the total water consumption is used to manufacture this package

annually. Toothpaste which has a pack size of 80gm has the lowest production value. It is seen that the specific brand has an annual production rate of 3.2 million pack unit producing 244.3 tons of paper. The production process of the paper consumes 3.27 Megalitre water and 142.5 MWh electricity annually with an overall costing of 5.3 million TK annually.

5.3.4 Brand 04

TABLE 5.7: UNIT WEIGHT AND RESOURCE CONSUMPTION PER UNIT OF PACKAGING (BRAND 04)

Pack Size (gm)	GSM	Unit Weight	Costing (TK per Unit)	Water Consumption (Litre per Unit)	Electricity Consumption (KWh per Unit Package)
40	300	4.71	1.49	0.10	0.00436
70	300	6.76	1.78	0.10	0.00436
90	300	8.12	1.97	0.10	0.00436
100	350	9.29	2.09	0.10	0.00436
140	350	11.55	2.42	0.10	0.00436

TABLE 5.8: ANNUAL PRODUCTION OF PAPER & CONSUMPTION OF RESOURCES (BRAND 04)

Pack Size (gm)	Annual Production Units	Weight of Annual Paper Produced (gm)	Annual Production Cost (TK)	Annual Water Consumption (Litre)	Annual Electricity Consumption (KWh)
40	4463000	21020730	6649870	446300	19458.68
70	647300	4375748	1152194	64730	2822.23
90	3350200	27203624	6599894	335020	14606.87
100	4801000	44601290	10034090	480100	20932.36
140	2945600	34021680	7128352	294560	12842.82
Total	16207100	131223072	31564400	1620710	70662.96

From these two tables, it is perceived that consumers tend to buy the toothpaste which has the pack size of 100gm most as it has the highest production value. Almost 30% of the total electricity consumption is used to manufacture this package annually. Toothpaste which has a pack size of 70gm has the lowest production value and it takes only 4% of the total electricity consumption annually. It is seen that the specific brand has an annual production rate of 1.6 million pack unit producing 144.6 tons of paper. The production process of the paper consumes 3.27 Megalitre water and 70.7 MWh electricity annually with an overall costing of 3.1 million TK annually.

5.3.5 Brand 05

TABLE 5.9: UNIT WEIGHT AND RESOURCE CONSUMPTION PER UNIT OF PACKAGING (BRAND 05)

Pack Size (gm)	GSM	Unit Weight (gm)	Costing (TK per Unit)	Water Consumption (Litre per Unit)	Electricity Consumption (KWh per Unit Package)
12	300	3.68	1.20	0.10	0.00436
45	300	5.79	1.50	0.10	0.00436
80	300	8.02	1.84	0.10	0.00436
100	350	9.30	2.05	0.10	0.00436
200	350	15.69	3.00	0.10	0.00436

TABLE 5.10: ANNUAL PRODUCTION OF PAPER & CONSUMPTION OF RESOURCES (BRAND 05)

Pack Size (gm)	Annual Production Units	Weight of Annual Paper Produced (gm)	Annual Production Cost (TK)	Annual Water Consumption (Litre)	Annual Electricity Consumption (KWh)
12	1710000	6292800	2052000	171000	7455.60
45	445000	2576550	667500	44500	1940.20
80	62000	497240	114080	6200	270.32
100	479000	4454700	981950	47900	2088.44
200	282900	4438701	848700	28290	1233.44
Total	2978900	18259991	4664230	297890	12988.00

From these two tables, it is perceived that consumers tend to buy the toothpaste which has the pack size of 12gm (the smallest pack size) most as it has the highest production value. More than half (57%) of the total water consumption is used to manufacture this package annually. Toothpaste which has a pack size of 80gm has the lowest production value takes only 2% of the total electricity consumption annually. It is seen that the specific brand has an annual production rate of around 3 lakhs pack unit producing 20.13 tons of paper. The production process of the paper consumes 0.3 Megalitre water and 13 MWh electricity annually with an overall costing of 46 lakhs TK annually.

5.3.6 Annual Summary of Oral Care Market

TABLE 5.11: ANNUAL SUMMARY OF ORAL CARE MARKET

Brand	Annual Production Units	Annual Weight Of Packaging Produced (metric ton)	Annual Production Cost (Crore TK)	Annual Water Consumption (Liters)	Total Electricity Consumption per Year (KWh)
Brand 01	2978900	18.26	0.46	297890	12988.00
Brand 02	32677600	221.59	5.40	3267760	142474.34
Brand 03	77408250	582.20	14.00	7740825	337499.97
Brand 04	16207100	131.22	3.16	1620710	70662.96
Brand 05	67533780	449.51	11.37	6753378	294447.28
Total	196805630	1402.79	34.40	19680563	858072.55

The above data represents 96.5% of the whole toothpaste market of Bangladesh.

5.4 Waste Collection & Management

After purchaising, the secondary layer of the toothpaste packaging turns straight to paper waste as it has no utile value. In this portion of the study, the waste truck trips and the SWM cost was calculated which are needed to cover the paper waste produced by the toothpaste industry (96.5%).

TABLE 5.12: WASTE COLLECTION & MANAGEMENT

Parameter	Data	Unit
Total Weight of Waste	1402790	kg
Density of Paper Waste	81.7	Kg/m^3
Volume of Total Paper Waste Generated	17170.03	m^3
Compaction Factor	1.5	-
Volume of Total Paper Waste for Transport	11446.69	m^3
Capacity of Garbage Truck	8	m^3
Total Trip Needed for this Waste	1431	-
SWM Cost	930	TK/Ton
Total Management Cost for Paper Waste	1304595	TK

5.5 Probable Emissions Calculations during Manufacturing of Pulp

TABLE 5.13: AMOUNT OF PULP

Total Weight of Waste Produced Annually (metric ton)	Amount of Pulp (95% Paper) in Tons
1,402.79	1,335.65

TABLE 5.14: CHEMICAL EMISSION THROUGH PULP MANUFACTURING

Chemical	Per unit Emission (kg/ton)		Mass of Pulp (Metric Tons)	Total Emission (KG)	
	minimum	maximum		minimum	maximum
Hydrogen Sulfide	0.30	3.00	1,335.65	399.80	3,997.96
Methyl Mercaptan	0.30	3.00		399.80	3,997.96
Dimethyl Sulfide	0.30	3.00		399.80	3,997.96
Dimethyl diulfide	0.30	3.00		399.80	3,997.96
Particulate Matter	75.00	150.00		99,948.92	199,897.83
Sulfur Oxide	0.50	30.00		666.33	39,979.57
Notrogen Oxides	1.00	3.00		1,332.65	3,997.96
Volatile organic Compunds		15.00			19,989.78
Biochemical Oxyegn Demand	10.00	40.00		13,326.52	53,306.09
Total suspended solids	10.00	50.00		13,326.52	66,632.61
Chemical Oxygen Demand	20.00	200.00		26,653.04	266,530.44
Adsorable Organic halide	0.00	4.00		0.00	5,330.61

5.6 Alternate to Existing Packaging Method

This section of the research has identified several considerations that manufacturers should address when designing new packaging solutions. Connection with the consumer is an important feature of packaging. A kit must convey the product's content as well as how it can be used, as well as any other relevant material. The use of unambiguous text and symbols is important in foreign exchange. Details about the content as well as other premium data was included in proper labeling.

5.6.1 Existing Primary Packaging Formation

The existing primary packaging used for the toothpaste is a plastic tube. It is a combination of 5 layers of 3 materials. The materials used are polyethylene, ethylene acrylic acid co-polymer & aluminium foil. Even for a large amount of polyethylene, the inclusion of aluminum foil and the combination of materials renders it difficult to recycle using traditional techniques as the layers are compressed together (PE).

TABLE 5.15: EXISTING PRIMARY PACKAGING FORMATION

Individual Layer	Material Type
Outer Clear Film	Polyethylene
Tie layer	EAA
Barrier Layer	Aluminium Foil
Tie layer	EAA
Inner Clear Film	Polyethylene

5.6.2 Alternate Primary Packaging Formation

HDPE (High Density Polyethylene) is a widely recyclable material. Formation of several grades of HDPE material would bring the solution to the existing non-recyclable plastic tube problem.

Despite the difficulties of making a squeezable tube, incorporating various grades and thicknesses of HDPE laminate into a tube that satisfies container recycling requirements, protects the component, and withstands the demands of high-speed manufacturing, all while staying easily squeezable, is a viable choice. The effectiveness of this concept would be determined by choosing the required HDPE grades to combine.

Due to absence of aluminum foil, the shelf life of the product might turn to half as before. But if the tubes are recyclable, hopefully the manufacturers can cope with this drawback.

5.6.3 Packaging Detail Information of Secondary Packaging

Here is a visual representation of the existing secondary packaging system & the information it provides to the customers .

FIGURE 5.2: EXISTING SECONDARY PACKAGING

According to BSTI labeling standards, the information mentioned below must be on the package of any product and currently the secondary packaging meets that need for any product.

- Name of the product
- Product type
- BDS code & BSTI logo
- Address of the manufacturer
- Net weight
- Batch No.
- Manufacturing & Expiry date
- Components
- Price

5.6.4 Packaging Detail Information of Primary Packaging

FIGURE 5.12: EXISTING PRIMARY PACKAGING

The information existing primary packaging provides are:

- Name of the product
- Product type
- BDS code & BSTI logo
- Address of the manufacturer
- Net weight
- Components

5.6.5 Missing information on primary packaging

- Batch no
- Manufacturing date & expire date
- Price

FIGURE 5.13: EXISTING PRIMARY PACKAGING PORTION TO BE FILLED WITH MISSING INFORMATION

5.6.6 Additional information on primary packaging

- QR code
- User direction

6 Conclusion

In the study, the primary goal was to identify the packaging that have minimum customer utility value of Fast Moving Consumer Goods (FMCG). After analyzing the characteristics of the packaging materials of the product under study which was selected through a questionnaire survey, the layer of the packaging with reduction potential was recuperated. After studying thoroughly, the possible amount of waste material with reduction potency was quanitified along with the possible conservation which are disclosed below:

Elimination of the secondary layer of the toothpaste packaging of the brands under study will result to,

- Conservation of 19.68 Million Liters water and 858072.55 KWh electricity annually.
- Generation of 1402.79 Tons of paper that costs around 34.40 crore to produce which would eventually turn to waste because of no utile value can be constricted.
- 1430 waste truck trips and 13 lakhs of waste management cost would be extricted annually.

Probable emission of a potential human carcinogen was estimated with the help of previous studies in relative field. Eliminating the secondary layer of toothpaste packaging will extricate the atmosphere from these malignant componants.

Alternations to the existing primary packaging were also suggested through the study. This alternative would make the package recyclable which would save a lot of cost from the producer's end and less damage would be done to the environment.

Finally, while packaging plays an important role in ensuring long-term development, squandering these packaging results in a lack of environmental harmony as well as an abundance of natural and economic resources. The customers are the most important players in the industry, even though the producers are in charge. A well-informed, environmentally aware, and ethical population is more successful than any legislation.

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8 Appendix

Survey on Fast Moving Consumer Goods (Via Google Form)

Fast moving consumer goods are those goods (FMCG) that we use daily for various purposes. These are a wide range of products that we use daily, like toothpaste, soap, face cream, shampoo etc.

Point to note is that these FMCGs often come in multiple layers of packets in the consumer end. Primary Packaging (Layer 1) - The container that keeps the product itself Secondary Packaging (Layer 2) - The packet that is used to cover the product outside, often made of paper

The objective of this survey is to identify the behavior of users/consumers in regard to the usage of the secondary packaging materials used in these products. The outcome of this survey will help us to determine the waste reduction potential of the packaging items of FMCG goods.

FIGURE 5.14 : ILLUSTRATION OF DIFFERENT LEVELS OF PACKAGING.

- Your age *

  - 10-18
  - 19-24
  - 25-30
  - 31-40
  - 41-50
  - 50+

- Occupation *

  - Student
  - Service Holder
  - Businessman
  - Other:

- After buying any goods like toothpaste, face cream etc. which contain a secondary paper box packaging system, what do you do with the secondary layer of packaging? *

  - Throw it as a waste paper into a bin
  - Use it for any other purposes (please mention in the box below)

  Mention Here

  Your answer

- Many consumer goods such as toothpaste, face cream etc. come in a plastic tube inside a paper packet. If you were to buy the product what would you prefer? *

  - Product with plastic tube inside a paper packet
  - Sealed product with plastic tube only

- Skin Care products such as face cream, face wash, glow cream, night cream, face packs etc. come in plastic tubes, containers etc. Often, these containers have a paper packet over them as well. Do you Think this paper packet grows your interest in buying the product? *
  - Yes
  - No

- Many dry food items come with a paper board layer along with the plastic wrapper inside. Do you use the paper board or do you waste it? *
  - There is no utility, I waste it
  - Yes there is utility (please mention in the text below)

  Write utility here

  Your answer

- Which of the products mentioned below would you buy even if the paper layer of the packaging is eliminated? (you can select multiple) *
  - Toothpaste
  - Skin Care Products(face cream, face wash)
  - Dry Food(dry cake, toast, biscuit)
  - Pharmaceutical Products
  - Baby Food Products
  - Spices
  - Bundle Offer Products
  - Coffee Mate
  - Dairy Products
  - None of the Above

- How often do you read the information printed on the packaging of the product? *
  - Always
  - Often
  - Rarely
  - Check the date of expiration only
  - Other:

- Do you think, the secondary packaging contains a higher value for branding and influences a consumer to purchase? *

  - Yes
  - No

- What gets your attention better? *

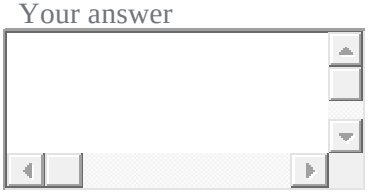
  - "eco friendly", "minimum waste", "less resources used" etc. and other environmental branding
  - Conventional branding and other forms of physical product branding

- Do you prefer to use products that produce less waste? *

  - Yes, I use products with less waste
  - No, I don't prefer products with less waste
  - No, never thought of it this way

- If there is anything you like to share, your opinion or thoughts about FMCG wastes, feel free to drop it below. (Not mandatory)

Your answer



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