

**THE FUTURE OF BIOPLASTICS: A CASE STUDY OF
PTT GLOBAL CHEMICAL PUBLIC COMPANY LIMITED**



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PTT GLOBAL CHEMICAL PUBLIC COMPANY LIMITED**

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ABSTRACT

The purpose of this paper is to identify the concerning factors that affect the success of bioplastic business in Thailand and to find the evidence that Thailand can become the regional hub for bioplastics or not. The qualitative research was conducted by using in-depth interviews with ten respondents who are professional in this research area.

The research results that there are many good signs or factors that support the potential growth of bioplastics in Thailand. With the support from government and public factors, plus a good start-up case in this business by PTT Global Chemical Plc. (PTTGC), and including the readiness of plastic manufacturers, the bioplastics has a bright future in Thailand.

KEY WORDS: Bioplastics/ Bio hub/ Biodegradable/ PTTGC/ PLA

24 pages

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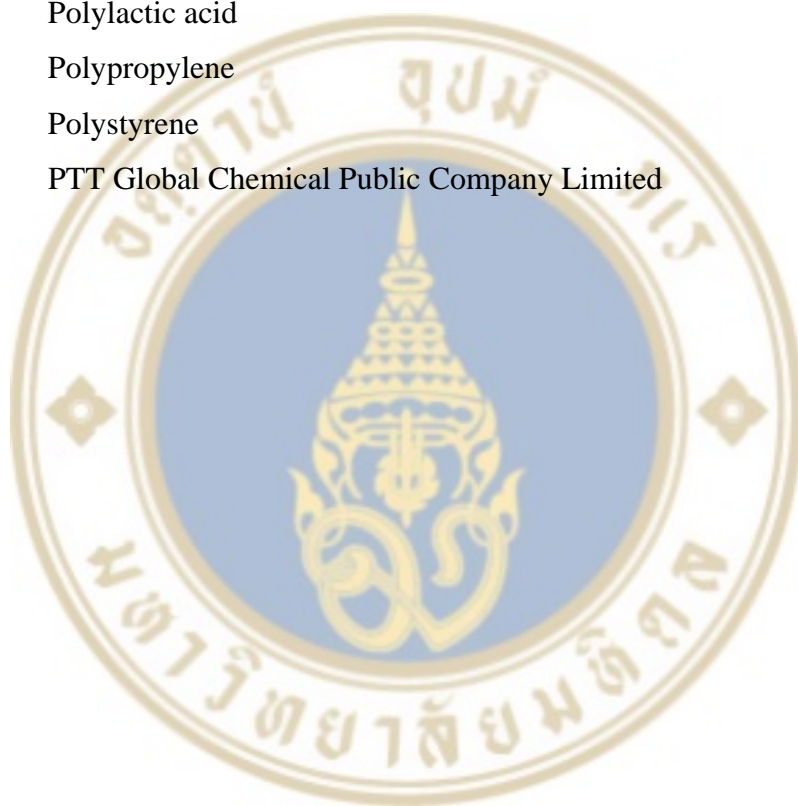
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LIST OF ABBREVIATIONS

BOI	Board of Investment of Thailand
LCA	Life Cycle Assessment
PET	Polyethylene terephthalate
PLA	Polylactic acid
PP	Polypropylene
PS	Polystyrene
PTTGC	PTT Global Chemical Public Company Limited



CHAPTER I

INTRODUCTION

This chapter presents background and purpose of study of this research. The importance of plastics, concept of changing from conventional plastic to a more bio-based material, and opportunities for bioplastics business in Thailand such as feedstocks availability and consumer's acceptance towards green products are described.

1.1 Background

Plastic materials are a fundamental determinant of sustainability and knowing that they are of such necessary in our daily life (Geiser, 2001). The exceptional properties of plastic materials made their performance over others: metal and wood, and currently considered very important materials (Aguado and Serrano, 1999; Azapagic et al., 2003; Plastics Europe, 2008; Rosato and Rosato, 2003). In fact, the amount of plastics produced throughout the entire 20th Century is as large as the amount produced during the only first 10 years of the 21st Century (Thompson et al., 2009).

Theinsathid et al. (2009) states Thailand is an agricultural country; its major products of economic are crops and sugar. The country has become one of the world's largest sugar exporters resulted from the constantly growth sugar production in Thailand for over 20 years. This industry plays a significant role in the country's economic and social development, generating more than 50 billion baht yearly from domestic and exports sales, making it become one of the country's leading industrial sectors.

Since, green products often place themselves the better position in quality and being safe for the environmental when compared to non-green products (Borin et al., 2013), Mülhaupt (2013) questions about the problems threatening the future of

plastics which are the declining oil reserves, littering problem, and global warming that could lead us to enter a new era of green technology and exit petro chemistry with a regeneration of a more bio or green materials.

Hence, manufacturers are seeking for healthier and safer materials and having great interest in developing and commercialized the bio-based plastics based from plants for a variety of uses in many products and packaging, as alternatives for chemicals and materials of daily consumer products. Theoretically, Bio-based materials can be composted or recycled since they are promising their feedstocks are renewable, their production process may be more energy efficient comparative to petroleum-based plastics processing (Alvarez-Chavez et al., 2011).

As a result, to make bioplastics more comparable to conventional plastic, a good example case that reflects the adoption process of bioplastics in Thailand could be helpful to stimulate Bioplastics industry in Thailand. The results of study could provide directions that support Thai plastics manufacturers to make significant contribution to bioplastics and make sustainable growth in this field.

1.2 Purpose of study

This study aims to determine the proper growth towards the bioplastics based on the case study of PTT Global Chemical Public Company Limited. The research questions are mainly focused on “Can Thailand become the regional hub for bioplastics in near future?” and “What are the concerning factors that affect the success of bioplastics business in Thailand?”

CHAPTER II

LITERATURE REVIEW

This chapter discusses about the finding of bioplastics gathering from literatures, journals and other relevant secondary researches. The previous findings include bioplastics' definition, transformative global trends, green purchase intentions, prospective of Polylactic acid (PLA), which is the most expected and widely used bioplastics, and the innovation adoption process to accept the bioplastics in general.

2.1 Bioplastics

Since the Environmental Preference Spectrum for the health-care industry was developed by Rossi and Lent in 2006, bio-based plastics are much further along in the commercial development. Alvarez-Chavez et al. (2011) claims the substitution of petroleum-based plastics with bio-based plastics is seen as a promising alternative since it will reduce the pressure on landfills from plastic solid wastes and the dependency of plastics on fossil fuels that have less health and environmental impacts.

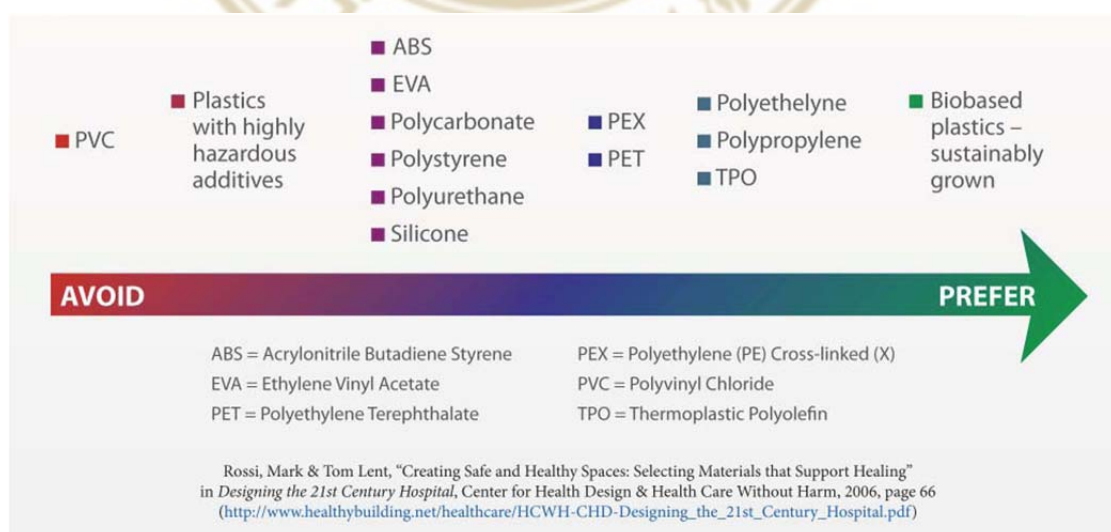


Figure 2.1 Plastics: Environmental preference spectrum

Source: (Walsh, 2010)

According to Bioplast (2013), “Bioplastics” can be categorized into three main categories: (1) Biodegradable based on “renewable resources” materials e.g. Polylactic acid (PLA) or Polybutylene succinate (PBS), (2) Bio polyethylene based on “renewable resources” materials that can partially replace the petro-based commodity plastics e.g. Polyethylene terephthalate (PET), Polyethylene (PE), and Polypropylene (PP) or engineering plastics e.g. Polyamides (PA) and Polycarbonate (PC), but are not biodegradable, and (3) Biodegradable Petro-based materials.

2.2 Transformative global trends

The top three trends that chemicals CEOs believe it will transform their business in the next five years are technological advantages, shifts in global economic power, and resource scarcity and climate change. For technology investments, only one-third of CEOs feel that they are well prepared for R&D. Hence, developing skilled workforce is a major priority due to the short supply of engineers and technical staffs in chemicals businesses. Also, most of chemicals CEOs said environmental sustainability is important; they concern more about raw material prices and strongly commit to CO₂ reduction. (PwC, 2014) In other words, the chemical companies try to be innovative on helping their customers to reduce the environmental footprint.

2.3 Green purchase intentions

Young et al. (2010) states consumers’ decision- making process becomes increasingly complex when they choose to adopt a sustainable lifestyle. There is a positive relationship between green product quality and customer loyalty and between green product quality and customer satisfaction but it is limited aspects since their project did not provide product descriptions (Chang and Fong, 2010). Therefore, the company who concerned about environmental issues has the aims of achieving consumers’ and society’s satisfaction by putting intention to develop more green products (Soonthonsmai, 2007).

However, “Many people don’t put dollars and cents first when going green, basing their decisions instead primary on ethics and desire to help the planet”. (Smart Money, 2010)

2.4 Prospects of PLA bioplastics

Apart from the new greenish touch, cost-effective and highly adaptable polymers play an important role in sustainable development (Mülhaupt, 2013). While a made from fossil fuels conventional plastics persist for many years after disposal, bio-bags are degradable and can decompose in the correct environment with proper microorganisms such as bacteria and fungi. Bioplastics have the potential to decrease the use of fossil fuels and to avoid non-degradable and bulky plastic wastes, and related environmental and health impacts (Alvarez-Chavez et al, 2011).

Among polymers for producing plastic, sugar-based cellulose; the major component of biomass, wood, and cotton, is the most plentiful organic compound produced by living organisms (Klemm et al., 2004). In 2009, Madival et al. state a biodegradable plastic made from Polylactic acid (PLA); a thermoplastic aliphatic polyester produced from lactic acid that uses glucose obtained from corn starch and sugar cane as the carbon source synthesized by microorganisms (Iwata, 2015), is wildly used when compared to conventional petroleum-based plastics. Vink et al. (2007) also confirm that PLA has lower environmental footprint than those petroleum-based plastics such as PS, PP, and PET.

Generally, Polylactic acid (PLA) and Polyhydroxyalkanoates (PHA) polymers are preferred over other bio-based polymers, according to the specified criteria. One of quantitatively tools that wildly used to assess the environmental impact of product throughout its lifespan is a Life Cycle Assessment (LCA); the principles and framework described in ISO 14040 (ISO, 2006). LCA is a tool for measuring products performance in terms of the projections of environmental improvement and sustainability (Dewulf and Van Langenhove, 2002).

An example of using LCA with bioplastic product is a calculation on the production and disposal between bio-plastic and conventional plastic carrier bags. The investigation found that Bio-bags are 80 percent more environmentally friendly than

normal plastic bags throughout its life cycle production stages when geothermal energy is used (Khoo et al., 2010). To sum up, Khoo et al. (2010) state a solution for solving plastic waste issues is a conservative approach required in the introducing of bio-based carrier bags.

According to Iwata (2015), bioplastics have already been used as food packaging materials or in miscellaneous disposable goods with day-to-day usage. In the prospect, bioplastics are expected to be used as materials for fisheries, for example, as fishing lines or fishing nets, as agricultural engineering materials, such as sandbags or mulch films, or as sanitary goods, such as paper diapers and in a medical context as bio absorbable materials, for example surgical sutures or scaffolds. However, PLA is exposed to high temperature and humidity conditions and limited to be used for short shelf life products packaging such as blister, clamshell, trays and bottles.

In most cases, the amounts of energy and resources in production process have not been taken into account, although bio-based products have been mostly considered as a sustainable solution for replacing petroleum-based polymers, (Khoo, 2010). In addition, the true practical use of bioplastics is suspended by many problems. More study is needed to enhance environmental friendly and safer plastics, and it is also necessary to address the range of concerns surrounding the sustainability of the bio-based plastics industry (Alvarez-Chavez et al, 2011). For example, Iwata (2015) claims that when a non-bio degradable plastic is blended with a biodegradable plastic, only the biodegradable components will be degraded in the environment plastic. The non-biodegradable plastics will still make an environmental pollution due to they are broken up into smaller pieces and diffused into the environment.

Although, PLA is the most commonly used bio-based polymer, PLA is not competitive enough with commodity plastics since it has no clear needs of market. Hence, the most expectant bioplastics, PLA is still far behind the commercialization step (Vink et al., 2007). Moreover, many of factors' that effort an innovative plastic industry is derived in collaboration with technology push and demand pull, the manufacturers should focus on value added or higher product application (Theinsathid et al., 2009).

2.5 Innovation adoption

An innovation idea or product perceived to be new by the potential adopter when compare to existing products. It can also be defined objectively as ideas, behaviors, or things that are qualitatively different from existing forms. Blackwell et al. (2012) state some new products are significant to make competitive strength for most organizations through increase sales and profits. Moreover, many chemical companies think it's important to understand that innovation means more than new product development. The innovation should help improve processes, or create new services or even business models (PwC, 2014).

The winning firms generate “idea power” that provides competitive advantage, not only in new products but also in new idea in every area: lower-cost manufacturing processed, better packaging, and more efficient planning systems, however, it is important to remind that underlying needs may not be changed. Occasionally the changes have negative effects on the people who do not adopt them; an introducing of a new product is more significant when it can change how society is organized (Kanter, 1987).

2.5.1 The diffusion process of innovative product

Rogers (1982) finds that the diffusion process of innovative product or new idea is defined as the communication through certain channels overtime in a social system which is influenced by four primary success factors:

2.5.1.1 Innovation: New product, service, or idea

2.5.1.2 Communication: How consumers learn about new products, either through formal and informal channels. Marketers must also consider influence of advertising, sales persons, opinion leader.

2.5.1.3 Time: An individual's adoption decision from product awareness to product purchase or reject.

2.5.1.4 Social system: An interrelated of people, groups or systems that marketers may refer as market segments or target markets which can be described in terms of innovativeness or openness to new products or ideas.

2.5.2 The five main characteristics to introducing new products

Hassan (1990) indicates five main characteristics to support the successful to introducing new products which can be used to rate the adoption in the marketplace:

2.5.2.1 Relative advantage: The degree to which consumer may perceive it offer significantly greater benefits than the product they currently use.

2.5.2.2 Compatibility: The degree to which a new product is consistent with an individual's existing practices, values, needs, and past experiences of the potential adopters.

2.5.2.3 Complexity: The degree to which an innovation is perceived as difficult to understand and use. The more complex the new product, the more difficult it will be to gain acceptance.

2.5.2.4 Trialability: When consumers can experiment with or try the new product on a limited basis with limited financial risk such as sampling, couponing, and trial-sized product, the more success adapts. However, these methods also work for expensive, complex, high-involvement, even though a bit more creativity is required.

2.5.2.5 Observability: Also, communicability reflects the degree to which the results of using a new product are visible to neighbors. The more observable of its benefits, the products is more likely to diffuse faster and be successful.

CHAPTER III

RESEARCH METHODOLOGY

This chapter presents research objectives, research setting, and sampling and data collection conducted in this study.

3.1 Research objectives

This research aims to observe trends and ideas, rather than prove a hypothesis. The methodological approach of this paper is based on exploratory research, using qualitative research by having a depth interviews to understand more on the acceptance and application regarding to the future of bioplastics in Thailand, paralleled with a case study of one leading petrochemical company in Thailand: PTT Global Chemical Public Company Limited (PTTGC). The case study is used to investigate and understand the specific circumstances and difficulties, and not for the generality purpose. The company data, secondary data, company reports, and observation are also used to conclude research results.

3.2 Research setting

The list of open-ended questions is developed based on the necessity of finding out about the future of bioplastics in Thailand in the view of PTTGC. This interview technique allows unlimited answers since the interviewees are freely to express their opinions towards the asked issue.

3.2.1 The key research questions

- What are the factors that support the growth of bioplastics?
- How to make Bioplastics business become more competitive?
- How can bioplastics be sustainable to commercialize in Thailand?

- What are the advantages or disadvantages of bio-based plastic compared to conventional plastics?

3.2.2 The selective sampling respondents

The in-depth interviews based on the research questions were conducted with ten relevant persons and organizations in Thailand. The professionals are involved or consider getting involved in one of the following: (1) PTTGC (2) Thai government organization related to bioplastics industry (3) Consultancy related to bioplastics (4) Bioplastics producer or consumer. The selective sampling respondents' companies or institutes are:

- PTT Global Chemical Public Company Limited (PTTGC): 3;
- Thai Bioplastics Industry Association (TBIA): 1;
- The National Innovation Agency (NIA): 1;
- The Plastics Institute of Thailand (PITH): 1;
- Plastic Industry Club, The Federation of Thai Industries (PIC): 1;
- Bioplastics producer or consumer: 3

3.3 Sampling and data collection

Total ten interviewees were selected as representative of key respondents in their respective sectors and conduct one-on-one depth-interviewing. The key respondents are defined as the one who faced needs that will be required in bioplastics market in Thailand and are positioned to give significant results by answering and advising solution to above questions. The individual interview conducted between 15 - 30 minutes is preferred to be a face to face interaction and high level of interviewee commitment is required.

CHAPTER IV

DATA ANALYSIS

This chapter presents the research findings of the key research questions. The findings are grouped into four topics: The factors that support the growth of bioplastics, the directions to make bioplastics business become more competitive, the sustainable ways to commercialize bioplastics, and the advantages or disadvantages of bio-based plastic.

4.1 What are the factors that support the growth of bioplastics?

The worldwide demand of bioplastics has been projected to be increasing continuously. According to Green Network (2015), the 300 percent growth of bioplastics, which including bio-based and biodegradable plastics will be reached within 2019 or in the next three years while more than 75 percent of bioplastics expected to be produced in Asia. Thailand, as an agricultural country, has also prepared many factors such as feedstocks and the readiness of bioplastic producers to develop the bioplastics industry in the country to become Asian bio-hub in the near future.

The readiness of plastic manufacturers in Thailand is the key factor for the growth in bioplastics. According to The size of Plastic Manufacturers in Thailand report from Plastic Intelligence Unit (2015), more than 80 percent of the registered plastic manufacturers in Thailand are SMEs. However, these plastic manufacturers have potential to adapt their compounding and molding in the plastic production process to use bioplastics in some product such as biodegradable bags, plant nursery bag, plastic cup, and food packaging and expected to apply in further applications.

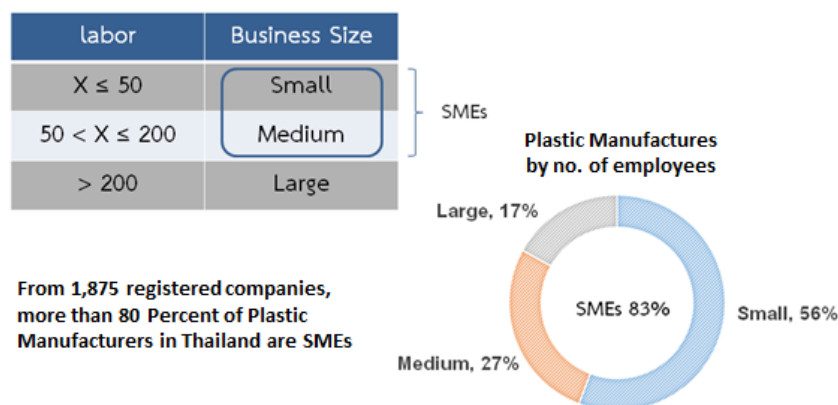


Figure 4.1 Size of Plastic Manufacturers in Thailand as of September 2015

Source: (Plastic Intelligence Unit, 2015)

These plastic manufacturers are adaptable to change with the technology driven. Bioplastic application is also in the mainstream direction for companies' growth because end users are aware of going green more than in the past. Since many current machines have been operated for long times and expected to be out date in the few years, the interview resulted that most of the plastic manufacturers are in between of purchasing new machines which are able to support the future innovative production. Technological advantages will transform their business into better position (PwC, 2014).

A skillful and quality labor is also an important part to support the readiness of plastic manufacturers. Hence, in 2014 Plastic Industry Club, The Federation of Thai Industries (PIC) discussed about the competitiveness among The ASEAN Economic Community (AEC) countries and put labor standard issue to be one of its strategy.

The interesting of research and development in bioplastics for both government and public companies in Thailand has been increasing consequently. This raises the support from government such as an increasing of Corporate Income Tax deduction in Research and Development expenses from 200 percent to 300 percent which make bioplastics gain more acceptances by reducing the difficulty of the production and become more competitive to conventional plastic.

In addition, the exemption of machinery import duties and the eight year exemption of corporate income tax do not interested enough for Thai plastic

manufacturers due to the cost of production of bioplastic in Thailand are still higher when compared to investment in neighborhood countries. Therefore, the Board of Investment of Thailand (BOI) has additional supporting on production costs reduction by assigning the Department of Energy to reduce cost of electricity and natural gas. Moreover, the BOI promotes more investment in bioplastics by giving three year exemption of import duty for 90 percent of raw materials that will use to produce and sale product domestically.

As suggested by the Ministry of Science and Technology, National Innovation Agency (NIA) has agreed with the framework to enhance the investment in bioplastics industry. Currently, Thailand is in the second phase of National Roadmap for the Development of Bioplastic Industry (2011-2015), the framework concerns strategies; ensuring availability of biomass supplies as raw materials, production technologies, product development, establishing new and innovative business, and developing infrastructure with the expected results in four aspects.

4.1.1 Economy

The employment approximately 200,000 people in bioplastic industry and related business resulted from the establishment of bioplastic manufacturing plant will bring the revenue to the government 6,260 million baht. Furthermore, the development of bioplastic production business, especially the PLA, will create 10,000 million aht investment values, and enlarge to the commercial scale with the productivity as 100,000 tons per year in 2015.

4.1.2 Social

Following groups of people will gain both direct and indirect benefits from the bioplastic: (1) The farmers who grow sugar cane and cassava, (2) the manufacturers of sugar and starch, (3) related people in plastics industry and (4) researchers and students.

4.1.3 Technology

The development of pilot plant in the form of patents increases intellectual property in Thailand. The expansion of knowledge, and research and development of

Thai researchers also drive technology in bioplastics industries to the international level.

4.1.4 Environment

The effective waste management and the more environmentally friendly product will be developed paralleled with the development of bioplastics.

4.2 How to make bioplastics business become more competitive?

Regarding to an interviewing with Chairman of The Thai Bioplastics Industry Association (TBIA), Thailand still has low demand in bioplastics from consumers currently. More publications to stimulate the use of bioplastics and the public relations to educate the benefits and importance of the use of bioplastics are needed which is related to one of the characteristics of the successful new products mentioned by Hassan, 1990. The more consumers perceive bioplastics can offer significantly greater benefits than the conventional plastics they currently use will create relative advantage. In fact, there is potential demand of bioplastics in global market. The supporting from government such as monetary policy for bioplastic industries would also catch attention of both local producers and foreign investor.

For the PTT Global Chemical Company Limited (PTTGC), the company has recently invested in NatureWorks LLC who represents the world's leading bioplastics manufacturer and famous in using natural plant and sugars to create the Proprietary Polylactide polymer marketed under the Ingeo brand name. Recently, PTTGC has announced to establish bioplastics manufacturing plant in Thailand. This significant investment will allow PTTGC and NatureWorks LLC to continue their growth by expanding its capacity to meet global demand for bio-based products.

With the aim to push Thailand to become an Asian bio-hub and become a global leader in bioplastics industry by 2020 as per Chief Operation Officer of PTTGC mentioned, the investment will strengthen PTTGC's green growth strategy towards sustainable development by offering more green products to the customers while integrate more renewable and environmentally friendly materials in its portfolio.

Moreover, since the medium size of plastic converters and producers in Thailand may not be able to invest in such a new innovative business with some risk factors concerning, the investment from PTTGC would be a good start-up for bioplastics manufacturing in Thailand. If PTTGC success, new producers will follow to join in the bioplastics and stimulate Thai economics in long run.

4.3 How can bioplastics be sustainable to commercialize in Thailand?

Thai people's consuming behavior has been changed to the more environmental friendly products recently. The greener product they use, the more people perceived that they are young, modern, and sophisticated adopt a sustainable lifestyle. To response to a sustainable lifestyle as per Young et al. (2010) mentioned, the plastics manufacturers try to improve their production process to support bio-based production in order to best serve their end users requirements towards the green products. This also confirms a positive relationship between green product quality and customer loyalty claimed by Chang and Fong (2010).

As a result, the bioplastics application is expecting to be increased in the near future. Moreover, with the availability of product experimental before commercialized by the supporting of leading petrochemical companies in Thailand, the SMEs can have sampling or trial-sized of bioplastic materials such as PLA. They can do the product use test to find the defects, adapt, and experiment new application based on a lower financial risk which could reduce the real production cost.

Regarding to Theinsathid et al. (2009), technology push and demand pull is important factors to effort an innovative plastic product. PTTGC is currently importing PLA from its partnership; NatureWorks LLC and has introducing many PLA projects which could replace the conventional plastic in some daily usage products. The collaborations are between PTTGC and both the government and public sectors in Thailand which give a good visible example of bioplastic application in various purposes to Thai consumers. The more application revealed to public, the more observable of bioplastics benefits, which could shorten the diffusion process.

Firstly, the collaboration on research and development with Royal Project Foundation and Thailand Research Fund has developed bioplastics for agricultural

practice. There are greenhouse covering plastic and bioplastic nursery bags currently using at many agricultural projects. The use of biodegradable plastics made from plants is environmental friendly and can help farmer to do easy planting without removing the bioplastic nursery bags, it can disposal in natural conditions.

Secondly, the launching of bioplastic yoghurt cup for Dairy Home's organic yoghurt products from three main parties; PTTGC, Dairy Home, and NatureWorks LLC increases an awareness to other companies to follow. Since Thai consumers have higher acceptance of pricier organic foods, Dairy Home which previously only sold its yoghurt products at higher-end supermarkets had been able to extend its market to at other leading stores such as Tops Supermarket, Gourmet Market, Villa Market, Foodland, Isetan, Big C, and Tesco Lotus (Changson, 2014). This also has confirmed Soonthonsmai (2007) that a company like Dairy Home who concerned about being 100 percent organic in both product and packaging has the aims of achieving consumers' and society's satisfaction by putting intention to develop its green products.

Lastly, PTT Group and its popular Amazon Coffee chain introduced coffee cups made of PLA. The Amazon PLA cup is a 100 percent made from plants that reduce the greenhouse gas emissions about 67 percent. The concern of green products as per Chang and Fong (2010) mentioned also bring a positive relationship between customer satisfaction and green product that resulted for an increasing number of Amazon's customer after launched the bioplastic cup.



Figure 4.3 Dairy Home biodegradable yoghurt cup and Amazon PLA cup

Above all collaborations reinforced the firm's strategy to become a petrochemical business leader who pays serious attention to economic, social and environmental impacts and also make PTTGC become a role model on bioplastics path.

To confirm the diffusion of innovations by Rogers (1982), PTTGC is expected to form the new Green Chemical Flagship in 2016 in order to fully integrate the bio-based value chain in two main line: Sugar base and Palm base since Thailand is the world's leading sugarcane producing country. With the expectation to bring bioplastic materials into the mainstream of plastic production, the communication of PTTGC through its Green Chemical Flagship would attract public interests through the collaboration with new company and the adoption of new product application for instance.

As per the information from sales person who contact directly with plastic manufacturers and end users, the target markets of PTTGC have disclosed their openness to bioplastic materials, they have asked for the more detailed about product application compared to conventional plastic which could fortunately result product purchase in near future.

4.4 What are the advantages or disadvantages of bio-based plastic compared to conventional plastics?

The limited sourcing options of new bio-based polymers discourage manufacturers from switching. From the machinery and hardware side, there is an obstacle for growth since there is small number of key players supplying the biodegradable raw materials. However, PLA still has an attractive growth prospect for all players in the value chain since many companies committed to making the PLA market success.

In order to support the PLA market, the extension of PLA production in Thailand can become a part of the success. The establish of bioplastic plant in Thailand is a potential opportunity to make Thailand becomes bio hub in this region, leads to the reduction of production cost and more affordable price of bioplastic products, which could stimulate the demand to use bioplastic product domestically.

For the price aspect, NatureWorks LLC has recently revealed that PLA come together with benefits and advantages. For example, a French company, Danone, has entirely replaced the previously used PS in cups and packaging with PLA, enabling it to reduce 75 percent of CO₂ emissions while retaining its production line speed, productivity output, and product shelf life, without increasing the retail price. Moreover, the bioplastics are recyclable and in fact are cheaper than conventional plastics. The calculation showed that, assuming a barrel of oil costs 90 US Dollars and a bushel of corn 5 US Dollars, the bioplastic material under the brand name Ingeo is about 18 percent cheaper than general purpose polystyrene (GPPS) but still be 13 percent more expensive than PET (Bioplast, 2013). In fact, the price gap between bioplastics and conventional polymers were about 300 percent a few years ago, however, it has been decreased to about 30 percent recently which make the bioplastic application more attractive than before.

Above observability advantages reflect the degree to which the results of using a bioplastic are competitive to conventional plastic which could make bioplastics became successful optional raw material, especially for the companies who concern and aware of green purchase intentions.

CHAPTER V

RECOMMENDATIONS AND CONCLUSION

This chapter presents summary of findings, recommendations, limitations and suggestion for further studies.

5.1 Summary of findings

To answer the research question, this study evidenced that Thailand has very good conditions to be the production hub of bioplastics in Southeast Asia. There are essential reasons such as feedstock availability, especially the sugarcane, the well adoption to new technologies of Thai plastic industry, and the great support from Thai government. Bioplastics are more comparable to conventional plastic since some concerning factors have been solved. The readiness of plastic manufacturers has been well developed and the Price gap of raw materials was reduced in the past few years. Moreover, the study discovers that PTTGC is considered a good case study to follow regarding its introducing of bioplastics applications to public. There were many PLA projects launched, with the corporation with government and public sectors, that strengthen PTTGC's sustainable in green growth strategy. The success from those collaboration projects provides direction that supports Thai plastic manufacturers to make more contribution to bioplastics and make them become more attractive to their customers.

5.2 Recommendations

Based on the conclusion, there are three approaches to make bioplastics more applicable and well known in current market.

5.2.1 Create strong relationship

With the support from related government organizations and the leading petrochemical companies in Thailand, a strong relationship among Thai plastic manufacturers can strengthen the bioplastics industry in Thailand.

5.2.2 Promote sustainable benefits

A continuously promoting sustainable benefit from the use of alternative bio-based products could create demand in green product.

5.2.3 Focus on value creation

Company should put effort on developing product to meet the needs of target consumer. An improving of packaging design that matched lifestyle and perception of end customers will result more users and more sales.

5.3 Limitations

Since Thailand is famous as an agricultural country and currently is a leading sugarcane producing country, Thai government is very interested on investing in Bioplastic business, which can confirm by many supporting towards the bioplastics such as putting it as one of developing road map for Thailand. Only the positive information has been informed to Thai people, including Thai plastic manufacturers. As a result, most of the respondents express the good aspects of implementing bioplastics to their business. Although the disadvantages of bioplastics has been asked, every respondent are showing that they are risk taking and adapt to change if the change can make them different and be in the better position. Further study of different samples such as companies or government organizations which are PTTGC's competitors or presenting as the opposite side of the bioplastics could project the success of Thailand Bio-hub better.

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