Biodegradable Plastic Bags for Commercial and Consumer Use – A Feasibility Study on Eco-Friendliness

ASUVEETHA, E.M.

(17PIR002)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore – 641 043

In partial fulfilment of the requirements for the Degree of

MASTER OF SCIENCE IN INTERIOR DESIGN AND RESOURCE MANAGEMENT

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25/4/19

Signature of the
Head of the department

25.04.2019

Signature of
the Supervisor

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"No duty is more urgent than that of returning thanks"

James Allen

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INTRODUCTION

"If each and every one of us does at least one green good deed daily towards our green social responsibility, there will be billions of green good deeds daily on the planet"

- Harsh Vardhan

Consumer is a person who purchases, orders, receives, or uses goods for non-business or non-professional purpose, or for whom a service is rendered, furthermore who is the addressee of information or an offer related to goods or services (Cseres, 2005).Customer satisfaction is a measure of how your organization's total product performs in relation to a set of customer requirements (Hill, 2017).

Over the last 60 years plastics production has increased manifold, owing to their inexpensive, multipurpose, durable and lightweight nature. These characteristics have raised the demand for plastic materials that will continue to grow over the coming years. However, with increased plastic materials production comes increased plastic material wastage creating a number of challenges, as well as opportunities to the waste management industry (Hanladakis, 2018).

It would be hard to imagine modern society today without plastics. Plastics have found a myriad of uses in fields as diverse as household appliances, packaging, construction, medicine, electronics, and automotive and aerospace components.

Plastic shopping bags could be the most ubiquitous consumer item on Earth. Their light weight, low cost, and water resistance make them so convenient for carrying groceries, clothing, or any other routine purchase that it is hard to imagine life without them. The first plastic "baggies" for bread, sandwiches, fruits, and vegetables were introduced in the United States in 1957. Plastic bags were appearing in homes and along curbsides around the world by the late 1960's. These bags start as crude oil, natural gas, or other petrochemical derivatives, which are transformed in plastics factories into chains of hydrogen and carbon molecules known as polymers or polymer

resin. (High-density polyethylene resin is the industry standard for plastic bags). The polyethylene is super-heated and the molten resin is extruded as a tube, sort of like the process of making pasta. After the desired shape is achieved, the resin is cooled, hardened and can be flattened, scaled, gusseted, punched, or printed (Sawin, 2015).

There are two types of polyethylene, namely low-density (LDPE) (high-pressure synthesis) and high-density (HDPE) (low pressure synthesis). Both types of polymers are resistant to water and salt solution and water absorption is negligible at room temperature. Water vapor permeability is fairly low in HDPE, as would be expected due to its lower permeability. Gas permeabilities are not particularly low, and LDPE, in particular, is not to be recommended as an oxygen barrier, i.e., it would not be used for packaging of type of foods where oxygen ingress is undesirable. Water and oxygen permeability have important implications in the consideration of these polymers as food packaging materials.

Various types of additives can occur in polyethylene used in food packaging. These include, pigments, carbon black (for ultraviolet light resistance), slip additives (e.g., silica) to lower coefficient of friction of film and improve the rate of movement of film through printing and wrapping equipment, antistatic additives (to reduce dust attraction caused by buildup of static changes), antiblock additives (used in film grades used for the manufacture of bags in order to overcome difficulties in separating them from a pile) and also to facilitate rapid opening of the bags on automatic filling equipment, and antioxidants (to prevent degradation during processing and during service life of the article) lists, Crompton, (2007).

The typical plastic bag that weighs just a few grams and is a few millimeters thick might seem thoroughly innocuous were it not for the sheer volume of global production. Producing plastic bags uses about 20-40 per cent less energy and water than paper sack production does, and generates less air pollution and soil waste, according to lifecycle assessments by both industry and nonindustrial groups. Officials from the plastic industry also note that plastic bags take up less space in a landfill, and

that neither product decomposes under the prevailing conditions in most landfills. Given the proper conditions, the paper sack would decompose rapidly, while the plastic bag would not (Vickers, 2015).

The biodegradability or rather, the non-biodegradability of conventional petroleum based plastic is a pressing environmental issue. Approximately ten million tons of plastic products are discarded each year (Halley et al, 2001). Management of waste is one of the major problems facing modern society and is not just limited to plastics. However, a combination of legislative measures and Government initiatives, the increasing cost of landfill disposal and public interest in support of recycling has meant that plastics recycling must increase. Generally plastics are made from crude oil. Recycling plastics therefore helps to conserve this natural resource (Goodship, 2007).

Reusing and recycling plastic have been the first step in combating the amount of municipal waste that is produced every day. However, mountains of synthetic waste are still generated at a dangerous rate despite efforts to reuse and recycle. A piece of petroleum-based plastic takes approximately 200 years to decompose naturally.

As the demand for plastic products continues to rise, so does the pressure of finding a more eco-friendly alternative to conventional petroleum based plastic. The search for an alternative has led researchers to develop biodegradable plastic blends from organic matter such as corn or potato starch. However, progress in the development of starch-based degradable plastic is slow and there is doubt whether degradable plastics are truly feasible. Degradable plastics are usually not as petroleum-based plastics, also, and the breakdown products may be toxic to the environment. Indiscreet disposal of plastic bags lead to land, water and air pollution-a major cause for environmental degradation. They can pose a potential threat to ecology and in the long run affect flora, fauna and human beings- the consumers.

Over the last few decades, consumer involvement in health care has been dramatically transformed. Not the least of these transformations has been consumers' active participation in decision making about their own health and the health of their

family members. The advent and growing popularity of the Internet and its searchable World Wide Web have revolutionized consumers' access to information (Lewis, 2006).

Plastic bags can be designed and manufactured for reusable use. The reuse of plastic bags can reduce the environmental effects by number of reuses occurs. The waste generation, energy usage, water usage, pollution generation, and other environmental impacts can be dividing by the number of uses for the bag. Sustainable grocery bags can be made with bio based or recycled plastic, produced without regulated heavy metals or toxins, made with clean manufacturing principles, and produced fair with safety practices (Greene, 2014).

Such information should prepare them to analyze and be cautious about the carry bags they use for shopping in the first instance. Their cautious responsible consumer behavior should force retailers also to practice giving away packed items in good quality plastic bags. Above all Government considering the damage inflicted at the national level should insist on use of only such bags which are written recyclable or biodegradable.

Biodegradation is the disintegration of materials by bacterial, fungi or other biological means. Biodegradable plastics are defined by the American Society for Testing and Materials (ASTM) as where degradation results from the action of naturally occurring micro-organisms such as bacteria, fungi and algae.

Need for study

Recently in 2018, the State Government of Tamil Nadu had imposed total ban on plastic carry bags, (Exhibit: 1) considering the magnitude of its impact on human/ animal ecology. Studies have pointed out the following facts about plastic and paper bags.

- Plastics can take hundreds and thousands of years to decompose.
- Paper bags are not strong as plastics and cannot be used several times.
- It takes 91 per cent less energy to recycle a pound of plastic than paper.

Hence it was felt necessary to find out if there has been a change in the mind set of consumers as well as retailers on the use of substitutes for plastic/paper bags; i.e. biodegradable or bio based bags. Moreover it also warranted testing biodegradable bags to qualify for their biodegradability.

As research review also proved that research on these lines was a felt lacuna, this micro -level study on **"Biodegradable Plastic Bags for Commercial and Consumer Use – A Feasibility Study on Eco-Friendliness"** was launched with the following broad objectives.

Major objective

Study the potential use of biodegradable bags as ecofriendly substitutes for plastic carry bags.

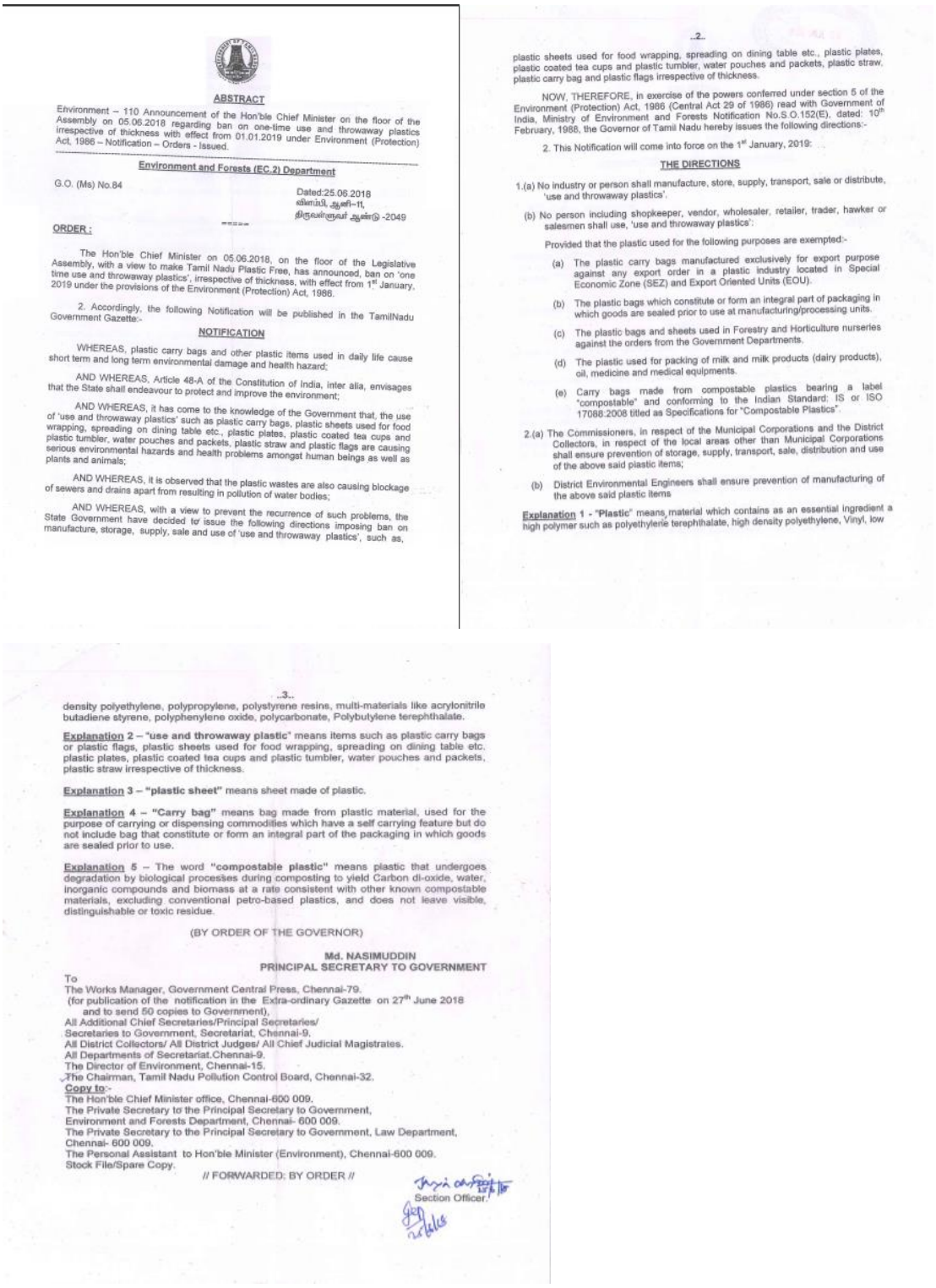
Minor objective

1. **Find out the pre and post mindset of consumers on use of carry bags after plastic ban**
2. **Examine retailer's standpoint regarding ban on plastic bags**
3. **Identify producers of biodegradable bags**
4. **Analyze quality of biodegradable bags for their eco friendliness**
5. **Assess the bio-based bags for degree of degradability**

Hypothesis

1. **Consumers and retailers may take to the ban imposed on plastic carry bags seriously**
2. **Marketed biodegradable bags are exclusively biodegradable**

It is hoped that the study would throw light on acceptance by consumers and retailers on the life style behavior on the one hand and the prospects for motivating bio based bags as ecofriendly substitutes for plastic carry bags.



ABSTRACT

Environment – 110 Announcement of the Hon'ble Chief Minister on the floor of the Assembly on 05.06.2018 regarding ban on one-time use and throwaway plastics irrespective of thickness with effect from 01.01.2019 under Environment (Protection) Act, 1986 – Notification – Orders - Issued.

Environment and Forests (EC.2) Department

G.O. (Ms) No.84 Dated:25.06.2018
விளம்பி, ஆனி–11,
திருவள்ளுவர் ஆண்டு -2049

ORDER :

The Hon'ble Chief Minister on 05.06.2018, on the floor of the Legislative Assembly, with a view to make Tamil Nadu Plastic Free, has announced, ban on 'one time use and throwaway plastics', irrespective of thickness, with effect from 1st January, 2019 under the provisions of the Environment (Protection) Act, 1986.

2. Accordingly, the following Notification will be published in the TamilNadu Government Gazette:-

NOTIFICATION

WHEREAS, plastic carry bags and other plastic items used in daily life cause short term and long term environmental damage and health hazard;

AND WHEREAS, Article 48-A of the Constitution of India, inter alia, envisages that the State shall endeavour to protect and improve the environment;

AND WHEREAS, it has come to the knowledge of the Government that, the use of 'use and throwaway plastics' such as plastic carry bags, plastic sheets used for food wrapping, spreading on dining table etc., plastic plates, plastic coated tea cups and plastic tumbler, water pouches and packets, plastic straw and plastic flags are causing serious environmental hazards and health problems amongst human beings as well as plants and animals;

AND WHEREAS, it is observed that the plastic wastes are also causing blockage of sewers and drains apart from resulting in pollution of water bodies;

AND WHEREAS, with a view to prevent the recurrence of such problems, the State Government have decided to issue the following directions imposing ban on manufacture, storage, supply, sale and use of 'use and throwaway plastics', such as,

..2..

plastic sheets used for food wrapping, spreading on dining table etc., plastic plates, plastic coated tea cups and plastic tumbler, water pouches and packets, plastic straw, plastic carry bag and plastic flags irrespective of thickness.

NOW, THEREFORE, in exercise of the powers conferred under section 5 of the Environment (Protection) Act, 1986 (Central Act 29 of 1986) read with Government of India, Ministry of Environment and Forests Notification No.S.O.152(E), dated: 10th February, 1988, the Governor of Tamil Nadu hereby issues the following directions:-

2. This Notification will come into force on the 1st January, 2019:

THE DIRECTIONS

1.(a) No industry or person shall manufacture, store, supply, transport, sale or distribute, 'use and throwaway plastics'.

(b) No person including shopkeeper, vendor, wholesaler, retailer, trader, hawker or salesmen shall use, 'use and throwaway plastics':

Provided that the plastic used for the following purposes are exempted:-

(a) The plastic carry bags manufactured exclusively for export purpose against any export order in a plastic industry located in Special Economic Zone (SEZ) and Export Oriented Units (EOU).

(b) The plastic bags which constitute or form an integral part of packaging in which goods are sealed prior to use at manufacturing/processing units.

(c) The plastic bags and sheets used in Forestry and Horticulture nurseries against the orders from the Government Departments.

(d) The plastic used for packing of milk and milk products (dairy products), oil, medicine and medical equipments.

(e) Carry bags made from compostable plastics bearing a label "compostable" and conforming to the Indian Standard: IS or ISO 17088:2008 titled as Specifications for "Compostable Plastics".

2.(a) The Commissioners, in respect of the Municipal Corporations and the District Collectors, in respect of the local areas other than Municipal Corporations shall ensure prevention of storage, supply, transport, sale, distribution and use of the above said plastic items;

(b) District Environmental Engineers shall ensure prevention of manufacturing of the above said plastic items

Explanation 1 - "Plastic" means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate, high density polyethylene, Vinyl, low

..3..

density polyethylene, polypropylene, polystyrene resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, Polybutylene terephthalate.

Explanation 2 – "use and throwaway plastic" means items such as plastic carry bags or plastic flags, plastic sheets used for food wrapping, spreading on dining table etc. plastic plates, plastic coated tea cups and plastic tumbler, water pouches and packets, plastic straw irrespective of thickness.

Explanation 3 – "plastic sheet" means sheet made of plastic.

Explanation 4 – "Carry bag" means bag made from plastic material, used for the purpose of carrying or dispensing commodities which have a self carrying feature but do not include bag that constitute or form an integral part of the packaging in which goods are sealed prior to use.

Explanation 5 – The word **"compostable plastic"** means plastic that undergoes degradation by biological processes during composting to yield Carbon di-oxide, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable or toxic residue.

(BY ORDER OF THE GOVERNOR)

Md. NASIMUDDIN
PRINCIPAL SECRETARY TO GOVERNMENT

To
The Works Manager, Government Central Press, Chennai-79.
(for publication of the notification in the Extra-ordinary Gazette on 27th June 2018 and to send 50 copies to Government),
All Additional Chief Secretaries/Principal Secretaries/
Secretaries to Government, Secretariat, Chennai-9.
All District Collectors/ All District Judges/ All Chief Judicial Magistrates.
All Departments of Secretariat,Chennai-9.
The Director of Environment, Chennai-15.
The Chairman, Tamil Nadu Pollution Control Board, Chennai-32.
Copy to:-
The Hon'ble Chief Minister office, Chennai-600 009.
The Private Secretary to the Principal Secretary to Government,
Environment and Forests Department, Chennai- 600 009.
The Private Secretary to the Principal Secretary to Government, Law Department,
Chennai- 600 009.
The Personal Assistant to Hon'ble Minister (Environment), Chennai-600 009.
Stock File/Spare Copy.

// FORWARDED: BY ORDER //

Section Officer.

Exhibit: 1. State Government of Tamil Nadu had imposed total ban on plastic carry bags

II REVIEW OF LITERATURE

Literature pertaining to the study on **"Biodegradable Plastic Bags for Commercial and Consumer Use – A Feasibility Study on Eco-Friendliness"** is reviewed under the following headings:

A. Plastic – a Disturbance to Ecosystem
B. Impact of Plastics on Environment
C. Biodegradable Plastics
D. Eco-Friendly Plastics from Starch
E. Government's Support for Plastics Ban

A. Plastic - a Disturbance to Ecosystem

The word 'plastic' originated from Greek, meaning a material which can be molded or formed into any shape of one's choice. This etymology would allow even clay to be called a plastic, but in practice, only articles made of synthetic materials are referred to as 'plastics'. The American Society for Testing and Materials (ASTM) has defined plastic as "any one of the large and varied group of materials, wholly or primarily organic in composition, which may be formed into useful shapes by the application, singly or together, of heat and pressure (Sreedhar et.al, 2009).

In the 1950s, Karl Ziegler and Ginlio Natta independently developed a family of stereospecific transition-metal catalysts that led to the commercialization of polypropylene as a major commodity plastic. Today, polymeric materials are used in nearly all areas of daily life and their production and fabrication are major worldwide industries (Fried, 2007).

Plastic is a general term used for a wide range of high molecular weight organic polymers obtained mostly from the various hydrocarbon and petroleum derivatives. There is an ever-increasing trend towards the production and consumption of plastics due to their extensive industrial and domestic

applications. However, a wide spectrum of these polymers is non-biodegradable with few exceptions (Ahmed, 2018).

The most diversified use of polymers and resins is in the field of plastics. Since plastics have physical properties between and often overlapping those of fibers and elastomers, almost every known polymer can be included in the plastics field. By far the largest outlet is for constructional uses; i.e.; applications of molded, formed, cast, extruded, and other fabrications (NIIR Board, 2007)

The third category of polymeric materials exhibit properties intermediary to elastomeric and fiber-forming polymers. Plastic materials possess good tensile strength and rigidity with or without elongation or impact strength (Gowarikar, 2008).

During 1980's, there was so much visible plastic pollution that it was impossible to ignore plastic bottles littered in beaches, carrier bags fluttered from tree branches, and disposable products polluted canals and rivers. Plastic was piled up so high because it does not biodegrade, or break down into the environment very easily. People were throwing more and more disposable products away. This meant that landfill sites were filling up with items that may take up to a thousand years to decompose. All those trillion of plastic bags, foam cups, bottles, and plastic utensils remain in landfill for a very long time. Suddenly "disposable" did not seem convenient anymore, comments, Knight (2012).

It is obvious that the use of plastic and other resources must be rethought. Environmentalism is not just for tree huggers anymore- it is concerned with human inevitable future. If the recent global financial crisis produced anything positive, it is in a global rethinking of the value of goods. Economics combined with dwindling resources (most notably oil), pollutants in the food chain and in the atmosphere, and decreasing landfill space have made it clear that there is only one solution: reduce consumption and produce less waste. Although recycling helps, it is lowest on the resource conservation

hierarchy of “reduce, reuse, and recycle”. Recycling is a good option when an item cannot be reused, but recycling also consumes resources (Mancini, 2011).

People are already eco- conscious from many angles-recycling, composting, eating organic, consuming lots of granola and hugging trees but people had not considered the inherent problems associated with plastics. People wash and reuse single use water bottles over and over, thinking that they are being super eco-aware by preventing them from being recycled after a single use or heading straight into the trash and ultimately, a landfill. According to Sinha et al (2017) people do not realize each use and wash was breaking down cheap, unstable plastic more and more, and increasing the potential for chemicals and microscopic bits of plastic to leach into the drinks. The concept of why it is named ‘single use’ is now understood; definitely there is a reason why they are intended for single use (Sinha,et, al.,2017).

Plastic is a polymer. But not all polymers are plastics, and not all polymers are problematic. In fact natural polymers are actually the building blocks of life! Giant molecules, made up of repeating chains of smaller molecules are called monomers and are composed of carbon and hydrogen (organic compounds). Polymers are found throughout nature. The starch, proteins, and DNA in human bodies are polymers .Shell, horn, fingernails and hair are made of polymers, as in natural rubber. Resins such as shellac, secreted by the lac bag and often used as furniture finish, and amber, a fossilized tree resin are polymers, because natural polymers have evolved over millions of years alongside the planet’s living systems; such polymers biodegrade and return to the earth. (Terry, 2012).

Consumers have come to believe plastic as a miracle substance, and in some ways, it is. Plastic is lightweight and inexpensive .It can be molded into just about any shape. It can be rigid and strong or soft and flexible. Plastic wrapping keeps food fresh by blocking the harmful bacteria. A plastic beverage bottle is much lighter and cheaper than glass bottles and does not shatter like

glass. Some plastic fibers are even strong enough to stop bullets state, Kallen (2018).

Worldwide about one-half of all discarded plastic comes from packaging. Almost one-third comes from packaging that is discarded soon after use, typically in less than a year, and sometimes much sooner. Heavy – duty plastic construction materials have a longer life span, which means, that it was put into use decades ago, when plastics use began in earnest. They will start showing up in increasing amount in the near future, states, Stevens (2002).

The term "Plastics" is itself inadequate and misleading in that it refers to a wide range of materials. Some plastics are rubbery and some do not melt when heated; some is strengthened with glass fiber to become composites, while others are used in the form of simple films or foams. Different plastics are considered by the public as being very similar, and their difference are hard to distinguish by eye, yet their tailored chemistries, mechanical properties, and additives content often tie each plastic to a specific use (which also makes them harder to recycle and reuse in multiple applications). Thus, even though plastic products are sophisticatedly designed and fabricated for even the simple uses, most are still typically destined to become (very durable) trash, reports Tolinski (2012).

B. Impact of Plastics on Environment

During the 1960s percipient environmentalist became aware that the increase in volume of synthetic polymers, particularly in the form of one-trip packaging, presented a potential threat to the environment. This was particularly evident in the appearance of persistent plastics packaging litter in the streets, in the countryside and in the seas. Because of the well-understood mechanisms of polymer degradation and stabilization, the hydrocarbon polymers were selected as the basis for polymers with enhanced but controlled degradation (Scott, 2002).

It has become popular in certain circles to blame many of the contemporary problems on advances in technology. In keeping with this trend,

people often blame the packaging industry for increasing amount of garbage and litter, and the disposal problems associated with it. The fact that the development of the modern packaging industry has had a major effect on reducing the cost of consumer goods both in manufacture and distribution, and the critical role it plays in protecting one's health is often ignored. However, it must be in fairness be admitted that until very recently the packaging industry is so concerned with the problem of providing adequate and attractive packages once they had served their initial functions. Ecologists have made people fully aware that no human system can be considered in isolation. Each human activity must be contemplated in relation to the total environment; people should therefore extend their consideration of packaging practice to the point of ultimate disposal or recycling of the material from which the packages were made (Guillet, 2003).

The earliest industrial polymers were derived from natural products, either by extraction from biological sources , as in the cases of natural rubber, or by conversion by chemical reaction from natural products , as in case of paint films. Both still play an essential part in modern technology even though their uses have been complimented by synthetic rubbers and surface coatings. Perhaps the most remarkable aspect of polymers derived from natural product is that such environmentally unstable materials as natural rubbers and linseed oil should be the basis of environmentally durable industrial products (Scott, 1999).

Over the last 60 years plastics production has increased manifold, owing to their inexpensive, multipurpose, durable and lightweight nature. These characteristics have raised the demand for plastic materials that will continue to grow over the coming years. However, with increased plastic materials production comes increased plastic material wastage creating a number of challenges, as well as opportunities to the waste management industry. Waste management and pollution challenges, emphasize on the various chemical substances (known as "additives") contained in all plastic products for

enhancing polymer properties and prolonging their life. Despite how useful these additives are in the functionality of polymer products, their potential to contaminate soil, air, water and food is widely documented. These additives can potentially migrate and undesirably lead to human exposure via e.g. food contact materials, such as packaging. They can, also, be released from plastics during the various recycling and recovery processes and from the products produced from recyclates. Thus, sound recycling has to be performed in such a way as to ensure that emission of substances of high concern and contamination of recycled products is avoided, ensuring environmental and human health protection, at all times (Hahladakis, 2018).

For this and other reasons standards for biodegradability and computability testing of plastics have been sought. An environmental dilemma with more far-reaching implications is climate change. The need for rapid and deep greenhouse gas (GHG) emissions cuts is one of the drivers for the resurgence of industrial biotechnology generally, and the search for bio-based plastics more specifically (Philp, 2013).

The high collection and separation cost of plastics waste, and the legislative push to increase recycling rates, require the inclusion of increasing proportions of low-quality plastic waste into recycled products. A robust method for upgrading mixed plastics recyclates is the incorporation of fillers and reinforcements (Scelsi, 2013).

The extensive use of plastics, lack of waste management, and casual community behavior towards their proper disposal pose a significant threat to the environment. This has raised growing concerns among various stakeholders to devise policies and innovative strategies for plastic waste management, use of biodegradable polymers especially in packaging, and educating people for their proper disposal. Current polymer degradation strategies rely on chemical, thermal, photo, and biological procedures. In the presence of proper waste management strategies coupled with industrially controlled biodegradation facilities, the use of biodegradable plastics for some applications such as

packaging or health industry is a promising and attractive option for economic, environmental, and health benefits (Ahmed, 2018).

Researchers in Germany are warning that the impact of micro plastics in soils, sediments and freshwater could have a long-term negative effect on such ecosystems. They say terrestrial micro plastic pollution is much higher than marine micro plastic pollution – estimated at four to 23 times higher, depending on the environment. Surfaces of tiny fragments of plastic may carry disease-causing organisms and act as a vector for diseases in the environment. Micro plastics can also interact with soil fauna, affecting their health and soil functions. Earthworms, for example, were found to make their burrows differently when micro plastics were present in the soil, affecting the earthworm's fitness and the soil condition. Chlorinated plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources, and also the ecosystem. This can cause a range of potentially harmful effects on the species that drink the water. (https://www.unenvironment.org/news-and-stories/story/plastic-planet-how-tiny-plastic-particles-are-polluting-our-soil)

Over 400 million tons of plastic are produced globally each year. It is estimated that one third of all plastic waste ends up in soils or freshwaters. Most of this plastic disintegrates into particles smaller than five millimeters, referred to as micro plastics, and breaks down further into nanoparticles, which are less than 0.1 micrometer in size. Sewage, for example, is an important factor in the distribution of micro plastics. In fact, 80 to 90 per cent of the particles contained in sewage, such as from garment fibers, persist in the sludge. Sewage sludge is then often applied to fields as fertilizer, meaning that several thousand tons of micro plastics end up in the soils each year. (https://www.igb-berlin.de/en/news/underestimated-threat-land-based-pollution-microplastics)

C. Biodegradable Plastics

Biodegradable polymers can be derived not only from renewable bio resources but also from petroleum. Some synthetic aliphatic polyester has been

known to be biodegradable polyesters and are synthesized by polycondensation reaction between aliphatic diacids and aliphatic diols or by ring-opening polymerization of lactones (Ebhesajjad, 2013).

The prefix “bio-“ in bio plastics sometimes is used not to indicate the origin of the material (bio-based) but to express a “bio-“ functionality of the material, in general either biodegradability or biocompatibility (Kabasci, 2014).

PLA is a versatile biodegradable and compostable polymer, which can be processed using conventional production equipment. Commercial PLA grades are copolymers of L- and D-Lactic acid, and a proper variation of L-/D-Lactic acid ratio allows production of different rein grades for processing into a wide spectrum of products, since, the raw material for PLA resins is expected to yield a positive impact on global agricultural economy. Nevertheless, there are a number of areas which still need to be improved, especially in applications where PLA is intended to be used as a substitute for existing thermoplastics. One of the main drawbacks of PLA is its slow crystallization rate, which largely limits the actual range of possible replacement of non-biodegradable and non-compostable polymers (Fakirov, 2015).

Recently, biodegradable and renewable derived polymers have attracted much attention due to the environmental concerns and sustainability issues associated with petroleum based polymers. Such a polymer is poly lactic acid (PLA) , a biodegradable and bio absorbable , renewably derived thermoplastic polyester extensively investigated over the last several decades. PLA is compostable polymer derived from renewable sources (Ren, 2010).

There are increasing interests on the enzymatic degradation of polymers in recent years due to the needs in the biomedical areas for biodegradable polymer implants and controlled release systems. Furthermore, biodegradable bioconversion process are becoming more and more as the most desirable means of polymer waste management. Hydrolyses and oxidations are the primary processes for polymer degradations. Under the normal situations both

enzymatic and non-enzymatic processes can occur simultaneously. It is therefore important to understand both the processes (Fukuda, 2004).

"Biodegradable polymers or compostable polymers" were first commercially introduced in the 1980s.These first generation biodegradable products were made from a conventional polymer, usually polyolefin (e.g. Polyethylene) mixed together with starch which was eaten by microorganisms; the products were broken down, leaving small fragments of polyolefin (Rudnik, 2008).

A plastic is designed to undergo a significant change in its chemical structure under specified environmental conditions, which results in a loss of some properties that may be measured by standard test methods which are appropriate to the plastic. ISO/DIS 17088 specifies test methods and requirements to determine and label plastics that are designed to be recovered through aerobic composting. It particularly establishes the requirements for labeling of materials and products, including packaging made from plastics, as "compostable"; Compostable in municipal and industrial composting facilities and biodegradable during composting (Rudnik, 2008).

An important factor is that the term biodegradable has not been applied consistently in the media field of sutures, bone reconstruction and drug delivery, the term biodegradable has been used to indicate hydrolysis. On the other hand, for the environmentally degradable plastics, the term biodegradation may mean fragmentation, loss of mechanical properties, or sometimes degradation through the action of living organism. Deterioration or loss in physical integrity is also often mistaken for biodegradation. Nevertheless, it is essential to have a universally acceptable definition of biodegradability to avoid confusion as to where biodegradable polymers can be used in agriculture or fit into the overall plan of the polymer waste management. Many groups and organizations have endeavored to clearly define the terms 'degradation', 'biodegradation' and 'biodegradability' (Bastioli, 2005).

The first polymers used were natural products, especially cotton, starch, proteins and wool. Early in twentieth century, synthetic polymer began to be produced. The first polymers of importance, Bakelite and Nylon, showed the tremendous possibilities of the new materials. Global consumption of biodegradable polymers increased from 14 million Kg in 1996 to 68 million Kg in 2001. The advantages of natural polymers include the renewable resources from which they originate, their biodegradability, and the environmentally friendly products of degradation that are produced (Yu, 2009).

Practical applications of bio-derived polymers generally focus on bio-based thermoplastics, which are not only biodegradable or compostable, but are considered advantageous to the environment. Points that may be made in support of using bio-derived polymers can be based on:

(1) The opportunity to close the carbon cycle by eventually returning plant-based carbon to the soil through biodegradation or composting and thereby reducing environmentally returning environmental impacts;

(2) Less use of fossil energy and reduced carbon dioxide emissions over manufactured product life cycles (Plackett, 2011).

Advances in petroleum- based fuels and polymers have benefited mankind in numerous ways. Petroleum-based plastic can be disposable and highly durable, depending on their composition and specific application (Sun, 2005).

D. Ecofriendly Plastic from Starch

Edible packaging is a useful alternative or addition to conventional packaging to reduce waste and to create novel applications for improving product stability, quality, safety, variety, and convenience for consumers. The ability of biopolymer-based food packaging materials is to carry and control-

release active compounds. As diverse edible packaging materials derived from various by-products or waste from food industry are being developed, the dry thermoplastic process is advancing rapidly as a feasible commercial edible packaging manufacturing process. The employment of Nano composite concepts to edible packaging materials promises to improve barrier and mechanical properties and facilitate effective incorporation of bioactive ingredients and other designed functions (Janjarasskul ,et al., 2010).

Development of edible/biodegradable films/coatings for effective food packaging has generated considerable interest in recent years due to their potential to reduce and/or replace conventional, non-biodegradable plastics. As food manufacturers require packaging materials to satisfy for food grade, maintain/enhance product shelf-life stability and safety and utilize nominal values of packaging, the reduction or replacement with alternative biodegradable forms would clearly allow improvement in overall operating costs while reducing waste streams. Edible films have limited application primarily because of their inferior physical characteristics. For example, single, lipid-based films have good moisture barrier properties but contain no mechanical strength. Consequently, laminated films were formed by adhering two or more biopolymer films together. However, laminated films are advantageous to single, emulsion-based biopolymer films due to their possession of enhanced barrier properties. The creation of laminated structures has the potential to overcome these shortcomings by engineering edible/biodegradable films with multiple functional layers (Hopkins, 2009).

Edible films and coatings based on water-soluble proteins are often water-soluble themselves but possess excellent oxygen, lipid and flavor barrier properties. Proteins act as a cohesive, structural matrix in multicomponent systems, yielding films and coatings with good mechanical properties. Lipids, on the other hand, act as good moisture barriers, but have poor gas, lipid and flavor barriers. By combining proteins and lipids in emulsion or bilayer (a membrane consisting of two molecular layers), the positive attributes of both

can be combined and the negatives minimized. Characteristics of developed edible/biodegradable films are as follows:

- Thickness of manufactured edible/biodegradable films range from 25μm to 140μm
- Films can be clear, transparent, and translucent or opaque depending on the ingredients used and the processing technique employed
- Aging specific film types under controlled environmental conditions improved mechanical properties and gas barrier properties
- Storing films at ambient condition (18-23°C, 40- 65 per cent RH) for five years did not significantly alter structural characteristics
- Films formed from various ingredients can be relatively easily laminated together
- Manufactured films can be labeled, printed on or heat sealed
- Small variations in film microstructure (e.g. biopolymer phase separation) affect film properties (Han, 2005).

E. Government's Support for Plastic Ban

According to UN estimates, every year the world uses 500 billion plastic bags. Half of the total plastic used is single-use or disposable items such as grocery bags, cutlery and straws. India generates about 15,342 tons of plastic waste per day (TPD).Asserting India's commitment to 'green social responsibility', Harsh Vardhan, India's Environment Minister, said that Indian philosophy and lifestyle has long been rooted in the concept of co-existence with nature. The Indian government has committed to organizing and promoting the World Environment Day celebrations through a series of engaging activities and events generating strong public interest and participation. From pan-Indian plastic clean-up drives in public areas, national reserves and forests to simultaneous beach clean-up activities – India will lead the initiative by setting an example.

In India, 70 per cent of total plastic consumption is discarded as waste. Around 5.6 million tonnes per annum (TPA) of plastic waste is generated in the

Country, which is about 15,342 tonnes per day (TPD).Government data shows that 17 States and Union Territories have imposed complete ban on manufacture, sale and use of plastic carry bags, but there is no proposal to impose ban on the use of polythene bags completely throughout the country. The use of plastic carry bags has been partially banned in some pilgrimage centers, tourist and historical places located in various States of India.

The government has notified the Plastic Waste Management Rules, 2016, which regulate manufacture, sale, distribution and use of plastic carry bags including those of compostable plastic and plastic sheets for packaging or wrapping applications (Ghosh, 2018).

There is a bit of plastic everywhere, in the wallets, on dining tables and kitchens, in the cars and buses and in the phones and offices. It is nearly impossible to imagine a world without plastics. From its beginning in 1950, global plastic production has increased dramatically from two million tonnes to 380 million tonnes in 2015 (Goswami, 2018). But more efforts have to be done to ban them from commercial and consumer use

. III. DESIGN OF THE STUDY

The methodology pertaining to the study on "**Biodegradable Plastic Bags for Commercial and Consumer Use- A Feasibility Study on Eco-Friendliness**" was streamlined to include the following stages.

A. **Consumer Behavior Regarding Carry Bags**

B. **Retailers Views On Carry Bags**

C. **Experimental Study On Biodegradable Bags**

A. Consumer Behavior Regarding Carry Bags

The primary person who runs the wheels of any business is the consumer. Everything revolves around him. All their activities leave a trail- good or bad- in the neighborhood. As consumers they have to be concerned about the happenings around them and should analyze how their actions contribute to it. Use of carry bags for shopping and responsible disposal, lies only with them. Hence this part of the study was streamlined to include the following steps.

1. Selection of the Area

The area selected for the study was in and around Coimbatore City in Tamil Nadu. The major residential areas like Saibaba colony, Koundampalayam, R.S.puram, Gandhipuram, Peelamedu, Race cource etc. where retail outlets and shopping complexes and also wide was chosen adopting **convenient sampling**. In this method sample is selected according to the convenience of the investigator. This convenience may be in respect of availability of data, accessibility of the units etc (Gupta, 2010). Ease in approachability, availability of adequate sample and nearness to the place of stay of the investigator prompted selection of this area for the study.

2. Selection of Sample

Fifty consumers (homemakers) who were used to shopping formed the basic sample for the study. The primary purpose of sampling is to obtain maximum information about the characteristics of the population with maximum of cost, time and effort and also to set out the limits of accuracy of such estimate (Gupta, 2010). The method of sampling preferred was **convenient sampling**. The method of convenience sampling is also called as chunk. A chunk refers to that fraction of the population being interviewed or

investigated which is selected neither by probability nor by judgment but by convenience. Willingness of the sample to participate and disclose facts, amicable behaviors and a friendly nature were the factors considered in the selection of the concerned sample.

3. Selection of Method and Tool

The investigator personally visited the fifty houses in the main area of the City to elicit information about the concerned topic. The method therefore was **interview** and **observation**. The interview method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses. This method can be used through personal interview and if possible through telephone interviews (Kothari, 2014). **Observation** is a scientific tool and the method of data collection for the researcher. When it serves a formulated research purpose, it is systematically planned and recorded and is subjected to checks and controls on validity and reliability (Kothari, 2014). The tool used was a **checklist**. It requested details on the behavior of the consumers, who went for shopping. Carrying bags to bring the bought items is considered as a **pre planning behavior** before shopping in consumers. Hence the response of the selected sample on these lines was requested. For successful experimentation, a **pilot study** is necessary accords Nayak, (2013). Pilot study, will bring to light the unexpected problems related to the experiment carried on. The checklist was tried on five consumers and the necessary modifications were effected in the original based on their responses. A copy of the checklist is presented under Appendix I

4. Conduct of the Study

When an original enquiry is conducted for the collection of data, it is named primary method and the collected data are called **primary data** (Singh, 2017). The investigator visited all the 50 consumers in person, explained the

objectives of the study, collected the data and documented them for further analysis. The survey was done during their leisure and after creating good rapport with them. Findings of the study are presented under Chapter I

B. Retailer's Views on Carry Bags

Retailer is a company that buys products from a manufacturer or wholesaler and sells them to end users or customers (www.myaccountingcourse.com). To decipher the view points of the retailers who are presumed to be promoters of carry bags, a survey was felt imperative. The word 'survey' has been derived from the word 'sur' or 'sor' and 'veeir' or 'veior' which means 'over' and 'see' respectively. In this case a **normative survey** was the type chosen. A normative survey describes and interprets what exist at present. A normative survey is concerned with condition or relationships that exist, practices that prevail, beliefs, points of view or attitudes that are held, processes that are going on, influences that are being felt, and trend that are developing (Rajpal, 2017). Based on this a normative survey was conducted on these lines.

1. Selection of the Area

The area selected for the study adopting convenient sampling was Coimbatore in Tamil Nadu. **Convenience sampling** is a kind of non-probability sampling technique was whenever the sample is taken from a group of people straight forward to contact or to succeed in. There are not any other criteria to the sampling methodology except that people be available and willing to participate (Lewis, 2012) Coimbatore is a City in the south Indian State of Tamil Nadu. This area was chosen as the locale, by virtue of the presence of the required sample spread over a vast area like Gandipuram, R.S.puram, Saibaba colony, Peelamedu, Ukkadam and the like. Moreover nearness to the place of stay of the investigator and accessibility added to the advantages.

2. Selection of Sample

Although the basic purpose of sampling is to represent adequately the views of an entire universe or population without actually interviewing

everyone in the population, sampling has an added benefit when invasion of privacy is an issue (Bosoia, 2002). One hundred retail shops dealing with Grocery, Clothing, Stationery, Toys, Food, and the like was the sample chosen for the study adopting **convenience sampling**. It was seen to it that they offered carry bags for those who did shopping in their units. Convenience sample is known as unsystematic, careless, accidental or opportunistic sampling (Gupta, 2010). Willingness of the sample to participate in the survey and disclose required data was ensured. Only those samples doing retail business with more than 10 years of experience were chosen.

3. Selection of the Method and Tool.

The method adopted was **direct personal interview**, which requires a person known as the interviewer asking questions generally in a face-to-face contact to the other persons. This sort of interview may be in the form of direct personal investigation or it may be indirect oral investigation (Kothari, 2014) and **participatory observation**, where the information is sought by way of investigator's own direct observation without asking from the respondent; the information obtained under this method relates to what is accurately happening and is not complicated by either the past behavior or future intentions or attitudes (Kothari, 2014). The tool was a **structured checklist**. As the aim was to find out promotion of carry bags by them, details pertaining to type of bags given away and their inclination to switch over to eco-friendly bags were mainly requested. A copy of the checklist is presented under Appendix II. Evidently data collection vested on collection of **primary data**. Primary data are those which are collected afresh and for the first time, and thus happen to be original in character (Singh, 2017).

4. Conduct of the Study

The samples were met during their leisure, objectives of the study explained and data collected was recorded then and there. The data was analyzed and the findings are presented under Chapter IV.

C. Experimental Study on Marketed Biodegradable Bags

The normative survey on retailers revealed the existence of industries manufacturing biodegradable bags both in the study locale as well as in other places.

Box: 1. Manufacturers of biodegradable bags

1. Regeno venture Pvt Ltd 1/433 a 1st floor, Chinniyampalayam, Coimbatore, Tamil Nadu -641012	Produced 100% plastic free bags using entirely starchy products from vegetable starch (tapioca, corn etc.) and natural extracts.
2. Technicon e-Serve Pvt.Ltd. #2, Balaji Apartment, Valluvar kottam high road, 1st street, Nungambakkam, Chennai-600034	Produced 100% biodegradable and compostable bags which are leak proof and heat and cold resistant, from sugarcane starch.
3.PKM Traders 280(4),4th street, Gandhipuram, K.Pudur, Madurai-625007	Produced 100% eco-friendly bags made from corn starch, they are water resistant.

Considering convenience of the researcher, the unit functioning within the study locale was preferred. Hence, this aspect of the study included the following stages

1. Selection of Area

The area selected for the study was Saibaba colony in Coimbatore, adopting convenient sampling, where a sample is selected according to the convenience of the investigator (Gupta, 2010). The normative survey brought to light that the retail shops were found to buy biodegradable bags from the local market. Hence a biodegradable (plastic free) bag manufacturing unity was identified within the Coimbatore urban limits. This satisfied the sample for the

conduct of this part of the study. Hence one factory which dealt with production of these bags was chosen adopting purposive sampling. When the researcher deliberately selects certain units for study from the universe, it is known as **purposive sampling** (Gupta, 2010).

2. Selection of the Method and Tool

The method adopted was **experimental study**. Gupta (2010) quotes Greewood to have defined "An experiment as the proof of a hypothesis which seeks to look up two factors in a causal relationship through the study of contracting situation which have been controlled on all factors except the one of interest, the latter being either the hypothetical case or the hypothetical effect" The producers of the biodegradable bags stated that the bags will decompose completely in soil and hence will be eco-friendly. Hence **water testing (for potability after disposal) and soil testing (for sustaining fertility of the soil after decomposition)** were the tools adopted for the study. The quality of the potable water and soil had to be tested before and after burial of the bags. Therefore the following tests were carried out to determine their quality as furnishing in the ensuring section.

a. Chemical Analysis of Soil – Pre and Post Disposal of Bags
b. Microbial Analysis of Soil – Pre and Post Disposal of Bags
c. Potability of water- Pre and Post Disposal of Bags

3. Conduct of the Study and Documentation of Data

The tests were carried out following standard test batteries (as explained in Appendix III) and at various intervals. The test for quality of water and soil was done by experts in a reputed soil testing lab in Coimbatore City. The findings of the study which qualify for the eco-friendly quality of the water and soil is presented under Chapter IV.

It is hoped that the findings will prove positive for the selected biodegradable bags for then eco-friendly quality, which if practiced (purchasing and disposing of specific bags) will definitely improve the quality of potable water and the soil for its fertility potential.

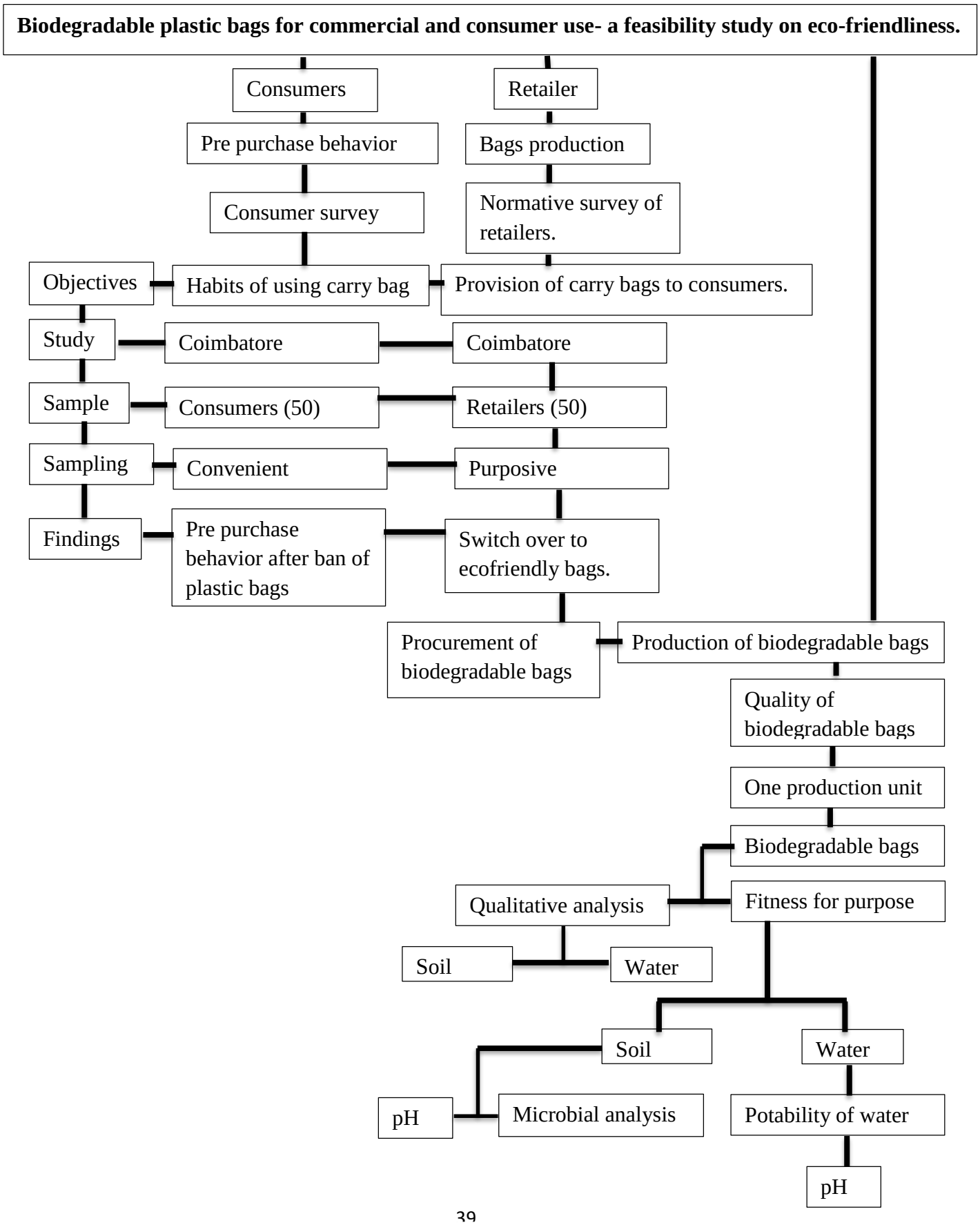


Exhibit: 2. Design of the study

IV RESULTS AND DISCUSSION

The findings pertaining to the study on **"Biodegradable Plastic Bags for Commercial and Consumer Use - A Feasibility Study on Eco-Friendliness."** are discussed under the following headings:

A. Consumer Behavior on Use of Plastic Bags

B. Retailers Standpoint on Promoting Plastic Bags

C. Use of Plastic Bags by Consumers- Influential

D. Promotion of Plastic Bags by Retailers- Influential

E. Quality of Marketed Biodegradable Bags

A. Consumer Behavior on Use of Plastic Bags

Consumer behavior is the study of how, why and what people do when they buy products or avail of some services. It attempts to understand the buyer decision making process, both individually and in groups (Majumdar, 2010). Further it is concerned with all aspects of purchasing behavior – from pre-purchase activities through to post-purchase consumption, evaluation and disposal activities. It is also concerned with all persons involved, either directly or indirectly, in purchasing decisions and consumption activities including brand-influencers and opinion leaders (Tadajewski, 2009).

All are consumers and in doing retail shopping there arises a compulsory **pre-purchase behavior** to prepare oneself on how to bring the purchases back home. Keeping this in view this part of study was analyzed under the following headings:

1. **Consumer's Pre-Purchase Behavior**
2. **Eco-Friendly Behavior**

1. Consumer's Pre-Purchase Behavior

Before embarking on shopping, may it be is conscious or planned, consumers go prepared with a shopping bag, or otherwise they may be forced to carry in the bags provided by the shop owners. In recent years all have become dependent on the retailers. Hence this aspect was discussed under:

1.1 Habitual Method of Carrying Goods after Shopping/Purchasing

1.2 Type of Bags Carried for Shopping

1.3 Type of Bags Offered by Retailers

1.1.Habitual Method of Carrying Goods after Shopping/Purchasing

Consumers generally plan for shopping, where their plans stop with what to buy and where and how to buy. Transporting or shifting goods after purchase is never preplanned excepting a few. Only very few consumers think about that too and take bags to carry them home. Hence enquiry of the selected consumers on their preparatory (consumer) behavior was found imperative. Responses were recorded for both the period before and after imposing of ban (January 2019) on plastic bags. The findings are explained under the following Table

Table: 1. Habitual Method of Carrying Goods after Shopping/Purchasing

Method/Habit practiced	Percent responding (N=50)	
	Before Ban	After Ban
Take bags while shopping	42	92
Buy bags from retail stores (if needed)	58	8

*Ban on plastics was imposed from January 1st 2019.

Only 42 per cent of the samples practiced the habit of carrying bags while shopping. The others reported to be buying bags from retail outlets if necessary. As providing carry bags was customary with retailers to consumers who gave them good business, carrying one was not found to be necessary. With the importance on ban on plastic carry bags (which were by convention

the type of carry bags provided by shops), the sample homemakers had re-imbibed their civic responsibility and hence 92 per cent of them had started taking (plastic free) carry bags on their own. **The ban had actually achieved success in two ways: one creating a conscious ban on plastic bags and secondly instilling a civic responsibility in all consumers to be more eco-friendly.** A negligible eight per cent still loathed the practice of carrying bags considering it (carrying own bags) as a disturbance/nuisance to their shopping spirit, forgetting to take one or still trying to depend on others to supply them one.

1.2. Type of Bags Preferred/Carried for Shopping

Consumers whether they preferred to take bags for carrying goods while shopping is immaterial, as all have to shift the goods by some means to their households. Given the choice, the type of bags they preferred or carried is the question under consideration. Hence the responses received on this score are explained under Table 2

Table: 2. Type of Bags Preferred/Carried for Shopping

Type of Bags Preferred/ Carried	Percent responding (N=50)	
	Before Ban	After Ban
Cloth bags	66	84
Plastic bags	34	-
Paper bags	-	16
 Cloth bags	 Plastic bags	 Paper bags

Sixty six per cent of the sample homemakers preferred taking or carrying cloth bags while shopping. Cloth bags can be reused and they are one time investment for

longer period. Rest 34 per cent of the homemakers preferred plastic bags as they are cost effective. Home makers with civic responsibility and concern about future environment (an additional 18%) had shifted to cloth bags after plastic ban in Tamil Nadu, and 16 per cent of plastic users were found to shift to paper bags as they are less expensive and can cause less harm to the environment on disposal.

1.3.Type of Bags Offered by Shop Owners

Situations where consumers do not bring carry bags, it was customary for retail outlets to give one. Table gives the pertinent data.

Table: 3. Type of Bags Offered by Retailers

Bags Offered by Retailers	Percent responding (N=50)	
	Before Ban	After Ban
Cloth bags	34	50
Biodegradable plastic bags	-	26
Paper bags	-	24
Plastic bags	60	-
Non –woven bags	6	

A majority of 60 per cent of the sample consumers reported that the shops offered only plastic bags, while 34 per cent stated it to be cloth bags. This was before the ban was imposed. After the ban 50 per cent reported that cloth bags were offered. While 26 per cent agreed to have been offering either biodegradable plastic bags or paper bags, none of the shops visited by the samples offered plastic or non-woven bags. This may be because of **two reasons: one the retailers used providing bags as a promotional measure and secondly they may have an inner fear that they will be caught if they float plastic bags.**

It was also found that big shops offered plastic bags of good quality with appreciable microns, while smaller shops gave away only light weight

single use polyethylene plastic bags which can harm the environment if disposed carelessly.

2. Eco-Friendly Behavior

Findings discussed above were projective of the general consumer behavior on the issue. The tenet lies in finding out if they had turned really eco-conscious, the ultimate aim behind the ban. Therefore to understand whether the samples were aware of the quality of plastic bags given away to them by retailers an inquiry was made on that score. Details on their status of awareness are presented under the following headings:

2.1 Awareness on Quality of Plastic Bags

2.2 Awareness on Biodegradable Bags

2.3 Knowledge on Ill-Effects of Non-Woven Bags

2.4 Method of Disposal

2.5 Reuse of Plastic Bags

2.1. Awareness on Quality of Plastic Bags

This aspect of the study deals with status of the consumers regarding their awareness on the quality of plastic bags in terms of micron layer (Table)

Table: 4. Consumer Awareness on Quality of Plastic Bags

Status of consumer	Percent responding (N=50)	
	Before Ban	After Ban
Aware of micron	12	82
Not aware of micron	88	18

Box 2. What is Micron?

Micron is the thickness of the bag, where a micron is equal to 0.00004 inches. A mil is a common unit of thickness for plastic film and is equal to 0.001 inches 0.01= 1 gauge = 0.254 microns. Single use plastic, light weight polyethylene plastic bags are less than 35 microns. When these plastic bags are thrown after its primary use they take hundreds of years to degrade.

Only 12 per cent of the consumers were aware of the concept of micron before plastic ban whereas 82 per cent of the samples agreed to have come to know about microns only after plastic ban. They had become informed through neighbors, newspaper, television and other social media. Even after plastic ban in Tamil Nadu 18 per cent of the samples were not aware of the benefits of micron high plastic bags.

2.2. Awareness on Biodegradable Bags

As a panacea, the Government had taken to promotion of biodegradable bags to replace plastic bags. Hence an attempt was made to find out if the consumers were aware of these substitutes. Details are presented under Table.

Table: 5. Awareness on Biodegradable Bags

Status of consumers	Percent responding (N=50)	
	Before Ban	After Ban
Aware of biodegradable plastic bags	68	92
Not aware of biodegradable plastic bags	32	8

Box 3. Biodegradable bags

Biodegradable bags are bags that are capable of being decomposed by bacteria or other living organisms. Most of these bags are made out of corn starch and vegetable oil (Tanya Ha, 2007)

It was quite surprising to record a good 68 per cent of the sample to have known about biodegradable bags before the ban though an additional 24 per cent stated that they were aware of biodegradable bags as stable substitutes for plastic bags after the ban. A good reason attributed for their ignorance was that they believed more on cloth bags

as being durable, healthy and comfortable for use, hence did not think it was necessary to know about biodegradable bags.

Those who were aware of it agreed that they gained knowledge from numerous advertisements which proclaim that biodegradable bags are 100 per cent biodegradable citing GO: 84. These aspects warranted finding out if they know about non-woven bags and their ill-effects to the environment.

2.3 Knowledge on Ill-Effects of Non-Woven Bags

As non-woven bags are also available in the market and are otherwise offered by shops in the place of biodegradable bags, awareness of consumers on these lines was questioned. The survey revealed that all the consumers (100%) were aware of non-woven bags. Further enquiry into whether they know that they cause ill-effects brought forth the following as explained in Table 6.

Table: 6. Knowledge on Ill-Effects of Non-Woven Bags

Status of consumer	Percent responding (N=50)	
	Before Ban	After Ban
Aware of the ill-effects of non-woven bags	10	78
Not aware of the ill-effects of non-woven bags	90	22

Box 4. Non-woven bags

Non-woven bags have a layer of plastic coated on it, where it cannot be recycled or combusted (burnt). Many homemakers' mistake non-woven bags with cloth bags as they look almost similar to each other (Das, 2014).

Non- woven bags also having a coating of plastic, leave a harmful effect on the environment when disposed indiscreetly. Yet only ten per cent of the sample consumers knew about its ill-effects before ban on plastics. While

imposing ban on plastic bags, the Government had also banned non-wovens, but was not that strict about it.

Even after plastic ban, only 78 per cent knew about the ill-effects of non-woven bags. More than 20 per cent were still unaware of non-woven's ill-effects on the environment. Though social media play a big role in transferring information to local public, awareness generation on such matters of global significance has failed to reach the consuming public. Hence it was felt necessary to find out whether any attempts have been made by the Corporation/Municipality to generate awareness on the consumer's waste collection and management mechanisms.

2.4 Method of Disposal

Enquiry revealed that the Corporation/Municipality had kept two waste bins to collect wet and dry waste respectively. The staff from these offices had instructed the samples to dispose degradable and non-degradable waste in separate bags given by the Corporation/ Municipality to each house in the ward. Adequate awareness also had been done. The survey revealed, still a majority of 62 per cent of the samples to be disposing all waste in single bags without separating them. Only the rest (38%) were found to dispose waste in

Box 5. Waste management

Waste has to be segregated into two types: one as dry waste and other as wet waste, where dry waste can also be described as inorganic or non-biodegradable waste. Segregating waste helps divert it from landfill ensuring its recycling properly. These wastes will not rot or disintegrate over time and has little or no moisture content. Dry waste includes wood and related products, metals and glass. Wet waste typically refers to organic waste usually generated by eating establishments and is heavy in weight due to dampness. Waste can also be segregated on the basis of being biodegradable or non-biodegradable (Chandra, 2015).

two different dustbins (as instructed) maintained in specific area (Municipal dust bins in two colors).

2.5. Reuse of Plastic Bags before Disposal

The samples were questioned on how many times they used plastic bags before disposal. The findings are revealed in the following Table (7)

Table: 7. Reuse of Plastic Bags before Disposal

Use of Plastic Bags	Percent responding (N=50)
Single use	20
Twice –few times after primary use	24
Until it tears (maximum usage)	56

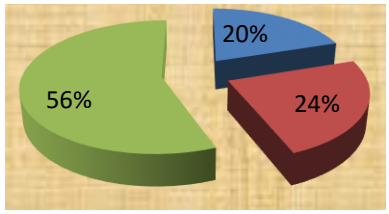


Figure: 1. Reuse of Plastic Bags before Disposal

Single use plastic bags or light weight polyethylene bags have traditionally been given for free to customers by shops/stores when purchasing goods. These bags are called single use plastics because they are less than 35 micron and they cannot be reused like any other bags. Once after its primary use these bags are mostly thrown away. Only 20 per cent of the homemakers used single use plastics for just one use and were found to throw it away after its primary use, but 24 per cent of the samples used it twice or few more times after its primary use. It was very agonizing to record a majority of 56 per cent of the sample to save it for further use and use it until it was torn. Consumer behavior on the score, that is, practical use of plastic carry bags was found to be very depressing. The consumers were not found to be aware of the ill-effects of using such low micron plastic bags on their health status. It is definitely a great move on the Government to have imposed the ban on plastic bags as they not only pollute the environment, but also cause health issues (cancer, etc.) in human beings when they use them.

B. Retailer's Standpoint on Promoting Plastic Bags

Market survey is the survey research and analysis of the market for a particular product/service which includes investigations into customer inclinations. Market researchers have a tool kit made up of desk research, telephone interviews, face-to-face interviews, self-completion questionnaires, focus group and observation. They employ special techniques for selecting samples and analyzing the data (Hague, 2004).

To understand the situation prevailing in the selected locale concerning floating of shopping bags as promoted by the retailers (who throng 90% of the market), a market survey was conducted and the findings are presented under the following aspects:

1. **Promotion of 'Bag Culture'**
2. **Quality Consciousness on Bags Promoted**
3. **Place of Procurement of Biodegradable Bags**

1. Promotion of Bag Culture

It was evident from the study that all retailers irrespective of the products sold were found to supply bags to the customers to carry the products. Hence this part of the study is analyzed under:

1.1 Practice of Providing Bags

1.2 Type of Bags Provided

1.1. Practice of Providing Bags

The following Table (8) delineates the practice followed by the sample retailers in providing bags after sales to consumers.

Table: 8. Practice of Providing Bags

Practice of shop owners	Percent responding (N=50)	
	Before Ban	After Ban
Provide carry bags	90	78
Do not provide carry bags	10	22

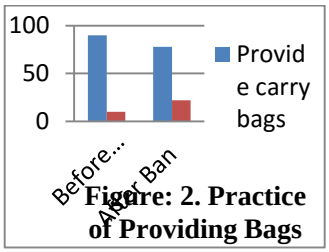


Figure: 2. Practice of Providing Bags

Providing carry bags is a custom for retailers to maintain healthy relationship with the customers and also to make it easy for them to carry bought items. Evidently customers feel convenient to shop in their shops. The study revealed 90 per cent of the retail outlets to have been providing carry bags for the bought items before plastic ban. The practice was found to have slowly dwindled to 78 per cent after the ban because most of the retail outlets could not provide a substitute for plastic bags. The rest 22 per cent of the retailers stopped providing bags and had requested their customers to bring their own bags. They also stated that most of the customers were bringing their own bags for shopping nowadays. Hence, not providing bags for bought items didn't affect their business in any away.

1.2. Type of Bags Provided

Details on the types of bags provided to customers were enquired of and the responses are as tabulated under Table (9).

Table: 9. Types of Bags Provided

Bags provided	Percent responding (N=50)	
	Before Ban	After Ban
Cloth bags	28	44
Biodegradable plastic bags	6	22
Paper bags	4	22
Plastic bags	40	-
Non –woven bags	22	12

Most of the retail outlets provided plastic bags for their customers as they are cheap and convenient. Only 28 per cent of the shopkeepers provided cloth bags as a good initiative to save environment. They add to the value as cloth bags can be reused, are washable and are durable. Twenty two per cent of shops offered non-woven bags to their customers unknowing the real fact about non-woven bags. Only a negligible proportion of retailers provided biodegradable plastic bags (6%) and paper bags (4%) to their customers. Once the plastic ban was imposed in Tamil Nadu 44 per cent of the shopkeepers started giving cloth bags and 22 per cent each provided biodegradable plastic bags and paper bags respectively.

Biodegradable bags being new in the market and quite less expensive than cloth bags they were preferred. Sincerely considering paper bags as both cheap and eco-friendly the shop keepers had started offering them to the customers. It was heartening to record none of the samples to offer plastic bags after the ban. Contrarily even after the Government order of banning plastics, 12 per cent was found to provide non-woven bags. They agreed that they had mistaken non-woven bags for cloth bags, hence continuing the practice. These

facts highlight the need to generate awareness among retailers too on types of plastics and their ill-effects on environment and to health of mankind.

2. Quality Consciousness about Carry Bags

This aspect of the study is dealt under the following headings:

2.1 Awareness on Quality of Plastic Bags

2.2 Knowledge about the Ill-Effects of Non-woven Bags

2.1. Awareness on Quality of Plastic Bags

Details pertaining to this part of the study are explained under Table

Table: 10. Awareness on Quality of Plastic Bags

Status of knowledge	Percent responding (N=50)	
	Before Ban	After Ban
Aware of Micron	02	80
Not aware of Micron	98	20

Most of the retailers (98%) were not aware of micron in plastic bags. Plastic bags with less than 50 micron are banned in various States of India. It was pathetic to record that even shop keepers, who have to be abreast with the happenings around them in the market sector, were not even aware of micron details in plastic bags. They were not even aware of the concept till the ban was imposed. Despite all efforts by the Government and media to circulate information, only 80 per cent agreed to know about the concept after the ban. A good 20 per cent still

were in the darkness. These facts are proof enough to project the market scenario in its reality. The retailers who are the primary consumers to use plastic for packaging their products in the first instance were found to be less informed – a fact that has to be changed for good. This necessitated finding out if they at least knew about non-woven bags and their damaging effects to man and the environment.

2.2 . Knowledge about the Ill-Effects of Non-woven Bags

The following Table presents details on the awareness of retailers on its ill-effects of non-woven bags

Table: 11. Knowledge about the Ill-Effects of Non-woven Bags

Status of sample	Percent responding (N=50)	
	Before Ban	After Ban
Aware of ill-effects of non-woven bags	6	84
Not aware of ill-effects of non-woven bags	94	16

Box 6. Non-woven bags

Non-woven fabrics are flat or tufted porous sheets made directly from separate fibers, molten plastic or plastic film. Most of the retailers think non-woven bags as one among cloth bag variety, but they are not. Non-woven polypropylene bags are tagged as 'eco-friendly' because they can be reused more than once. They last longer than simple plastic bags (Pourdeyhimi, 2014)

It was not surprising to record more than 94 per cent of the sample to be unaware of the ill-effects of non-wovens before Government's plastic ban. Nevertheless, though a majority of 84 per cent accepted to have come to know about it after the ban, 16 per cent still were unaware of it. Hence instead of plastic bags they were found to continue offering non-woven bags. Those who had started giving away biodegradable bags therefore, became the next sample for interrogation.

3. Place of Procurement of Biodegradable Bags

Those who had started offering biodegradable bags were questioned about the sources from where they procured the bags. The findings are presented under the next Table.

Table: 12. Sources for Biodegradable Bags

Particulars		Percent responding (N=50)
Local manufacturers		70
Other sources	Bangalore	20
	Chennai	10

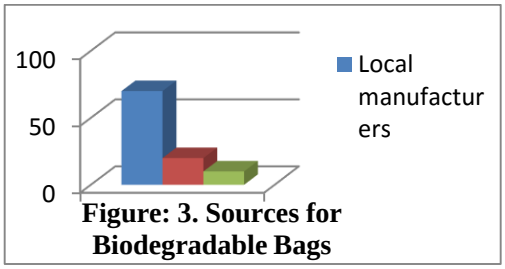


Figure: 3. Sources for Biodegradable Bags

Seventy per cent of the sample shop keepers obtained biodegradable plastic bags from local manufacturers. Coimbatore Corporation had taken the initiative to promote biodegradable plastic bags, in an effort to check pollution caused by disposable plastic bags and to curtail use of plastic bags by both retailers and consumers. With this backdrop the City Corporation had launched the sale of biodegradable bags through selected outlets.

Hence all the 70 per cent who purchased from local sources had started placing orders to local manufacturers. While 20 per cent of the remaining obtained the same from Bangalore, ten per cent depended on Chennai sources. **Hence Hypothesis (1) is accepted.**

The findings brought to light that **the ban on plastics (and before that too) had catalyzed a few manufacturers to produce eco-friendly biodegradable bags in the local area –a new arena for entrepreneurship.** This motivated further studies on these lines.

Comprehension on this concept relating to the behavior of both consumers and retailers on the issue, prompted finding out the influential

factors that played a role in their behavior. This aspect is dealt under the next heading

C. Use of Plastic Bags- Influential

An influential is someone or something that has an impact on or shapes how people act or how things occur (http://www.yourdictionary.com>influential). Hence, the factors which could have influenced the behavior of consumers and retailers were analyzed under the following headings.

1. **Consumer Behavior Vs Influential**
2. **Retailer's Practice Vs Influential**

1. Consumer Behavior Vs Influential

These aspects of the study analyzed the influence of shopping practice on consumer behavior related to use of plastic bags. The details are discussed as under:

1.1 Age as an Influential on Consumer Behavior

1.2 Consumer Behavior Vs Educational Level as Influential

1.1 Age as an Influential on Consumer Behavior

This aspect of the study is analyzed under the following Sub headings:

1.1.1. Age Vs Habit of Carrying Bags
1.1.2. Age Vs Types of Bags Preferred
1.1.3. Age Vs Consumer Awareness on Micron on Plastic Bags
1.1.4. Age Vs Awareness on Biodegradable Plastic Bags
1.1.5. Age Vs Knowledge on Ill-Effects of Non-Woven Bags
1.1.6. Age Vs Reuse of Plastic Bags

1.1 Age Vs Habit of Carrying Bags: Table: 13 presents the concerned data

Table: 13. Age Vs Habit of Carrying Bags

Methods and habits practiced		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Take bags for shopping	N=21	Before Ban	14.29	23.81	47.62	14.28
	N=46	After Ban	17.39	26.09	43.48	13.04
Buy bags if needed	N=29	Before Ban	24.14	34.48	34.48	6.90
	N=4	After Ban	50	50		

Age was found to be influential in sustaining the habit of taking carry bags for shopping before and after the ban. Buying carry bags from retail stores (without carrying one) was again influenced by age; only thing in that the younger generation was bound more to do it. With age consumers had shown mature behavior regarding this practice as those above 40 years of age never bought bags from retail stores after the ban.

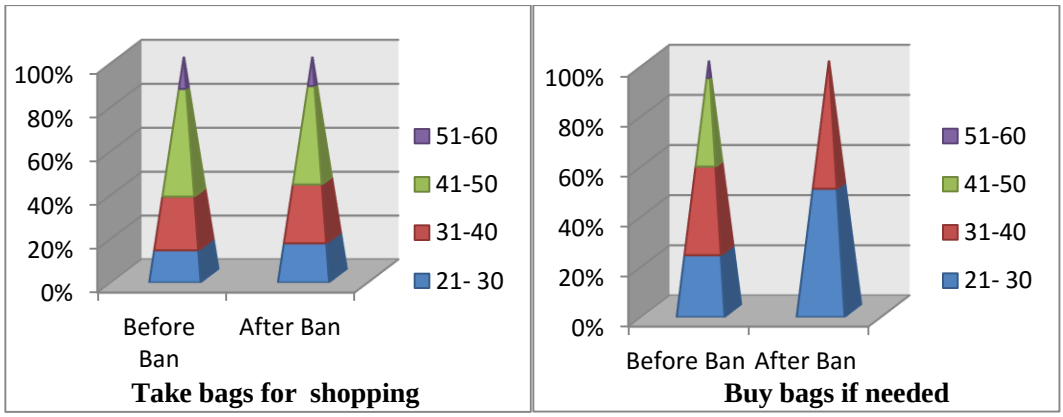


Figure: 4. Age Vs Habit of Carrying Bags

1.1.2. Age Vs Types of Bags Preferred: Table 14 presents the status on the concerned issue.

Table: 14. Age Vs Types of Bags Preferred

Types of bags preferred/ carried		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Cloth bags	N=33	Before Ban		30.3	54.55	15.15
	N=42	After Ban	7.14	33.33	47.62	11.9
Plastic bags	N=17	Before Ban	58.82	29	41	11.76
		After Ban	-	-	-	-
Paper bags		Before Ban	-	-	-	-
	N=8	After Ban	87.5	12.5	-	-

Preference for cloth bags was found to increase with increase in age level of the consumers. It was heartening to record all those who had practiced use of plastic carry bags, irrespective of age, had cut the habit; at the same time a good 16 per cent among the samples had started using paper bags, where again the younger generation stole the show.

1.1.3. Age Vs Consumer Awareness on Micron on Plastic Bags: The following table illustrates existing status.

Table: 15. Age Vs Awareness on Micron on Plastic Bags

Status of consumers		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Aware of micron	N=6	Before Ban	66.67	33.33		
	N=41	After Ban	24.39	31.71	39.02	4.88
Not aware of micron	N=44	Before Ban	13.64	29.55	45.45	11.36
	N=9	After Ban		22.22	44.45	33.33

It was pathetic to record that only 12 per cent of the consumers were aware of micron in plastic bags. Age factor was found to have an influence on awareness about micron in plastic bags before and after the ban. The younger

generation (below 40 years of age) was found to be more knowledgeable, both before and after the ban.

Unfortunately 88 per cent was not aware of micron in plastic carry bags for which age was a factor as more than 57 per cent belonged to the 41-60 years of age. Even after imposition of the ban a good 18 per cent were not aware, with a larger representation from the elderly range.

1.1.4. Age Vs Awareness on Biodegradable Plastic Bags

The following Table gives details on the same.

Table: 16. Age Vs Awareness on Biodegradable Plastic Bags

Status of consumers		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Aware of biodegradable plastic bag	N=34	Before Ban	23.53	29.41	38.24	8.82
	N=46	After Ban	21.74	32.61	36.96	8.70
Not aware of biodegradable plastic bag	N=16	Before Ban	12.5	31.25	43.75	12.5
	N=4	After Ban	-	-	75	25

Age was not found to be an influencing factor on awareness of consumers on biodegradable plastic bags. Even after the ban the proportion from the 41-60 years of age were found to be unaware of biodegradable bags. Social networking, literacy level, frequency of shopping all had a say in deciding this.

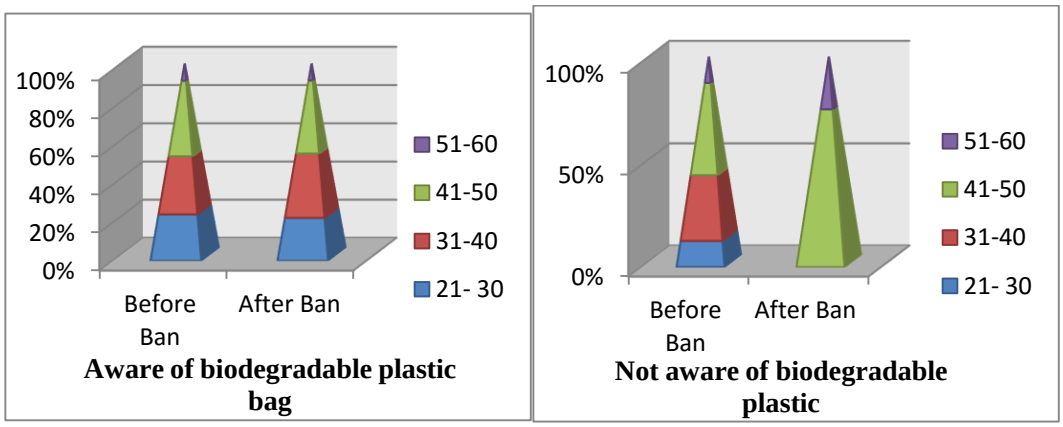


Figure: 5. Age Vs Awareness on Biodegradable Plastic Bags

1.1.5. Age Vs Knowledge on Ill-Effects of Non-woven Bags

Details on this score are presented under Table.

Table: 17. Age Vs Knowledge on Ill-Effects of Non-woven Bags

Status of consumers		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Aware of the ill-effects of non-woven bags	N=5	Before Ban	60	40		
	N=39	After Ban	25.64	38.46	28.21	7.69
Not aware of the ill-effects of non-woven bags	N=45	Before Ban	15.56	28.89	44.44	11.11
	N=11	After Ban	-	-	81.82	18.18

Age of the consumers was found to have an influence on the consumer's awareness of the ill-effects of non-woven bags. This can probably be attributed to the instructions from retailers or other shops like café, canteen, bakery etc.

who resist packing in plastic bags as was the practice followed earlier. This changed mindset of the retailers probably could have been an influential factor.

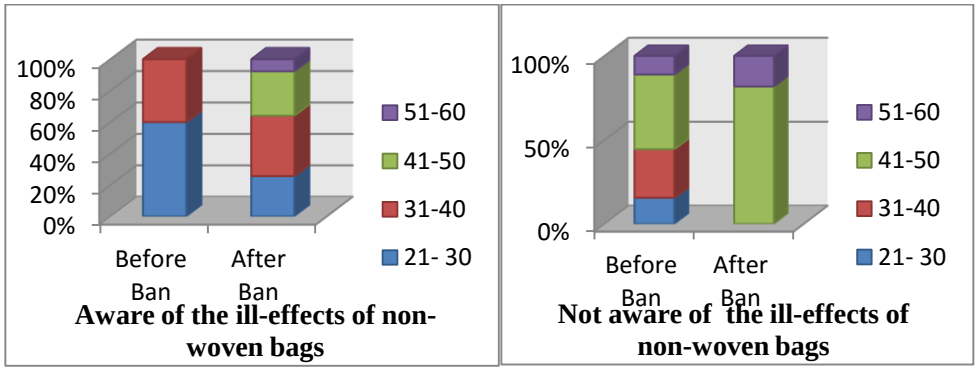


Figure: 6. Age Vs Knowledge on Ill-Effects of Non-woven Bags

1.1.6. Age Vs Reuse of Plastic Bags: Data pertaining to this aspect of the study is presented below.

Table: 18. Age Vs Reuse of Plastic Bags

Status of consumers		Per cent responding			
		Age (Range in years)			
		21- 30	31-40	41-50	51-60
Single use	N=10	20	50	20	10
Two or multiple use	N=14	41.67	16.67	33.33	8.33
Until it tears (maximum usage)	N=28	10.71	28.57	50	10.71

Age factor influenced use of plastic bags for multiple uses as is evident from the 41-67 per cent of the sample among those in 21-30 years of age who reported so. Similarly it was disheartening to record 50 per cent among 41-50 years age range to have been using it till it was torn. Probably they thought it was mature consumer behavior.

1.2. Consumer Behavior Vs Educational Level as Influential: This aspect of study was channelized to include the following details

1.2.1. Education Level Vs Pre-purchasing Habit of Carrying Bags

1.2.2. Education Level Vs Types of Bags Provided

1.2.3. Education Level Vs Awareness on Micron

1.2.4. Education Level Vs Awareness on Biodegradable bags

1.2.5. Education Level Vs Awareness on Ill-effects of Non-woven bags

1.2.6. Education Level Vs Use of plastic bags

1.2.1. Education Level Vs Pre-purchasing Habit of Carrying Bags: This part of study is analyzed under the following table

Table: 19. Education level Vs Pre-purchasing Habit of Carrying Bags

Methods and habits practiced		Per cent responding				
		Education level				
		Practice	Illiterate	Schooling	Graduate	Post graduate
Take bags while shopping	N=21	Before Ban	14.29	42.86	33.33	9.52
	N=46	After Ban	10.87	21.74	50	17.39
Buy bags from retail stores (if needed)	N=29	Before Ban	6.90	3.45	62.07	27.59
	N=4	After Ban			50	50

Educational level of the consumers was not found to have an influence on their pre purchase practice. Nevertheless those consumers who had had tertiary education (beyond Higher Secondary level) showed a higher inclination to buy bags after the ban.

1.2.2. Education Level Vs Types of Bags Preferred: Information on these facts are presented under Table.

Table: 20. Education level Vs Types of Bags Preferred

Types of bags preferred/ carried		Per cent responding				
		Education level				
		Practice	Illiterate	Schooling	Graduate	Post graduate
Cloth bags	N=33	Before Ban	15.15	30.30	45.45	9.09
	N=42	After Ban	11.90	23.81	47.62	16.67
Plastic bags	N=17	Before Ban	-	-	58.82	41.18
	N=0	After Ban	-	-	-	-
Paper bags	N=0	Before Ban	-	-	-	-
	N=8	After Ban	-	-	62.5	37.5

Educational level of the consumers was found to influence types of bags preferred for carrying goods after shopping, both before and after ban, especially regarding cloth bags. Plastic bags were found to have been preferred only by consumers who were graduates or post graduates before ban, a shameful situation. But all of them had totally reformed after ban and had shunned plastic bags. Similarly, only their educational status (those who reported) had influenced use of paper bags after the ban, a habit which was not practiced earlier.

1.2.3. Education Level Vs Awareness on Micron: Table presents the concerned data.

Table: 21. Education level Vs Awareness on Micron

Status of consumers		Per cent responding				
		Education level				
		Practice	Illiterate	Schooling	Graduate	Post graduate
Aware of micron	N=6	Before Ban			66.67	33.33
	N=41	After Ban	7.32	19.51	51.22	21.95
Not aware of micron	N=44	Before Ban	11.36	22.73	47.73	18.18
	N=9	After Ban	22.23	22.22	44.44	11.11

Awareness on micron in plastics was found to be directly proportional to the educational level of the consumers. Their awareness level from before to after the ban had increased with an increase in their education level. Yet, the proportion of illiterate group who were not aware of micron in plastic bags had increased especially after the ban. Hence adequate intervention on this needs to be taken on a war footing.

1.2.4. Education Level Vs Awareness on Biodegradable bags: The next Table illustrates the existing data.

Table: 22. Education level Vs Awareness on Biodegradable bags

Status of consumers		Per cent responding				
		Education level				
		Practice	Illiterate	Schooling	Graduate	Post graduate
Aware of biodegradable plastic bag	N=34	Before Ban	5.88	11.76	58.82	23.53
	N=46	After Ban	8.70	15.22	54.35	21.74
Not aware of biodegradable plastic bag	N=16	Before Ban	18.75	37.5	31.25	12.5
	N=4	After Ban	25	75		

Education definitely was found to have profoundly influenced the consumer's knowledge on biodegradable bags, both before and after the ban.

1.2.5. Education Level Vs Awareness on Non-woven bags: The following Table gives detail on the same.

Table: 23. Education level Vs Awareness on Non-woven bags

Status of consumers		Per cent responding				
		Education level				
		Practice	Illiterate	Schooling	Graduate	Post graduate
Aware of the ill-effects of non-woven bags	N=5	Before Ban			60	40
	N=39	After Ban	5.13	15.38	58.97	20.51
Not aware of the ill-effects of non-woven bags	N=45	Before Ban	11.11	22.22	48.89	17.78
	N=11	After Ban	27.28	36.36	18.18	18.18

Though only 10 per cent of the sample who were educated (graduates and post graduates) were aware of the ill-effects of non-woven bags, the ban had increased the proportion of educated consumers on their awareness level. Ban on plastics/ non-woven could mobilize only additional 68 per cent where the educational level of the consumers was found to have an influence. The illiterate group still remained unaware of the ill—effects of plastic bags and non-woven bags.

1.2.6. Education Level Vs Use of Plastic bags: Details on this score are presented under Table.

Table: 24. Education level Vs Use of Plastic bags

Status of consumers		Per cent responding			
		Education level			
		Illiterate	Schooling	Graduate	Post graduate
Single use	N=10	10	10	30	50
Two or multiple use	N=12	16.67	25	33.33	25
Until it tears	N=28	7.14	21.43	64.29	7.14

More than illiterate and school completed consumers the graduates and post graduates were found to use plastic bags till they were worn out. Perhaps they wanted to establish that they could be used no more. Anyways this has been more prevalent more among educated consumers.

D. Promotion of Plastic bags by Retailers –Influential

As retailers are also human beings (consumers), what role certain influential factors had on urging them to promote plastic bags was found out. Hence, this aspect of the study is dealt under the following headings:

1. **Age Vs Influence on Retailer's Behavior**
2. **Retailers Behavior Vs Educational Level as Influential**

1. Age Vs Influence on Retailer's Behavior: This aspect of the study is further analyzed under the following headings:

1.1. Age of Retailers Vs Practice of Providing Bags to Consumers
1.2. Age of Retailers Vs Type of Bags Provided
1.3. Age of Retailers Vs Awareness on Micron in Plastic Bags
1.4. Age of Retailers Vs Knowledge About the Ill-Effects of Non-Woven Bags

1.1. Age of Retailers Vs Practice of Providing Bags to Consumers: The following data illustrates the existing data.

Table: 25. Age of Retailers Vs Practice of Providing Bags to Consumers

Practice of shop owners		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Provide carry bags	N=45	Before Ban	8.89	17.78	51.11	22.22
	N=39	After Ban	7.69	20.51	53.85	17.95
Do not provide carry bags	N=5	Before Ban	20	40	40	
	N=11	After Ban	18.18	18.18	36.36	27.28

Experienced shop owners (90 per cent) were found to provide bags and it was evident that with experience in salesmanship (in terms of age of shop owners), the trend to provide carry bags to consumers to increase. Even after ban the trend was found to continue. It was wise on 22 per cent of the sample shop owners to decide not to provide bags after the ban, where again their age factor has been responsible to make them take the decision.

1.2. Age of Retailers Vs Type of Bags Provided: Information on these facts are presented under Table.

Table: 26. Age of Retailers Vs Type of Bags Provided

Practice of shop owners		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Cloth bags	N=14	Before Ban		14.29	50	35.71
	N=22	After Ban	4.55	13.64	50	31.82
Biodegradable plastic bags	N=3	Before Ban	33.33	66.67		
	N=11	After Ban	18.18	36.36	27.27	18.19
Paper bags	N=2	Before Ban	50	50		
	N=11	After Ban	9.09	4.09	72.73	
Plastic bags	N=20	Before Ban	5	15	60	15
		After Ban				
Non- woven bags	N=11	Before Ban	9.09	4.04	54.55	18.18
	N=6	After Ban	16.67	16.67	50	16.66

With increase in age providing cloth, plastic and non-woven bags were habitual as in evident through the Table. Younger graduates were found to be keen on providing biodegradable and paper bags even before the ban. While all age groups resented or completely avoid giving plastic bags irrespective of age (after the ban), the proportion of aged shop owners to have shifted to providing cloth, biodegradable and paper bags had also increased.

1.3. Age of Retailers Vs Awareness on Micron in Plastic Bags: The ensuring Table gives details on the same

Table: 27. Age of Retailers Vs Awareness on Micron in Plastic Bags

Status of knowledge		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Aware of Micron	N=1	Before Ban		100		
	N=40	After Ban	12.5	20	55	12.5
Not aware of Micron	N=49	Before Ban	10.20	18.37	51.02	20.41
	N=10	After Ban		20	30	50

Before ban on plastic carry bags it was found that a majority of them were not aware of plastic bags but then age factor (for 80 per cent) had helped them to understand the concept better after the ban.

1.4. Age of Retailers Vs Knowledge about the Ill-effects of Non-woven Bags: The following Table illustrates the existing data.

Table: 28. Age of Retailers Vs Knowledge about the Ill-effects of Non-woven Bags

Status of sample		Per cent responding				
		Age (Range in years)				
		Practice	21- 30	31-40	41-50	51-60
Aware of ill-effects of non-woven plastic	N=3	Before Ban	66.67	33.33		
	N=42	After Ban	9.52	21.43	50	19.05
Not aware of ill-effects of non-woven plastic	N=47	Before Ban	6.38	19.15	53.19	21.28
	N=8	After Ban	12.5	12.5	50	25

Younger generation (21-40 years) was found to be knowledgeable about the ill-effects of non-woven bags, though 84 per cent became aware after the

ban only. Here age factor has played a role in making them understand the ill-effects better. Nevertheless, among those who were not aware of the ill-effects, (94 per cent) only 16 percent gained knowledge after the ban where age factor played a role.

2. Retailer's Behavior Vs Educational Level as Influential

This aspect of the study is studied under the following headings:

2.1. Education Level of Retailers Vs Practice of Providing Bags to Consumers

2.2. Education Level of Retailers Vs Type of Bags Provided

2.3. Education Level of Retailers Vs Awareness on Micron on Plastic Bags

2.4. Education Level of Retailers Vs Knowledge about the Ill-Effects of Non-Woven Bags

2.1. Education Level of Retailers Vs Practice of Providing Bags to Consumers:

Information on these facts are presented under Table.

Table: 29. Education Level of Retailers Vs Practice of Providing Bags to Consumers

Practice of shop owners		Per cent responding				
		Education level				
		Practice	Schooling	Graduate	Post graduate	Illiterate
Provide carry bags	N=45	Before Ban	44.44	33.34	11.11	11.11
	N=39	After Ban	46.15	35.90	7.69	10.26
Do not provide carry bags	N=5	Before Ban		100		
	N=11	After Ban	18.18	54.55	18.18	9.09

Education (up to schooling or graduation) was found to motivate shop owners to provide carry bags to consumers, which sustains even after the ban. Here

again their educational level only had made them restrict their habit of providing bags.

2.2. Education Level of Retailers Vs Type of Bags Provided: Table presents the concerned data.

Table: 30. Education Level of Retailers Vs Type of Bags Provided

Status of consumers		Per cent responding				
		Education level				
		Practice	Schooling	Graduate	Post graduate	Illiterate
Cloth bags	N=14	Before Ban	35.71	42.86	7.14	16
	N=22	After Ban	68.18	9.09	9.09	13.64
Biodegradable plastic bags	N=3	Before Ban		66.67	33.33	
	N=11	After Ban	18.18	54.55	27.27	
Paper bags	N=2	Before Ban		100		
	N=11	After Ban	9.09	90.91		
Plastic bags	N=20	Before Ban	40	30	15	15
		After Ban				
Non- woven bags	N=11	Before Ban	63.64	36.36		
	N=6	After Ban	33.33	33.34		33.33

Education level of shop owners definitely played a major role in the choice of type of bags distributed to consumers. The same factor has also been responsible to create a changed mind set in them after the ban.

2.3. Education Level of Retailers Vs Awareness on Micron on Plastic Bags:

Details on this score are presented under Table.

Table: 31. Education Level of Retailers Vs Awareness on Micron on Plastic Bags

Status of knowledge		Per cent responding				
		Education level				
		Practice	Schooling	Graduate	Post graduate	Illiterate
Aware of Micron	N=1	Before Ban			100	
	N=40	After Ban	45	37.5	10	7.5
Not aware of Micron	N=49	Before Ban	40.82	40.82	8.16	10.20
	N=10	After Ban	20	50	10	20

Education level was not a matter which had been of help to them to be aware of micron in plastic before ban. Among those whoever were not aware of micron in plastic bags even after ban was found to have completed schooling. Education cannot alone bring in changes in one's behavior, their ethical sense and mind set should also cooperate

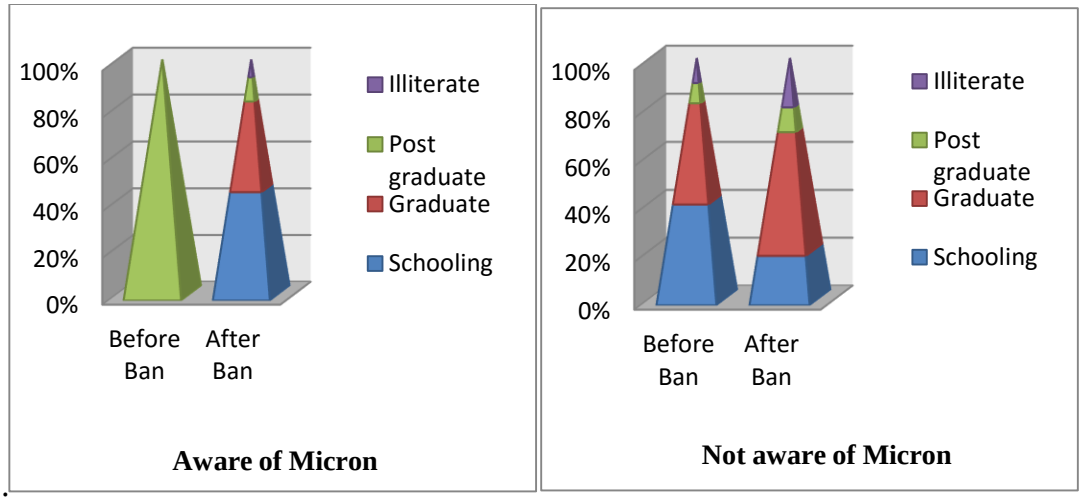


Figure: 7. Education Level of Retailers Vs Awareness on Micron on Plastic Bags

2.4. Education Level of Retailers Vs Knowledge about the Ill-Effects of Non-Woven Bags: The ensuring Table gives details on the same

Table: 32. Education Level of Retailers Vs Knowledge about the Ill-Effects of Non-Woven Bags

Status of sample		Per cent responding				
		Education level				
		Practice	Schooling	Graduate	Post graduate	Illiterate
Aware of ill-effects of non-woven plastic	N=3	Before Ban		66.67	33.33	
	N=42	After Ban	40.48	42.86	11.90	4.76
Not aware of ill-effects of non-woven plastic	N=47	Before Ban	42.55	38.30	8.51	10.64
	N=8	After Ban	37.5	25		37.5k

Post graduates remained unaffected both before and after the ban. Among the Graduate and school-completed shop owners imposition of the ban has created ripples and were found to react in the positive towards the ban.

E. Quality of Marketed Biodegradable Bags

The investigatory study on the manufacturing unit producing biodegradable (plastic free) bags revealed that they were using entirely starchy products from vegetable starch (tapioca, corn, etc) and natural extracts; so it was decided to find out the quality of the bags produced by them. Starch is an attractive bio-based polymer because of its low-cost base and hence cost competitiveness compared to conventional plastics, its biodegradability, its abundance, and its renewable source. Starch-based bio-degradable plastics were first developed in the 1970s (Westhoff et al, 1974), where thermoplastic starch (TPS) polymers were produced from starch and selected plasticizers and additives (e.g., glycerol, water, urea and salts). However due to poor properties

and inherent water susceptibility, these materials have tended to focus on niche markets for low-performance applications (Halley, 2014).The producers of the bags were confident in that their products will totally degrade in soil and water within a definite time frame and vouched that they will not be a deterrent to future plant growth in anyway or for potability respectively. Hence these three experiments were carried out, the findings of which are presented under:

1. **Quality of Soil for pH**
2. **Quality of Soil for Microbial Content/Fertility**
3. **Quality of Water for Potability after Disposal**

1. Quality of Soil for pH

To compare and find out the quality of soil after pre and post decomposition of the biodegradable bags, soil samples were taken before burying the bags in the soil and three months after burying them. Periodic checking was done every fifteen days after disposal to check the status of biodegradation. **It was found that one standard bag took three and half to four months to completely biodegrade.**

Box: 7. Soil standard Test for pH

Soil pH: The negative logarithm of the activity of H+ in solution is denoted by pH which indicates the acidity/ alkalinity of the soil when measured in an aqueous or KCI extract. The pH value of soil vary from 3-10. The acid sulphate and podzolic soils are low in pH whereas calcareous and alkali soils are very high in pH due to strong base such as Na+ or K+ and weak acids such as HCO3-. The pH of the soil determines the mineral content as well as microbial composition. High pH releases K+, Mg2+, Ca2=, Mn2+, Cu2+, and Al3+ by weathering processes of soil whereas low pH favors solubility of salt including carbonates, phosphates and sulphates.

For pre and post quality check the following scientific methods for collection of soil was done religiously.

a. Obtaining Soil Sample, the Scientific Way

Soil samples were collected normally from a depth of 15 cm and were transferred to clean containers. Three to five samples were taken for each replication and mixed evenly. From the mixed sample, at least 10-25 g of soil was taken as a representative sample of the particular replicate.

b. Selection of Method

The method adopted to check the pH value of the soil before and after disposal of bags was **soil standard test.** The samples were handed over to a reputed soil testing laboratory in Coimbatore. The findings of the test are presented under Table.

Table: 33.Quality of Soil for pH

Particulars	pH value	Remark
Sample-1 (pre disposal)	6.8	Neutral
Sample-2 (post disposal)	7.0	Neutral

The findings proved that the pH level was neutral and biodegradable bags did not affect the soil. pH value less than 7 is acidic, pH value more than 7 is alkaline. As pH cannot be so accurate, pH value between 6.5 – 7.5 is considered as neutral. Hence it is **concluded that the quality of the soil after this biodegradable bag decomposition will not harm growth of plants in them. This is proof that the biodegradable bags taken for testing are quality wise eco-friendly.**

2. Quality of Soil for Microbial Content/Fertility

The procedure followed was similar to the one adopted for chemical testing of soil.

Box: 8. Test for Soil Fertility

The fertility of soil depends not only on its chemical composition, but also on the quantitative and qualitative nature of microorganisms. The microorganism inhabiting soil can be classified into bacteria, actinomycetes, fungi, algae and protozoa and the branch of science dealing with them and their activities in soil is known as soil microbiology (Rao, 2006)

Selection of method: The method used to test the microbial content of the sample soil (pre and post disposal of biodegradable bags) was **soil dilution and plate count method**. This method has been generally used to estimate the number of microorganisms in the rhizosphere soil, an estimate of the total population of fungi, actinomycetes and bacteria per g of soil**. This test was done mainly to test changes in the fertility of the soil due to the disposal method.**

These tests were also carried out in a reputed laboratory. The findings are presented under the following Table

Table: 34. Microbial Quality (fertility) of the Selected Soil Sample

Name of the Sample	Microbial count
	Total Bacterial Count (cfu/gm)
Sample-1 (pre-disposal)	$30x\ 10^5$
Sample-2 (post-disposal)	$35x10^5$

Based on Table results it is evident that there is an increase in the bacterial count after decomposition of the biodegradable bags. Bacteria present

in the soil helps the biodegradable bags to degrade, as there is increase in the bacterial count on the sample taken after degradation of biodegradable bag. **It showed that biodegradable bags consist of source for bacteria to grow. These bags can degrade in any soil with low bacterial count as they themselves have the source for bacteria to grow.**

Hence it is concluded that the biodegradable bags marketed by the company are cent percent eco-friendly and can be recommended for floating safely for consuming public. Disposal of the same cannot hinder future plant growth.

3. Quality of Water for Potability after Disposal

To compare and find out the quality of water after pre and post solution of dissolved biodegradable bag, water samples were taken before and after dissolving the bag in the water. It was found that one standard bag took twenty four hours to completely dissolve. For pre and post potability check the following scientific methods of collection of water was done religiously. Potable water means drinking water that does not contain any determinants that exceed the maximum acceptable value. It means it is different from drinking water though this is intended to be used for human consumption, food preparation, utensil washing, oral and or personal hygiene (Mahindru, 2004)

a. Selection of Water Sample

Water sample was taken from a potable cold water tap; generally cold water is left to run constantly for at least two minutes before collecting the sample, 100 ml of water was taken as a representative sample.

b. Selection of Method

The method adopted to check the pH value of the water before and after dissolving of bags was **standard water test**. A standard bio degradable bag sample was dissolved in the water sample. The samples (one each before and

after dissolving in water) were handed over to a reputed water testing laboratory in Coimbatore. The findings of the test are presented under Table.

Table: 35.Quality of Water for Potability after Disposal

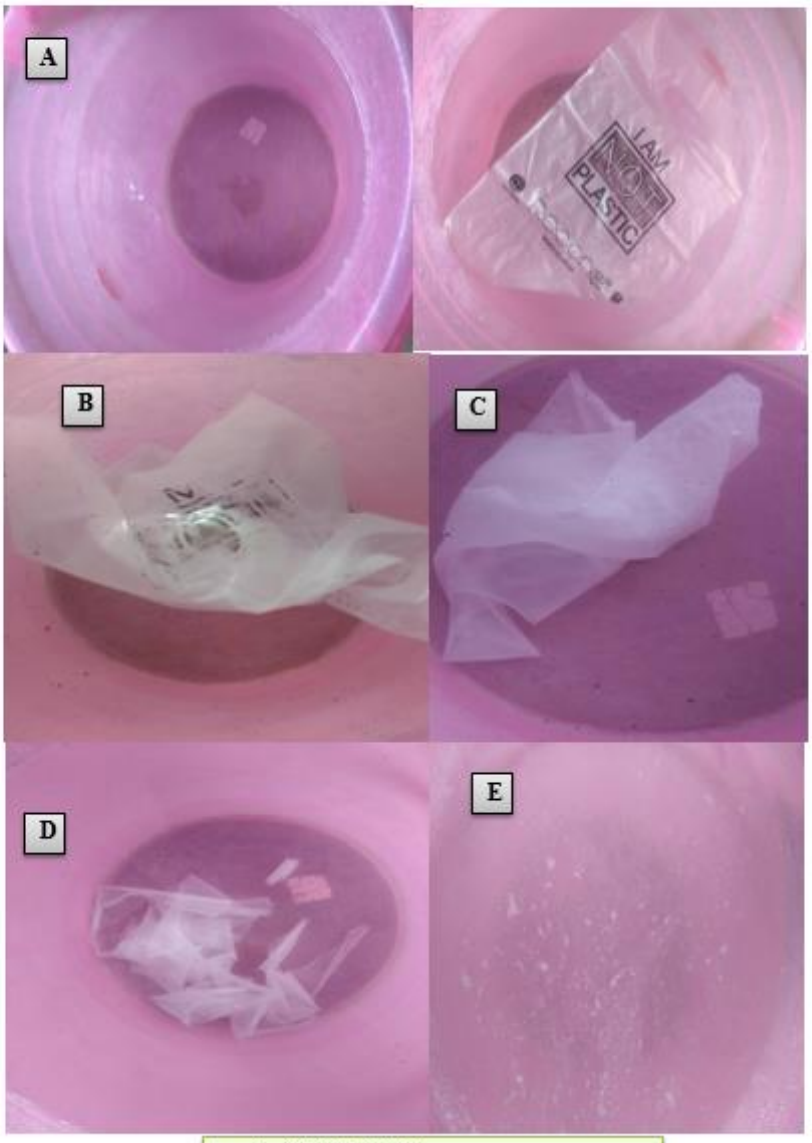
Particulars	pH value	Remark
Sample-3 (pre disposal)	6.5	Neutral
Sample-4 (post disposal)	7.2	Neutral

The findings proved that the pH level was neutral and biodegradable bags did not affect the quality of water. pH value less than 7 is acidic, pH value more than 7 is alkaline. As pH cannot be so accurate, pH value between 6.5 – 7.5 is considered as neutral. Hence it is **concluded that the quality of the water after completely dissolving biodegradable bag remains potable. This is proof that the biodegradable bags taken for testing are quality wise eco-friendly.**

The study has proved that the biodegradable bags. Selected for the study are benign; hence eco-friendly and harmless the environment and living organism. Hence Hypothesis (2) is accepted.

A. Biodegradable bags
Biodegradable bags degradability in soil
B. After one month
C. After two months
D. After three months

Exhibit: 3. Biodegradable bags degradability in soil



A. Potable water
Biodegradable bags dissolving in water
B. After one hour
C. After five hours
D. After twelve hours
E. After twenty four hours

Exhibit: 4. Biodegradable bags dissolving in water

V. SUMMARY CONCLUSION

It would be hard to imagine modern society without plastics. Plastics have found a myriad of uses in fields as diverse as household appliances, packaging, construction, medicine, electronics, and automotive and aerospace components.Plastic shopping bags could be the most ubiquitous consumer item on Earth. Their light weight, low cost, and water resistance make them so convenient for carrying groceries, clothing, or any other routine purchase that it is hard to imagine life without them.

The Hon'ble Chief Minister of Tamil Nadu has announced, ban on **'one time use and throw away plastics',** irrespective of thickness, from 1st January, 2019 under the provisions of the Environment (Protection) Act, 1986.Coimbatore Corporation has launched bio bags that are starch-based and are compostable and claim that these bags burn like paper and turn into ash unlike plastic, and also they dissolve in water. Whereas, it has to come to the knowledge that, the use of '**use and throwaway plastics**' such as carry bags, sheets used for food wrapping, spreading on dining table, plates, coated tea cups and tumblers, water pouches and packets, straw and flags of plastic origin are causing serious environmental hazards and health problems amongst human beings as well as plants and animals.

This backdrop raised a natural curiosity in the investigator to comprehend how far the end users (Consumers) and promoters (Retailers) have imbibed this concept in their routine activities. Hence, a micro level study on "**Biodegradable Plastic Bags for Commercial and Consumer use – A Feasibility Study on Eco-Friendliness**" was launched with the following objectives:

6. ***Find out the pre and post mindset of consumers on use of carry bags after plastic ban***
7. ***Examine retailer's standpoint regarding ban on plastic bags***
8. ***Identify producers of biodegradable bags***
9. ***Analyze quality of biodegradable bags for their eco friendliness***
10. ***Assess the bio-based bags for degree of degradability***

Fifty homemakers (Consumers) and fifty retailers were chosen adopting convenient sampling and a standard interview schedule was administered to find out their opinion and practices regarding the issue. Finding it feasible the method chosen was a normative survey. An experimental study to test the degradability of a biodegradable bag locally provided by a manufacturer was also done. The findings of the study are summarized as under:

Opinion of the End Users

- With the imposition of ban on plastic carry bags (which were by convention the type of carry bags provided by shops), the sample homemakers had re-imbibed their civic responsibility and hence 92 per cent of them had started taking (plastic free) carry bags on their own.
- After the ban 50 per cent reported that cloth bags were offered while 26 per cent agreed to be getting either biodegradable plastic bags or paper bags from the shops. After the ban none of the shops visited by the samples offered plastic or non-woven bags.
- Only 20 per cent of the homemakers used single use plastics for just one use and were found to throw it away after its primary use, but 24 per cent of the samples used it twice or few more times after its primary use.
- Consumer behavior on this score, that is, practical use of plastic carry bags was found to be very depressing. The consumers were not found to be aware of the ill-effects of using such low micron plastic bags on their health status.

Views of Retailers

- Ninety per cent of the retail outlets had been providing plastic carry bags (being cheap and convenient) for the bought items before the ban, which had dwindled to 78 per cent after the ban.
- Only a negligible proportion of retailers provided biodegradable plastic bags (6%) and paper bags (4%) to their customers.

- It was heartening to record none of the samples to offer plastic bags after the ban. Contrarily even after the Government order on banning plastics, 12 per cent was found to provide non-woven bags.
- Despite all efforts by the Government and media to circulate information, only 80 per cent agreed to know about the concept after the ban. A good 20 per cent still were in the darkness. These facts are proof enough to project the market scenario in its reality.

Influential on Consumer's Behavior Post Plastic Ban

- Age factor was found to have an influence on awareness about micron in plastic bags before and after the ban.
- Age of the consumers again was found to have an influence on the consumer's awareness about the ill-effects of non-woven bags. Changed mindset of the retailers not to provide plastic bags probably could have been an influential factor.
- Plastic bags were found to have been preferred only by consumers who were graduates or post graduates before ban, a shameful situation. But all of them had totally reformed after ban and had shunned plastic bags.
- The proportion of illiterate group who were not aware of micron in plastic bags had increased especially after the ban. Hence adequate intervention on this aspect needs to be taken on a war footing.
- Ban on plastics/ non-woven could mobilize only additional 68 per cent where the educational level of the consumers was found to have an influence.
- The illiterate group still remained unaware of the ill—effects of plastic bags and non-woven bags.
- More than illiterate and school completed consumers the graduates and post graduates were found to use plastic bags till they were worn out.

Influential on Retailer's Behavior Post Plastic Ban

- Experienced shop owners (90 per cent) were found to provide bags and it was evident that with experience in salesmanship (in terms of age of shop owners), the trend to provide carry bags to consumers to increase. Even after ban the trend was found to continue.
- While all age groups resented or completely avoided giving plastic bags irrespective of age (after the ban), the increased proportion of aged retailers who had shifted to providing cloth, biodegradable and paper bags is a welcome change.
- Before ban on plastic carry bags it was found that a majority of them were not aware of the ill-effects of plastic bags but then age factor (for 80 per cent) had helped them to understand the concept better after the ban among retailers too.
- Younger generation (21-40) was found to be knowledgeable about the ill-effects of non-woven bags, though 84 per cent became aware only after the ban. Nevertheless, among those who were not aware of the ill-effects, (94 per cent) only 16 per cent gained knowledge after the ban where age factor played a role.
- Education (up to schooling or graduation) was found to motivate to provide carry bags to consumers, which sustained even after the ban. Here again their educational level only had made them restrict their habit of providing bags.
- The retailer's education level definitely influenced choice of type of bags distributed to consumers. The same factor has also been responsible to create a changed mind set in them after the ban.
- Education level was not a matter which had been of help to them to be aware of micron in plastic before ban. A change in one's behavior, their ethical sense of mind and mind set had to cooperate.
- Post graduates remained unaffected both before and after the ban. Among the Graduate and school-completed shop owners imposition of the ban has created ripples and were found to react in the positive towards the ban.

- Seventy per cent of the sample shop keepers obtained biodegradable plastic bags from local manufacturers. Coimbatore Corporation had taken the initiative to promote biodegradable plastic bags, in an effort to check pollution caused by disposable plastic bags and to curtail use of plastic bags by both retailers and consumers.
- With this backdrop the City Corporation had launched the sale of biodegradable bags through selected outlets. While 20 per cent of the remaining obtained the same from Bangalore, ten per cent depended on Chennai sources.
- The findings brought to light that **the ban on plastics (and before that too) had catalyzed a few manufacturers to produce eco-friendly biodegradable bags in the local area – a new arena for entrepreneurship.** This motivated an experimental study.

Quality Test on Marketed Biodegradable Bags

The biodegradable bag made locally which was promoted by 70 per cent of the selected retailers was tested for their eco friendliness and biodegradable quality. The findings are summarized as under:

- ***It was found that a standard bag took $3^1/_2$ to 4 months to totally decompose in soil.***
- ***Similarly it took 24 hours to totally dissolve in water***.

Findings of the soil test

a. <u>Test for pH value of soil</u>

- Quality of soil **for pH** was done adopting **soil standard test** taking soil samples of both pre and post decomposition. Likewise quality of soil for **microbial content/ fertility** was done adopting the same procedure for sample collection and testing using **soil detection and plate count** method. Pre sample soil refers to the soil before burying the biodegradable bag. Post soil sample refers to soil after the bag has degraded completely (after $3^1/_2$ -4 months)

- The findings proved that the pH level was neutral and biodegradable bags did not affect the quality of the soil on that score. The pH value less than 7 is acidic; pH value more than 7 is alkaline. As pH cannot be so accurate, pH value within 6.5 – 7.5 is considered as neutral. Hence it is **concluded that the quality of the soil after this biodegradable bag decomposition will not harm growth of plants in them. This is proof that the biodegradable bags taken for testing are quality wise eco-friendly.**

b. <u>Test for quality of soil for microbial content/ fertility</u>

- Based on results it is evident that there is an increase in the bacterial count after decomposition of the biodegradable bags in soil. Bacteria present in the soil had helped the biodegradable bags to degrade, as there is increase in the bacterial count on the sample taken after degradation of biodegradable bag.
- **It showed that biodegradable bags consist of source for bacteria to grow. These bags can degrade in any soil with low bacterial count as they themselves have the source for bacteria to grow.**
- **Hence it is concluded that the biodegradable bags marketed by the company are cent percent eco-friendly and can be recommended for floating safely among consuming public. Disposal of the same cannot hinder future plant growth.**

c. <u>Test for pH value of water</u>

- Water quality was also tested before dissolving and after dissolving the bags in water adopting test for **potability (pH value).**
- The findings proved that the pH level was neutral and biodegradable bags did not affect the quality of water. pH value less than 7 is acidic, pH value more than 7 is alkaline. As pH cannot be so accurate, pH value within 6.5 – 7.5 is considered as neutral.

- Hence it is **concluded that the quality of the water after completely dissolving biodegradable bag remained potable. This is proof that the biodegradable bags taken for testing are quality wise eco-friendly.**

As the study has proved that the consumers and retailers had responded to have positively accepted the switch over from plastic bags to eco-based bags, **Hypothesis (1) set for the study is accepted.**

The experimental study having proved that the selected biodegradable bag is benign (harmless) for both soil and water the **Hypothesis (2) set for the study is also accepted.**

Conclusion

It is concluded that both the consumers and retailers had taken to plastic ban as a boon. The quality of the biodegradable bag commercialized in the market also had emerged eco-friendly and benign on soil and water. Hence the following recommendations are put forth.

- **Recommendations for Future Research**

1. **Experimental studies on trying out various eco-friendly permutation combinations for making biodegradable bags can be taken up**
2. **Comparative analysis of bio-based bags using different constituents for their eco-friendliness can be initiated.**
3. **Awareness programmes to transform consumers more eco- conscious and to avoid plastics can be taken up.**

It is hoped that the study has been an eye opener on a "subject" which was really an eyesore for the community till recently.

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Appendix-I (A)

An interview schedule to elicit information on "**Biodegradable plastic bags for commercial and consumer use- a feasibility study on eco-friendliness.**"

1. Name of the interviewee :
2. Name of the interviewer :

A. General information:

1. Name of the family head :
2. Age
   ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60
3. Education
   ☐ Illiterate ☐ Schooling ☐ Graduate ☐ Post graduate
4. Address :

5. Contact number :
6. E-mail ID :
7. Type of the family
   ☐ Joint family ☐ Nuclear family
8. Do you use plastic bags
   ☐ Yes ☐ No
9. Do you carry your own bags to shops
   ☐ Yes ☐ No
10. If yes, what type of bags do you prefer to carry
    ☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags ☐ Non-woven bags
11. If cloth bags, why do you prefer cloth bags for shopping
    ☐ Reusable ☐ Durable ☐ Eco-friendly ☐ Plastic ban
12. If plastic bags, why do you prefer plastic bags
    ☐ Occupies less space ☐ Easy to carry ☐ Cheap
13. If no, what kind of bags do they provide for bought products
    ☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags
14. If no, why do you prefer not to take bags while shopping
    ☐ May forget ☐ Disturbance ☐ Buying one doesn't cost much
15. Where the provided bags charged
    ☐ Yes ☐ No

16. If yes, how much is per bag's cost (mentioned in rupees)

☐ 2 ☐ 5-10 ☐ 11-15 ☐ >15

17. Are you aware of the microns in plastic bags

☐ Yes ☐ No

18. If yes, what was the source

☐ Neighbours ☐ Social media ☐ Newspaper ☐ Television

19. Do you use two dustbins

☐ Yes ☐ No

20. How long do you use "use and throw" or "one use plastics"

☐ One use ☐ Twice and few times ☐ Until it tear

21. Have you heard about biodegradable bags

☐ Yes ☐ No

22. If yes, will you suggest biodegradable bags for your family and friends

☐ Yes ☐ No

23. Are you aware of government order NO : 84

☐ Yes ☐ No

24. Do you know why this law was passed

☐ Yes ☐ No

25. Are you aware of non-woven bag's side effects

☐ Yes ☐ No

26. What kind of bags will you suggest

☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags

27. Why do you suggest this bag

☐ Eco-friendly ☐ Durability ☐ Low cost ☐ User friendly

28. Do you think we can survive without plastic carry bags

☐ Yes ☐ No

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Appendix-I (B)

An interview schedule to elicit information on "**Biodegradable plastic bags for commercial and consumer use- a feasibility study on eco-friendliness.**"

1. Name of the interviewee :
2. Name of the interviewer :

A. General information:

1. Name of the family head :
2. Age
   ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60
3. Education
   ☐ Illiterate ☐ Schooling ☐ Graduate ☐ Post graduate
4. Address :

5. Contact number :
6. E-mail ID :
7. Type of the family
   ☐ Joint family ☐ Nuclear family
8. Do you carry your own bags to shops
   ☐ Yes ☐ No
9. If yes, what type of bags do you prefer to carry
   ☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags ☐ Non-woven bags
10. If cloth bags, why do you prefer cloth bags for shopping
    ☐ Reusable ☐ Durable ☐ Eco-friendly ☐ Plastic ban
11. If paper bags, why do you prefer plastic bags
    ☐ Eco-friendly ☐ Plastic ban ☐ Cheap ☐ DIY
12. If no, what kind of bags do they provide for bought products
    ☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags
13. If no, why do you prefer not to take bags while shopping
    ☐ May forget ☐ Disturbance ☐ Buying one doesn't cost much
14. Where the provided bags charged
    ☐ Yes ☐ No
15. If yes, how much is per bag's cost (mentioned in rupees)
    ☐ 2 ☐ 5-10 ☐ 11-15 ☐ >15

16. Are you aware of the microns in plastic bags

☐ Yes ☐ No

17. If yes, what was the source

☐ Neighbours ☐ Social media ☐ Newspaper ☐ Television

18. Have you heard about biodegradable bags

☐ Yes ☐ No

19. If yes, will you suggest biodegradable bags for your family and friends

☐ Yes ☐ No

20. Are you aware of government order NO : 84

☐ Yes ☐ No

21. Do you know why this law was passed

☐ Yes ☐ No

22. Do you know non-woven bag's side effects

☐ Yes ☐ No

23. What kind of bags will you suggest

☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags

24. Why do you suggest this bag

☐ Eco-friendly ☐ Durability ☐ Low cost ☐ User friendly

25. Do you think we can survive without plastic carry bags

☐ Yes ☐ No

Avinashilingam Institute for Home Science and higher Education for Women University. Coimbatore-641043, Tamil Nadu, India.

Appendix-II (A)

An interview schedule to elicit information on "**Biodegradable plastic bags for commercial and consumer use- a feasibility study on eco-friendliness.**"

1. Name of the interviewee :
2. Name of the interviewer :

A. General information:

1. Name of the shop:
2. Age
   ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60
3. Education
   ☐ Illiterate ☐ Schooling ☐ Graduate ☐ Post graduate
4. Address :

5. Contact number :
6. E-mail ID :
7. Legal rights of the shop
   ☐ Owner ☐ Partnership
8. Nature of ownership
   ☐ Owned ☐ Rented ☐ Leased
9. Type of shop
   ☐ Departmental store ☐ Hypermarket ☐ Supermarket ☐ Speciality store ☐ Kirana (Groceries)
10. Do you have branches within city limit
    ☐ Yes ☐ No
11. If yes, how many branches within city limit
    ☐ <2 ☐ 2-5 ☐ 5-10 ☐ >10
12. Have you got licence for your shop
    ☐ Yes ☐ No
13. Do you provide carry bags for bought items
    ☐ Yes ☐ No
14. If yes, what type of bags do you provide for bought items
    ☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags ☐ Non-woven bags

15. Do you charge for providing bags

☐ Yes ☐ No

16. If yes, how much is per bag's cost (mentioned in rupees)

☐ 2 ☐ 5-10 ☐ 11-15 ☐ >15

17. From where and whom do you get these bags

☐ Local ☐ Imported

18. If imported, from where

☐ Bangalore ☐ Chennai ☐ Madurai

19. Are you aware of the microns in plastic bags

☐ Yes ☐ No

20. If yes, what was the source

☐ Neighbours ☐ Social media ☐ Newspaper ☐ Television

21. Have you heard about biodegradable bags

☐ Yes ☐ No

22. If yes, will you suggest biodegradable bags for your family and friends

☐ Yes ☐ No

23. Are you aware of government order NO : 84

☐ Yes ☐ No

24. Do you know why this law was passed

☐ Yes ☐ No

25. Do you know non-woven bag's side effects

☐ Yes ☐ No

26. Do you suggest customers to bring their own bags

☐ Yes ☐ No

27. Does customer bring their own bags for shopping

☐ Yes ☐ No

Avinashilingam Institute for Home Science and higher Education for Women University. Coimbatore-641043, Tamil Nadu, India.

Appendix-II (B)

An interview schedule to elicit information on "**Biodegradable plastic bags for commercial and consumer use- a feasibility study on eco-friendliness.**"

1. Name of the interviewee :
2. Name of the interviewer :

A. General information:

1. Name of the shop:
2. Age
   ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60
3. Education
   ☐ Illiterate ☐ Schooling ☐ Graduate ☐ Post graduate
4. Address :

5. Contact number :
6. E-mail ID :
7. Legal rights of the shop
   ☐ Owner ☐ Partnership
8. Nature of ownership
   ☐ Owned ☐ Rented ☐ Leased
9. Type of shop
   ☐ Departmental store ☐ Hypermarket ☐ Supermarket ☐ Speciality store ☐ Kirana (Groceries)
10. Do you have branches within city limit
    ☐ Yes ☐ No
11. If yes, how many branches within city limit
    ☐ <2 ☐ 2-5 ☐ 5-10 ☐ >10
12. Have you got licence for your shop
    ☐ Yes ☐ No
13. Do you provide carry bags for bought items
    ☐ Yes ☐ No
14. If yes, what type of bags do you provide for bought items
    ☐ Plastic bags ☐ Paper bags ☐ Cloth bags ☐ Biodegradable bags ☐ Non-woven bags
15. Do you charge for providing bags

☐ Yes ☐ No

16. If yes, how much is per bag's cost (mentioned in rupees)

☐ 2 ☐ 5-10 ☐ 11-15 ☐ >15

17. From where and whom do you get these bags

☐ Local ☐ Imported

18. If imported, from where

☐ Bangalore ☐ Chennai ☐ Madurai

19. Are you aware of the microns in plastic bags

☐ Yes ☐ No

20. If yes, what was the source

☐ Neighbours ☐ Social media ☐ Newspaper ☐ Television

21. Have you heard about biodegradable bags

☐ Yes ☐ No

22. If yes, will you suggest biodegradable bags for your family and friends

☐ Yes ☐ No

23. Are you aware of non-woven bag's side effects

☐ Yes ☐ No

24. Do you suggest customers to bring their own bags

☐ Yes ☐ No

25. Does customer bring their own bags for shopping

☐ Yes ☐ No

Appendix-III

CHEMICAL TEST- STANDARD PROCEDURE

Total bacterial count:

1.0 Scope: This Method gives general guideline for the Detection of *Total Microbial Count* organism present in soil sample.

2.0 Apparatus and glass wares: Weighing Balance, Measuring Cylinder, Conical Flask, Auto clave, Bio-safety cabinet, PH Meter, Bunsen Burner , BOD Incubator, Sterile Petri plates, Micropipettes, Water bath, Incubator, Test tube, Colony counter

3.0 Culture media and reagents: Plate Count Agar, Peptone water (PH-7.0)

4.0 Preparation of test sample: Blend the sample in a sterile blender jar for 2 minutes or macerate with sterile mortar , using 10 ml of diluting fluid per gram of sample(In Pour plate technique diluting fluid , with a 1g inoculum of a 1/10 Suspension). The diluting fluid for preparing the homogenate should be 0.1 percent peptone.

5.0 Procedure:

5.1 Take two sterile petri dishes using a sterile pipette, transfer to each dish 1 ml of the test sample.

5.2 Take two other sterile petri dishes, using a fresh sterile pipette, transfer to each dish 1 ml of the sample. First decimal dilution (10^{-2}) of the test sample and repeat the procedure described with the further dilutions, using a fresh sterile pipette for each decimal dilution.

5.3 Aseptically pipette 1 ml each of the sample and 1 ml each of suitable dilutions into the duplicate petriplates and pour 10-15 ml of agar medium(cooled to 45º -50º c) and rotate the Petri dishes clockwise and anti clockwise for uniform distribution of the inoculums and allow to Solidify.

5.4 Pour the media and diluents in control plates. (The elapsing time between the dilution and media. Plating is not to exceed 15 minutes).

5.5 Carefully mix the inoculums and allow to solidify, after solidification invert and incubate the

Plates for 72 hours at 30ºC.

6.0 Observations:

6.1 After the specified the period of incubation count the colony using colony counting equipment.

6.2 The colonies in each dish should contain not be more than 300 colonies.

7.0 Method of calculation: (counting of total colonies or typical colonies)

For a result to be valid, it is generally considered necessary to count the colonies on at least one dish containing at least 10 colonies [total colonies, typical colonies or colonies complying with identification criteria.

Calculate the number N of microorganisms present in the test sample as a weighted mean from two successive dilutions using Equation (1):

$$N = \sum C / V \; X \; 1.1 \; X \; d$$

Where, $\sum C$ = The sum of the colonies counted on the two dishes retained from two successive dilutions, at least one of which contains a minimum of 10 colonies;

V = The volume of inoculum placed in each dish, in milliliters;

d = The dilution corresponding to the first dilution retained [d 1 when the undiluted liquid product (test sample) is retained].

8.0 Results:

TPC 1 g of sample at 30°c is expressed in CFU.

[TPC: Total Microbial Count, CFU: Colony Forming Unit]

pH of the soil sample:

1.0 scope: This Method gives general guideline to identify the ph of the soil sample.

2.0 Apparatus and glass wares: pH Meter, Beaker, Test tube.

3.0 Culture media and reagents: Water (PH-7.0), Hydro chloric acid, Sodium Hydroxide.

4.0 Preparation of test sample: One pinch of soil sample is mixed with aqueous solution for testing pH of the sample.

5.0 Procedure: with pH meter dipped into the solution the pH of the soil is identified.

6.0 Observations: pH meter detects the approximate pH value of the soil.

7.0 Results: pH value is recorded.

pH of the water sample:

1.0 scope: This Method gives general guideline to identify the ph of the water sample.

5.0 Apparatus and glass wares: pH Meter, Beaker, Test tube.

6.0 Culture media and reagents: Water (PH-7.0), Hydro chloric acid, Sodium Hydroxide.

7.0 Preparation of test sample: water sample is taken in clear test tube for testing pH of the sample.

5.0 Procedure: with pH meter dipped into the water sample the pH of the water is identified.

6.0 Observations: pH meter detects the approximate pH value of the water.

7.0 Results: pH value is recorded.

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women

Deemed to be University Under category 'A' By MHRD, (Estd. u/s 3 of UGC Act 1956)

Re Accredited with 'A' Grade By NAAC, Recognised by UGC Under Section 12 B

Coimbatore - 641043, Tamil Nadu, India

24 January 2019

To
Ms.E.M.Asuveetha
Department of Resource Management
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear E.M.Asuveetha,

Ref: Your proposal No. IHEC /18-19/IDRM/04 entitled "Biodegradable Plastic Bags for Commercial and Consumer Use – A feasibility study on Eco-Friendliness" submitted for approval to the IHEC on 30.09.18.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC /18-19/IDRM/04 entitled "Biodegradable Plastic Bags for Commercial and Consumer Use – A feasibility study on Eco-Friendliness" submitted by you. The Approval number for the same is AUW/ IHEC/IDRM-18-19/XPD/04.

We wish you all the best in your research endeavours.

Regards,

V. Uma Mageshwari
Dr.S.Uma Mageshwari
Member Secretary

Institutional Human Ethics Committee