Success and Failure Factors for the Adoption of Bio-Based Packaging

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Master Thesis Report

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Abstract

The purpose of this study is to provide insight into the factors that determine the willingness of key market players in the Indian food industry to adopt bio-based plastic packaging. First, the key market players are identified within the important market segments in the specified industry. After the identification of key players, the literature is surveyed in the context of eco-innovations, innovation adoption in emerging countries and Roger's market adoption theory. In addition, the sustainability point of packaging and its perceived attributes are elaborated on and analyzed using the selected framework.

Semi-structured interviews with the key market players in the food packaging industry are conducted in the context of adoption theory. The results of the survey reveal that there are only two groups in the industry, those that are currently considering bio-based plastic packaging and those that have not yet considered it. Due to the low number of completed questionnaires, advanced multivariate statistical methods cannot be used for data analysis. Nevertheless, the questionnaire is used in the analysis section; for further investigation of important concepts, semi-structured interviews are performed which clarify the environmental strategies and programs of players in the market who expect opportunities for CO2, material, water and energy reduction to emerge in both the short-term and long-term. Their responses also underscore the increasing importance of "Life Cycle Assessment" in decision-making, i.e., as factors that determine the willingness of especially brand owners to adopt bio-based plastic packaging. However, the contribution of bio-based materials to these sustainability programs has not been clearly perceived as a positive attribute. Moreover, there is no significant indication that supports the use of bio-based materials in comparison to conventional plastics regarding the implemented cases of some life cycle assessments. Last but not least, the packaging material is perceived as being highly cost sensitive. One of the important findings is that market players are not willing to pay a premium price for packaging material merely on the basis of it being environmental friendly; therefore, it is necessary to add value to ensure the potential adoption of these environmental materials. Moreover, this obstacle may be overcome with the help of decreased cost by economies of scale in the bio-packaging materials.

This thesis concludes by emphasizing that value chain alignment is necessary, originating from the raw material to the end of recycling, for potentially adopted bio-based packaging material. This alignment can be stimulated by legislation; however, in some European countries, there is no signal detected to the contrary specifically for this industry.

Keywords: Bio-based packaging, adoption of eco-innovation, technology transformation, emerging economy

FOREWORD

This project has been made possible by the collaboration of the IMIM partnership and the diverse theoretical background present at each partner university, which greatly enriched the analytical process.

I want to thank Tom Lindström and Magnus Gimåker for their collaboration and insights, which have truly helped clarify key packaging industry issues. Also, I would like to express my sincere gratitude to Fredrik Rosen for his wise advice and guidance concerning the market dynamics in the context of this thesis.

I wish to give special recognition to my tutor, Michael Novotny, whose insight and vision have proven invaluable for the development of this master's project. Thanks to his recommendations and contributions during our worthwhile meetings, new ways to visualize the industry dynamics were found and the most relevant issues for the study were identified.

Last but not the least, I would like to thank all my family and the great friends that were with me during these two years for encouraging and for supporting me emotionally, psychologically, professionally, practically and especially sincerely.

Umit Emre ERDOGAN

Stockholm, May, 2013

NOMENCLATURE

Abbreviations

ABS	Acrylonitrile/Butadiene/Styrene
B2B	Business to Business
B2C	Business to Customer
BIS	Bureau of Indian Standards
BRIC	It refers to the countries of Brazil, Russia, India and China
CAGR	Compound Annual Growth Rate
COMPASS	Comparative Packaging Assessment
R&D	Research and Development
EU	European Union
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FICCI	Federation of Indian Chambers of Commerce and Industry
HDPE	High Density Polyethylene
GDP	Gross Domestic Product
LCA	Life Cycle Assessment
MEI	Measuring Eco-Innovations
PBS	Poly (Butylene Succinate)
PC	Poly Carbonates
PE	Poly Ethylene
PHA	Poly Hydroxy Alkanates
PIQET	Packaging Impact Quick Evaluation Tool
PLA	Poly Lactic Acid
PS	Poly Styrene
PP	Poly Propylene
TAM	Technological Acceptance Model
TBL	Triple Bottom Line
USDA	United States Department of Agriculture
UTAUT	Unified Theory of Acceptance and Use of Technology

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INTRODUCTION

This chapter describes the background, the purpose, the limitations and the method used in the presented project.

1.1. Background

Globalization has had several effects on countries around the world. One of the effects on the mature European economy, especially in food packaging industry, is that companies in Europe are trying to find new markets in order to supply more products and services through the utilization of competitive and so-called “sustainable” solutions.

Secondly, with increasing use of technology, there has been a shift in the products and services. Media has also adapted to this change. Every day, a growing number of books, newspapers, journals, and articles are being written, delivered and consumed in the cyber world. Therefore, it is crucial that print media acknowledges the importance of a decreasing demand, which concerns the entire forest-based industry, especially in the northern Europe.

On the other hand, environmental concerns have been placed on the agenda, especially by Western countries, and affect every country in the world. In fact, according to researchers, oil-based products such as plastics can be considered one of the most important factors, not only causing climate change, but also polluting the environment with materials that do not biodegrade. To illustrate, the ´Great Pacific Garbage Patch´, a huge amount of plastic waste in North Atlantic and Pacific Oceans discovered at the end of the last century, causes a great deal of damage to sea animals and a reduction in carbon storage. The full extent of its environmental effects has not been determined (Bryan, 2009). Currently, it is argued that the available supply of forest-based materials, such as bio-based packaging used as a substitute for current oil-based plastics, is an important indicator for a transformation from an oil-based society to a more environmental and sustainable society. Likewise, there is an impressive potential for the Northern European forest-based industries and R&D units which are searching for new markets in consideration of a never ending reduction in the paper-based materials.

Innventia, a R&D company operating in the forest-based industry, has been looking for new products and new technological solutions for the future. In particular, the number of new biomaterial solutions for packaging is increasing, triggered by global environmental concerns. Cooperation of advanced technologies in the field, these biomaterials may create ´sustainable solutions´, starting with the food packaging industry (Innventia, 2013).

Currently, fossil-based plastics and metal compounds such as aluminum laminate materials dominate as substitutes for paper and bio materials in the food packaging industry (PlasticsEurope, 2011). In particular, emergent markets in the countries of Brazil, Russia, India and China (BRIC), especially India, have seen an increasing demand and growth rate in food packaging during the last couple of years. This creates a great deal of potential for the market. However, there is a trend in which eco-friendly products diffuse slowly into markets (Ozaki, 2011).

As mentioned, there are several innovations that are ready to push technology to the market, but, on the other hand, there are different markets in different countries and industries acting differently on the same case. There have been several studies of bio-based, bio polymers and nano-cellulose materials (Alvarez-Chavez, et al., 2012; Bohlmann, 2007; Guilbert, et al., 2011; Shen, et al., 2009). However, there is almost no research about diffusion and adoption of these bio-innovations in emerging economies. In Europe, sustainable concerns are a hot button; however, this may vary in different economies.

In addition, each country has different policies for coping with these environmental problems. For example, last year, Italy banned the use of plastic bags in supermarkets which has increased the bio-based material use in the bags (Ward, 2010). Other European countries are planning to establish similar regulations. Because of these specific legislations, each country should be approached as independent even though there is interdependency with each other.

1.2. Purpose

Concerns about the fossil-based society, environmental factors and demand reduction in the printed paper market are pushing the new bio-packaging solutions into the market. However, there is a wide gap between what is known about bio-packaging and what is in practice in the market. This gap needs to be clarified in order to understand the market's willingness to adopt bio-based plastic packaging innovations.

Research Questions:

a. What supports are available for the adoption of bio-packaging materials?

b. What are the obstacles for the adoption of new bio-packaging materials?

In order to answer these questions, the general market condition, key players of the supply chain, and potential of the market are investigated.

In the following chapters, an industry overview and theoretical framework is provided, including adoption factors of the packaging industry. Next, research methods are described by a working plan.

1.3. Delimitations

It is necessary to point out that this research focuses not only on biodegradable plastic materials, but also on the potential of all bio-based plastics materials. There is an important difference between them (Shen et al., 2009; Guilbert et al., 2011; Alvarez et al., 2012). Bio-based plastics are not always biodegradable but are all plastics produced from renewable resources. However, biodegradable plastics are not necessarily produced from a renewable source. As stated in in the introduction, the main issue is addressing problems with petroleum-based plastics. Secondly, biodegradables are less applicable for durable solutions, which hamper their replacement with petroleum-based plastics (Shen, et al., 2009). The graphical representation of bio-plastics is given below to make this demarcation clear.

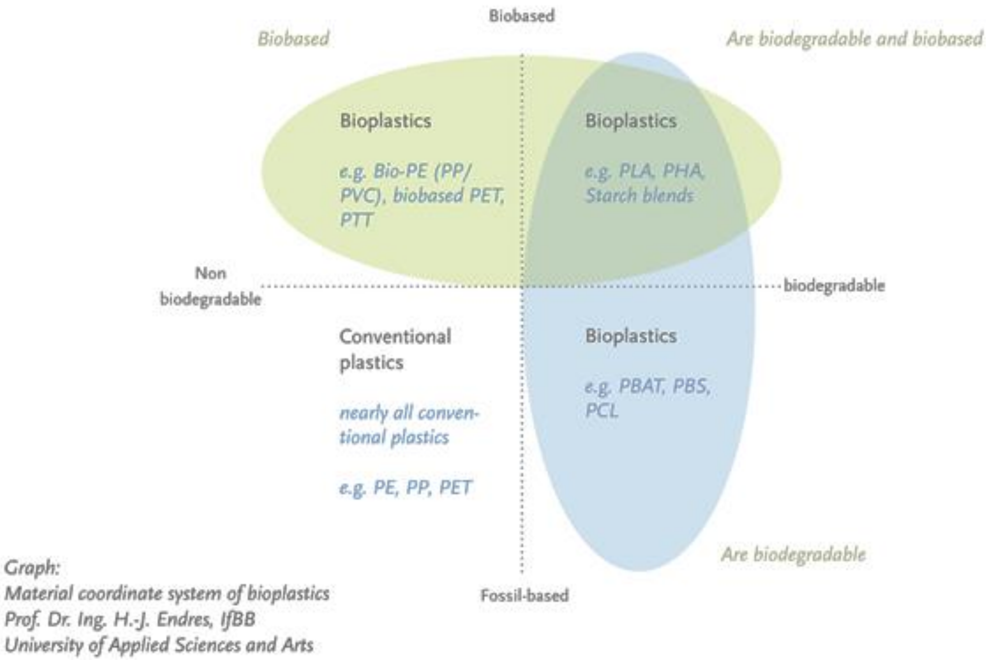


Figure 1: Classification of bio-plastics
Source: European Bio-plastics Report: "What are bio plastics?"

Some scope is formed during the research. The study takes the food packaging industry as its main focus. Geographically speaking, India is the main economy studied among many emerging economies. Philosophical aspects of phenomenon that affect the food packaging will not, per se, be discussed because this paper is not aimed at the philosophical issues underlying the concepts. Rather, the goal of this paper is to gain a better understanding of the dynamics of a specified industry which has a potential for technological innovation, especially in the areas of bio-based and renewable materials. Lastly, this paper only concerns primary and secondary packaging materials.

1.4. Method

The methods used to address the problem defined above consist of several different approaches. This study is explanatory in nature, because it focuses on testing potential adoption factors of new technologies in a specified industry which is discussed in the conceptual model. The data testing the conceptual model is collected by the means of semi-structured interviews and online structured surveys.

First of all, in order to understand drivers for and barriers to the adoption of packaging innovation in the food packaging industry, it is necessary to understand and map the industry and key players who are relevant to these decisions. In other words, an understanding of the dynamics of the market is essential to analyzing the adoption factors. Because there is a physical distance with the industry as well as the need to have a novel overview of that industry, secondary data with market researches and national reports are collected for the first part of the thesis, which is a comprehensive literature review. Most of the data are collected from secondary sources such as reports provided by governmental bodies, consulting companies and research companies as well as reports by food organizations (Food and Agriculture Organization, FAO; Federation of Indian Chambers of Commerce and Industry, FICCI) and official news about regulations and policies (Gazette of India). This information is used as a tool for the following part of the study, which is aimed at understanding the perceptions of the key market players as to adoption factors. Influential factors of the food packaging market are then analyzed. In this way, a demand analysis of the market is performed. At the end of the first part, key players of the industry are described and the most important considerations for the future of overall industry are outlined. That is to say, the outcome of the first part provides the context and input for the second part of the research.

The main purpose of the study is to gain insight into what motivates the key players, identified in the first section, to consider using bio-based plastic for their packaging. In order to do that, the adoption theory is applied in the second part of the study, in which the elements of the adoption theory are analyzed. In addition, the perceived values of new technologies to dissemination are discussed. At the end of the discussion, semi-structured interviews with the key players of the industry are planned. The main objective of these interviews is to provide a contextualized understanding of the opinions and needs of the actors concerning food packaging on the market. Therefore, it is suitable to use a qualitative method (DiCisso-Bloom & Crabtee, 2006). It is suggested that the interviews should be conducted with decision makers of the key players with knowledge about the needs of supply chain, as well as with end customers. Because adoption factors of each type of innovation can be specific and have differing degrees of importance, the use of semi-structured interviews was considered. While a structured interview has a rigorous set of questions from which one cannot digress, a semi-structured interview is partly open; allowing new ideas to be introduced in response to what the interviewee says (Collis & Hussey, 2010). This flexibility provides re-formulation and renewal of the conceptual study while conducting research. Also, some specific cases that can be uncovered during these interviews may point to potential success factors of the bio-packaging formulation. Finally, we learn whether the adoption factor is perceived as important and the degree of that importance is clarified by the use of a structured online survey. By doing so, the drivers and the barriers in the adoption of bio-packaging materials in food packaging industry can be clarified and provide potential input for the future studies.

1.4.1 Interviews

There are several ways to collect qualitative data for a study, most particularly through interviews. Since the interviewees in this research study are selected from three different sectors of the food packaging industry, it is important to grasp each individual's unique perspective. Collis & Hussey (2010) propose using a semi-structured interview in order to understand the interviewee's environment, especially when the subject is perceived as confidential or commercially sensitive.

In cases in which flexibility matters, semi-structured interviews are beneficial methods. By this means, one can change and raise the questions and approach differently according to the course of the interview. One of the main advantages of semi-structured interviews is the ability to reveal another aspect of a topic and uncover different perspectives during the session, which cannot be done within the strict boundaries of a structured interview. Having the freedom to explore the desired phenomenon with further discussion and in greater detail is also another important advantage of the semi-structured interview. However, it should be noted that this property makes the data collected more difficult to analyze.

All in all, although there are some obstacles such as physical distance to overcome, in this research study, semi-structured interviews are selected as the most appropriate method in order to reach research objectives.

1.4.2 Data Collection

In the first part of the study, the secondary data are chosen for the analysis of the market and for defining key players along the supply chain in India, as is mentioned. Researchers should acknowledge that the data illustrated in the secondary sources can be biased and fallacious. There are two main precautions taken in order to avoid these drawbacks. Generally, in order to obtain valid data, the reports from governmental bodies, international organizations, consulting and research companies are reviewed. Moreover, to avoid biased information, the data found are compared and filtered according to their commonality in different sources. In this way, the data is utilized in an effective and convenient way to serve the purpose of the research.

In the second part, the structured questionnaire and semi-structured interviews are performed to gain an understanding of the market drivers and barriers to adoption of bio-based materials. Essentially, the small questionnaire is conducted in order to obtain a general idea of the key players' positions concerning bio-based packaging materials. This general information is to be used in the semi-structured interview to get further and more comprehensive information for the same players. There are two main reasons for that. First, the knowledge and interest of interviewees about bio-packaging can be measured in this structured questionnaire, which will be used in the second phase semi-structured interviews to obtain further information. Also, the analysis of data is another main concern from the researcher's point of view. Analyzing the data collected from structured questionnaire is more convenient and provides valid general information about the market. In contrast, data which are collected via semi-structured interview are not easy to analyze and compare because of its nature, although it provides more information about the research.

1.4.3 Interviewees

Interviewees are chosen because of their knowledge and critical role in the decision making process in the food packaging market. End customers are not interviewed for several reasons. Firstly, from the end customer's point of view, the observability of bio-based material packaging is low. In other words, end-customers cannot easily differentiate whether the packaging materials are bio-based or oil-based; therefore, it has been observed that, in that sense, there is no demand from end customer. Secondly, as discussed in the first part of this thesis, the market is dominated by brand owners and retailers, which means that end-customers have no direct role in the introduction of new material to the industry. End-customers have some say in packaging regarding convenience, protection, portion control, communication and design. Hence, end-customers can play an indirect role on the decision chain of the packaging materials that can be easily discussed and investigated by market players. Also, last but not least, implementation of the survey to the Indian end-customers is not appropriate. The aim of this study is to identify the barriers and drivers for the adoption of bio-packaging materials. This is about the adoption of the material along supply chain, especially by key players. For this reason, end-customer interviews would be time consuming and provide no viable input to this study.

The brand owners, retailers and packaging converters are included in this empirical study as they provide valid information.

1.4.4 Reliability, Validity and Bias Factors

While using qualitative data, it is essential to filter the collected data from the semi-structured interviews to eliminate unnecessary information, after which the credible data can categorized in order to easily assimilate and utilize valuable information. In this way, the data can be analyzed to reach a verifiable conclusion (Collis & Hussey, 2010).

Since the primary data in this research is coming from the interviews, it is important to treat that data objectively and avoid allowing personal opinion and bias to influence its analysis (Stenbacka, 2001). One must consider qualitative studies as the tools for not only explaining the phenomenon but also understanding the dynamics behind of it. In this research, as the information is collected from a specific market and specific industry, it is hard to transpose it to a different market and location because of the inherent specific properties of that industry and its market.

The validity of the research is also an important consideration in the context of reviewing literature. To ensure that the primary data is representative, several players along the supply chain are chosen for the interviews. In the first part of the research, the dominant players of the market are discussed with the help of secondary data. In the second phase of the research, a number of interviews are performed with key players – the converters, brand owners and retailers – in the context of adoption theory.

PACKAGING INDUSTRY OVERVIEW

It is necessary to understand the structure of the food packaging industry in order to investigate barriers and drivers in that industry. Without knowing the basic dynamics and having an overview of the market, any discussion would be superficial. Therefore, the general information and current available statistics about the industry are given in the next chapter of the research.

Packaging industry can be divided into two main groups: the demand side and the supply side; the supply side stands for providers and supply side stands for end customers. In spite of the fact that each group has its own various investment potentials and growth, both divisions are dependent on growth values.

On the supply side, with %81, package manufacturing has the largest share in the industry, followed by packaging services at %14 and packaging machinery at %5 (Manalili, et al., 2011). From these sub/sectors, it can be seen that packaging machinery is highly globalized, with US and European companies dominating the market as major country producers and exporters. According to Packaging Gateway research (2010), the production of packaging machinery reached 22 billion Euros in 2007. However, packaging manufacture is not as highly globalized as machinery, the reason being that producers want to cut down on the variable cost by setting up the operations nearer to the end customers. This sub-sector is composed of small and medium enterprises.

The packaging service is comprised of establishments that provide packaging services and labeling of client-owned product. The service sector does not include the manufacturing of packaging or the label itself.

In the total packaging market, paper has %34 share, followed by rigid plastic (%27), metal (%15), glass (%11), flexible packaging (%10) and others (3%) (Manalili, et al., 2011). There is growth in the share of flexible packaging in the last years because of its variety of uses and reduced transportation cost of the material.

On the demand side, the packaging industry may be categorized by type of end consumer, such as individual, institutional and industrial users. Further, the industrial users may be sub-classified into food, beverage and petrochemicals. This paper especially focuses on the demand side of the packaging industry to understand the motivation for and barriers to the adoption of bio-based packaging solutions in the market.

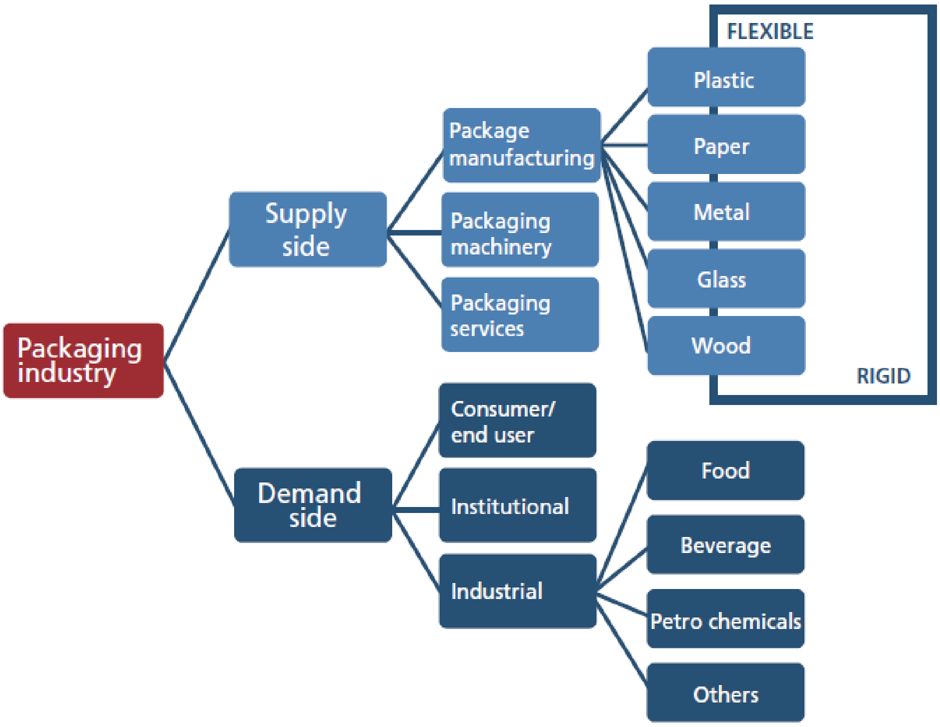


Figure 2: Classification of packaging
Source: Packaging Gateway Report (2010)

In the global packaging industry, food has the greatest share with 50% and was valued at 380 billion USD as of 2009. Adding the beverage shares (19%), it accounts for more than half of worldwide packaging industry. The growing demand in the food and beverage market in developing countries is stimulating demand for the packaging industry (Global Industry Analysts, Inc., 2010).

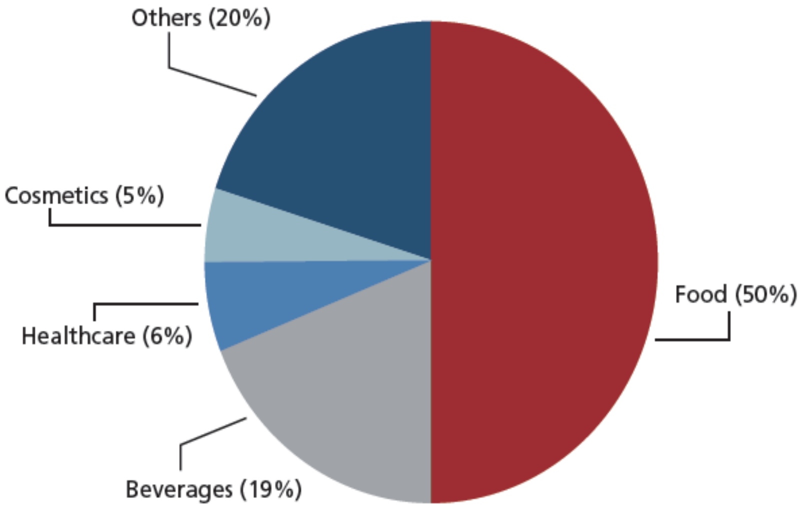


Figure 3: Value share of packaging industry
Source: Global Industry Analysts, Inc. (2010)

After this general overview of the packaging industry, it is obvious that food packaging has the largest share and greatest importance from the top perspective. Now, the research focuses specifically on the current food packaging sector rather than the other packaging sectors because it clearly has the largest share and potential of the packaging industry by far.

Initially, to gain an understanding of the stimuli of the food packaging industry, regional food packaging sales are researched worldwide. According to retail volume, the Asia Pacific region, with about 700 billion units, has the highest sales, followed by Western Europe with almost 400 billion units in 2012 (Euromonitor, 2012). This shows the great potential of the Asia Pacific market in the consumption of food packaging. Also, according to the same research, India has the greatest compound annual growth rate (CAGR) to be with almost 10% percent between the countries as an emerging market although it has much lower retail volume than China (325 billion units), with about 110 billion units of sales according to research conducted in 2012 (Euromonitor, 2012). The potential and the market size of the Asia Pacific region is shown in the first figure, and then India with the fastest growth is given in the second figure by CAGR but not by unit volume.

In terms of food packaging types, flexible packaging is the largest segment in the entire industry, with the usage rate of flexible plastic, flexible paper and flexible aluminum steadily increasing (Euromonitor, 2012). Knowing that flexible materials are becoming more and more important is essential as this segment offers a potential advantage for the application of bio-materials, provided that necessary technical and non-technical properties are in place. This issue is discussed in the technological cluster portion of this research.

2.1 *The food industry in India*

In the previous chapter, the importance and the potential of the Indian food packaging industry was discussed. Now, to understand the business in detail, it is necessary to point out some important drivers of this industry that are specific to that country, in particular, size and potential growth.

First of all, worldwide, India is the second largest food producer, with 182 billion USD just after China in 2012. The food industry is the 5th largest industry in the country with a 7% of GDP; it is expected to reach 300 billion USD in 2015. Its global rank and share of global food production is given to show the potential of the Indian food processing industry. It is no surprise that this potential is the key driver of food packaging in the country.

Table 1: Food Processing and potential of India

India's Competitive Advantages in Food Processing			
	India	*Global Rank*	*Share in Global Production*
Arable Land (million hectares)	161	2	-
Irrigated Land (million hectares)	55	1	-
Coast Line (km)	8'041	19	-
Major Food Crops (MT)	35	3	4%
Fruits (metric tonnes)	47	1	10%
Vegetables (metric tonnes)	82	2	10%
Rice/Paddy (metric tonnes)	132	2	22%
Wheat (metric tonnes)	65	2	12%
Milk (metric tonnes)	88	1	16%
Sugarcane (metric tonnes)	289	2	21%
Pulses (metric tonnes)	12	1	21%
Tea (metric tonnes)	0.88	1	28%
Edible Oilseed (metric tonnes)	25	3	7%
Cattle (million)	226	1	20%

Source: Cygnus Report, India Food Processing Sector (2005)

According to researchers, the size of food industry is an indication of India's untapped food packaging potential. This potential may be explained by comparing of some developed countries according to food packaging consumption per capita. According to Food 360 Report completed by the Federation of Indian Chambers of Commerce and Industry (FICCI) in November 2012, food packaging consumption per capita in India is 0,3 kg per year, which is much lower than Japan (15 kg), Australia (13,5 kg) and the USA (13 kg). Additionally, according to Euro Monitor and U.S.D.A Economic Research Service in 2009, India has one of the lowest packaged food consumption per capita in the world. These figures show the difference in consumption related to food packaging sector. However, these statistics alone do not demonstrate the great potential of the food packaging sector; for some reason, people simply do not consume packaged food as a tradition, social custom or lifestyle. Yet, if this figure is considered together with the increase in food exports from India, increasing income level, urbanization and organized sector with Westernized lifestyle, it may show the future untapped potential of the food packaging industry. For that reason, it is necessary to analyze these segments individually in order to understand the market.

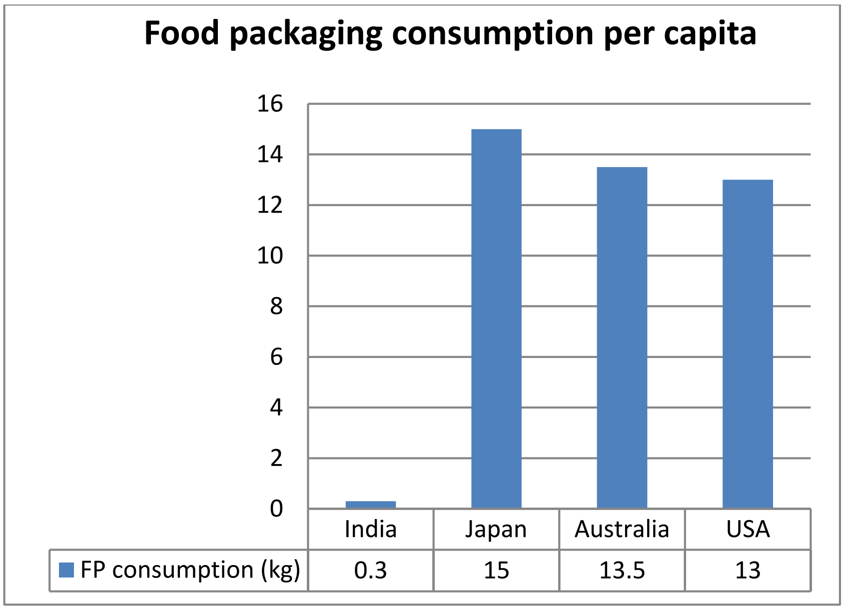


Figure 4: Food packaging consumption per capita
Source: Food Report of Federation of Indian Chambers of Commerce and Industry (FICCI) (2012)

2.2 *Segments for Food Packaging Market in India*

According to research, there are three main factors that affect the food packaging industry: urban vs. rural area, income level and the organized and unorganized sector in the industry. In this chapter, the report analyzes these main factors and their effect on the food packaging.

2.2.1 Urban vs. Rural Segmentation

Urbanization is one of the crucial global trends that affect the food packaging industry. With an urban life style, consumption of packaged food is increased, simply because the combination of a Westernized urban life style and limited time.

As seen in these statistics, over the years, both urban and rural populations have increased. When the number of people gets larger, the demand for food in general and packaged food in particular increases accordingly.

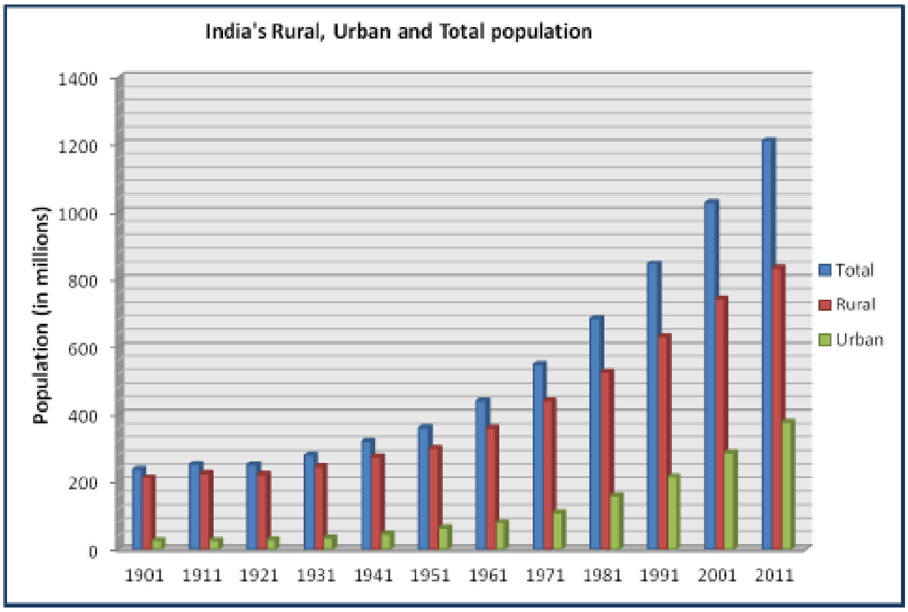


Figure 5: India’s Rural, Urban and Total population
Source: Government of India, Ministry of Home Affairs (2012)

In addition, it is seen that urban population is growing at 1.5 times the rate of the overall population. According to this research, the urban population is expected to reach 32% of the overall population in 2021, up from 28% in 2006 (Census, 2012). According to researchers, this change may support the growth of packaged food industry.

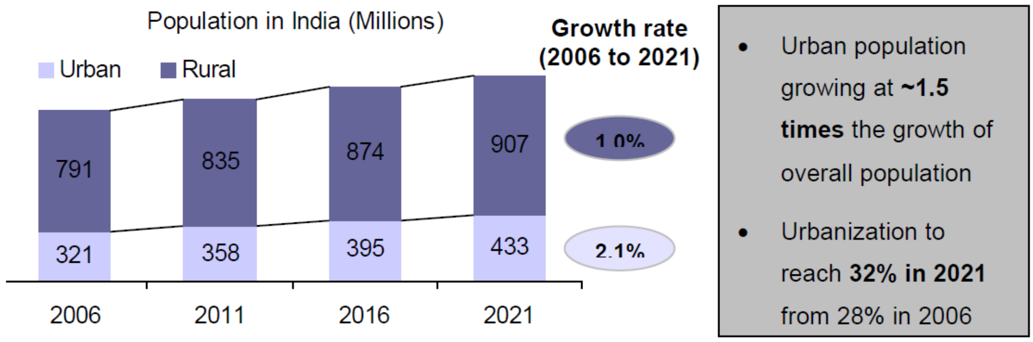


Figure 6: Change in Population in India
Source: Census Bureau Report (2012)

When the industry is segmented into urban and rural industry, a clear difference is observed in the amount of packaged food consumption. The urban area has a 77% share in overall consumption of packaged food, while the rural area has only a 23% share. From the supply to the end, there are several reasons for this difference. However, this paper does not aim to investigate the reasons for these phenomena. From the market point of view, it should be stated that there is a considerable difference between urban and rural society and strategies in food packaging should be corresponding different when introducing new products into these segments.

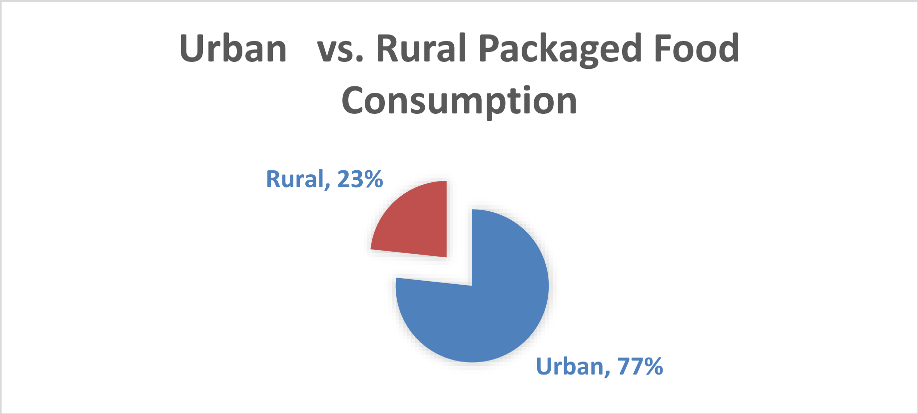


Figure 7: Urban vs. Rural Packaged Food Consumption
Source: Packaged Food Sales in India by international Market Bureau of Canada (2011)

In the urban population of India, it can be seen that consumers are open to non-traditional food, whereas the rural population is more conservative about traditional food, as well as being generally more price sensitive to the cost of non-traditional food because of their lower income levels. Due to that lower income level, economy products with smaller packaging size are more desirable in the rural areas. 90% of the soups, ready meals, canned/preserved and frozen packaged food are consumed in urban cities. Because of the limits on time and a Westernized life style, convenience and ease of preparation are the keys for urban areas, which may be affected by advertisements. However, market players are trying to establish distribution channels in the rural areas which are non-sensitive to promotional changes.

2.2.2 Income Level in India and Effect of Food Packaging

As a general argument, the consumption of processed and packaged food increases as levels of income increase. Income levels in the Indian population have seen a considerable increase over time. Here, the change in income comparison between 2005 and 2013 with the number of household at 2005 prices is given to illustrate the radical change in this emerging economy. Increase Compound Annual Growth Rate (CAGR) in High and Middle Classes and also a decrease in the low class may change the lifestyle of people in the context of food consumption (TATA Strategic Management Group, 2011).

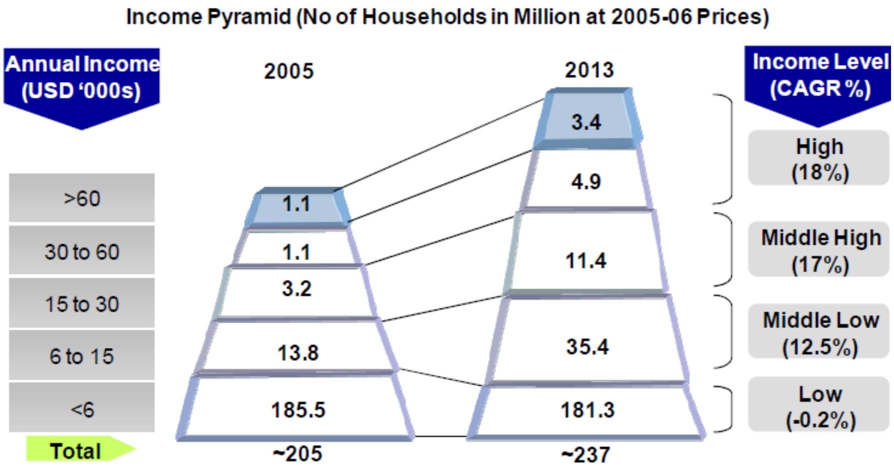


Figure 8: Income Pyramid in India
Source: TATA Strategic Management Group Report (2011)

As a comparison, India has a low GDP per capita. In terms of GDP per capita, India, with 3.663 USD, is in the 130th rank in the world, based on International Monetary Fund Research in 2011. In addition, share of food in total income is 53% of per capita income where as it is 9,7% in USA, 22% in France, 23% in Thailand, according to the research of the Ministry of Food Processing Industry, World Bank. Merely examining the statistics of GDP per capita is problematic because it is not a measure of personal income. However, both lower per capita income and higher share of food in consumption indicate a price sensitivity in India, which can negatively affect the packaged food industry. This is also discussed in the chapter on the economical profitability of bio-packaging innovations.

Table 2: Share of food in total income

Countries	% per capita income
USA	9,7%
France	22%
Thailand	23%
India	53%

Source: Ministry of food processing Industry, World Bank (2010)

Information gathered at one point of time is not enough to understand the behavior and dynamic structure of the market. For this reason, it is necessary to search for and look at trends in different time perspectives. It is clear that the share of food in the total expenditure is decreasing in India over time, both in urban and rural areas, as given in the table. Therefore, price sensitivity has been decreasing accordingly. This rising income level drives the packaged food and therefore the food packaging sectors.

Table 3: Share in Total Consumer Expenditure in processed food

Item Group	Rural					Urban				
	Share in total consumer expenditure in									
	1987-88	1993-94	1999-2000	2004-05	2009-10	1987-88	1993-94	1999-2000	2004-05	2009-10
Cereals	26.3	24.2	22.2	18.0	15.6	15.0	14.0	12.4	10.1	9.1
Gram	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
Cereal substitutes	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Pulses & Products	4.0	3.8	3.8	3.1	3.7	3.4	3.0	2.8	2.1	2.7
Milk & Products	8.6	9.5	8.8	8.5	8.6	9.5	9.8	8.7	7.9	7.8
Edible Oil	5.0	4.4	3.7	4.6	3.7	5.3	4.4	3.1	3.5	2.6
Egg, Fish & Meat	3.3	3.3	3.3	3.3	3.5	3.6	3.4	3.1	2.7	2.7
Vegetables	5.2	6.0	6.2	6.1	6.2	5.3	5.5	5.1	4.5	4.3
Fruits & Nuts	1.6	1.7	1.7	1.9	1.6	2.5	2.7	2.4	2.2	2.1
Sugar	2.9	3.1	2.4	2.4	2.4	2.4	2.4	1.6	1.5	1.5
Salt & Spices	2.9	2.7	3.0	2.5	2.4	2.3	2	2.2	1.7	1.5
Beverages Etc.	3.9	4.2	4.2	4.5	5.6	6.8	7.2	6.4	6.2	6.3
Food Total	**64.0**	**63.2**	**59.5**	**55.1**	**53.6**	**56.4**	**54.7**	**47.9**	**42.5**	**40.7**
Non-Food Total	**36.0**	**36.8**	**40.6**	**45.0**	**46.4**	**43.6**	**45.3**	**51.9**	**57.5**	**59.3**
Total Expenditure	***100.0***	***100.0***	***100.1***	***100.1***	***100.0***	***100.0***	***100.0***	***99.8***	***100.0***	***100.0***

Source: Report NSS 66TH, Ministry of Statistics of Program Implementation, 2010

2.2.3 Organized vs. Unorganized Sector

Retailing is seen as one of the key stakeholders in the packaged food industry. Also, the existence of retails in the food market could play a substantial role in the decision-making process concerning new product solutions like bio-based packaging material in the market. Therefore, the current retail sector is analyzed in the targeted market. According to FAS Mumbai analysis and trade estimates, organized retail has only a 2% percent share of the total food retail sales. The food retail market includes retail sales of all food products, both packaged and unpackaged, as well as beverages. Although retailing and retail chains have small shares in the current market, they are increasing with the support of Foreign Direct Investment (FDI) that triggers consumption of food packaging. In fact, FDI in the multi-brand retailing decision was taken in the government in December 2012 (USDA, Global Agricultural Information Network, 2012).

To conclude the literature, there is a big market potential regarding the food packaging in India. Extensive urbanization, rising income levels and the organization process of food packaging trigger this potential. However, there is no signal indicating the growth of bio-based adoption in the food packaging market, despite of the existence of some niche bio-degradable material suppliers. This study can provide insight into this business by increasing understanding of the barriers to and drivers for the emerging bio-based economy.

FRAME OF REFERENCE

The reference frame is a summary of the existing knowledge and previously performed research on the subject. This chapter presents the theoretical reference frame that is necessary for the performed research, design or product development.

3.1. Innovation and Sustainability

In order to analyze and resolve the research problem, it is necessary to determine an appropriate framework. As discussed earlier, the aim of this research is to understand which factors motivate companies to consider bio-plastic for their packaging solutions. Therefore, the concepts that will be discussed should be analyzed from the market perspective. The question we intend to answer is strongly related to the technological transition process of innovations, environmental friendly innovations and adoption theory, especially in the emerging economies and, in the first part of the literature, these concepts are discussed to clarify the point of view in this context.

First, we have to define the term “innovation”. According to Rogers (1995):

“An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption.”

The innovation-decision process is essentially an information seeking and processing activity with the aim of reducing uncertainty about the advantages and disadvantages of innovation.

In the literature, the uses of “innovation” and “technology” are nearly synonymous (Rogers, 1995). However, respectively, the former is a more dynamic and the latter a more static phenomenon. A technology is a design for instrumental action that reduces uncertainty in the cause-effect relationships involved in achieving a desired outcome. Technology has two components: “hardware” and “software”. The hardware consists of tools, physical objects and materials while software is contained in the information base. Generally, social embedding of the hardware aspects of technology is less visible than its machinery or equipment. Indeed, sometimes the hardware side of technology dominates. But in other cases, a technology may be almost entirely comprised of information (Rogers, 1995).

The use of bio-based material in the packaging industry is defined as a “change” or “transition”. In order to link the technical and social dimensions of change, the term “technological transitions” is a concept widely accepted by scholars. Rotmans et al. (2001) describe the generic term ‘transitions’ as “transformation processes in which society changes in a fundamental way over one or more generations”. Transitions include a set of possible development paths, the tendency, scale, and speed of which can be influenced but never entirely controlled by government policy or by only one body in the society (Rotmans, et al., 2001). Transition seems to boost itself with many causalities and co-evolutions that are caused by independent developments. Considering that transitions are multi-dimensional with different dynamic layers, several developments must come together in several domains for a transition to occur (Rotmans et al., 2001). As the focus on this thesis lies on the diffusion and implementation of new technologies, namely new bio-based materials for food packaging, the discussion will be in the context of technological transition. Geels (2002) states that technological transitions “consist of a change from one socio-technical configuration to another, involving the substitution of a technology as well as changes in elements such as user practices, regulation, industrial networks, infrastructure, and symbolic meaning”. According to Geels (2002), these configuration processes do not come into view easily since the elements in a socio- technical configuration are attached to and aligned with each other. Apparently, technology plays a crucial role in fulfilling societal needs; however, this relationship depends upon its connection with other elements as well. Technologies perform their functions based on concrete user context, which are made up of users, their preferences, competencies, cultural values, and interpretations. In other words, according to user context, market structure and demand, these technologies are to be produced, distributed and tuned (Geels, 2004). Nevertheless, new technologies have some problems in emerging since regulations, infrastructure, user practices and maintenance networks are aligned with the currently existing technology. The infrastructure developed upon conventional plastics and recycling systems can be given as an example of these problems. Hence, it is possible to observe a mismatch between new technology and the established socio-institutional framework, as described by Rosenberg (1976):

"When new technologies emerge, they are still inefficient, crude, badly adapted and cannot immediately compete on the market with established technologies".

For the transition process to be successful, these obstacles should be overcome. Before elaborating on how to overcome mismatches that can prevent new technologies from becoming successful, an overview of technological innovation in emerging economies which is in the scope of this study is provided below.

A technological innovation provides at least some degree of advantage for its potential adopters. For emerging economies, technological innovation is a key element of industrialization and catching up of developing countries. On the other hand, technology is generally risky, expensive and route-dependent. Therefore, it is more efficient for the emerging economies to simply acquire foreign technology that has been already created in more developed countries. As a matter of fact, if an innovation is easy to diffuse and adopt in the industry, regardless of its nature and type, technologically backward countries could catch up very quickly by adopting it (Romer, 1994; Eaton & Kortum, 1995). Hence, countries with emerging economies are using several financial and fiscal incentives to attract Foreign Direct Investment (FDI) in order to trade for technology. Apart from that, adoption and diffusion of technology require some effort which are not without cost and is unconditional. The process of adoption and diffusion process relies on considerable and well-guided technological effort (Lall, 2005) and the adoptive capacity of the host country (Cohen & Levinthal., 1989). Additionally, it cannot be said that the social interest of the emerging country easily intercepts with the private interests of multinational national enterprises (MNE). However, the existence of positive technological transfer through the effect of FDI to local firms is arguable. Furthermore, technological changes in industrialized countries, which are foreign technologies and partial, may not be suitable for the economic and social status of the developing countries (Atkinson & Stiglitz, 1969; Acemoglu, 2002).

Despite these on-going debates, many relevant questions remain unanswered. What drives technological change and catching up in emerging economies, especially in India? What is the role of FDI and to what extent can emerging economies build their industries through FDI? What could be the effect of FDI on industry structure, especially in the retail sector? In this paper, these questions are also addressed indirectly in a specific case, i.e., what are the drivers and barriers of packaging industry in India as an emerging economy? In particular, as discussed in the Industry analysis section, what is the effect of FDI on the retail chain that will affect the market's last years?

The indigenous technological capabilities of the emerging country are also relevant to technological transfer within the country. However, emerging economies are faced with the resource constraints to meet high investments' cost and the high risk challenge of innovation (Erdilek, 1984; Hoekman, et al., 2004). According to some researchers, to overcome these problems, encouragement of indigenous innovation and acquisitions of foreign knowledge must work in parallel in order to maximize the benefits of innovation (Fu & Gong, 2008). In other words, they cannot be successful by remaining independent from each other (Pietrobelli, 2000). In this context, the technological transfer of packaging innovations can emerge from indigenous innovations and also directly from the foreign innovations. The success of the efforts of emerging economies to attain the levels of more developed countries can rely on both these interconnected factors. In the case of this research, foreign innovations, specifically, the use of new packaging materials in the Indian food industry, are studied as a unit of analysis. Therefore, more detailed information about the catching up and leapfrogging of emerging economies is not included in this study.

It should not be forgotten that the perceived drivers and barriers of the market player in the adoption of new innovations is the main concern of this study. Apart from the argument concerning the innovations of emerging economy concept, the mechanism of commercially successful innovations in these emerging economies should be questioned. In other words, the manner of the technological change and the drivers of successfully placed innovation in the market are the important issues for further analysis. Accordingly, the discussion follows the mechanisms of this technological transfer, namely sources of innovation, the technological push and market pull concept. In pursuit of the most frequently utilized models of technological change, the concept of eco-innovation, which is relevant to bio-based packaging materials, will be examined from several different perspectives. In this way, the commonly accepted determinant of these eco-innovations will be covered through gaining an understanding of the dynamics of technological push and market pull perspectives in an innovation study.

3.2. Technological Push and Market Pull Concept

In this study, the potential of one specific technological change is reviewed; namely, this consideration includes technological change from the use of petroleum based materials to bio-based materials in packaging industry. Over the years, many scholars have investigated the mechanisms and economics of technological change (von Hippel, 1976; Mowery & Rosenberg, 1979; Meyers & Marquis, 1969; Schmookler, 1966). These areas of research have generated two alternative perspectives that are mainly shaped around either technology or market.

From a broader perspective, there is a significant dichotomy in this phenomenon, referred to as technological determinism and technological instrumentalism. The former concept states that technology can itself drive the change process while the latter posits that the change process is guided only by those that use it.

According to technological determinists, technological innovation has the power to stimulate social change. As a matter of fact, innovation itself can be attributed as a determining factor for adoption. In contrast, the adoption of innovation depends largely on its potential users, such as organizations in which it might be used and individuals who might use it.

From the technology push perspective, technology and science play key roles in developing successful technological innovations. It fosters change in the characteristics of the industry structure through new solutions. On the other hand, scholars claim that the demand pull approach introduces and clarifies an important set of market features that can determine and affect the performance of innovation.

These two different approaches have created many debates in the past years. For example, (Mowery & Rosenberg, 1979) state that it is difficult to differentiate a demand-pull condition from a technology-push one because of the interconnection between these demand supply curves. According to Dosi (1982), demand pull systems were insufficient to explain that “market signals” stimulate the prime movers of innovative activity.

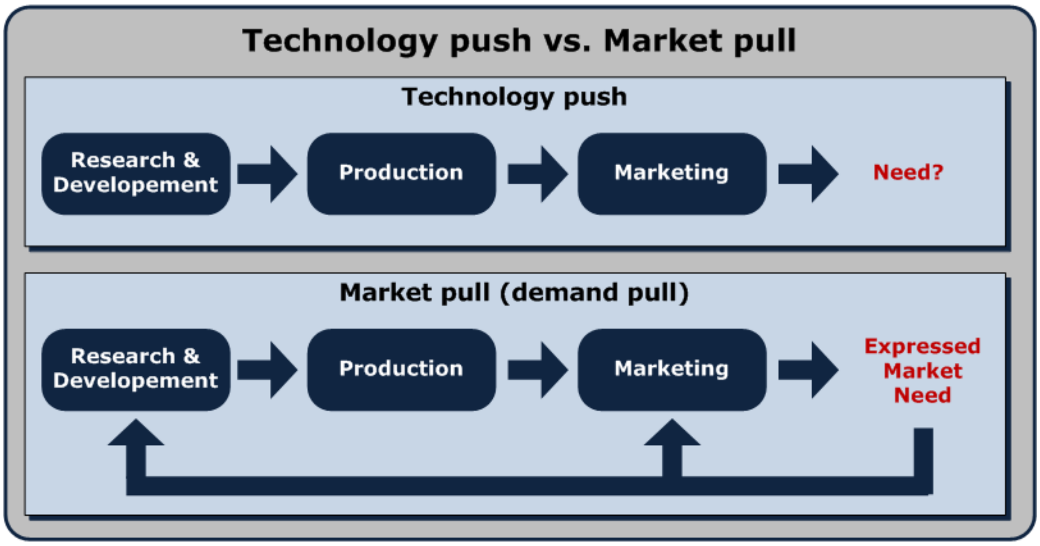


Figure 9: Technology Push vs. Market Pull Diagram (Managing Innovation and Entrepreneurship in Technology-based Firms, Taken From Martin, Michael J.C. (1994).)

In recent years, these two alternative perspectives have been investigated and provide different views about sources of innovation. After side by side comparisons between technology and demand as a source of innovation, classical studies have agreed on the mutual importance of these two sources. According to this argument, science and technology provide certain trajectories of innovation, whereas demand is a significant integral part in the economic performance of the innovations in order to guide these trajectories into the right economic spots. (Dosi, 1982; Kline & Rosenberg, 1986). However, this mutual understanding creates many other questions. The first question is whether demand has a power to stimulate innovation in addition to selecting it. Secondly, how the companies can take advantage of both technology and demand in the process of development and commercialization of innovations is questioned. Other than that, an attempt is made to clarify the mechanisms for the firms in order to leverage the different sources of innovation. And finally, whether the firms or institutes play an active or passive role in the process of leveraging technological and demand sources can be left as an open question. In the light of this discussion, one of the most commonly known mutual concepts is introduced by the research institutes. According to this theory, both technology and market inventory stimulate certain potential trajectories. These routes can either be driven from the market side by customer segments, their needs and internal experiences or internal, external competence and the partner/competition relationship from the technology-based firms. It is important to note that intersection points of these two trajectories symbolize potential innovations that can be successful in the market from an economic point of view. Therefore, firms, even the research institutes that mainly specialize with technological inventory, have started to develop market field studies to envisage and capture some of these potential intersections in order to capitalize on their inventory and take advantage of being prime movers in the potential industry. The following figure represents the latter model that is a combination of technological push and demand pull perspectives.

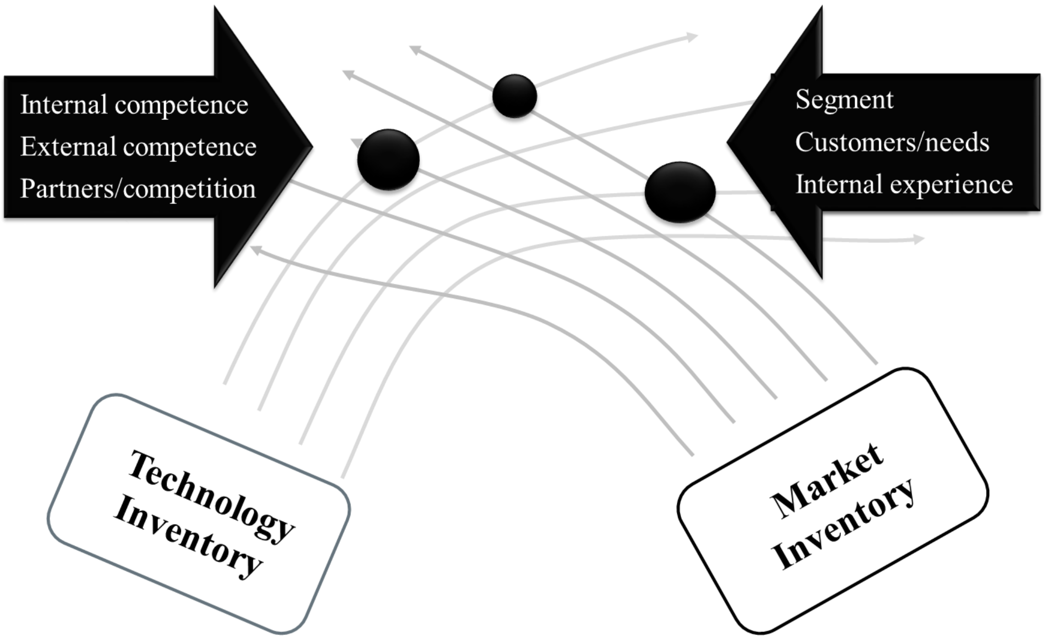


Figure 10: Research Perspective about combined technology push and demand pull

3.2.1 Technology push market pull concept in eco-innovations

First of all, it is necessary to introduce the accepted definition of eco-innovation. In this research, eco-innovation is defined in the same manner as the EU based ‘measuring eco-innovations’ project. The MEI definition is as follows (Kemp & Pearson, 2008):

“Eco-innovation is the production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives”.

Current studies show that there is no strong encouragement for eco-innovation from the demand side because of the fact that these environmental products are still too expensive (Rehfeld, et al., 2007); it is debated that consumers can also stimulate innovations (Brohmann, et al., 2009), but this argument is rarely supported by empirical evidence. According to Kammerer (2009), customer benefits have a key role in eco-innovations as soon as these innovations provide added value to the customer. That is to say, it may be impossible to disseminate some eco-innovations segments like electricity in the market whereas customers are seen to be willing to pay a premium price in some eco-innovation product segments such as food.

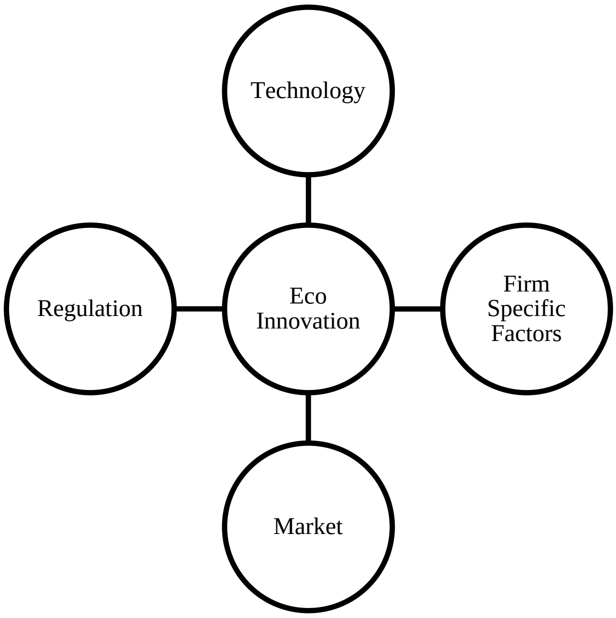


Figure 11: Determinant of eco-innovation (Rennings, 2000)

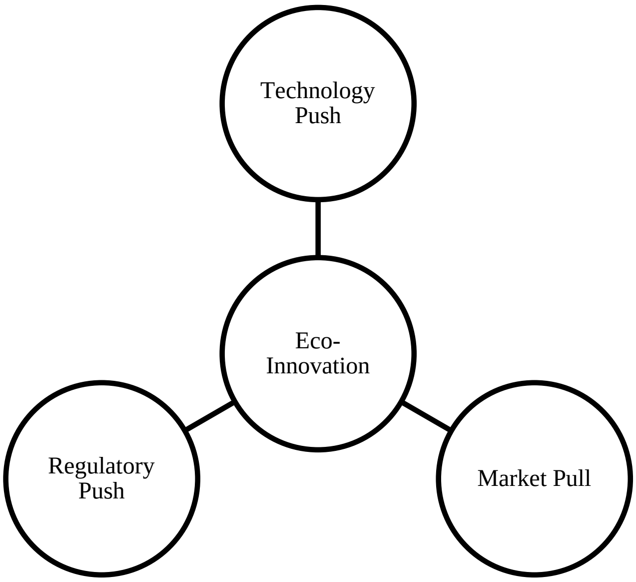


Figure 12: Determinant of Eco- innovations (Horbach, et al., 2012)

Technology-based firms and research institutes push the technology to the market. As it is seen in both models, market pull is situated as one of the main determinants of eco-innovation.

The concept of environmental innovations is designated with the model of sustainable development described in the Brundtland report, commissioned by the United Nations in 1987 (Schiedrig, et al., 2012). This report describes sustainable development as that which meets present needs without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). This definition has been broken down into three sections: environmental, economic and socio-political sustainability (Barbier, 1987). In this way, the concept of the 'triple bottom line' (TBL), also referred to as a concern for people, profit and the planet, was introduced to translate the principles of sustainability into a practical definition for the business world. The concept of 'Triple Bottom Line' was popularized by John Elkington in 1997 in order to take a more complete approach to sustainability. He noted that society depends on the economy and the economy depends on the global ecosystem, whose health represents the ultimate bottom line (Elkington, 1997). Lately, Culture has been introduced as a fourth dimension of sustainable development (United Cities and Local Governments, 2010). Later, the engaged theory and circles of sustainability, which are intended to overcome interdependent problems, were developed by researchers as a means to assess sustainability in these four dimensions (McCarthy, et al., 2010; Scerri & James, 2010). Within this context, environmental innovations are the innovations regarding human engagement within nature, while considering the following factors:

1. Materials and energy
2. Water and air
3. Flora and fauna
4. Habitat and settlements
5. Built-form and transport
6. Embodiment and food
7. Emission and waste

The interest of this project is in “material and energy (1)”, regarding to food packaging materials considerations. However, other factors such as water consumption (1), emission and waste (7), transport (5) are also related to the food packaging industry. In order to give an example, today, many companies that have been interviewed have a sustainability agenda with the goal of minimizing material and water consumption, CO2 food print. Also, they are also studying ways to minimize the logistic cost by transporting (5) the product more efficiently than and as well as effective packaging methods. And last but not the least; packaging is also associated with protection of food (6) and food waste (7). Therefore, from the sustainability point of view, the introduction of new material in food packaging has the potential to affect the industry in many ways. Because of the factors stated, it is necessary to clarify and structure packaging’s role in sustainability in the following part of the research.

3.2.2 Life Cycle Assessment (LCA)

Life Cycle assessment (LCA) is a well-known sustainability tool. Currently, there are a great many life cycle applications to support packaging decisions on the market. The aim of a LCA in packaging is to measure and quantify the impacts of the products and packaging systems in line with world-wide accepted methodologies. With the help of this information, decisions can be made and strategies can be adopted to determine the most effective and efficient packaging design. One of the most important aspects of the packaging LCA studies is that they show that “rules of thumb” or “common sense solutions” simply do not work in practice. Therefore, LCA is a powerful tool with which to eradicate common myths about packaging and sustainability issues. Increasing use of LCA by retailers and brand owners can create a pull in the demand side of the industry. At the same time, it can trigger the technology push of eco-innovations with a reliable datasets. However, there is no standardization of LCA tools. Also, selection of system boundaries in the assessment can tip the balance of selection of optimum material for a given scenario. Nevertheless, because of its importance, further discussion of a comparison between bio-based packaging and conventional plastics is given in the analysis section.

3.3 *Disruptive and Sustaining Innovations*

From the innovation perspective, adoption of new packaging materials can be approached in different ways. According to disruptive theory, new technologies can be either sustaining or disruptive.

Sustaining innovations are seen as a continuum of the performance increase along the available established performance of the current product or services. From this perspective, renewable packaging materials can support other development in the packaging industry and not necessarily represent radical change in the supply chain. The tendency of sustaining innovations is to increase the demand of current high-end market customers. Both incremental improvement and radical shifts in the innovations can be sustaining as well as improving the performance of product and allowing premium pricing and greater profit margins by meeting with the requirements of highly demanding customers (Christensen, 2011).

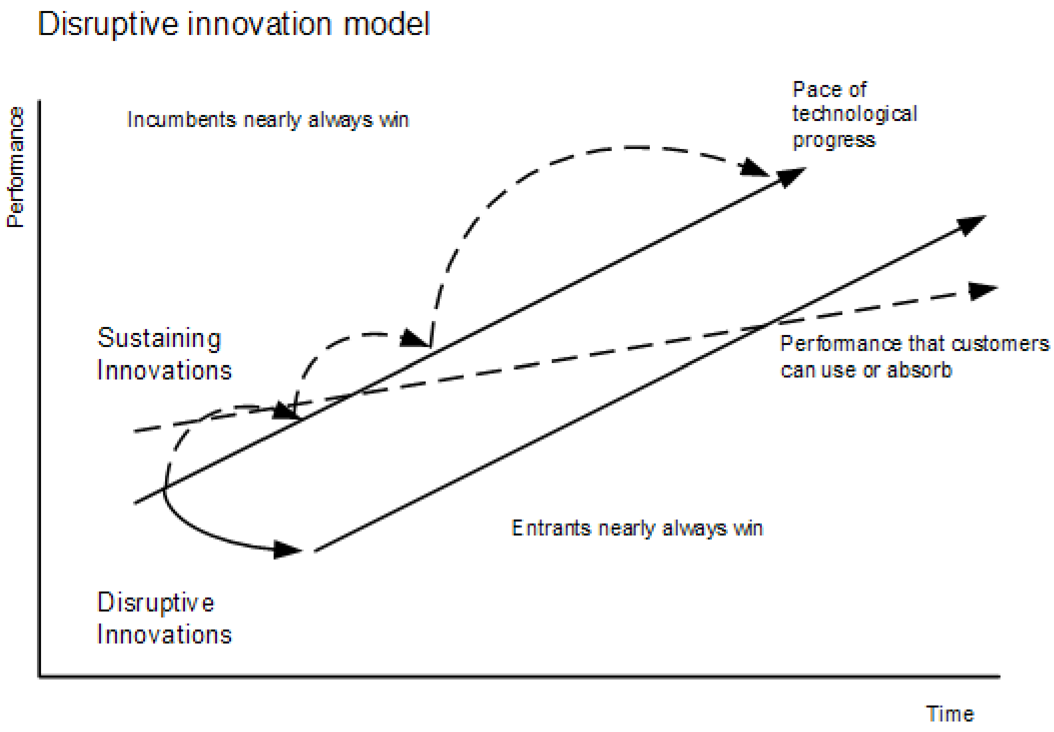


Figure 13: Disruptive Innovation Model (Anthony, et al.2008)

In the case of disruptive innovations, however, the new product or services can be either "low-cost" or "new market". Because integration in food packaging is simply low in India, it can be surmised that there is a potential for new markets in that industry. However, disruptive innovations are likely to be simpler, more convenient and less expensive than products on the market that are currently offered by incumbent firms. For now, these properties are not associated with bio-based packaging materials. Low-cost innovations can reduce performance and change the demand from functionality and reliability to convenience and cost. The leading market players are generally not willing to use disruptive products because they change the traditional performance metrics of the same market. Moreover, new market innovations can reach totally new customers, called "non-consumers" because they have not been part of the original market (Christensen, et al., 2004).

Although this model is recognized as providing a powerful framework for evaluation of the strategic argument of the technological innovations, it has been criticized as not giving any importance to the dynamics of customer behaviors and focusing mainly on the supplier side (Danneels, 2004). Also, disruptive theory only takes one or two performance metrics into consideration in its analysis. However, in the real world, customers can simultaneously evaluate the products on several performance metrics. Therefore, it is important to apply complementary studies for customer behavior when considering disruptive innovation research (Christensen, et al., 2010).

3.4 *Adoption theory*

The main purpose of this paper is to obtain information concerning what drives market players to or hampers them from considering the adoption of bio-based materials in their packaging applications. Because this concerns the dissemination and adoption of innovations into society, adoption theory provides a suitable approach to this research. However, it is necessary to discuss this concept from different perspectives in advance to understand which adoption theory fits with our case, and why and how this research can make use of it to reach the objective.

Adoption theory is designed to understand, explain, or predict how, why, and to what extent individuals or organizations will adopt or purchase new offerings. The studies about the adoption and development of new ideas are widely known as Innovation or Diffusion Theory. Here, it is necessary to give the definition of diffusion. Diffusion is defined as the process by which innovation is adopted and gains acceptance by individuals or members of a community. In the literature, Rogers defines diffusion as “the process by which an innovation is communicated through certain channels over time among members of a social system” (1995, p. 5). Related to adoption and diffusion of innovations, there has been lengthy research (Surry & Brennan, 1998). Rogers (1995) distinctly separates the diffusion process from the adoption process. While the diffusion process permeates society and groups, the adoption process is most relevant to the individual.

According to Rogers (2003), adoption is perceived as the first level of behavioral utilization. In another work, he (1995) defines the adoption process as “the mental process through which an individual passes from first hearing about an innovation to final adoption” (p. 35). The five steps in this process are: 1) knowledge (awareness), 2) persuasion (interest), 3) decision (evaluation), 4) implementation (trial) and; 5) confirmation (adoption). According to this theory, the process will proceed through the various steps and lead to adoption, or alternately, lead to rejection of the innovation for potential adopters.

Although there is a classification between spontaneous and planned diffusion, it is important to point out that Rogers does not make an important differentiation. According to some researchers (unnamed), the spontaneous spread of new ideas may be classified as diffusion whereas the planned spread of new ideas may be classified as dissemination in his study.

Historically, theoretically superior technologies such as the Apple operating system, the Dvorak keyboard and Betamax recorders have lost the competition to the Intel-Windows operating system (WINTEL), QWERTY keyboard and VHS standard. After all, there is a common understanding that the adoption of technology is a more complex process than the technical superiority of a product. (Abrahamson & Rosenkopf, 1997; Rogers, 1995; Ryan & Gross, 1943; Valente, 1995). Therefore, researchers try to clarify the mechanisms of adoption in society with various theories.

Most probably, the first widely known study about diffusion was done by French sociologist Gabriel Tarde (1903). He modeled the original S-shaped innovation curve in order to illustrate that most innovations have an S-shaped rate of adoption. For the researcher studying the adoption of ideas, the S-curve has become an important model, especially in business. An example of an S-Curve is shown below:

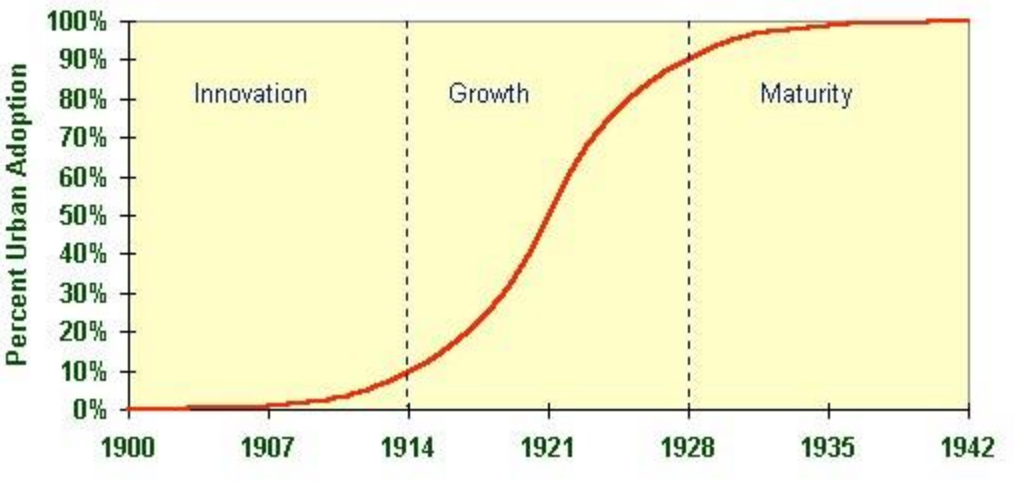


Figure 14: S-shaped innovation curve (Tarde, 1903)

By this means, it can be possible to identify innovations with a relatively fast rate of adoption (steep slope) versus those with a slower rate (gradual slope). Later, Ryan and Gross (1943) published a study about the diffusion of hybrid seed among a group of farmers. At the time of study, corporations entered into the business of agriculture and therefore there was a change in the industry concerning higher productivity, efficiency, competitiveness and agricultural innovations. During that transition process, Ryan and Gross aimed to study which innovations in agriculture were adopted. One of the most important conclusions they reached is that diffusion is a social process that is exposed to subjective evaluations rather than a rational economic decision -making process as it spreads from earlier to later adopters (Valente, 1995). According to this perspective, the effect of social factors was underscored by this study. In addition, Ryan and Gross also supported the S-curve study of Tarde and further, classified the farmers into five main categories: innovators, early adopters, early majority, late majority and laggards. Much later, researchers (Abrahamson & Rosenkopf, 1997; Rogers, 1995; Midgley & Dowling, 1978) modified and improved these categories. It was identified that farmers who are most likely to adopt had a higher socioeconomic status than members of the other categories. Likewise, these studies attempted to identify distinctive characteristics of each adopter level. After Ryan and Gross (1943), the next eloquent study in the diffusion area was written by Everett Rogers (1962). Rogers (1995) claimed that he synthesized over 3800 diffusion theory publications. Thus, he could establish a comprehensive framework that has been used in diverse studies such as anthropology, public health and of course business and marketing.

First of all, it should be noted that there are frameworks other than the Rogers Adoption theory in the literature. However, these theories are mainly based on information systems (see Technology Acceptance Model, Lazy Users model, and Unified theory of acceptance and use of technology (UTAUT)); in addition, some of them are totally based on behavioral psychology (see theory of planned behavior). The Technological Acceptance Model (TAM) tries to explain how users come to accept and use a technology and introduces a number of factors that influence their decisions as to how and when they will use it. According to this model (Davis, 1989), perceived usefulness and perceived ease of use are the driver factors of adoption. However, from the market perspective, the aim of the research cannot reached by only considering these two factors. Whereas this model is commonly used and redefined several times in the information system, for the barriers and drivers of adoption in real industry, more comprehensive tools are needed.

According to diffusion theory, innovations are not immediately disseminated into the population. Instead, they gradually diffuse over time (Tarde & Parsons, 1903). Individuals and social entities go through the innovation-decision process whereby they decide whether or not to adopt a particular innovation. In this perspective, adoption is defined as a "decision of make use of an innovation as the best of course action is available" (Rogers, 1995). In the literature, "Diffusion of innovations" by Rogers and "Crossing the Chasm" by Moore are two fundamental books that discuss adoption theory.

In this specific study, the brand owners, converters and retailers are decision makers as social entities. Therefore, dominance, or power distribution, in the supply chain of these players is important when evaluating the adoption of the new materials in packaging industry. Accordingly, general market information about the supply chain regarding Indian food packaging is also given in the packaging industry overview section of this study.

According to Rogers (1995), all innovations should have certain attributes in order to persuade and be adopted by consumers. This argument follows with some general characteristics of innovation and their adoption rate. This paper aims provide an understanding of key drivers and barriers in the adoption process of a specific product in a specific industry. For that reason, the adoption curve is not conducted with research but the perceived attributes.

In order to choose a framework, one must start from the widely accepted and universally relevant attributes which are based on past writings and researches. It can be argued that there are general attributes of innovations which have affected their rate of adoption. To avoid this generalization, the research narrows down the attributes into specific questions.

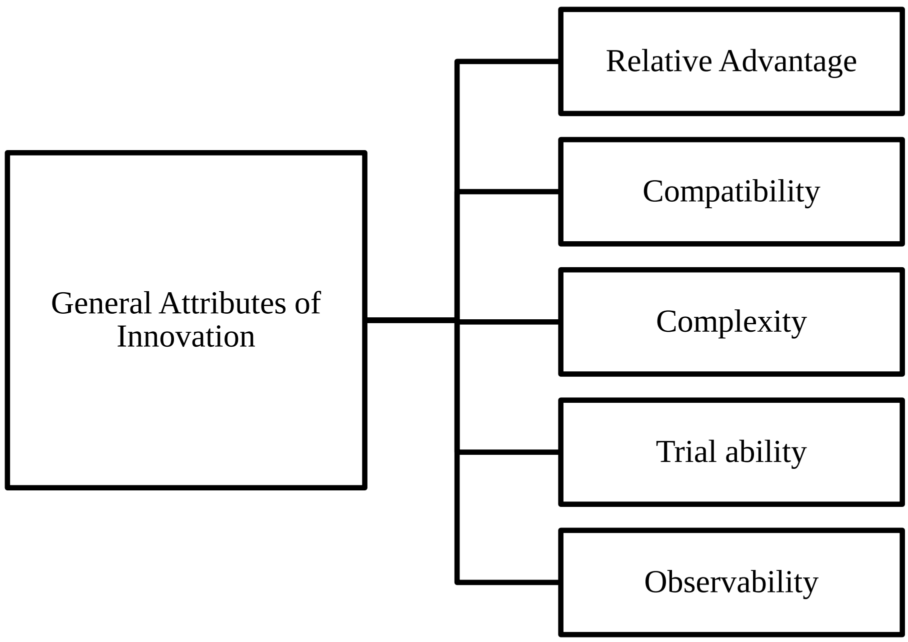


Figure 15: General Attributes of Innovation, Rogers (1995)

According to Rogers, these general attributes are (1) relative advantage, (2) compatibility, (3) complexity, (4) trial ability and (5) observability. It is necessary to understand these concepts to use them efficiently (Rogers, 1995).

The concept of perceived attributes (Rogers, 1995) has served as the basis for a number of diffusion studies (Fliegel & Kivlin, 1966; Wyner, 1974). Perceived attributes refer to the opinions of potential adopters who base their feelings about an innovation on how they perceive that innovation in regard to these key attributes. In other words, these perceived attributes cause people to be more likely to adopt an innovation if the innovation offers them a better way to do something, is compatible with their values, beliefs and needs, is not too complex, can be tested before adoption, and has observable benefits. The concept of perceived attributes is important because it shows that potential adopters base their opinions about an innovation on a variety of attributes, not just on relative advantage. Packaging research companies, therefore, should consider how potential adopters will perceive their innovations in terms of all of the five attributes, and not focus exclusively on the technical superiority of the product.

From the behavioral perspective, there have been several studies regarding adoption decision theories. In the theory of psychological field, human decisions are made by the dynamic interaction of man and his environment and are seen as a result of an interplay of diverse forces which develop under different circumstances. Therefore, if a person in his subjectively perceived environment feels something is worth striving for, i.e., adoption of bio-based materials, he or she then mobilize his/her personal powers to achieve this goal. In this same way, he or she reacts with his power to avoid a situation in which something negative and undesirable occurs. According to Lewin, uncertainty about the outcomes of innovations, lack of knowledge, insufficient capital, cultural practices and lack of opportunities can be barriers to the adoption of the new systems. Although this psychological theory considers the mechanisms of behavioral change and adoption, it mainly focuses on the change in human behaviors in general rather than the adoption of innovation. Albrecht et al (1987) argue that adoption is a result from the physiological field of the inhibiting and driving forces of innovation. However, these forces are not clearly stated and it is necessary to identify them specifically in each individual case.

Rogers' theory about adoption and market diffusion is one of the best known and most commonly used theories within this area. However, Rogers' diffusion theory has been criticized for not providing empirical evidence (Lowrey, 1991; Weiss & Dale, 1998). As a matter of fact, most of the arguments concern his model of the classical normal distribution curve of adopters (Wright & Charlett, 1995); the attributes of diffusion, which are said to affect the rate of diffusion, are rather suggested to be combined and reformulated (Weiss & Dale, 1998) or added to (and Herbig, 1995). However, since the purpose of this thesis is not to evaluate the validity of the diffusion theory but rather to use the theory as a guideline for the research design, it seems appropriate to use the most commonly used and accepted theory. Considering the suggestions of Weiss and Dale (1998), the appropriate attributes of innovation model will be elaborated on and used in the analysis part of the study in the specific case of market adoption of bio-packaging materials.

ANALYSIS OF SUSTAINABLE PACKAGING

4.1 *Packaging and Sustainability*

After the general discussion of the evolution of the sustainability concept, the topic can be narrowed down to packaging sustainability. In this respect, packaging has to have some properties that align with the triple bottom line of the sustainability. In general terms, it is seen that affectivity, efficiency, recyclability and safety are the most important criteria in the development of sustainable packaging in the literature (Verghese, et al., 2012).

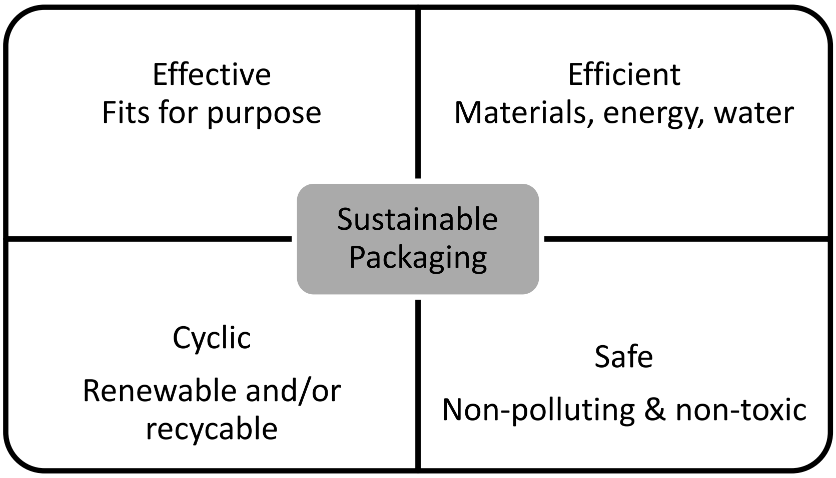


Figure 16: Determinants of Sustainable Packaging
Source: Packaging for sustainability (Verghese, et al., 2012)

4.1.1 Effective Packaging

Packaging should effectively deliver its functional requirements. According to the Consumer Goods Forum, effective packaging is fit for a purpose and achieves its functional purpose with minimal environmental and social impact. In this way, packaging meets all its functional requirements while minimizing the economic, environmental and social impacts of the product and its packaging. It introduces the triple bottom line of effective packaging (The Global Cunsomer Goods Forum, 2010).

Reduced product damage, increased product sales and compliance (labeling) can be counted as the economic benefits of effective packaging. From the social aspect, consumer convenience and accessible packaging such as easy opening for the older generation are potential benefits of affectivity. Finally, reduction of production waste and product damage in the supply chain can be counted as potential environmental benefits of sustainable packaging.

4.1.2 Efficient Packaging

Efficient packaging is designed to minimize resource consumption (materials, energy and water), wastes and emissions throughout its life cycle. In the literature, it has been commonly argued that there is a need beyond the incremental needs, i.e., there should be ‘step-changes’ or significant improvements in eco-efficiency. For instance, the proponents of natural capitalism have argued for radical improvement in resource productivity to reduce depletion of resources and pollution and to lower costs. According to some researchers, 75-90% improvement in resource efficiency is needed in order for the world's resource use to be sustainable (Weizsacker, et al., 1997; Weaver, et al., 2000).

From the triple bottom line perspective, reduced material, energy, water cost, increased supply chain efficiency, and cost savings passed on to consumers are some of the potential economic benefits of efficient packaging. Providing more affordable products and reduced weight or volume can be given as potential social benefits of the efficient packaging. Furthermore, reduced consumption of resources, reduced waste and emissions, reduced product waste and energy consumption and emissions from transport can be the most important potential elements of the environmental benefits of efficient packaging.

Life Cycle Assessment has been widely discussed in the efficiency of the packaging. LCA studies have indicated that minimizing packaging and maximizing the supply chain efficiency are two of the most important factors in reducing the environmental impact of packaging (Parker, 2008).

4.1.3 Cyclic Packaging

Cyclic packaging is effective in its use of renewable materials and recoverability at the end-of-life. In other words, 'Cyclic' packaging is designed to maximize the recovery of materials, energy and water throughout its life cycle.

In the book entitled "Cradle to Cradle", McDonough and Braungart (2002) stated that there is no waste in the nature. They claim that packaging materials should be designed to become nutrients for another process in order to minimize waste. It is suggested that bio-based materials should become the nutrients for the biological metabolism in organic processes such as composting in the same way that manufactured items such as glasses and conventional plastics should become nutrients for technical metabolism in industrial processes like material recycling.

Cyclic packaging has a potential to reduce material costs with recycled materials and, from the economic point of view, can increase the cost savings passed on to consumers. Regarding social benefits, it can reduce aesthetic impacts of litter and extend the viability of existing landfills. And also, with the reduction of consumption of resources, emission and waste, it can provide environmental benefits to the society.

In order to clarify the discussion, it is necessary to define some recycling terms. In close loop recycling, materials are reprocessed back into the same application. However, in Down-cycling, materials are reprocessed into an alternative, mainly lower value application. This often prevents further recycling. As an example, the recycling of the packaging material to the packaging material is closed loop recycling while the recycling of packaging material into mulch for another purpose is a sample of a "Down-cycling" process. Because of the availability of the further recycling and value of this application, closed loop recycling is generally the preferred method of recycling. Glass bottles are a good example in that they can be melted and remanufactured back into a new bottle or jar.

Composting, an organic form of recycling, is also an emerging technology for the recovery of the biodegradable plastic packaging. These materials can be collected separately for processing into organic products such as mulch or soil conditioner. Some of these materials are also suitable for home composting.

4.1.3.1 CROSS-CONTAMINATION BETWEEN METABOLISMS

As it is stated above, McDonough and Braungart (2002) described biological metabolism such as composting and technical metabolism, which is an industrial recycling process. They argued that products should be designed for one of these mechanisms by ensuring that one product design does not contaminate into the other, e.g., a biodegradable plastic shopping bag designed for composting, ending up in a conventional plastic recycling system or a polyethylene plastic bag ending up in a composting system (McDonough & Braungart, 2002). Because of that factor, some companies explicitly advise their consumers on appropriate disposal.

Recycling packaging has both significant economic and environmental advantages. Research has shown that recycled aluminum requires only 7% of the energy required for virgin aluminum; in addition, recycled high density polyethylene (HDPE) only requires 21% of the energy required for virgin HDPE (Grant, et al., 2001).

4.1.4 Safe Packaging

For people and the natural environment, safe packaging as a concept was introduced to minimize health and safety risks to humans and ecosystems throughout its life cycle. In contrast to traditional packaging, sustainable packaging introduces a broader consideration of human health and the ecosystem (Verghese, et al., 2012).

There are several potential benefits of safe packaging on triple bottom line sustainability. From the economic point of view, reduced cost of disposal, reduced risk of product recalls and reduced costs of carbon emissions, carbon tax can be seen as potential benefits of safe packaging. From the social viewpoint, it can help to reduce health and safety risks for consumers and neighbors. Also, the reduction of toxicity and a reduced contribution to global warming are the potential environmental benefits of safe packaging. These considerations can be addressed in the following way (Verghese, et al., 2012);

- The ecological effect of natural raw materials, especially with the land degradation and bio-diversity.
- The ecological and health impact of pollution from manufacturing processes.
- Risk associated with the migration of hazardous substances into food and beverages
- Health and safety risk in the supply chain because of the business
- Effects of packaging litter on wildlife.

Safe packaging should also include the environmental and ecological impacts of raw materials, especially the materials which are derived from forestry or harvesting. This consideration is addressed in the literature with the concept of "ecological stewardship". This term is used for programs that have an objective to reduce the social and environmental impacts of farming, forestry and fishing practices. Fiber-based packaging materials and bio-polymers from agricultural products can affect the sustainability of natural ecosystems and bio-diversity. Forestry operations may reduce the old growth forest. In the same way, selection of renewable materials needs to minimize any potential impact by using materials from sustainable managed forests. Food security issues must also be addressed in that the effect of diverting food crops to manufacture packaging is to be investigated. Due to these reasons, the Forest Steward Council, which is an independent non-governmental organization that promotes responsible managements of world's forests, certifies materials according to ecological stewardship criteria (Verghese, et al., 2012). For instance, Tetra Pak, a Swedish packaging company known worldwide, has been a member of Swedish Forest Stewardship Council (FSC) since 2006; as a long term goal, they aim to use FSC-certified fiber for all of their liquid cartons (Tetra Pak, 2010).

After the discussion of a given sustainability framework, the following scheme can be illustrated:

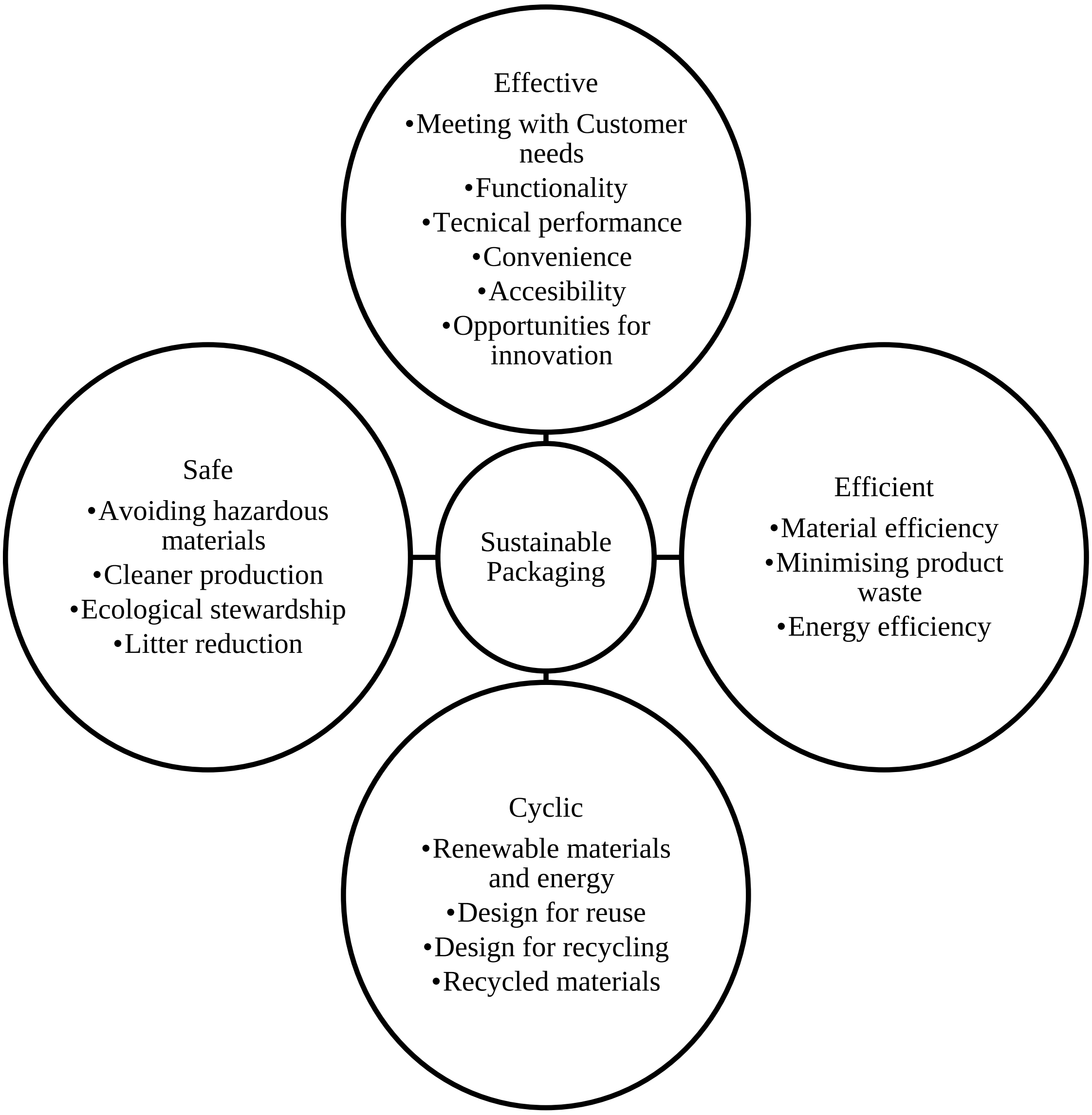


Figure 17: Main sustainable packaging properties

All of the factors mentioned above summarize the sustainability perspective of packaging. However, some new products and materials may not be successful even after satisfying the given criteria. Market diffusion of new technologies depends on several attributes of these innovations. In the next section, this paper will try to clarify these perceived attributes of bio-packaging materials that affect their dissemination into the market.

4.2 *Packaging Material Selection*

By its nature, material selection is associated with the triple bottom line of the product packaging system. Properties of the material and packaging converting process contribute to the economic, social and environmental value of the packaging. Material selection has an important impact on the effectiveness and environmental performance of packaging. In general, paper and board products, polymers, glass, aluminum and steel are the most commonly used food packaging materials. However, there has been an increase in the use of bio-based materials. In this research, renewable materials such as starch and cellulose are discussed mainly to illuminate the motives for their dissemination in the food packaging industry. Therefore, this chapter outlines the life cycle and applications of widely used and emerging packaging materials.
Environmental concerns about the non-renewable materials have caused the development of materials which are derived from renewable sources and new hybrid composites which include resin/cellulose for strength, mineral/fiber for the barrier papers and starch as a gas barrier. Calico, jute, hemp, kenaf, palm and sugar-cane are less commonly used renewable materials. In addition, there is a growing interest in edible films for food packaging, which are derived from plant and animal sources such as whey, collagen and gelatin. Non-renewable thermoplastics include polyethylene (PE) and polypropylene (PP), while renewable thermoplastics are starch and cellulose-based polymers and polylactic acid (PLA). Plastic polymers used for packaging are generally made from oil and gas-based nonrenewable resources and combinations of renewable and nonrenewable resources are also used.

In the framework of sustainable packaging discussed previously, there are four main properties of a sustainable package that should be effective, efficient, cyclic and safe. Among these properties, effective packaging is determined by its function. In other words, the affectivity changes according to the fit of purpose regarding to application. However, for the other properties discussed, mere functionality is simply not enough. In order to compare, determine and decide which material should be used as a sustainable packaging source, it is necessary to look throughout the lifecycle of the product.

4.3. Life Cycle Assessment (LCA) Analysis

As it is mentioned in the literature framework, Life Cycle assessment (LCA) is a well-known sustainability tool. Currently, there are a great many life cycle applications on the market to support packaging decisions. However, it can be said that adoption of LCA tools by the market players is not high especially in small companies. Regarding the increasing importance of LCA among market players, a comparison case between bio-based packaging and conventional ones is discussed in this part of the study.

According to the cradle-cradle model, bio-based materials should be used in organic recycling system such as composting. This has already been mentioned as biological metabolism.

Some properties of bio-based materials such as density are important in order to assess environmental impacts. When it is compared to conventional plastics, general bio-based materials have a higher density, thus creating a misleading comparison. Therefore, the material’s specific function over the full life cycle is an essential consideration while assessing the environmental impacts. For example, in order to compare that minimum thickness, a specific strength should be provided by both bio-based and petroleum-based plastics.

The aim of this research is not the life cycle assessment of bio-based packaging materials. On the contrary, the important consideration for the study is the perception of the market about these materials. Apparently, these products are now marketed as a sustainable solution of the conventional plastics. In order to discuss this perception, it is necessary to understand this sustainability tool and the methodology behind it. Even so, this topic will be covered as a holistic approach without including overly detailed technical information about the methods. Instead, the tool is presented with important factors and outcomes and its importance is discussed.

As it has already been mentioned, sustainability has four main considerations in line with packaging. A common argument about LCA is that it is a tool for use in assessing efficient, cyclic and safe packaging. However, effective packaging is determined by its function.

Bio-based packaging materials can be disposed of by composting, landfill, incineration and material recycling. Contrary to popular assumption, not all bio-based materials are degradable. Their degradation property relies upon different factors (Verghese, et al., 2012):

1. Type of renewable plastics, processing aids, plasticizers and compatabilizers.
2. Degradation environment such as temperature, pH, moisture content, microbial type, activity and content.
3. Nature of polymer bonds such as molecular weight, chain flexibility and crystallinity.
4. Water uptake of the polymers (hydrophobicity, hygroscopic).
5. Physical dimension of the polymer such as density and molecular structure. As a rule of thumb, polymers with a higher surface to volume ratio have higher degradation rates than those with lower surface to volume ratio.

These are important factors regarding not only amount of degradation but also the type of the degradation, e.g., aerobic and anaerobic.

Each step of packaging has some environmental impact as well as each material having its own unique impact. In this section, an overview of life cycle assessment and the some applications of LCA bio-based materials are given.

First, the lifecycle of the generic renewable thermoplastic is introduced below.

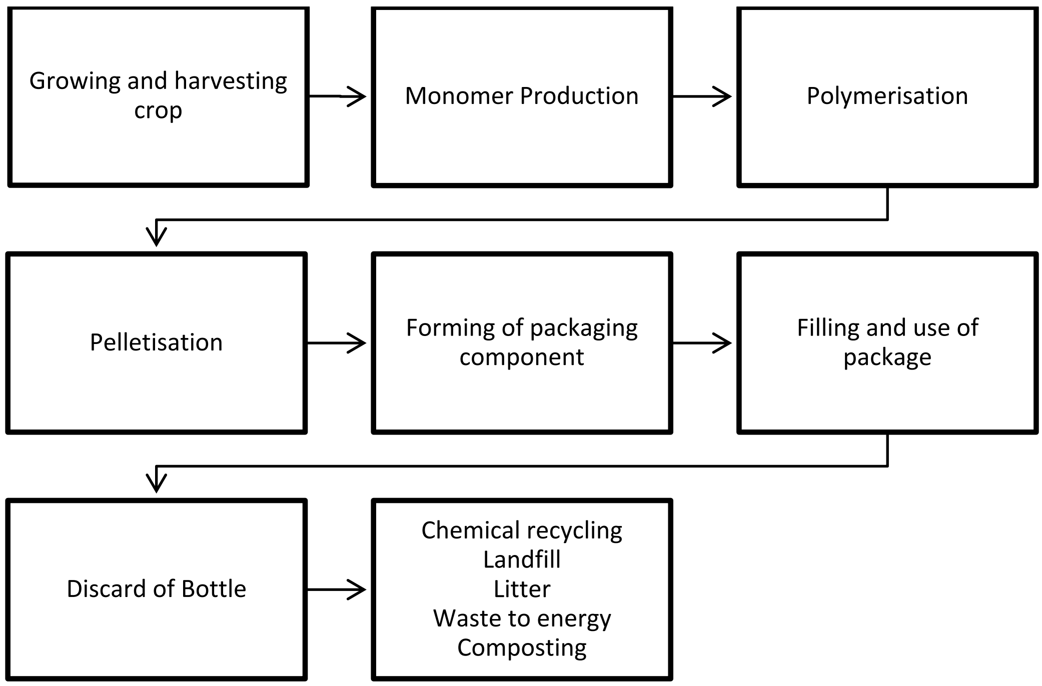


Figure 18: Life cycle of a generic renewable thermoplastic

4.2.1.1 LIFE CYCLE ASSESSMENT TOOLS

In the literature, there is a wide range of LCA tools available, from life-cycle maps for basic users to comprehensive software for expert LCA practitioners. While some LCA software products such as SimaPro and Gabi have been developed for general applications, some tools such as Packaging Impact Quick Evaluation Tool (PIQET), Comparative Packaging Assessment (COMPASS) are packaging specific tools that are developed for LCA design.

The increasing number of qualitative and quantitative assessment tools makes the selection of the appropriate tool for the chosen task more difficult. Also, the adoption of these tools should be considered regarding the environmental sensitivity of the market. For instance, it is unwise to choose and rely on certain LCA tools if the organization is still only considering and complying with regulations. When the supply chain is mature enough to collaborate with the data sources, it will help to determine which tools to use.

It should be noted that understanding and use of LCA tools will increase in coming years because of the sustainable sensitivity and need to comply with regulations and codes of practice such as the European Packaging Waste Directive and Australian Packaging Covenant. It can be said that because of its high volume of export, the Indian packaging industry will have to adapt to these regulations.

Also, it is necessary to say that LCA is a strong methodology for quantification of the environmental impacts of products and packaging. Therefore, it is expected to remain but it will evolve and be standardized for specific applications. Now, many LCA tools are using the global datasets available in their software systems. Because of the need for decision making on the local scale, and the differences in data among regions, there is a push toward region-specific datasets.

From the packaging perspective, most packaging LCAs only specialize in the impact of packaging material life cycles. However, although there are some exceptions, generally, many studies show that packaging material has a lower environmental impact than the food item it contains. (Erlov, et al., 2000; Roy, et al., 2009).

According to this argument, LCA will play a more sophisticated role as well as becoming more important in the future with different aspects. The following aspects of LCA can contribute to the protective role of packaging, containment and marketability of the products:

- Ecological and environmental benefits of the packaging such as decreasing waste of food by extended shelf life.

- Advantages and disadvantages of different formats in the supply chain. For instance, laminate pouches are not technically recyclable when they are compared with heavier steel or glass containers that are almost fully recyclable.

- The effect of the different packaging and serving size regarding to changing demographics and working lifestyle.

As mentioned, LCA is becoming more and more important in the market in order to determine the packaging strategy and sustainability of packaging. From another side, biodegradable packaging materials are widely available for potential packaging applications. Also, most biodegradable materials use renewable sources such as cornstarch.

Here, a comparison of the environmental impacts of PLA (polylactic acid), PET (polyethylene terephthalate) and PS (polystyrene) is given as an example by following case.

The Functional Unit of the case is 1000 containers of capacity 1 pound each for the packaging strawberries.

System boundary is stated as follows:

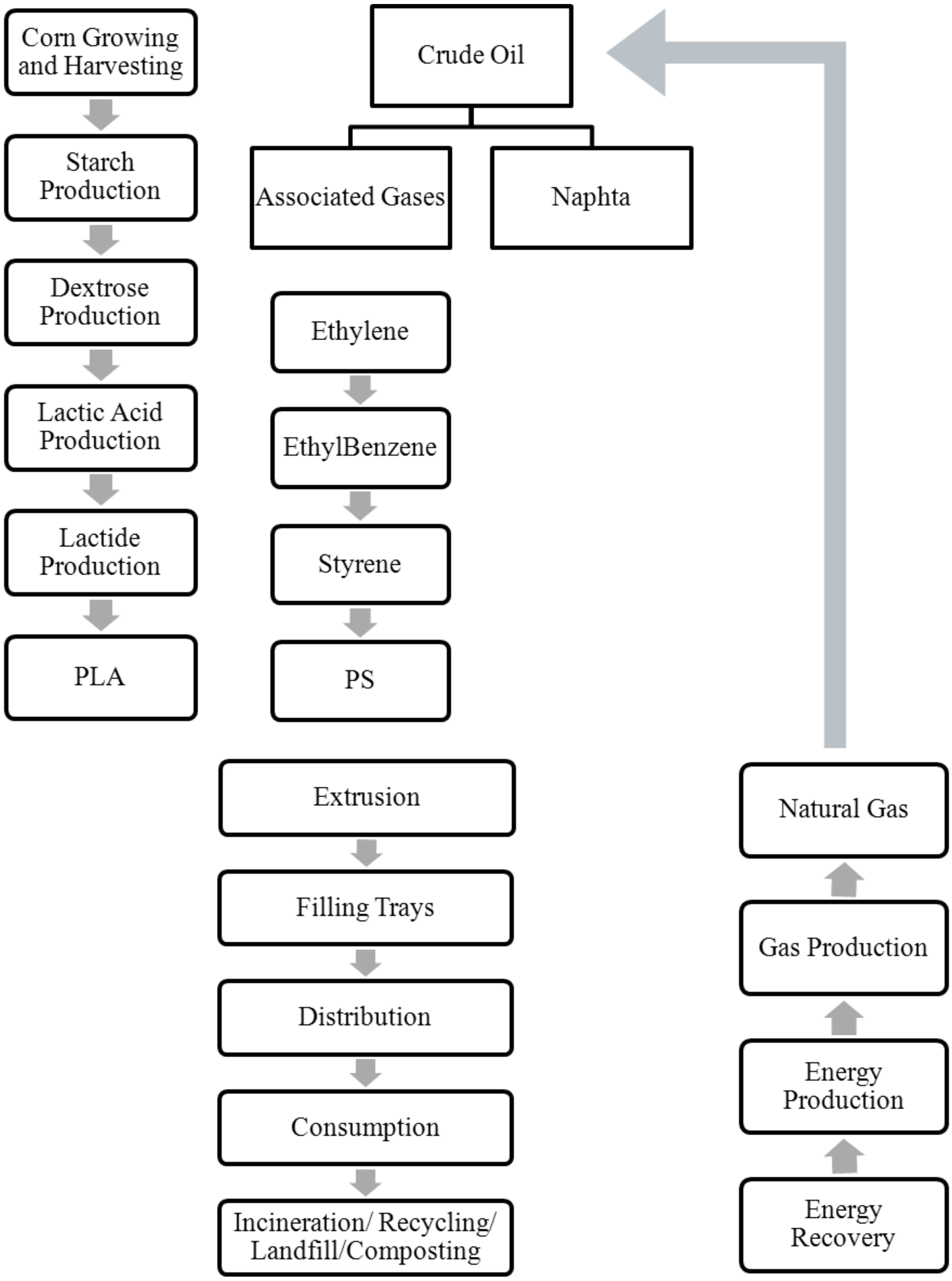


Figure 19: System boundary of LCA comparison (Taken from Madival et al. (2009))

Table 4: Results of the environmental impacts categories for the LCA of PLA, PET and PS clamshell containers for strawberries (Source: Madival et al. (2009))

Results: environmental impact categories for the LCA of PLA, PET and PS clamshell containers for strawberries.				
Impact Category	**Stage**	**PLA**	**PET**	**PS**
Global Warming	Resin Production	60	65	70
	Extrusion	15	16	12
	Thermoforming	22	24	18
	Electricity Production	3	4	3
	Transportation R	28,7	50,2	31,7
	Transportation C	41,8	39,2	30,1
	Sub-Total	171	198	165
	Transportation S	564	565	565
	Total	**735**	**763**	**730**
Aquatic Acidification, kg SO2	Resin Production	1,17	0,36	0,47
	Extrusion	0,06	0,07	0,05
	Thermoforming	0,11	0,12	0,09
	Electricity Production	0,001	0,02	0,02
	Transportation R	0,19	0,34	0,22
	Transportation C	0,28	0,27	0,2
	Sub- total	1,82	1,14	1,04
	Transportation S	3,84	3,83	3,83
	Total	**5,66**	**4,97**	**4,87**
Energy, MJ, surplus	Resin Production	2010[d]	2203[d]	2399[d]
	Extrusion	283	303	231
	Thermoforming	476	508	389
	Electricity Production	41	54	42
	Transportation R	477	837	528
	Transportation C	697	655	501
	Sub- total	3984	4560	4090
	Transportation S	9416	9440	9410
	Total	**13400**	**14000**	**13500**
Land Occupation, m2 or. Arable	Resin Production	0,04	0,37	0,001
	Extrusion	0,62	0,66	0,5
	Thermoforming	1,33	1,42	1,08
	Electricity Production	0,0009	0,0015	0,0011
	Transportation R	0,38	0,66	0,42
	Transportation C	0,55	0,51	0,39
	Sub- total	2,92	3,62	2,4
	Transportation S	7,4	7,38	7,4
	Total	**10,3**	**11**	**9,8**

Notes:

Transportation R -Transportation of resin from the supplier to container manufacturer by a 16 ton truck.
Transportation C - Transportation of containers from strawberry fillers to distribution/market by a 16 ton truck.
Transportation S- Transportation of 1000 lbs. Strawberries (only food and no containers) by a 16 ton truck.
Variations between the PLA, PET and PS values are due to rounding error in the software
[d] - Energy consumption for 1 kg of resin.

For presentation in this case study a selection if impact indicators were presented

The remaining indicators that were omitted from the presentation are: ozone layer depletion, aquatic eutrophication, respiratory organics, respiratory in-organics and aquatic eco-toxicity.

The important point is that there are some studies that compare the environmental impact of biopolymers and conventional polymers (Madival, et al., 2009). For example, in a case study by Madival et al. (2009), a comparison was made between one of the most commonly used biodegradable polymers, polylactic acid (PLA), and conventional packaging alternatives, PET and PS, for use in strawberry clamshell containers. According to the results, biodegradable materials and conventional plastics had a similar environmental impact. According to LCA methodology, there is no significant indication that PLA as a biodegradable material has a lower environmental impact than conventional plastics such as PET and PS.

Production of material and packaging material conversion impacts are similar for all materials. According to this argument, transportation and supply chain efficiency may have a much more significant environmental effect than packaging material. It should also be noted that it is very difficult to come to a conclusion for the whole system because all of the different producers use different supply chains modeled in the case. Furthermore, there are two main issues when considering LCA of bio-based materials. One is that the PLA producers purchased energy from the local renewable energy producers. Arguably, the other material players could have made the same decision. Hence, this difference is not determined by material and the choice of PLA producers.

4.4. Adoption Theory

As we mentioned in the literature, all innovations should have certain attributes in order to be persuade and it be adopted by consumers (Rogers, 1995). This argument follows with some general characteristics of innovation and their rate of adoption. This paper aims to understand key drivers and barriers in the adoption process in a specific industry and specific subject. For that reason, the adoption curve is not conducted via research but rather by the perceived attributes.

4.4.1 Relative Advantage

Relative advantage is the perception of being better than competing products. This relative advantage can be economic profitability, in status giving or in other ways. According to this thesis, the bio-based packaging innovation must have some advantage over competing or similar products in order to disseminate in the society. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be.

Potential adopters want to know the degree to which a new idea is better than an existing practice. So the relative advantage is often the content of the network messages about an innovation. The exchange of such innovation-evaluation information lies at the heart of the diffusion process.

Relative advantage in one sense indicates the strength of the reward or punishment resulting from adoption of an innovation.

4.4.1.1 ECONOMIC PROFITABILITY

According to this thesis, the dissemination of technological innovation is increased by the increasing relative advantage in the society. Certainly, one of the most crucial elements of this relative advantage is economic profitability. All the players in the value chain receive some amount of benefit from the production, transportation and sale of current products. From this perspective, it can be said that innovations should compete with current substitutes from the value perspective. That means new innovations should provide competitive profits along the value chain. Existing profitability may convince the key players to invest in the innovations. In that respect, it is important to mention the cost competitiveness of bio-packaging solutions. In the packaging industry, the current substitutes of bio-packaging solutions are conventional plastics. In order to understand economic competitiveness in the recent market, one could compare market prices of materials, as given in the table.

Table 5: Price Comparison of some packaging materials

Material	Average Price (Euro / kg)
Polyethylene (PE)	1,30-1,55
Polystyrenes (PS)	1,75-1,90
Acrylonitrile/Butadiene/Styrene (ABS)	1,90-2,45
Polycarbonates (PC)	3,10-3,70
Poly (Lactides) (PLA)	1,80
Poly (Hydroxy Alkanets) (PHA)	4,10-4,70
Poly (Butylene Succinate) (PBS)	3,50-4,00
Poly (Butylene Adipate-co-Ter.) (PBAT)	3,30-3,70

Source: Innventia Bio-Polymer Seminar (Data from 2011)

As it is seen from the table, the prices of bio-derived plastics have been higher than those of commodity grade resins. Therefore, it is argued that acceptability of bio-packaging materials by food packaging industry is not cost competitive at this point of time. However, the cost of product is a dependent variable to many different factors, such as economies of scale, cost of raw materials and number of suppliers in that industry.

Economies of scale are the important element when we are considering and comparing the cost of similar products. Namely, cost per unit of product is decreased by increasing size and scale because fixed costs are distributed over more units and the contribution of fixed cost is decreasing while number of unit is increasing. Also, variable cost is generally less because operational efficiency is usually higher in the higher scale industry.

When we look into the market, bio-plastics account for less than 1% of total plastic production and are expected to grow to 7% of total plastics market by 2020 (plastemart, 2012). It can be said that economies of scale make conventional plastics more cost competitive in the current industry. Also, it can be argued that the average market price of bio-materials could be totally different with the increasing scale of an industry. Once it becomes sufficiently competitive, it can be disseminated more easily, thus driving the change in the industry with increasing scale of economies.

Secondly, the price of conventional plastic is strongly correlated with the price of crude oil and crude oil prices change dynamically each and every day. Some researchers believe that there will soon be a peak in oil. In this case, it can cause acceleration in the adoption of substitute industries including bio-based industry. According to some researchers, we are already in an oil peak and we have to switch to a bio-based economy as soon as possible to be more efficient economically. Still, the trend in the price of oil is not obvious and cannot be predicted so easily as an effect of unexpected events. Historically, it could be said that the price of oil is affected by different factors such as amount of supply, political factors, embargos, wars, price controls, etc. Yet, understanding the cause of price change is not the subject of this thesis. This research deals with the potential price competitiveness of bio-materials with conventional plastics which totally depend on oil prices. This means that, if the price of crude oil increases for any reason ceteris paribus, the bio-materials will become more cost competitive from the economical point of view. This can trigger the adoption of bio-materials as a substitute for conventional plastics in every industry and in food packaging industry specifically.

Although the importance of packaging as the fifth P of marketing was mentioned earlier, materials of food packages in emerging countries such as India are generally considered as a kind of commodity product for food producers. In financial terms, these products are considered cost based products in benefit cost calculation and in the decision processes. In other words, they provide goods and services without a qualitative differentiation across the market. Therefore, it increases the importance of raw material cost of bio-packaging innovations in the rate of adoption. According to that perspective, the perception of packaging material as a commodity is an obvious question. It can be argued that packaging materials are value-based products which create qualitative differentiation from substitutes with their technical properties and also create differentiation in the market from the customer perspective. For the first statement, value addition and competitiveness of bio-materials in technical properties is discussed in the next chapter of this thesis. For the second, in order to understand customer perceptions about bio-materials, environmental sensitivity of market dynamics related to bio-materials could be discussed in this specific industry. The question is whether or not there are some customers who are willing to pay more for bio-packaged products in the current market. If this is the question, the industry could be segmented according to this niche customer. If not, the competitive marketing of bio-packaging solutions could be discussed in terms of another cluster and/or supported governmental policies, which are discussed later.

Last but not least, sourcing of packaging materials can also be considered an economical decision process. Reducing risk in the supply side of value chain is one of the most important processes for the firms in the value chain. According to its definition by Rogers, innovation is a way of risk reduction solution comparing the current alternatives although it creates some risk itself. According to some researchers, the number of sources in the supply side could play an important role in the decision of supplying in raw material selection. Namely, while there have been a huge number of plastic suppliers already in the market that can serve as substitutes for each other in case of emergency, the number of bio-based material companies is not comparably high and therefore cannot be substituted as easily as conventional plastics. Therefore, comparably high risk in the supply side also negatively affects the adoption of bio-packaging in the food packaging industry.

Firms can chose to invest in innovations by considering the potential future return of those innovations. In the short term, these may not be beneficial, but strategies in innovation can create a competitive edge in the long term.

4.4.1.2 TECHNICAL COMPETITIVENESS

Undoubtedly, one of the most important characteristics of an innovation is performing its own function in the same way or better than current products in order to be adopted by the value chain and by the society. In packaging, there are several technical specifications and barrier properties necessary according to functions and usage area of the material. For this reason, we have to examine and compare the technical properties of materials and determine the most promising product segment of packaged food industry.

Technical properties of these materials is a very comprehensive and in/depth issue. However, the goal of the article is not to provide all of the technical information about these bio-materials but to find the most appropriate and competitive market for the bio-based packaging materials.

There are mainly four barrier properties to be considered in food packaging applications, namely O_2, H_2O, CO_2 and light. According to specific food application, materials can be selected for packaging. Here, Oxygen permeability and water vapor permeability of different polymers can be seen.

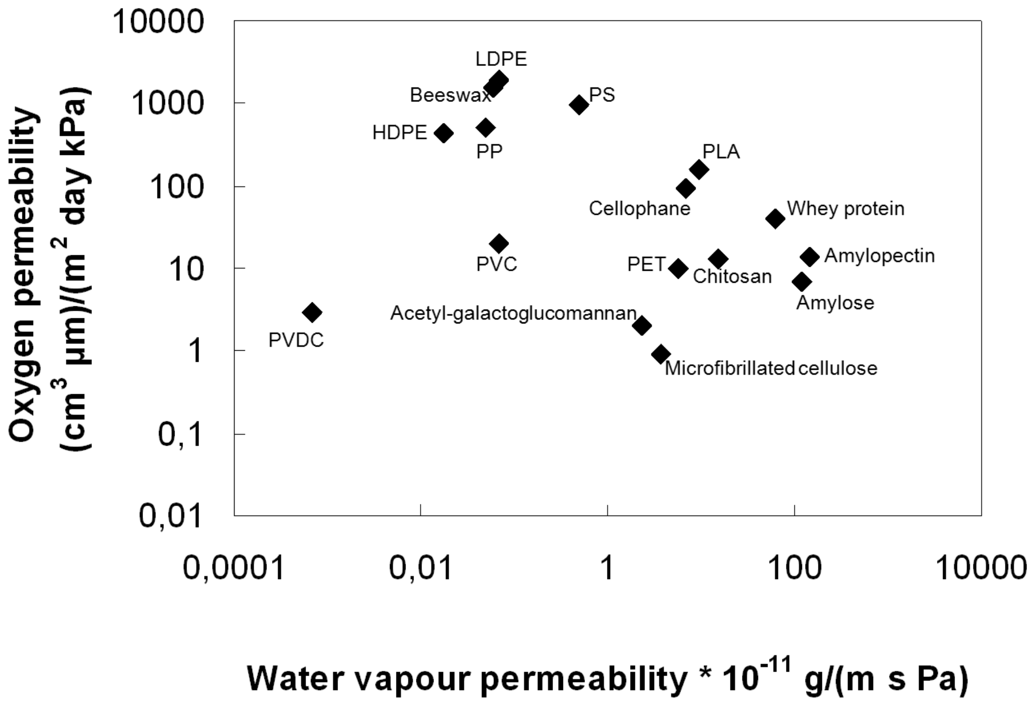


Figure 20: Technical Properties of Packaging Materials
Source: Innventia Bio-Polymer Seminar (Data from 2011)

From the marketing perspective, the technical competence of the materials cannot be easily extrapolated to applicable and easily understood marketing figures. Therefore, it may be too complicated to explain the performance of the materials to non-technical but relevant people in the decision chain. For this reason, the following more convenient figure also provides a comparison of conventional and micro-fibrillated cellulose material. These figures are also used and discussed during the research interviews with the key market players.

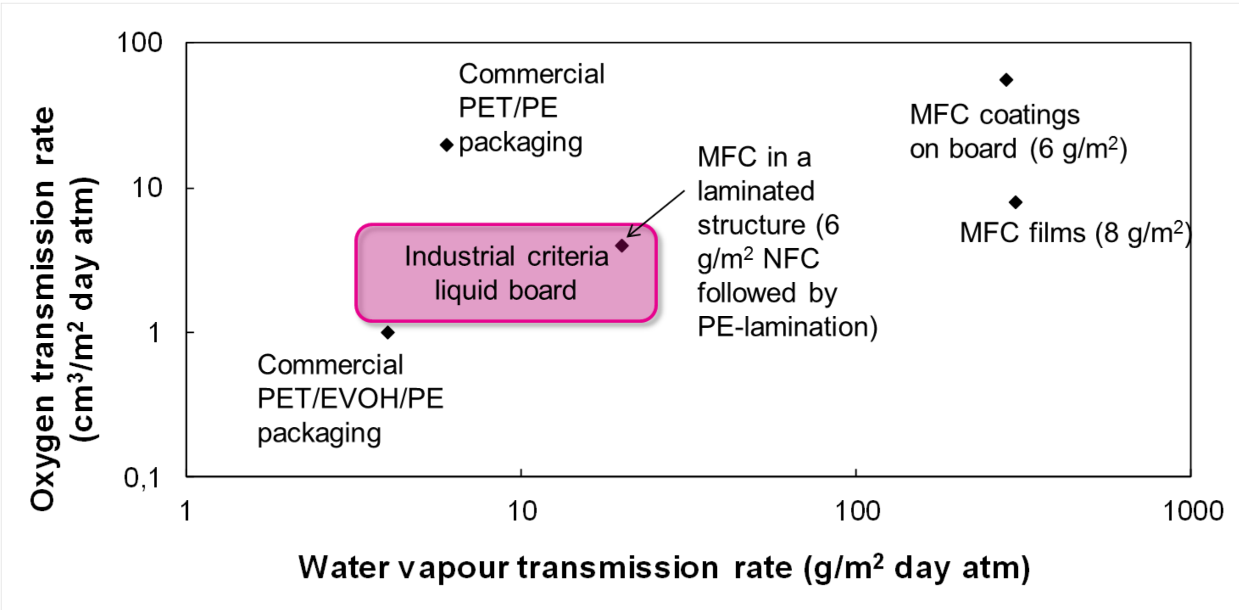


Figure 21: Technical Properties of Packaging Materials (market)
Source: Innventia Bio-Polymer Seminar (Data from 2011)

Table 6: Properties and uses of common plastics (Adapted from Innventia Bifrost Food Packaging Presentation by Tom Lindstrom)

Plastic material	Properties	Selected uses
High Density Polyethylene (HDPE)	•Excellent moisture barrier •Poor O2 and aroma barrier •Strong	•Bottles and jugs for milk, water and juice •Cups and tubs for cottage cheese, yogurt, butter and margarine spread •Bags for carrying groceries
Low Density Polyethylene and Linear Low Density Polyethylene (LDPE and LLDPE)	•Excellent moisture barrier •Poor O2 and aroma barrier •Tough	•Bags for fresh-produce and baked-goods •Pouches for frozen foods •Moisture-barrier and/or heat-sealing layer/coating on multilayer cartons
Polypropylene (PP)	•Excellent moisture barrier •Poor O2 and aroma barrier •Good heat resistance	•Bottles for ketchup, syrup and oils •Cups and tubs for cottage cheese, yogurt, butter and margarine spread •Overwraps for produce, baked goods and confectionery products •Pouches for snack foods •Trays for microwaveable paperboard cartons and trays
Polyvinyl Chloride (PVC)	•Good oil barrier •Good moisture, O2 and aroma barrier •Good stretch and cling	•Bottles for vegetable oils •Overwraps for produce •Overwraps for meat
Polyvinylidene Chloride (PVDC) polystyrene (PS)	•Excellent moisture, O2 and aroma barrier	•Barrier layer for coating in multilayer containers
Polystyrene (PS)	•Poor moisture, O2 and aroma barrier •Glossy and clear •Strong and stiff •Expanded foam is good cushioner and insulator	•Clear trays and cartons for baked goods, fresh produce and meat •Foamed trays and cartons for fresh produce, meats, poultry, fish, and eggs •Clear and foamed cups and plates •Clear or pigmented cutlery
Polyethylene terephthalate (PET)	•Good moisture, O2 and aroma barrier •Glossy and clear •Strong and durable •Excellent heat resistance	•Bottles for carbonated and noncrbonated beverages •Bottles for oils, dressings, ketchup, sauces, and syrups •Jars for peanut butter, mustard, etc. •Trays and lidding for dual-ovenable applications •Paperboard coatings for dual-ovenable applications
Ethylene-vinyl alcohol copolymer (EVOH)	•Poor moisture barrier •Excellent O2 and aroma barrier when protected from moisture	•Barrier layer (sandwiched between moisture-barrier layers) in retort pouches, tubs and cans and aseptic packages
Polyamide (PA) (Nylon)	•Poor moisture barrier •Excellent O2 and aroma barrier when protected from moisture •Tough •Good heat resistance	

4.4.1.3 STATUS ASPECTS

One of the most important motivations for almost any business to adopt an innovation is the desire to gain some market segment. It can be translated for end-customers that they can perceive the innovation as a status giving product, which will create demand for the business. Actually, just because of the end customers' motivation, the companies segment themselves into this demanding customer target. Therefore, it is necessary to look at the status aspect of bio-packaging innovation from the firms' and end customers' points of view.

Status of the bio plastic products can be divided into two groups. One is the image of the company that is trying to be seen as "green, environment friendly, sustainable" and the other is the environmentally sensitive customers that demand these green products and services from the industry.

Introduction of green material into the market can arise from different possible status reasons from the company perspective. One of them could be the sustainability strategy of the company. The firm may want to position themselves as a green and environmentally sustainable company as the result of a corporate social responsibility strategy. One can believe that the companies sustain more benefits with the help of sustainable investments. However, the objective of a company is generally based on increases in profit and the survival of the company. In other words, bio-based packaging solutions are not competitive if they are not economically feasible for a company. For that reason, companies try to increase their market segments by using bio-based products in addition to their current product segments in order to make bio-solutions feasible. In this way, some of the firms attempt to market their green products to eco-friendly customers. Basically, bio-packaging solutions are generally applied and marketed in this sector as a complement to a type of green, eco-friendly product. It creates total alignment in the value chain in terms of a totally green image.

From another perspective, some firms can create this image only with the product without changing existing packaging technology and their existing profitability. For example, one firm sells normal and ecological tomatoes using the same conventional packaging material. This is obviously creating an ecological image of the product rather than the firm. However, one can find some companies in which all products and services, even the packaging solutions, are bio-based. The last structure can be an incubator for bio-packaging innovations.

4.4.1.4 LEGISLATIVE FRAMEWORK

The policy and legislative framework forms the backbone of any institutional and implementation system.

It consists of regulations and policies about the food packaging driving bio-packaging. Incentives in the industry can drive the innovations into bio-based products. Furthermore, disincentives for the conventional plastics could be triggered in the same way. This section will be concluded by further analysis.

One must determine if there is legislation in place that supports bio-based products in the food packaging industry. In order to gain insight, it is necessary to research the regulatory framework at the national level as well as state level. At the national level, there are numerous provisions in the Indian legislative structure that have a bearing on the State's management of environmental resources. These rules and regulations came into existence as the result of several incidents. To illustrate, the Bhopal Gas Tragedy that occurred in December, 1984 resulted in the Environment (Protection) Act in 1986, followed by the Hazardous Wastes (Management and Handling) Rules in 1989 (Divan & Rosencranz, 2001). In the same way, the reason given for the floods in Mumbai on the 26th of July, 2005 was the clogging of drains, etc. by plastic carry bags. Due to this, the Maharashtra Plastic Carry Bags Rules, 2006 was introduced (UNEP, et al., 2007).

Recognizing the immense hazard of plastics, the Environment Ministry of India proposed putting in place a stricter regulatory regime for plastic manufacturers in 2009. According to "Plastics (Manufacture, Usage and Waste Management) Rules", no person shall use carry bags or containers made of recycled plastics or biodegradable plastics for storing, carrying, dispensing or packaging of food stuffs (Ministry of Envronment and Forest, 2009). Furthermore, it states that the determination of bio-degradability and the degree of disintegration of plastic material shall be as per the protocol of the Bureau of Indian Standards (BIS).

Second, it is necessary to determine whether there are any incentives that trigger potential bio-based material adoption in the market, or, conversely, if there are any disincentives such as higher taxes on petroleum-based product that will have the same effect. It is obvious that banning recycled plastics as well as biodegradable plastics for packaging food stuffs is a disincentive for the market adoption of this special kind of biodegradable materials.

The third factor is the implementation stage of these rules along the supply chain in cases of bio-based supporting legislations. It is obvious that every big player follows the rules in the case of banning and some regulatory restrictions. However, the lack of control mechanism and penalty code are the obstacles in the context of regulatory framework, at least in Europe.

And lastly, one must consider the potential reaction of key players in the case of incentive legislation to bio-based products. As already mentioned, every significant player follows the rules in the case of banning and some regulatory restrictions. However, some of the big players are not willing to directly follow the incentives. According to that idea, incentives are provisional remedies because of the temporary political agenda. Therefore, one business model is not thought of as robust depending on the volatility of the political agenda. Some industrial experts support the idea that, in the long run, one eco-innovation cannot be sustained on the market just because of the regulations. It will eventually become extinct and no business model should be based on this incentive.

4.4.2 Compatibility

Compatibility is the perception of being consistent with the existing values, past experiences and needs of potential adopters (Rogers, 1995). An idea that is not compatible with the prevalent values and norms of a social system is not adopted as rapidly as an innovation that is compatible (Moore & Benbasat, 1991). The adoption of incompatible innovation often requires the prior adoption of a new value system.

From the food packaging point of view, there are three major compatibility issues that will be discussed. First of all, the new technology should be compatible with its performance. Some facets of technical competitiveness have already been discussed in the relative advantage section. However, compatibility could be perceived in a manner that is completely different from the performance perspective.

The most significant change in switching from conventional petroleum-based plastic materials to bio-based plastic material is observed in the production process of the plastic material by suppliers. Therefore, suppliers should perceive the bio-packaging materials as compatible with their existing performance primarily. Now, in the market, there are some niche suppliers of bio-based products. Brand owners such as Coca-Cola and Heinz are supplied with generally 20-30% blended bio-based plastic products by these producers. From the performance point of view, these products are highly effective and almost totally interchangeable with conventional plastics. In that respect, brand owners have no compatibility problems. However, the physical properties of 100% bio-based plastics are not the same with the previous case. This comes inherently from the natural characteristics of the bio-based material and should meet performance requirements of the packaging materials (Shen, et al., 2009).

Secondly, the brand owners have already established recycling systems in their organizations. Therefore, these new packaging materials should be compatible with the recycling streams of those companies. If they are not, they will create extra cost for the company and become inconvenient for adoption.

Thirdly, the installation of the bio-based materials should be taken into consideration in the introduction stage. Although research and development managers as well as market managers do not attach too much importance to this concept, managers who are responsible for production could perceive it as a barrier and hamper the dissemination process. Therefore, this attribute could create a negative effect in the introduction of the new technology.

4.4.3 Complexity

Complexity is the perception of being difficult to understand and use (Rogers, 1995). Some innovations are readily understood by most members of a social system; others are more complicated and will be adopted more slowly. Introduction of bio-based packaging materials brings three main complexity issues to discuss in the adoption process.

First of all, there is still a substantial degree of uncertainty attached to bio-based products. This uncertainty is based on the unknown price development of these products. Also, technological uncertainties exist because of the early stage of development of innovations (Tidd, et al., 2005). Furthermore, there is an uncertainty due to competition between bio-fuel and bio-based industry for biomass (Gillespie, et al., 2011; Mathews, 2008; Bohlmann, 2007).The production capacity of bio-based plastics is very low in comparison to petroleum-based plastics (Shen, et al., 2009; ICIS, 2012). Therefore, it is possible to say that suppliers have bargaining power. On the other hand, a brand owner exercises power on suppliers as investors in these projects. In addition, they launch these packaging solutions to the market in the up-front investors. Both of these circumstances show the dependency of suppliers on the largest brand owners in the supply chain (Pfeffer & Salancik, 2003). Eventually, the relationship in the supply-chain is seen as more complex than expected with the introduction of bio-based packaging.

The second is about organizational complexity. Several questions should be asked and there may be some uncertainty that should be overcome prior to the introduction of new material in the organization. As discussed earlier, the technological development of bio-based packaging is still not sufficiently mature and the production capacity needs to grow (Shen, et al., 2009). Therefore, it requires more involvement from the brand owners' side, which causes added organizational complexity.

4.4.4 Trial-ability

Trial-ability is defined as the ability to experience an innovation on a limited basis (Moore & Benbasat, 1991). New ideas that can be tried on the installment plan will generally be adopted more quickly than innovations that are not divisible. A trial-able innovation leads to less uncertainty for the individual who is considering it for adoption, as it is possible to learn by doing (Rogers, 1995). There are two main aspects to the trial-ability of bio-based packaging solutions. One is the ability to experience bio-based packaging solutions in the production process and the other one is the ability to experience these solutions in the market place. The first is about the technological implementation of the innovation, whereas the second is about its market applicability.

From the brand owners` perspective, bio-based packaging solutions can easily be tried in their technological platform on a small scale. Because brand owners have great facilities for trials of new packaging solutions, there is no reason to see that as a barrier from the technological point of view. Still, it can be a question to ask so that the brand owner knows for certain.
In the marketplace trial respect, the dynamics of the packaging sector are seen as more complicated. There are two main issues concerning the bio-based packaging. First of all, labels

and standardization of these products are not certain enough to be sure about their validity. The second, even if the question of validity can be overcome, is a question of whether consumers are willing to pay premium prices because of the bio-based packaging (Yiridoe, et al., 2005).

4.4.5 Observability

Observability is defined as “the visibility of the results of innovation to others” (Rogers, 1995). According to Rogers (1995), an increase in observability leads to an increase in the rate of adoption of new innovations. In other words, the easier it is for individuals to see the results of innovation, the more likely they are to adopt that innovation. Such visibility stimulates peer discussion of a new idea, as friends and neighbors of an adopter ask him or her for innovation-evaluation information about it (Moore & Benbasat, 1991).

There are two main factors of observability regarding bio-packaging solutions. The first factor is whether the end customers and brand owners can observe the difference in bio-based plastic packaging. Secondly, the question of the brand owners is whether they can see their competitors adopting bio-based plastic packaging.

From the end user perspective, observability of the bio-based packages, that is, looking at a product to determine what kind of material was used to produce it is very difficult. However, because of the status aspects of the packaging, the brand owners try to make their products observable in the market with labeling and advertisement campaigns. Also, brand owners can be considered as experts in understanding what kind of materials were used by their competitors in business to business (B2B) market. From this perspective, observability of bio-based packaging is high. If the brand owner decides to invest in bio-based packaging research and/or adopt bio-based packaging solutions, he or she expects to receive some benefits from these solutions in the future. Therefore, observability of adoption can be considered as high for the innovation.

Although observability is high, the positive effect of observability in the adoption process can be a subject for debate. Evolution of the plastic packaging in the technological innovations has a reliable history over the past decades. This success of the plastics world makes the new progress of bio-plastics more attractive. In addition, leading brand owners such as Coca-Cola (2011) and Heinz (2012) took a pro-active stance by investing in the development of bio-based plastics. Observing these corporations adopting bio-based packaging innovations could likely influence the competitors’ decision making process in the same way. As a practical example, PepsiCo, the main competitor of Coca-Cola, has already responded to this adoption by starting to use bio-based packaging in their products (PepsiCo, 2011).

Therefore, it can be said that observability in bio-based packaging is high and positively affects the adoption process.

THEORETICAL FRAMEWORK TO UNDERSTAND EAGERNESS TO ADOPT BIO-BASED PACKAGING SOLUTONS

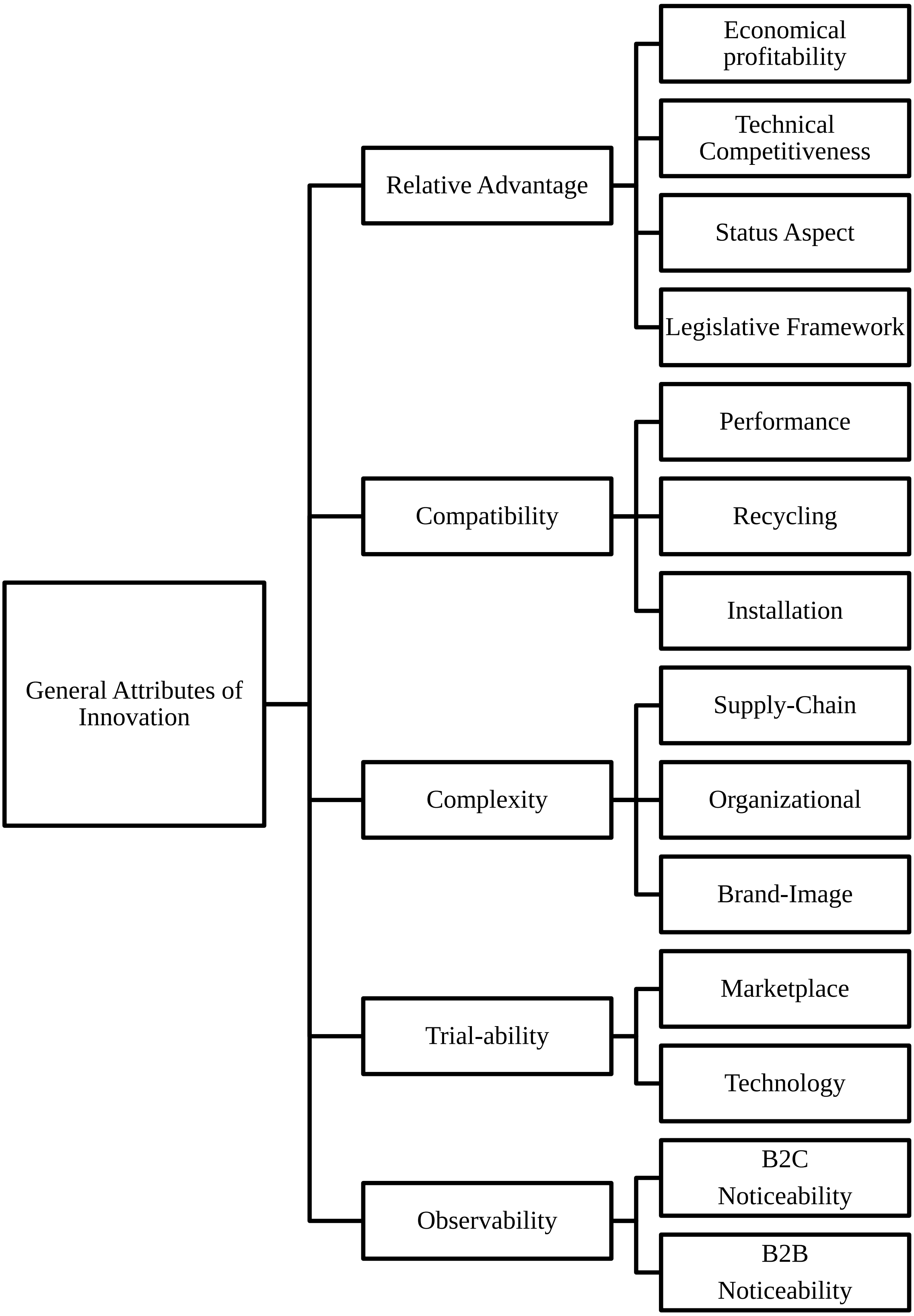


Figure 22: Theoretical framework to understand eagerness to adopt bio-based packaging solutions (Elaborated from Rogers (1995) regarding the packaging issues)

IMPLEMENTATION OF INTERVIEWS

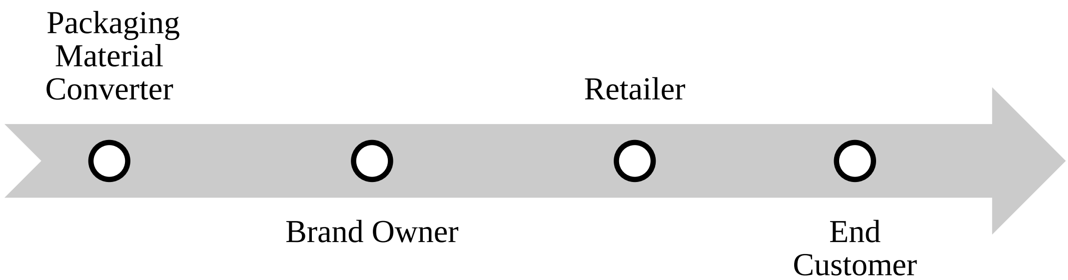
The working process is described in this chapter. The aim of the project is understanding potential drivers of and barriers to the adoption of bio-based packaging materials.

At the end of the second section, it had already been pointed out that there is immense potential in the food packaging industry in India. However, in order to understand adoption of new technology and material, it is essential to understand the perceived value of new technologies among the key players along the industry (Rogers, 1995). In other words, the introduction of new materials affect the entire supply chain, from the supplier to the end customer. Therefore, the research question can be answered by these key players among the industry. The drivers and barriers should be clarified with the key players of the supply chain who are the decision makers in terms of new bio-based solutions in order to disseminate in the market.

As it is discussed in the industry overview, brand owners have a strong position and dominance along the supply chain. On the contrary, organized retail sector represents only 2% of retailing now. However, especially in the urban areas, organized retailing is increasing and rapidly becoming important with the help of foreign direct investments in the food sector. To date, packaging is perceived as being price sensitive.

As a result, the numbers of companies selected correspond to the importance of the key players through supply chain. Mainly, brand owners and packaging material converters are selected as target group for the interviews because of their dominance in the market. Although the organized retailing was not interested to meet and discuss new packaging materials, the field research is applied by visiting one of the biggest retail shop in New Delhi. According to this observation, important findings are given in the result part. By this way, general behavior of retail markets is attached.

Figure 23: Supply Chain of the Food Packaging Industry



In the implementation stage, the semi-structured surveys are performed with the key players in India as described. The framework of the survey is identical to the theoretical framework discussed in the third section of the research. These surveys are processed in such a way that drivers and barriers in each potential adoption factors can be compared and contrasted. At the same time, the theory can be improved upon by flexibility and new findings during these surveys. In total, 10 semi-structured surveys are performed among executives of the key players in the industry, especially from the packaging material converters and brand owners.

The important points regarding to bio-based materials and future potential of the industry based on these materials are discussed in the semi-structured survey stage. Moreover, some potential cases in industry that can trigger or hamper the potential adoption of the industry are argued. Specific cases, if possible to obtain, are included in the research. The technological cluster part of the innovation has especially great importance regarding the cases. Because packaging products are perceived as a commodity product by end customers, there is no significant demand by them to pull the new materials form the market. Furthermore, since there is a lack of observability from the end users, the possibility of clustering these technologies in the direction of different demands is emphasized.

It should be noted that one setback has been experienced in the implementation of the structured questionnaire. It has been delivered to the relevant companies via the Internet and embedded e-mail, but the rate of response to the questionnaire was not high. In general, in contrast to European firms, in India, companies are not willing to share their knowledge and information via phone or the Internet. From this perspective, in the implementation stage, many difficulties have been encountered. According to some companies contacted, from the business perspective, responding to a structured interview is culturally inappropriate. Although the researcher has been faced with reluctance in this part of the research, some of the problem of implementation has been overcome by using the business network of the company with which he is collaborating.

Due to the low response rate (7 out of 40), the structured survey is not subjected to any analytical tools to analyze. Nevertheless, it has been used to grab background information about the market drivers and barriers. Afterwards, this information was used in the semi-structured interviews.

And finally, it is widely known that the top brand owners in India are the multinational companies. During the research, it has been discovered that the decisions concerning changes in the technology and structure of a multinational company are generally not only made on the local level in only one country. In short, the change in the packaging materials from the conventional to the bio-based ones is generally driven by the strategic decisions of these multinational companies. Therefore, some marketing and packaging managers from these companies have been interviewed in Europe as well as in India. By this means, the strategic as well as operational information of the company, especially about bio-based materials, is ascertained.

In total, 15 semi-structured interviews were performed with the key players of the industry. 11 of 15 interviews were performed face to face in India with the Indian companies. 4 of them were performed in Europe with the international companies which they have operations in India. In this way, both national and international strategies were acknowledged. 5 of them are packaging converters selected from the top 10 companies in India regarding their market share and 10 of these converters are the largest brand owners in Europe as well as in India. It should be noted that one company interviewed has vertical integration that it has its own brands and package converting business indigenously.

From the positional perspective, meetings were performed with the divisional managers, executives and owners of the selected companies because of the fact that they are the ones who can decide about the strategic change in the decision making process.

Retail chains in India were not interested with this research but one of the largest organized retailer was visited for better understanding and the field research in New Delhi. The information about this research is also discussed and added the conclusion part of this study.

In the next chapter, results of implemented interviews are summarized.

RESULTS

In the results chapter, the data that are obtained with the process/methods described in the previous chapter are compiled, analyzed and compared with the existing knowledge and/or theory presented in the frame of reference chapter.

In this research, the aim was to clarify the supports and obstacles for adoption of bio-packaging materials, specifically in the food packaging industry. India is the second largest food supplier in the world, although food packaging is not integrated with the industry. Furthermore, according to research, the environmental issues in India in regard to packaging are more concerned with the customer point of view than in European countries. Therefore, India has been selected.

First, in order to attain these purposes, general information about food industry is collected. The food industry, which is the main driver of food packaging, is studied. After that, important segments in the market were indicated for the next step of the research. According to the huge market potential and the increasing figures and market segments in the packaging industry, the key players of the supply chain, being alias decision makers, were investigated. In order to understand the perceptions about the bio-based packaging materials, information was collected from these key players via semi-structured interviews and questionnaires.

The main and most important reason behind the use of these new packaging materials is environmental concerns about the conventional plastics. Therefore the concept of sustainable innovations was discussed in the literature review. Later, an attempt was made to clarify the concept of sustainable packaging. According to this concept, in short, packaging should be effective, efficient, safe and cyclic in order to be sustainable. In regard to these properties, the life cycle assessment was described and introduced into food packaging, especially by focusing on bio-based materials.

Following a review of the state of art information and a discussion about sustainability, the market side of the phenomenon was explained. As was mentioned, the objective of the research is to clarify motives and obstacles of the bio-based materials in the packaging industry. In order to determine that, it is necessary to look at the industry from the market point of view. In reality, in order to be successful in the market, there are considerations other than that of sustainability. Therefore, the adoption theory was discussed and used as a tool to approach the market. According to this theory, an innovation should have some perceived attributes to be disseminated in the market. Attributes such as the relative advantage, compatibility, trial ability, complexity and observability were outlined and discussed in association with bio-based packaging materials. Each of these attributes was elaborated on from different perspectives. The adoption theory was used as a framework in the implementation stage of the research. The crucial findings from the literature concerning bio-based materials were discussed with the key players of the industry in the context of adoption theory. The semi-structured interviews and questionnaires are used as the methodology to obtain information from those individuals and entities. In this way, the perceived drivers and barriers for bio-based materials to compete in the market were analyzed. Finally, all the data were synthesized to utilize a holistic approach and a better understanding of the study.

As concluded in the theoretical section, this research will use the developed adoption theory as a framework for investigating market drivers and barriers for adoption and/or dissemination of bio-based packaging. This model is elaborated and tailored in accordance with the analysis of the bio-based packaging discussed. It is significant to highlight that, according to the innovation in emerging economies findings mentioned in the theoretical section, emerging economies are adopting the eco-innovations directly from the industrialized and developed countries, generally with the support of Foreign Direct Investments. And secondly, it is observed that change in the packaging material is strategic, i.e., multinational companies develop strategies globally rather than locally in that respect. Consequently, the semi-structured interviews are performed not only with the Indian companies but also with the European multinationals which have operations in India. According to this argument, sooner or later, their implementation of bio-based packaging material will be reflected in the Indian market if there is no different local consideration of that market. In brief, the perceptions of multinational key players are attached because of their important role in the value chain of food packaging. In addition to that, the importance of global strategy for the brand owners is emphasized each and every meeting in India. It can be highlighted that if there will be a strategic change such as packaging material change in packaging because of sustainability reasons, Indian branch will consider and most of the case, it is perceived that they are obliged to follow this trend in the national market.

The perceived attributes of the key players are detailed in the appendix. The tailored and developed adoption theory is used as a framework in the comparison table of these semi- structured interviews. The brief conclusion is given about the interviews in this chapter with the same framework of the study.

According to the interviews performed, it can be emphasized that the weakest point of bio-based packaging in food sector is the cost factor from the market point of view. The perception of the market players concerning the willingness of consumers to pay a premium price for the bio-based packaging products is also an important consideration. In the case of adoption, this premium cost should be distributed along the supply chain. At the least, one or more players should take the same range of risk for adopting these innovations. According to the research, packaging is perceived as a commodity product and is considered as cost-based when pricing. Therefore, converters, brand owners and retailers are not willing to pay more for bio-based materials than for conventional plastics. It is counted as the most important barrier to bio-based materials in order to compete. However, it can certainly be said that the difference between some bio-based materials and conventional plastics is decreasing because there are many studies of the process and technology of the former. At some point in the future, this difference may diminish due to increasing production of bio-based materials, which will cause larger economies of scale. Also, development in the technology and the processes can lead to improved efficiency. Another point is that price of the conventional plastics very much depends on the price of oil. This means that if there is an increase in oil because an oil-peak or regulation, petroleum-based products will not have a relative advantage regarding the cost. Lastly, taxation associated with the plastic materials can drive bio-based materials as an alternative. That increases the demand from the market for bio products which can be observed in some US states. However, up to now, there has been no sign of Indian food packaging industry moving in that direction. Nevertheless, the food industry is becoming more international each and every day and India is the second largest food exporter in the world market. Accordingly, a possible adoption of the bio-based material can be driven by international regulations rather than by local policies.

According to the research, it is found that the recycling infrastructure of the country is another crucial aspect. From the sustainability point of view, there are several recycling methods which depend on the government policy; bio-based materials are only sustainable if appropriate waste management systems are available. However, waste management system is in primitive stage in India. Also, it is perceived that market players do not consider government role as a driver of sustainable packaging materials. Therefore, main brand owners and packaging converters in the country focus on their own current incremental packaging improvements rather than radical change such as packaging material. Another important point is that market players believe that state governments should guide the industry in the case of some restrictions and prohibitions in the packaging material selection. In this case, government should give some alternative solutions to industry for following and complying regulations. Market players concern about the potential prohibitions and trying to guide and convince the government in that direction.

Another important point is that all of the market players agree that there is no customer awareness and observability in sustainable packaging products. In addition, they are not willing to pay more for sustainable packaging. In this case, they believe that packaging should add some other value than being bio-based to be accepted in the industry. Only, packaging with environmental friendly is not perceived as a solution or value for the industry in this moment. Because of high competition in the industry, the B2B noticeability is perceived high and it is perceived that some of the market players perform benchmark with new packaging products in the market during interviews. In this regard, the potential adoption in the market and the increasing awareness of the stakeholder can rapidly change the current technology in this emerging economy. For instance, 4 of market players were immensely interested some possible packaging solutions that have not been commercially available yet.

From the country perspective, one of the main purpose of the brand owners is reaching the rural consumers with small packaging products. The reason is that because of low income level, over 70% of the population cannot afford to buy standard package products. Therefore, they prefer for daily used, one used but cheap and small per unit products. The main purpose for the brand owners is to pack their products in a way that low income level consumers can buy them in a very cost effective way. For the current market sachets and pouches are used for this purposes. From the main research point of view, if there is a packaging material which can be cost competitive with this current product, penetration to the market can be observed.

From the complexity point of view, there is no strong barrier perceived among the value chain. For example, it is perceived that the adaptation can be performed and organization can be shaped very dynamically in the case of new value adding technology for the industry. If there is some value perceived by decision makers, complexity will not be a problem form the organizational and brand image level. However, it should be noted that, potential technology should not introduce additional complexity into the supply chain system. In most of the interviews, it is observed that the packaging converters were concerned about the risk mitigation of supplier and lack of supplying possibility these green packaging products. Therefore, the amount and the reliability of the suppliers of these materials are perceived as one of the major concerns of market players.

To conclude, India is an emerging economy and food packaging industry is increasing tremendously. To keep this pace, companies are trying to scale up and concerning their efficiency and especially cost competency. There is no major packaging material problem from the industry as well as from the consumers. However, industry has other problems about certification, unsaturated logistic and cost efficiency and productivity as discussed above. Also, small packages for urban areas and daily usage for targeting low income level customer are the general trend of the market. New packaging materials or solutions should solve some of these existing problems or they can be clustered some of these trends in order to be adopted in the market. Apart from that, there is no significant motivation for the market player to adopt bio-based packaging materials just because of environmental reasons.

DISCUSSION AND CONCLUSIONS

A discussion of the results and the conclusions that the authors have drawn during the Master of Science thesis are presented in this chapter. The conclusions are based on the analysis with the intention to answer the questions that are presented in this chapter.

The purpose of this research was to identify the drivers and obstacles for the adoption of bio-packaging material, especially from the market point of view. As a scope of analysis, Indian food packaging is selected to be studied as it is one of the most emergent economies in the world. In order to understand industry dynamics, the packaging industry is overviewed, especially as it pertains to the specified industry. According to this overview, there is an immense market potential regarding the food packaging in India. The urbanization, rising income levels and organizational process of food packaging, particularly in organized retailing are the main factors that stimulate food packaging. However, there is no signal about the growth of bio-based adoption in the food packaging market despite the existence of some niche bio-degradable material suppliers.

According to the main hypothesis, the introduction of new material is not only of particular concern to one specific firm in the supply chain but to the entire supply chain. Concordantly, the supply chain dynamics are analyzed in order to provide reliable insight about the perceived values of bio-packaging in this industry. According to that analysis, for implementation of the study, the brand owners, packaging converters and retailers with an increasing role in the industry are selected as the main target groups to be examined as potential decision makers in that kind of technological change process.

In the following chapter, the literature is discussed in the context of sustainable innovations, packaging and sustainability, technological change, technological diffusion and adoption theories. These concepts are argued based on the historical evolution of adoption theory. Adoption theories are discussed and Rogers' perceived attributes of the adoption frame is chosen to serve the purpose of this research.

In the following chapter, the sustainability framework of packaging is given. The major sustainability factors of packaging and their position in comparison with effective, efficient, cyclic and safe packaging are detailed.

Afterwards, the perceived attributes of bio-packaging are analyzed in the context of adoption theory. In this process, these main categories are elaborated to gain a better understanding from the broader perspective. In this process, advantages and disadvantages of potentially commercialized bio-based packaging are discussed from the marketing point of view.

Apart from those factors, Life Cycle Assessment is introduced as it is becoming an increasingly popular tool with which to evaluate environmental impact of the packaging materials. However, it can be seen that there is no significant evidence that bio-based materials have less environmental impact than conventional plastics in the packaging market. This statement is the most important outcome regarding the LCA method from the bio-based packaging perspective. Instead of supporting the argument, LCA shows that environmental impact can depend more on product and supply chain structure rather than on packaging material selection.

Although there are some implementations discussed in the analysis section, semi-structured interviews with the key market players, namely packaging converters, brand owners and retailers, are performed, mainly in the implementation stage. During this study, the difficulties and obstacles concerning implementation are pointed out in order to emphasize the lack of interest from the market. From the low response rate observed in this study, it is also apparent that the decision to implement bio-based plastic is very likely still beyond the horizon of most brand owners, retailers and packaging converters.

From the sustainability point of view, it is observed that most market players have environmental programs associated with reduction in packaging material, water and energy consumption in the production process. In addition to reductions in the cost of production, these constitute the main environmental programs of key companies. Therefore, it is unlikely to see high adoption rates, regardless of the evidence supporting these values from the sustainability point of view.

As is mentioned previously, there is no strong encouragement for environmentally friendly packaging solutions in the market. First of all, food packaging market is strongly cost driven. Therefore, customers are basically not willing to pay premium price for bio-based packaging material. However, decreasing the bio-based material price combined with the increasing economy of scale may refute this argument in the future.

To end the debate, the drivers and obstacles discussed in this research are not only specific about the bio-packaging materials in the food industry but are also strongly related to the other branch of the bio economy concept. It is observed that adoption of these materials is not necessarily about any single or specific industry; it concerns the current regime in which all the actors in the value chain have to contribute for their own roles.

If this is not properly created regarding the bio economy, it will stimulate polarity in the industry which will misalign the entire value chain. From this perspective, a bio-based packaging, bio-textile or any other eco innovation system can be adopted by the market if the entire system is entirely run by using bio-based materials; in this way, the system will become completely sustainable without jeopardizing the needs of future generations.

RECOMMENDATIONS AND FUTURE WORK

In this chapter, recommendations on more detailed solutions and/or future work in this field are presented.

As it is mentioned in the literature, environmental concerns do not necessarily translate into purchasing decisions. Likewise, eco-innovations may not be successful in the market merely by depending on their environmental impact advantage. Therefore, value addition to supply chain players and customers will play an important role in the market adoption of these innovations. In return, it can be stated that not only the change in the material but also different potential properties of these products will play important roles in the future of the packaging market. In light of this statement, the analysis of potential value-added factors in food packaging along the supply chain can contribute the literature as a continuum of this study.

In addition, there are some current problems which are specific to each category in food packaging industry. The potential solutions of these present problems can be solved in line with these new innovations. In this case, either the new materials may bring the solution with the help of their specific properties or another solution may appear in the market. For the former case, adoption can be driven directly by from the eco-product itself. The demand will be for these new innovations, whereas, in the latter case, bio-based packaging solutions will possibly be marketed as a cluster with other innovations. According to this research, it is perceived that the interest of market players in the market is not in packaging materials specifically. Therefore, adoption rate of market for bio-based materials can be highly affected by the other technological clusters which are marketed together. For this reason, the idea that the possible solutions with current problems and their adaptability with bio-packaging materials is supported can be investigated in further studies.

To conclude, the analysis of supply chain in different food segments is recommended for further research. Because each food segment has different necessities and different drivers, this analysis will be beneficial for the segmented market in order to target inherently compatible packaging solutions.

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APPENDIX A: PREPARED SURVEY

Bio-based materials in Food Packaging Sector

This survey is a part of my master thesis project. It is designed to take not more than 5 minutes, I will be grateful if you can participate in my research.

The master thesis is performed as a part the International Master in Industrial Management at KTH (http://imim.polimi.it), in co-operation with the research company Innventia (www.innventia.com).

The main aim of this research is to try to understand the perception of bio-based material solutions in the food packaging industry. Therefore, the answers should be based on your individual opinions. With bio-based materials it is meant materials that at least partly are produced from renewable biomass, they can be either biodegradable or non-biodegradable.

Best Regards,

Umit Emre ERDOGAN
Master Student @ Innventia-KTH
Stockholm-SWEDEN

What is the name of your company?

What is your position in the company?

What is your responsibility in decision hierarchy?

- ☐ Strategic
- ☐ Tactical
- ☐ Operational

What is your role in the supply chain?

- ☐ Material Supplier
- ☐ Packaging Manufacturer
- ☐ Brand Owner
- ☐ Retailer
- ☐ Packaging Machinery Manufacturer
- ☐ End Customer
- ☐ Other:

What is the current position of your company regarding bio-based packaging materials?
Implementation Level

- We have no bio-based packed products, not considered yet.
- We have no bio-packed products but we are considering it.
- We have no product yet, but we have decided to implement.
- We've have pilot project in small scale about bio-based packaging products.
- We are using bio-package in a large scale.

Do you expect that consumers are willing to pay for bio-based plastic?
Economic Profitability

- No one
- A niche market
- Several types of customer segments
- Majority
- All of the customers

Do you expect any change in your revenue with adoption of bio-based packaging?
Economic Profitability

- Large decrease
- Small decrease
- No change
- Small increase
- Large Increase

Do you perceive that price difference between conventional plastics (petroleum based) and bio-based plastics is an important factor for if your company will consider bio-based packaging solutions or not?
Economic Profitability

- Irrelevant
- Small Factor
- Moderate Factor
- Big Factor
- Crucial Factor

Do you see any competitive advantage/disadvantage by using bio-based products?
Status

- Big Disadvantage
- Small Disadvantage
- Indifferent

- Advantage
- Very big Advantage

Do you perceive that introduction of bio-based materials will have any effect on company´s total CO2 footprint? (High CO2 footprint = High CO2 emission)
Status

- Increase in CO2 footprint (Barrier)
- Small increase in CO2 footprint
- No effect at all
- Small decrease in CO2 footprint
- Large decrease in CO2 footprint (Driver)

Do you see any incentives from the other actors in your supply chain (e.g. retailers, suppliers, food service industry) for bio-based products?
Incentive

- Strong Disincentive
- Weak Disincentive
- Indifferent
- Weak Incentive
- Strong Incentive

Do you today, see any incentive from the "Legislation" perspective (taxes, regulations etc.) to use bio-based materials?
Incentive

- Strong Disincentive
- Weak Disincentive
- Indifferent
- Weak Incentive
- Strong Incentive

Do you expect any future incentives from the "Legislation" perspective (taxes, regulations etc.) to use bio-based materials?
Incentive

- Strong Disincentive
- Weak Disincentive
- Indifferent
- Weak Incentive
- Strong Incentive

From the technological perspective, do you think that compatibility (being consistent with the existing systems and processes) is an important parameter in the introduction of bio-based materials?
Technology-Compatibility

- Very negative, it can be a barrier.
- Negative, but it can be handled.
- No role
- Positive, but it may be not so important.
- Very positive, it can be a driver.

Do you perceive that compatibility is an important parameter in the installation process of bio-based materials?
Installation-Compatibility

- Very negative, it can be barrier.
- Negative, but it can be handled.
- No role
- Positive, but it may be not so important.
- Very positive, it can be driver.

From the waste management (recycling) perspective, do you see that compatibility is an important parameter in the introduction of bio-based materials?
Waste Management-Compatibility

- Very negative, it can be a barrier.
- Negative, but it can be handled.
- No role
- Positive, but it may not so important.
- Very positive, it can be driver.

From the supply chain point of view, what do you perceive about reliability of supply of bio-based packaging materials/products?
Installation-Compatibility

- Very negative (Barrier to adopt)
- Negative
- No role
- Positive
- Very positive (Driver to adopt)

Do you think that introduction of bio-based material introduces new complexity in your company?
Organizational Complexity

- Yes, it has totally negative effect and it makes implementation harder.

- Yes, it makes it complicate but it can be handled.
- No role at all.
- No, actually it can help to make process simpler than the current one.
- No, it makes the organization much simpler and therefore totally preferable from this perspective.

What do you think about the involvement of supply chain in the adoption of bio-based products?
Supply Chain Complexity

- Supply Chain is barrier for adoption, very negative.
- Negative but it can be adopted.
- No role at all.
- Positive but it is not so important.
- There is a strong involvement, very positive, it is a driver.

Do you expect that introduction of bio-based material affects your brand image?
Brand Image Complexity

- Yes, it damages our brand image strongly.
- Yes, it affects negatively.
- No role at all.
- Yes, it helps our brand image.
- Yes, it supports our brand image strongly.

Do you think that bio-based materials can be tried on the market shelf easily?
Market Trial-ability

- No, it is almost impossible to try. (Barrier)
- No, it is hard but it can be tried on a small scale.
- It can be tried but takes some time.
- It can be tried easily.
- It can be tried without any extra effort. (Driver)

Do you think that bio-based materials can be tried on the production line easily?
Technology Trial-ability

- No, it is almost impossible to try. (Barrier)
- No, it is hard but it can be tried on a small scale.
- It can be tried but takes some time.
- It can be tried easily.
- It can be tried without any extra effort. (Driver)

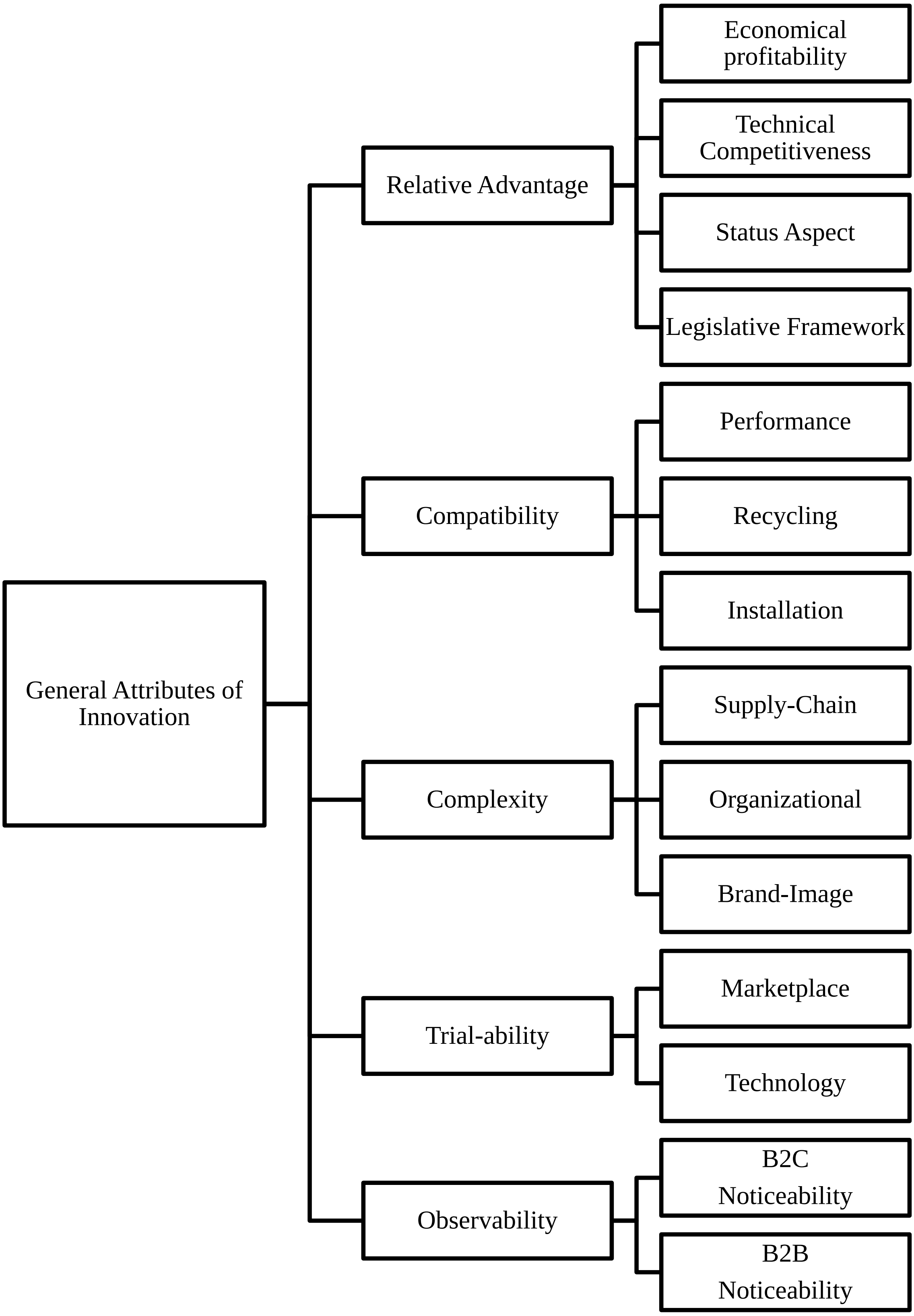
Do you think that the end customers play a role in a possible adoption of bio-based materials?
Business to Consumer Observability

- Important role in negative sense (They are barriers for adoption of bio-based materials)
- Intermediate role in negative sense (They are barriers for adoption of bio-based materials)
- No role
- Intermediate role in positive sense (They are drivers for adoption of bio-based materials)
- Important role in a positive sense (They are drivers for adoption of bio-based materials)

Do you think that the end customers play a role in a possible adoption of bio-based materials?
Business to Business observability

- Important role in negative sense (They are barriers for adoption of bio-based materials)
- Intermediate role in negative sense (They are barriers for adoption of bio-based materials)
- No role
- Intermediate role in positive sense (They are drivers for adoption of bio-based materials)
- Important role in a positive sense (They are drivers for adoption of bio-based materials)

APPENDIX B: FRAME OF SEMI-STRUCTURED SURVEY



APPENDIX C: FINDINGS OF INTERVIEWS WITH KEY MARKET PLAYERS

FACTOR / COMPANY	Unilever Sweden	Nestle Sweden	Elopack Sweden	Procordia Sweden
	Brand Owner	Brand Owner	Packaging Converter	Brand Owner
Position	Packaging Manager	Brand Manager Quality Manager (Responsible from packaging material)	Technical Manager	Packaging Manager
Decision Level	Operational	Tactical	Operational	Strategic
Awareness	They do not have any product, awareness also less.	They do not have any product in that segment; it is perceived they are not aware about these products.	They are not aware of bio-based materials as a technical manager.	They do not have any bio plastic material. But they are aware and discuss it. End customer should be aware of these solutions according to them.

	FACTOR / COMPANY	Unilever Sweden	Nestle Sweden	Elopack Sweden	Procordia Sweden
Relative Advantage	Economical profitability	Packaging is perceived totally price sensitive. And this business is all about money. Those changes should attract some market change.	Price sensitive product, they have only little margin to increase.	Price sensitive product.	It should justify the price. Price sensitive. They assume people are not willing to pay premium for that.
	Technical Competitiveness	Aluminum preferred because of its best barrier properties as a layer.	They focused on material thickness and weight in packaging.	Technological challenge is coming from using minimum material. PE is the easy way to solve bonding problems.	Convenience is the first agenda, people are default lazy. It takes time and cost to implement new solutions.

Relative Advantage	Status Aspect	Recycling is the main agenda with CO_2 reduction.	Bio-packaging materials are on the discussion. They focus on water and less water consumption.	For them it is not a differentiating factor now, but there is a trend about the materials used in the packaging.	Now, they see that they cannot use bio material as a marketing tool because of the debates on them. It is a question that whether we will benefit by going green.
	Incentives	They do not perceive any incentives.	They do not perceive any incentives.	They do not perceive any incentives.	They do not perceive any incentives. However, they have doubts about the implementation in the case of legislation.

	FACTOR / COMPANY	Unilever Sweden	Nestle Sweden	Elopack Sweden	Procordia Sweden
Compatibility	Performance	They have no bio-package. No information about performance.	They do not have any information. But perceive it can be ok and used for the existing products.	They do not have any information.	At least it should sustain same performance or better. Food waste is bigger issue.
	Recycling	They perceive no problem about recycling of new materials.	No info.	No info.	Recycling is not adjusted for that and it is a problem for them.
	Installation	They perceive no barrier about installation of new materials.	They perceive it is important and new materials may not be compatible with current machinery.	It can be hard according to new technology to adapt.	It should be compatible with machinery.
Complexity	Supply-Chain	They focus on upstream integration with suppliers. If suppliers have this product in their catalogue, they are interested to consider and try.	They give attention to suppliers. If suppliers have this product in their catalogue, they are interested to consider and try new technology.	For them the customer should demand such a product. Design is determined by customer.	Concerning about raw material capacity. Retailers have a power on supply chain; they should take the financial risk. Looking for more profit margins. Also. Supplier (Tetra pack) has bargaining power on them.

	FACTOR / COMPANY	Unilever Sweden	Nestle Sweden	Elopack Sweden	Procordia Sweden
Complexity	Organizational	They don't perceive any complexity in the organizational level.	They perceive complexity in factory.	From a technical point of view, it will be hard and will introduce more complexity.	It is easy if there will be no complexity in the implementation in the organization.
	Brand-Image	Image can be driver, because they want to be leader in every segment.	They like sustainability projects but economical sustainability has greater importance.	The kind of raw material will be the important in the future.	It is a complex discussion for them. Use of bio-mass while world is starving then using bio-based packaging material.

	FACTOR / COMPANY	Unilever Sweden	Nestle Sweden	Elopack Sweden	Procordia Sweden
Trial-ability	Marketplace	Perceived no barrier or motivation	There is no pressure from the market. Trial-ability can be easy.	Retailers are the key for introduction to the market.	Retailers are important for trial-ability.
	Technology	Perceived no barrier or motivation	Trial-ability in the factory can be hard. Installment can be problem.	In small scale, trial-ability is possible, full test is harder because of the time perspective.	No concern about technology

	FACTOR / COMPANY	Unilever Sweden	Nestle Sweden	Elopack Sweden	Procordia Sweden
Observability	B2C Observability	Perceive no observability.	Customer observability is weak.	Customer observability is weak.	Customer observability is weak. Consumer accept solutions but not with extra price. It can be tried much more in a niche segment and small companies more easily.
	B2B Observability	Perceive more observability from competitors.	Competitor's observability is strong.	Competitor's observability is strong.	Competitor's observability is strong. They searched for the supplier of Coca-Cola and Heinz and tried to supply material from them but because of the agreement they could not.

FACTOR / COMPANY	**Unilever Sweden**	**Nestle Sweden**	**Elopack Sweden**	**Procordia Sweden**
Trends / Clusters	Change in the size is trend now. Competitor can trigger adoption.	Minimization in material thickness and weight are trends.	Minimization in especially secondary packaging material, wrap-around design is increasing; reusability at the end is getting more importance because of convenience.	Catering Industry can demand in the case of domestic waste consideration.
	CO_2 emissions, and recycling are the main concerns.	Water consumption is the main concern.	Window in the package is demanded by retailers.	Niche markets and local products more applicable because of low risk and high profit margins to go green.

FACTOR / COMPANY	Unilever India	Nestle India	Cadbury India	Dabur India
	Brand Owner	Brand owner	Brand Owner	Brand Owner
Position	1 Development Executive 2 Packaging Development Managers	1 Packaging Development Manager	1 Associate Vice President- Packaging Development	1 Packaging Development Head 1 Senior manager Packaging Development 2 Corporate Packaging Development Managers
Decision Level	Strategic	Strategic	Strategic	Strategic
Awareness	They do not have any product, awareness also less.	They do not have any product in that segment; they are aware of some products but it is not up to date information.	They are not aware of bio-based materials as a technical manager.	They do not have any bio plastic material. But they are aware and discuss it. End customer should be aware of these solutions according to them.

	FACTOR / COMPANY	Unilever India	Nestle India	Cadbury India	Dabur India
Relative Advantage	Economical profitability	Packaging is perceived totally price sensitive. And this business is all about money. Those changes should attract some market change.	Market is completely price sensitive. Cost is one of their main elements. Consumers are not willing to pay more for bio-based product.	Price sensitive product.	It should justify the price. Price sensitive. They sure that the customers are not willing to pay premium for that. Totally cost driven, mass production market.
	Technical Competitiveness	Aluminum preferred because of its best barrier properties as a layer.	They focused on material thickness and weight in packaging. Minimization in packaging is global strategy that they follow.	Technological challenge is coming from using minimum material. PE is the easy way to solve bonding problems.	They have technical concern perceiving that bio-plastics is not competitive with conventional one. Their main aim is minimum use of material. Minimum thickness and weight.
	Status Aspect	Recycling is the main agenda with CO_2 reduction.	Bio-packaging materials are on the discussion. They focus on less water and energy consumption.	For them it is not a differentiating factor now, but there is a trend about the materials used in the packaging.	They don't see any benefit or status change with using bio-plastic product. Cost is strongly concerned.
	Incentives	They do not perceive any incentives.	They have not perceived any incentives by legislation or taxes yet.	They do not perceive any incentives.	They do not perceive any incentives and legislation. However, they have doubts about the implementation in the case of legislation.

	FACTOR / COMPANY	Unilever India	Nestle India	Cadbury India	Dabur India
Compatibility	Performance	They have no bio-package. No information about performance.	They do not have any information. But perceive it can be ok and used for the existing products.	They do not have any information.	At least it should sustain same performance or better. They perceive that bio-degradable have some heavy metal that can harm environment.
	Recycling	They perceive no problem about recycling of new materials.	They have a good waste management system inside the company (7-8 plants in India). However, waste management is primitive stage in India and difficult to manage. .	No info.	They pointed out especially lack of waste management. The recycling system is not there and no support for bio degradability.
	Installation	They perceive no barrier about installation of new materials.	They perceive it is important and new materials may not be compatible with current machinery.	It can be hard according to new technology to adapt.	It should be compatible with machinery.

	FACTOR / COMPANY	Unilever India	Nestle India	Cadbury India	Dabur India
Complexity	Supply-Chain	They focus on upstream integration with suppliers. If suppliers have this product in their catalogue, they are interested to consider and try.	Risk mitigation is one of their strategy for sourcing. They need more than one reliable supplier for minimizing the risk.	For them the customer should demand such a product. Design is determined by customer.	There is no barrier perceived for new materials.
	Organizational	They don't perceive any complexity in the organizational level.	They perceive complexity in factory.	From a technical point of view, it will be hard and will introduce more complexity.	It is easy if there will be no complexity in the implementation in the organization.
	Brand-Image	Image can be driver, because they want to be leader in every segment.	They do sustainability projects as well as they support economical sustainability such as reduction in water, energy and CO2.	The kind of raw material will be the important in the future.	They have environmental concern but they perceive they have no better alternative product than current one regarding cost and performance.

	FACTOR / COMPANY	Unilever India	Nestle India	Cadbury India	Dabur India
Trial-ability	Marketplace	Perceived no barrier or motivation	If there is a ready solution, they are ready to try. There is no pressure from the market. Trial-ability can be easy.	Retailers are the key for introduction to the market.	Retailers are important for trial-ability.
	Technology	Perceived no barrier or motivation	Trial-ability in the factory can be hard. Installment can be problem. But in small scale, it is perceived to be tried.	In small scale, trial-ability is possible, full test is harder because of the time perspective.	No concern about technology.

	FACTOR / COMPANY	Unilever India	Nestle India	Cadbury India	Dabur India
Observability	B2C Observability	Perceive no observability.	Customer observability is weak. They are communicating along the packaging labels, however, it should be clear and consumer should be aware about that.	Customer observability is weak.	Customer observability is weak. Consumer accept solutions but not with extra price.
	B2B Observability	Perceive more observability from competitors.	They are aware of what competitors do, however they do not follow any of them by doing their own R&D.	Competitor's observability is stronger than B2C.	They do not seek for benchmarking intentionally. But they see B2B more observable than B2C.

FACTOR / COMPANY	**Unilever India**	**Nestle India**	**Cadbury India**	**Dabur India**
Trends / Clusters	Change in the size is trend now. Competitor can trigger adoption.	Minimization in material, thickness and energy as well as CO2 emission.	Reducing material is the main target in packaging.	Minimization in material thickness and weight are trends
	CO_2 emissions, and recycling are the main concerns.	Food safety is their priority in every case. They are using LCA tool in decision of packaging material.	Overall packaging cost is trying to be handled with transportation conditions.	No other consideration.

FACTOR / COMPANY	Parksons Packaging India	TCPL India	IPP India	ITC India
	Packaging Converter	Packaging Converter	Packaging Converter	All Value Chain
Position	1 Executive Director 1 Asst. Vice President Marketing Sales 1 Senior Manager Marketing & Sales 1 Asst. Manager Marketing Sales	Managing Director	1 Vice President 1 Executive Director	Divisional Manager Packaging Development Principal Manager Packaging Development Manager Packaging Development
Decision Level	Strategic	Strategic	Strategic	Strategic
Awareness	They are aware of bio-degradable and renewable products but they don't use.	They are aware about the materials but do not have any in their product segment.	They have paper based packaging products. They are totally aware of these products. They don't have any bio-plastics.	They are totally aware of these products. They don't have any bio-plastics.

	FACTOR / COMPANY	Parksons Packaging India	TCPL India	IPP India	ITC India
Relative Advantage	Economical profitability	Packaging is perceived totally price sensitive business because of the income level of end customers.	Market is completely price sensitive. Cost is one of their main elements. Consumers are not willing to pay more for bio-based product.	Economically not profitable and this is the main concern for them. Price is the main barrier, if the cost will be the same there is no reason to change from plastics.	Economically not profitable and this is the main concern for them. Price is the main barrier, it should be adding value factor to change their existing packaging other than sustainability.
	Technical Competitiveness	They perceive as not competitive as conventional materials.	They focused on minimization of material and optimum daily packages such as sachets and pouches.	They have no technical concern. Just cost and regulation are considered.	The company tried some of them, they are not sure about bio-degradable materials are technically competitive in high humidity and temperature in India.
	Status Aspect	Packaging is not recognized as a status image yet.	They do not see any brand image change as a packaging converter. FSI certificate that they have is certify the raw material is coming from sustainable sources.	No brand concern. They are Packaging for various brands national and international.	There is no customer awareness and demand about this products. Everything is based on value. No consideration for status.
	Incentives	They do not perceive any incentives. Regulations are in primitive stage but they believe it is a matter of time.	They have not perceived any incentives by legislation or taxes yet.	Regulations are in primitive stage. In the case of legislation, they will comply.	There are some legislations but they are in primitive stage. They perceive that government says alternatives in the case of banning conventional plastics.

	FACTOR / COMPANY	Parksons Packaging India	TCPL India	IPP India	ITC India
Compatibility	Performance	They perceive is one of the main barrier.	They do not have any information. But perceive it can be ok and used for the existing products.	At least it should sustain same quality. They prefer incremental improvement with low investment.	For them, it should be something extra to make change the existing production system.
	Recycling	There is no waste management system to support this recyclability. It should trigger this materials.	They have a good waste management system inside the company (7-8 plants in India). However, waste management is primitive stage in India and difficult to manage. .	Total waste management system should be considered and adjusted.	There is no waste management system. Therefore, usage of bio-degradable in current landfill is perceived as another discussion.
	Installation	They perceive no barrier about installation of new materials.	They perceive it is important and new materials may not be compatible with current machinery.	They do not perceive any barrier.	They see that once it is decided, installation is not a big barrier as performance and cost.

	FACTOR / COMPANY	Parksons Packaging India	TCPL India	IPP India	ITC India
Complexity	Supply-Chain	They see scarcity of wood in India. It can be barrier for supplying bio-based material.	Risk mitigation is one of their strategy for sourcing. They need more than one reliable supplier for minimizing the risk.	For them the customer should demand such a product. Design is determined by customer.	They want to close the chain from the supply material to end consumer. The less amount of supplier is the barrier for them regarding risk mitigation.
	Organizational	They don't perceive any complexity in the organizational level.	They do not think it will be the barrier comparing the cost and performance discussion.	No barrier is perceived in that segment.	They don't see any barrier.
	Brand-Image	They don't see any barrier and driver as an image. If there is a certification in B2B, then it can change.	The certificates and awards they have establish their brand image. No driver for bio-degradable but driver for renewables.	It can be the driver but not the only driver. Legislation and overall cost are the most important drivers	It can be driver but not only with green packaging. It should add some value to chain.

	FACTOR / COMPANY	Parksons Packaging India	TCPL India	IPP India	ITC India
Trial-ability	Marketplace	Perceived no barrier or motivation	If there is a ready solution, they are ready to try. There is no pressure from the market. Trial-ability can be easy.	Cost the only barrier. Nobody want to invest sustainable projects.	They perceive as not a barrier.
	Technology	Perceived no barrier or motivation	Trial-ability in the factory can be hard. Installment can be problem. But in small scale, it is perceived easy to be tried.	Whit the small adjustment. That can be tried. No barrier	They perceive as not a problem.

	FACTOR / COMPANY	Parksons Packaging India	TCPL India	IPP India	ITC India
Observability	B2C Observability	Perceive no observability.	Customer observability is weak. They are communicating along the packaging labels, however, majority of customers seeks for value for money not for green product or packaging.	This is not very observable. But having sustainable raw material is important for some European customers. By increasing organized retail, cost effectiveness will be more important.	There is almost no observability from the end customer. They are even not aware.
	B2B Observability	Perceive more observability from competitors.	They are aware of what competitors do, observability is higher. However, it should the common understanding for driving force of bio-based packaging.	It is perceived no competitor concern. They are growing with double digits with current products.	Competitor's observability is higher than customer, however, there is no driving competition to these products.

FACTOR / COMPANY	Parksons Packaging India	TCPL India	IPP India	ITC India
Trends / Clusters	Lamination for cleaning and protection. Metalized coating for premium segment.	Minimization in material, thickness and energy. Smaller package size for smaller unit sales.	Flexible packaging is a trend. Shelf ready packaging will increase with the organized retail.	They want to see project to close supply chain in packaging.
	Small packages and transition from glass to plastics are trends.	Edible packaging is perceived as trend as well.	Recycled board has the cheapest price in India and open to export neighbor countries.	Cost effective packaging solutions are researched to catch rural market.

FACTOR / COMPANY	Heinz India	Kellogg's India	Big Bazaar India	Natur-Tech India
	Brand Owner	Brand Owner	Retailer	Plastic Bags, Cutlery products
Position	Packaging Development Manager Packaging Development Assistant Manager	Procurement Manager	They were not interested. It is used for field research.	Packaging Manager
Decision Level	Strategic	Strategic	Field Research	Operational
Awareness	They are aware of bio-degradable and renewable products but they don't use.	They do not have any product in that segment; they are aware of some products but it is not up to date information.	They are not interested about these products. The bio-degradable packages were not observed.	They are totally aware of these products and they have a competitive edge in these materials.

	FACTOR / COMPANY	Heinz India	Kellogg's India	Big Bazaar India	Natur-Tech India
Relative Advantage	Economical profitability	Packaging is perceived totally price sensitive business because of the income level of end customers.	Market is completely price sensitive. Cost is one of their main elements. Consumers are not willing to pay more for bio-based product.	Economically not profitable and this is the main concern for them. Price is the main barrier, their negotiation with supplier is based on cost.	Economically not profitable and this is the main concern for them. Price is the main barrier, if the cost will be the same there is no reason to change from plastics.
	Technical Competitiveness	They perceive as not competitive as conventional materials.	They focused on material thickness and weight in packaging. Minimization in packaging is global strategy that they follow.	No info. There are some damaged packaged products in the shelf. They are sold by discount.	In the evolution process, not mature comparing with the plastics which has 50 years of development.
	Status Aspect	Packaging is not recognized as a status image yet.	Bio-packaging materials are on the discussion. They focus on less water and energy consumption.	No brand concern. They are Packaging for various brands national and international.	They define and market themselves as a sustainable company with these product. This is the core competence of the company.
	Incentives	They do not perceive any incentives. Regulations are in primitive stage.	They have not perceived any incentives by legislation or taxes yet.	Regulations are in primitive stage. In the case of legislation, they will comply.	Only in some states of US, they see incentives because of the higher taxes of non-biodegradable waste.

	FACTOR / COMPANY	Heinz India	Kellogg's India	Big Bazaar India	Natur-Tech India
Compatibility	Performance	They perceive is a barrier of biodegradables but not renewable ones.	They do not have any information. But perceive it can be ok and used for the existing products.	At least it should sustain same quality. They prefer incremental improvement with low investment.	At least it should sustain same quality.
	Recycling	There is no waste management system to support this recyclability.	They have a good waste management system inside the company (7-8 plants in India). However, waste management is primitive stage in India and difficult to manage. .	There is no concern about recycling.	Total waste management system should be considered and adjusted.
	Installation	They perceive no barrier about installation of new materials.	They perceive it is important and new materials may not be compatible with current machinery.	No info.	They do not perceive any barrier. With the small adjustments they can install new products.

	FACTOR / COMPANY	Heinz India	Kellogg's India	Big Bazaar India	Natur-Tech India
Complexity	Supply-Chain	They focus on upstream integration with suppliers. If suppliers have this product in their catalogue, they are interested to consider and try.	Risk mitigation is one of their strategy for sourcing. They need more than one reliable supplier for minimizing the risk.	For them the customer should demand such a product.	Suppliers are not domestic which is barrier for them. They imported from China, Europe and Exported to Europe, USA.
	Organizational	They don't perceive any complexity in the organizational level.	They perceive complexity in factory.	No support or barrier is perceived in that segment.	No barrier is perceived in that segment.
	Brand-Image	Image can be driver, because they want to be leader in every segment.	They do sustainability projects as well as they support economical sustainability such as reduction in water, energy and CO2.	There is no incentive for them to buy bio-packaged products.	It can be the driver but not the only driver. Legislation and overall cost are the most important drivers.

	FACTOR / COMPANY	Heinz India	Kellogg's India	Big Bazaar India	Natur-Tech India
Trial-ability	Marketplace	Perceived no motivation to try these products. But it is no barrier as well in the case of potential competitive product.	If there is a ready solution, they are ready to try. There is no pressure from the market. Trial-ability can be easy.	Cost the only barrier.	Cost the only barrier.
	Technology	They Perceive no barrier or motivation.	Trial-ability in the factory can be hard. Installment can be problem. But in small scale, it is perceived to be tried.	No barrier.	That can be tried. No barrier.

	FACTOR / COMPANY	Heinz India	Kellogg's India	Big Bazaar India	Natur-Tech India
Observability	B2C Observability	They perceive no observability from the consumer.	Customer observability is weak. They are communicating along the packaging labels, however, it should be clear and consumer should be aware about that.	This is not very observable. Customer is not demanding these kind of products.	This is not very observable, Customer can feel the difference and it will be beneficial with increased awareness.
	B2B Observability	They perceive more observability from competitors.	They are aware of what competitors do, however they do not follow any of them by doing their own R&D.	No info.	This is totally a niche market, observable and B2B observability triggers and increases the market size. However, plastic producers are generally not focused on their products.

FACTOR / COMPANY	Heinz India	Kellogg's India	Big Bazaar India	Natur-Tech India
Trends / Clusters	Change in the size is trend now. Competitor can trigger adoption.	Minimization in material, thickness and energy as well as CO2 emission.	Flexible packaging is a trend. Shelf ready packaging will increase with the organized retail.	Products with short life-span can be target segment as a cutlery, plastic bags, and plates.
	CO_2 emissions, and recycling are the main concerns.	Food safety is their priority in every case. They are using PIQUEIT LCA tool in decision of packaging material.	In the discount products especially, many damaged packages are observed. The private brands are observed as cost competitive product.	CO_2 emission will be more important.