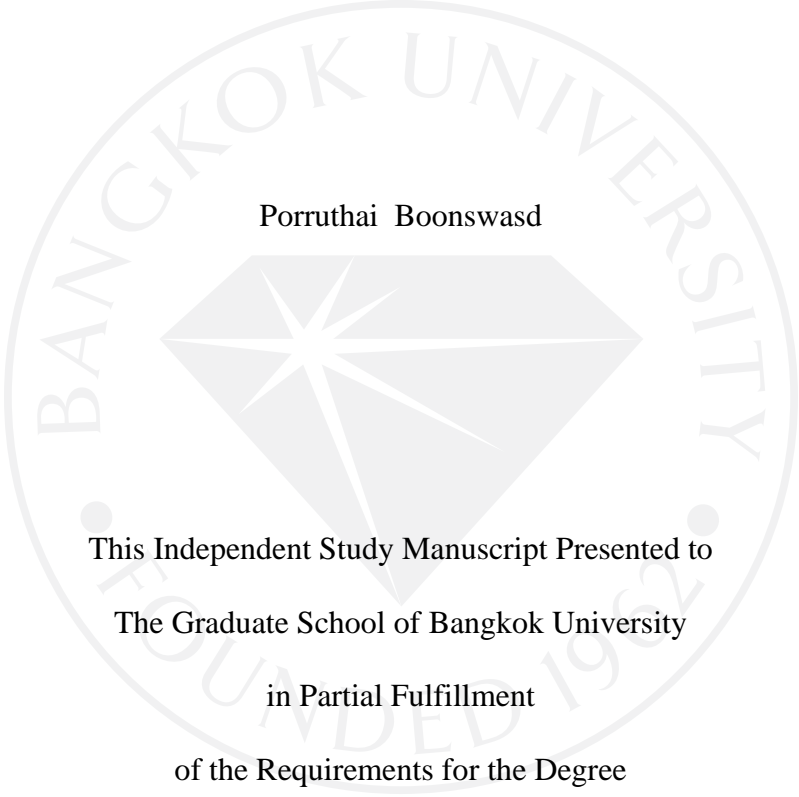


USING PATENT ANALYSIS TO ANTICIPATE TECHNOLOGY TRENDS:
A CASE OF COFFEE PROCESSING TECHNOLOGY IN THAILAND



USING PATENT ANALYSIS TO ANTICIPATE TECHNOLOGY TRENDS:
A CASE OF COFFEE PROCESSING TECHNOLOGY IN THAILAND

Porruthai Boonswad



This Independent Study Manuscript Presented to
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Author : Ms. Porruthai Boonswasd

Independent Study Committee:

Advisor



(Dr. Ronald Vatananan-Thesenvitz)

Field Specialist



(Dr. Xavier Parisot)



(Dr. Suchada Chareanpunsirikul)

Dean, Graduate School

August 9, 2019

Boonswasd, P. Master of Management (Business Innovation), August 2019, Graduate School, Bangkok University.

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Advisor : Ronald Vatananan-Thesenvitz, Ph.D.

ABSTRACT

The technological capability of the coffee industry in Thailand is limited. Coffee manufacturers operate in a red ocean where competition is focused around cost and not differentiation. This paper discusses the insights gained from a study of patents related to coffee processing technologies. The purpose of the study is to identify technology trends and innovative approaches in the coffee industry. PatSnap software is used to conduct a patent analysis of 211 patents from 106 countries in the period of 1999-2018. The analysis aims to reveal the global direction of R&D to forecast technological developments and applications in the coffee industry. The insights gained from the research are used to assist the strategic planning of technological development paths and their possible application in the Thai coffee industry. With a better understanding of the technological landscape, firms operating in the Thai coffee industry are better equipped to make product development decisions.

Keywords : Patent Analysis, Coffee Production Technology, Technology Trends, Technology Forecasting.

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Besides my advisor, I would like to thank the rest of my independent study committee for their encouragement and insightful comments.

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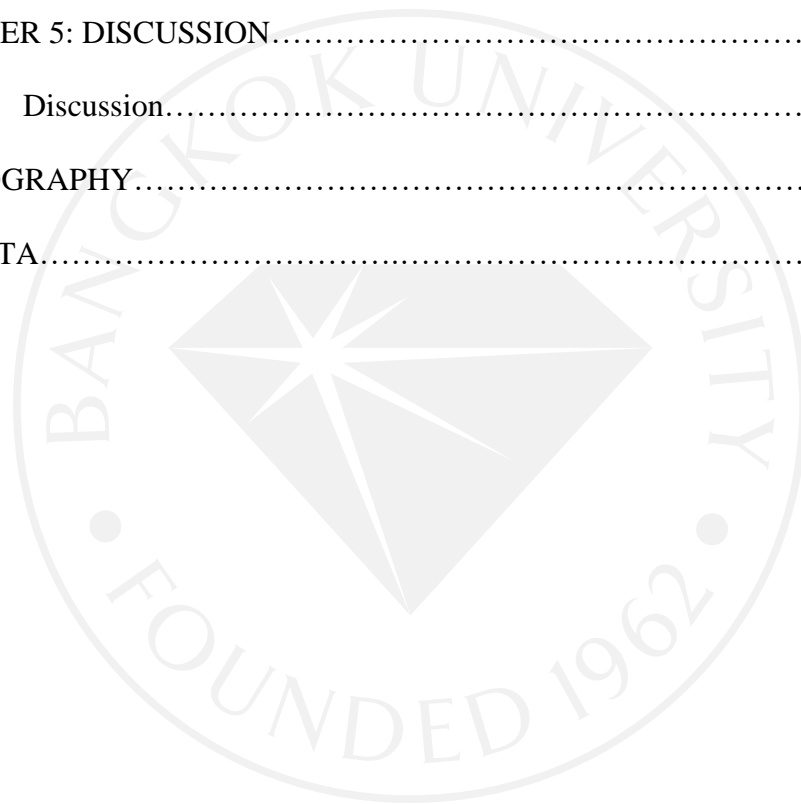
Porruthai Boonswasd

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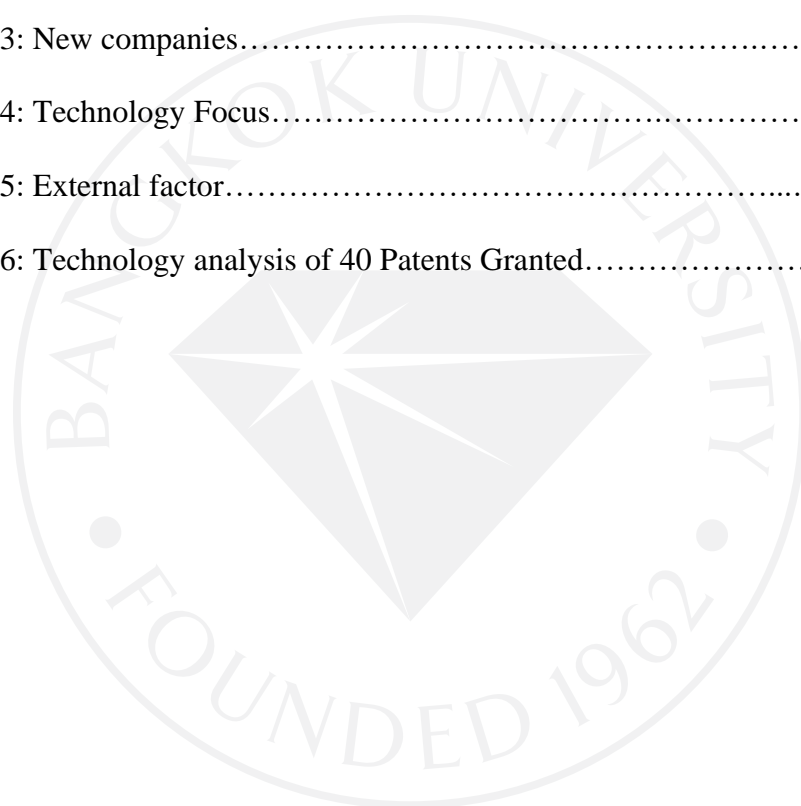
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CHAPTER 1

INTRODUCTION

Trending Economics (2018) provides information about the current economic conditions affecting coffee producers. The key reality we face at present is that, although the coffee business is booming in coffee consuming developed countries; current rock bottom prices are causing immense hardship to countries where coffee is a key economic activity, as well as to the farmers who produce it. According to Figure 1.1 coffee reached an all-time high of 280 USD/Lbs. in April 2011 and a record low of 100 USD/Lbs. in September 2018.

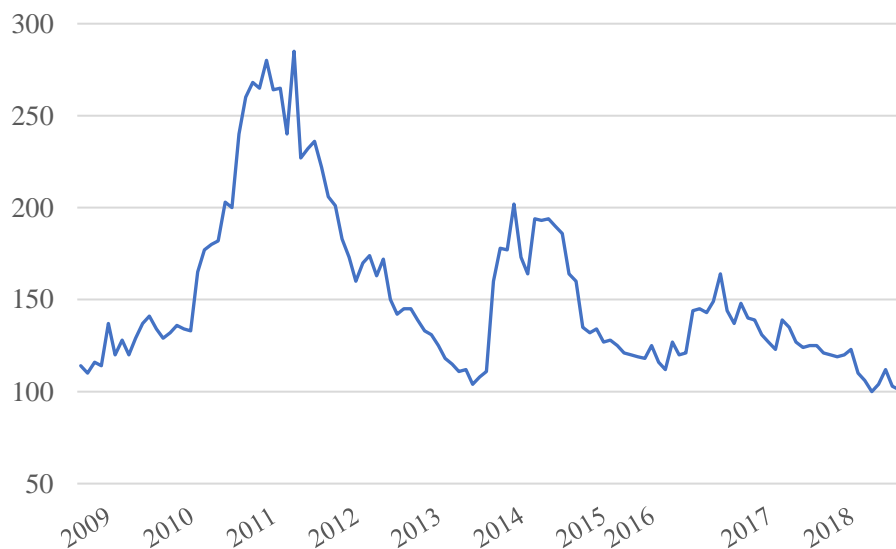


Figure 1.1: Coffee historical price chart from 2009-2018 (*Trading Economics, 2018*)

Arabica coffee is a world benchmark for international coffee trading futures contracts on the Inter Continental Exchange (ICE), with a 75% of global production proportion, and mostly cultivated in Brazil, which accounts for 40% of the world's total production volume. Robusta coffee accounts for the remaining 25%. In addition, 15% of global supply produced in Vietnam and Indonesia. Other major exporters

include Peru, India, Uganda, Ethiopia, Mexico and Côte d'Ivoire. Figure 1.1 shows the historical price of coffee from 2009 to 2018, indicating that the value of coffee beans tends to decline. Therefore, it is important to add value to coffee for the market to growth (Trending Economics, 2018).

Arabica coffee has been introduced to Thailand since 1849. Royal projects, government and private agencies have promoted Arabica coffee in the highlands as a replacement for opium poppy cultivation and reduces soil erosion. The Department of Agriculture (2018) has studied and selected Catimor as the officially coffee plant in 2007, which can resist rusting in coffee. Arabica coffee has an increasing area and production due to high consumption. Production is expected to 10,000 tons per year. Coffee is one of the economics commodities, which gives a significant national income. However, the coffee industry still suffers from low productivity and high production costs (Noppakoonwong, et al., 2015). Based on this data, the Thai government has launched a coffee strategy of 2017-2021 to promote coffee products. The strategy focuses mainly on the promotion of coffee planting and coffee production processes at the industry level to boost the competitiveness of the Thai coffee industry (Department of Agriculture, 2018). The total coffee export in 2018 from Office of Agricultural Economics (2019) and Office of Industrial Economics (2019) shows as Table 1.1.

Table 1.1: The total coffee export in 2018

Exported coffee	Volume (Kg)	Value (USD)	Average (USD/Kg)
Green bean	468,691	2,883,072	6.15
Roasted coffee	164,483	1,400,938	8.52
Instant coffee	3,950,087	20,680,982	5.24
Ready-to-drink	4,037,000	6,843,445	1.70
Total	8,620,261	31,808,437	3.69

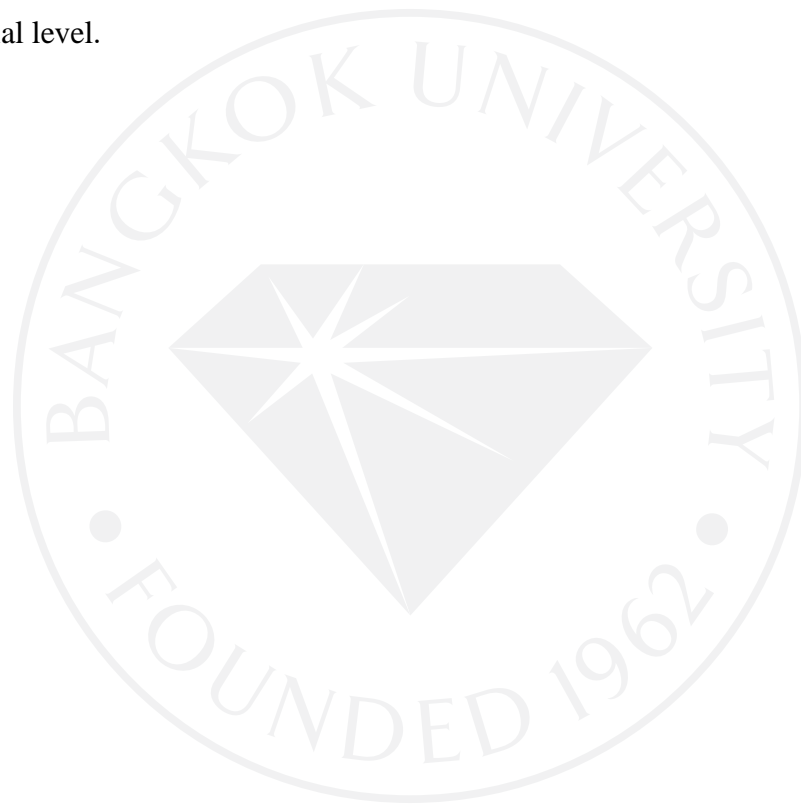
Problem Statement

Noppakoonwong, et al. (2015) shows coffee consumption in Thailand is approximately 200 cups per person per year, which is relatively low compared to 500 cups in Japan and 700-800 cups in the United States. According to Euromonitor International (2018), the size of the coffee market in Thailand was valued at 2.02 Billion USD (64.7 Billion Baht) in 2017, divided into the home coffee market of 1.19 Billion USD (38 Billion Baht) and the outbound coffee market of 0.83 Billion USD (26.7 Billion Baht). Ready-to-Drink (RTD) coffee saw a slowdown in off-trade volume growth during 2017 compared with 2016, it still maintained a reasonable pace of growth, which in turn attracted new manufacturers. Even Ajinomoto (Thailand), the leader and the first manufacturer of RTD coffee in Thailand with 'Birdy' brand, had a declining market share in 2017. Whilst the consumers' need for convenience will support the demand for RTD coffee, the underlying dynamics driving consumers' consumption of coffee will continue to pose a challenge for RTD coffee. This trend indicates that if ready-to-drink coffee industry cannot increase the quality of coffee to be compared to fresh coffee, it will certainly affect future business growth (Food Intelligence Center, 2017).

The future of coffee production is based on sustainable practices and initiatives that can be used in all parts of the coffee supply chain: improving the condition at the origin, recycling of packaging materials, reducing emissions, developing eco-friendly facilities and the important thing is designing new coffee products (Iriundo-Dehond, et al., in press). The technological capability of the coffee industry in Thailand is limited. Coffee manufacturers operate in a red ocean where competitions are focused around cost and not differentiation. Identifying the opportunity to develop technologies with patent

analysis will help reveal trends and direction of research and development of major corporations worldwide, as well as new business opportunities and technologies to gain a competitive advantage (Setthithon, 2015).

Under the current competitive pressure, innovation is necessary to develop new business opportunities in order to remain profitable and achieve a sustainable growth. Technology analysis and planning can facilitate strategic investment decisions at the industrial level.



Objectives of Study

This research project aims to study patents related to Coffee Processing Technology to reveal the global direction of R&D to forecast technological developments and applications in the coffee industry. With a better understanding of the technological landscape, firms operating in the Thai coffee industry are better equipped to make product development decisions.

Scope of Study

1. Analyzing the existing R&D situation of coffee processing technology by conducting a patent analysis.
2. This study covers only Coffee Processing Technology at the industry level. Excluding planting, preliminary processing and brewing in a coffee shop.

Figure 1.2 Coffee process provides an overview of the coffee processing process, to better illustrate the scope of the patent analysis presented in this paper. The process can be described in 7 steps: planting, harvesting, cherry processing, drying, milling, and trading to coffee shop or coffee factory (Iriundo-Dehond, et al., in press). Tasting, roasting, grinding and brewing are the processes depend on coffee production. From the cherry process, there are by-products called coffee cherry or cascara. This research focuses only the coffee processing technology at the industrial level only and excludes planting, harvesting, by-product and coffee shop.

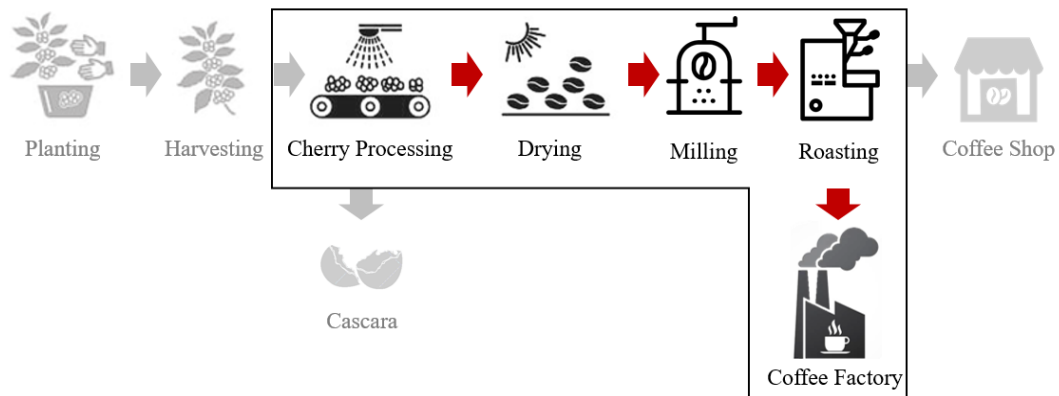


Figure 1.2: Coffee process (*Iriondo-Dehond, et al., in press*)

Research Goals and Question

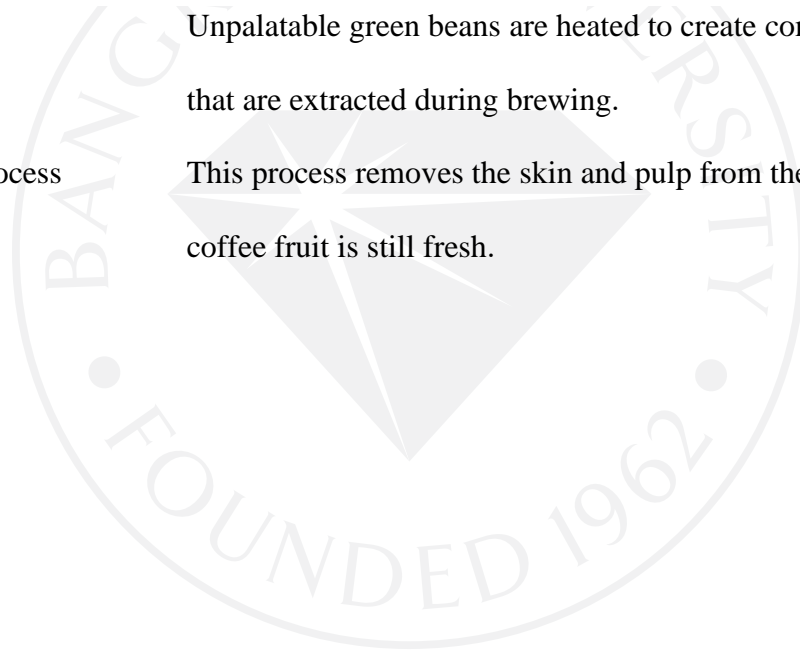
Significance of the Study

Academic Outcomes — This study will be used patent analysis as a flexible method to strategize and planning the future development trend of technologies to support strategic and long-term planning

Practitioner Outcomes — The insights gained from the research are used to assist the strategic planning of technological development paths and their possible application in the Thai coffee industry. With a better understanding of the technological landscape, firms operating in the Thai coffee industry are better equipped to make product development decisions.

Definition of Key Terms

Arabica	Coffee obtained from beans of the <u>Coffea arabica</u> tree
Aroma	The smell that is released from freshly ground coffee and from freshly brewed coffee
Green Bean	Unroasted coffee beans
Hulling	Removal of the coffee bean's skin, called parchment
Parchment	A skin covers wet-processed coffee beans after coffee cherries have been skinned, the pulp removed, and the beans dried.
Roast	Unpalatable green beans are heated to create complex flavors that are extracted during brewing.
Wet Process	This process removes the skin and pulp from the bean while the coffee fruit is still fresh.



CHAPTER 2

LITERATURE REVIEW

2.1 Forecasting Technologies

Daim, et al. (2006) provides a comprehensive review of available methods and parameters being forecasted (Table 2.1).

Table 2.1: Technological forecasting methods

Category	Definition	Forecasting Methods
Direct	Direct forecast of parameter(s) that measure an aspect of this technology	Expert Opinion (Delphi, Surveys, NG), time series analysis, trend extrapolation (growth curves, substitution, life cycle)
Correlative	Correlative parameter(s) that measure the technology with parameters or other technologies	Scenarios, lead-lag indicators, cross impact, technology progress function, analogy
Structural	Explicit consideration of cause-and-effect relationships that effect growth	Causal models, regression analysis, simulation models (deterministic, stochastic, gaming), relevance trees, morphology

Technical trend analyses alone usually cannot incorporate the organizational and political scenarios that will influence future technologies (Daim, et al., 2006).

This study uses methods from each category to anticipate emerging technologies. The analysis covers the technical and personal perspectives.

A technology-driven roadmapping processes starts from capability analysis for technology planning and ends with business opportunity analysis for market planning. Lee, et al. (2009) suggest the use of patent data as a proxy measure of technological capability and support decision-making during the process. In the study of forecasting emerging technologies, Patent analysis identifies the possible technology position (Daim, et al., 2008).

2.2 Patent

2.2.1 Patent Information

World Intellectual Property Organization (2018) described the patent information is an important resource for researchers and inventors, entrepreneurs, commercial organizations and patent professionals to identify important trends in specific technical. Patent information is an important basis for policy planning. The source of patent by online offering services from both the Patent Office (free) and from commercial sources (subscriptions). Patent map is the visualized expression of all patent analysis results to understand complex and various patent information easily and effectively.

Patent document contain all information that has been published in patent documents or obtained from statistical analysis including technical legal, business-relevant and public policy-relevant information, (World Intellectual Property Organization, 2018).

Within the patent document showing

1. Applicant: Name of the individual or company applying to have a particular invention protected.

2. Inventor: Name of the person or persons who invented the new technology and developed the invention.

3. Description: Clear and concise explanation of known existing technologies related to the new invention and explanation of how this invention could be applied to solve problems not addressed by the existing technologies; specific embodiments of the new technology are also usually given.

4. Claims: Legal definition of the subject matter for which protection is sought or granted; each claim is a single sentence in a legalistic form that defines an invention and its unique technical features.

Normally, Patent offices worldwide use International Patent Classification (IPC) to categorize patents by a system of codes that groups inventions according to technical areas. There are approximately 70,000 different IPC codes for different technical areas. European Patent Office (2019) described a simple family patent is a set of patent documents that are considered to cover a single invention. The technical content covered by the application is considered the same. Every member of a simple patent family will have the same priority in all respects.

The International Patent Classification (IPC) system provides a widely used patent classification with the following main categories:

- A. Human Necessities
- B. Performing Operations; Transporting
- C. Chemistry; Metallurgy

D. Textiles; Paper

E. Fixed Constructions

F. Mechanical Engineering; Lighting; Heating; Weapons; Blasting

G. Physics H Electricity

Each main category contains class, subclass, main group, and subgroup to breakdown the content.

World Intellectual Property Organization (2018) divided the patent legal status into 4 categories;

1. Examination of a patent application is still pending
2. The application has been withdrawn or was rejected
3. A patent has been granted and is still valid
4. A granted patent has expired, lapsed or been revoked

2.2.2 Patent Analysis

Patent analysis is the filtering, classifying, arranging, and processing of all types of patent specification, and data distribution of patent information that are published through data retrieval and using data obtained in quantitative and qualitative analysis. Searching for technology themes and retrieving patents is the first thing that needs to be done to get the data for patent analysis (Guo, et al., 2012). After searching for information according to technology theme through the selected software, the data retrieved will be analyzed. The analysis of patents has two parts: enterprise technical strength assessment and IPC technical structure to find ways to generate new ideas. The analysis aspects of enterprise technical strength are applications' R&D strength, Innovation strength, and R&D team. This process is designed for fuzzy front-end based on patent analysis (Lee, et al., 2009). A complimentary roles of patent analysis is using

data mining to provide insights into the business-focused for specific technology themes.

Abraham and Moitra (2001) presented an Indian innovative assessment method through patent analysis, divided into 4 parts: Summary statistics, Trends, Correlations and patterns, and International comparisons. Understanding trends in technology development and innovation levels from patent data analysis can help entrepreneurs to develop strategic plans and better compete in their business environment. The method technological level classification in individual patents by reading the abstracts, was based on knowledge of the particular subject area, and defines the scale reflecting a truly revolutionary advance.

Patents are useful for competitive analysis and technology trend analysis (Daim, et al., 2006). Patents are analyzed to manage research and development and evaluate competitive opportunities, including to avoid abuse. Patent analysis is a useful method to use patent information to find information about a particular industry or technology used to predict patent growth. In general, there is a similar tendency to grow according to S curve, in the early stages of technology, the number of patents that come out is very limited. Once passed, a period of time will increase rapidly. Several indices have been introduced to measure technological strength as a function of patent quantity or patent quality. Patent analysis shows that it is valuable to planning technology development from strategy analysis at the national level to creating a unique technology model. Most of the countries can access patent information freely and there are several guidelines for improving techniques using keywords and classification. As with information, text and journals, very few patents developed as something that has commercial value. But most are technically important because they support or lead to

subsequent developments in technology Understanding growth in technology and using keyword or phrase metrics is profound in overall technology forecasting models.

Suzuki (2011) Patent information is one of the valuable benefits that the patent system gives to society in return for inventors. Patent protection is a monopoly of related technologies over a period of time. The use of patent information is a function of the patent system. Patent information, such as the publication of an unlimited patent application, has a unique advantage in technical information covering a wide range of technologies, including cutting-edge technology, including foreign invention information in local languages. Patent information, including the content of special privileges or intellectual property rights, is part of current economic activities. In addition, patent information is a useful indicator for strategies for developing a technology or global strategy for each organization in response to the increasingly intense competition.

Multinational companies, universities and research institutes use patent data in the early stages of research and development to identify research and development goals in order to evaluate inventions and use patent information to manage intellectual property. (Dehghani & Dangelico, 2018).

2.3 Technology opportunity analysis using Technology Roadmapping

Technology Roadmapping (TRM) can be obtained from a linkage between strategy, technology and target-driven marketing planning to identify the technology needed from market demand analysis. The literature-based discovery (LBD) approach was used to identifying technical disciplines to solving technical problems and was actually applied to develop disruptive technology roadmap (Lee, et al., 2009).

Technology-driven roadmapping has 4 layers to develop business opportunities based on technology assets. Starting from R&D planning, going through technology planning, product planning, and end with market planning as can see in Figure 2.1

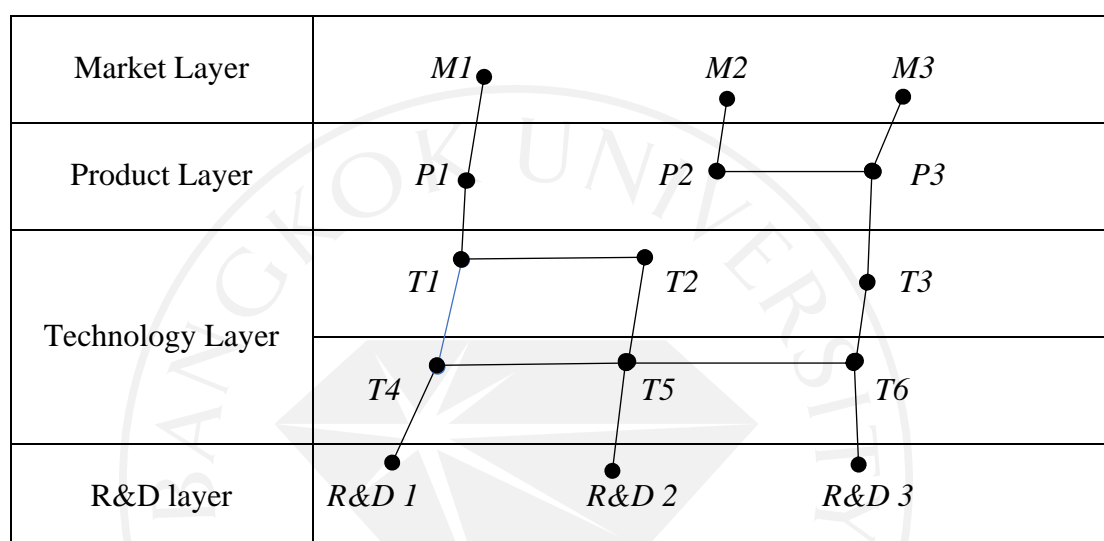


Figure 2.1: Market-Driven Technology Roadmap (Lee, et al., 2009)

2.4 Current Coffee Processing Technologies

Food Intelligence Center (2017) described coffee production process in Thailand. After the raw material preparation process, coffee beans are processed through roasting, which is the most important step in coffee production. The final smell of coffee products will depend on the roasting process and will make the first product to come out, namely, “Fresh Coffee Beans” and when bringing the coffee beans into the grinding process will be a “Fresh Ground Coffee”.

The “Instant Coffee” is divided into 3 processes according to the product type, including Powder, Agglomerated and Freeze-Dried. The production of “Ready to

Drink coffee” products which are produced by adding value by bringing fresh ground coffee power or instant coffee powder into the RTD process (Food Intelligence Center, 2017).

Roasting coffee beans is a very important step in the coffee production process because it produces specific sensory properties, which means taste, aroma and color that are important characteristics of coffee quality (Mussatto, et al., 2011)

“Instant coffee” products have the largest market share and drive the growth of the domestic market. With a value of 32,023 million Baht, accounting for 70.1 percent of the total coffee product sales in Thailand. Instant coffee responds to the lifestyle of the new generation, especially the working-age consumers with medium and lower levels that require convenience and speed. The product that holds the market share in the second is “Ready to Drink Coffee”. The sales value is 10,562 million Baht or 23.1 percent of the total value of coffee products sold in Thailand. The main target group is a labor group who want to be alert at all times, such as bus and truck drivers who have to travel for a long time (Food Intelligence Center, 2017).

The products that dominate the market share, followed by “Fresh Ground Coffee” and “Fresh Coffee Beans”, which have a value of 2,833 million Baht and 246 million Baht, or 6.2 percent and 0.5 percent of the total value of coffee product sales respectively. Both products have target groups that are consumers in medium to high income groups. This target group is likely to increase continuously according to the popularity of fresh coffee in Thailand (Food Intelligence Center, 2017).

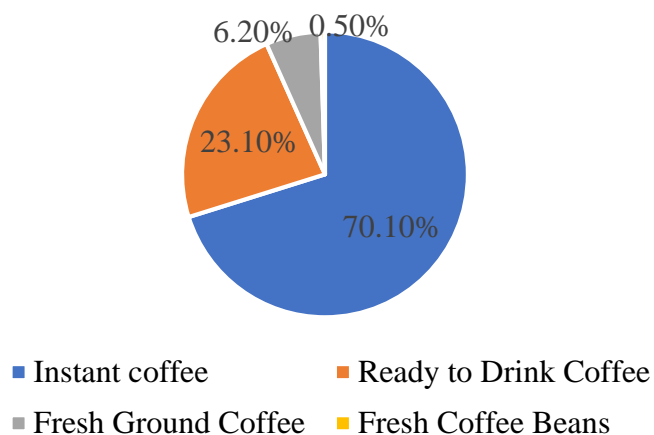


Figure 2.2: Coffee market share classified by proportion of sales value in Thailand
(*Food Intelligence Center, 2017*)

2.5 Recent Innovations in Coffee

Coffee is one of the most complex natural beverages. It contains a mixture of hundreds of molecules and occurs during production process and after consumption during catabolism by human. The different concentrations depending on various factors, including the coffee plant origin and its metabolism. These molecules exert anti-cancer properties (Gaascht, Dicato and Diederich, 2015).

Gaascht, Dicato and Diederich (2015) also found 750 mL of regular dark coffee in daily consumption helps to protect and prevent cancer progression. Effect of product attribute beliefs of ready-to-drink coffee beverages on consumer-perceived value and repurchase intention (Wang and Yu, 2016) In 2016, Wang and Yu compared the effects of the product attribute in ready-to-drink (RTD) coffee beverages by sensory, packaging and branding, and content functional attributes on perceived value and repurchase intention. They found that RTD coffee beverages consumers focus on utilitarian value is the most important factor of repurchase intention. The sensory

attributes are also very influential. This study shows that in addition to the value of the product, the taste is also a top priority.

Chen and Lee (2015) investigated the green claims of Starbucks and found that ethical sourcing significantly affects consumer's purchase intention.

Ferro and Pierrot (2018) described the European coffee market about innovative ideas in coffee. Innovation in coffee is part of the fourth wave. Skilled coffee brewers and baristas create a deeper understanding about coffee properties. They use advanced equipment to produce and develop a variety of portfolios and qualities. In addition, new methods for processing and using coffee beans in the European market are:

2.5.1 Nitro coffee is a coffee that looks like beer. Starbucks began experimenting with nitrogen-induced coffee in the United States stores. Meanwhile, Nitro coffee is gaining popularity in Europe, especially in the United Kingdom.

2.5.2 Cascara tea made from dried coffee cherries. Recently, Cascara tea was rarely produced for export. It is commonly used in some countries where coffee is grown, such as Bolivia. A variety of Web Shops throughout Europe, now selling cascara tea. For example, BOOT (the Netherlands), Bean Coffee (UK) and Capasseo (Germany).

It will be a good reason to consume coffee as a healthy lifestyle and shows that there are still many opportunities for the growth of the coffee drink market. In addition of sustainability development, Innovative coffee products may have to combine the study of coffee molecules, values, novel and flavors that are in line with the needs of consumers.

CHAPTER 3

METHODOLOGY

Research Design

This independence study will develop a forecasting technology trend based on patent analysis to strategize and plan the future development of technologies in coffee processing. Patent analysis is applied using PatSnap software to evaluate the technology to application dominated emergence, and forecasting technologies for strategizing the future development path from application to market dominated emergence.

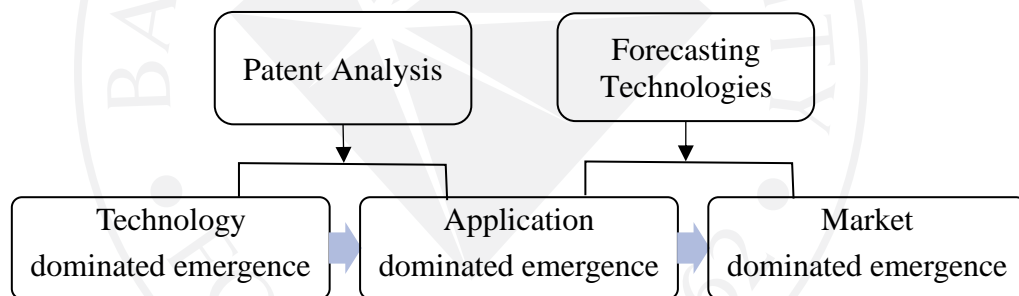


Figure 3.1: Analysis methods and industrial emergence stages

The framework shown in Figure 3.1 is using patent analysis to assess existing technology and their applications, based on which future technology developments and trends are forecasted. The forecast is used to formulate strategies for future development paths from applications to markets (Li, et al., 2016).

This study has brought patent information around the world from software for quantitative and qualitative analysis. A detailed study of important patents and analyzes

has been conducted with experts in food industrial technology to plan the coffee technology development in Thailand.

Boolean operators are used to combine concepts or ideas when searching data on coffee industry. AND or OR is used to determine the number of results viewed to meet the desired issue.

3.1 Using PatSnap software to study the latest developments and follow end-to-end evolution of technologies from patent register in Thailand. Analyze the patents from PatSnap by qualitative and Quantitative analysis

The specific keywords are Coffee processing technology. With the Boolean operators, the keywords for searching are Coffee industrial technolog* 'OR' Coffee processing technolog* are not found any result. So The specific keyword "Coffee" is used for patent in Thailand.

The information we collect for each patent is as follows:

1. Publication Number
2. Title
3. Application Date
4. Publication Date
5. Inventor Name
6. Current Assignee
7. International Patent Classification (IPC)
8. Abstract detail

3.2 Using PatSnap software to study the latest developments and follow end-to-end evolution of technologies from worldwide patents databased. Analyze the patents from PatSnap by qualitative and Quantitative analysis.

The specific keywords are Coffee processing technology. With the Boolean operators, the keywords for searching are Coffee industrial technolog* 'OR' Coffee processing technolog*

3.3 Identify the key external factors that may shape the growth of technologies-based industry by industrial historical document, article reviewing to see the trend, and interview the industrial experts to review the possible factors as opportunities, enablers, or barriers from market, policy and industry dynamics.

Expected output is the macro-level influential factors such as market trends, government policies, industrial competition, etc. to shape the growth of technologies-based industry.

3.4 Anticipate technology trends by using the technology analysis results.

Expected output is better understanding of the technological landscape to make product development decisions.

Research Instrument

1. PatSnap platform for retrieve the most relevant patent documents and extract the related Intellectual Property.

Area	Purpose
Research Productivity: Number of patents	A history of patents applied for and/or granted can provide an insight into the research activities in the field.
Technology focus	Study trends across various technologies and all opportunities.
Inventors and Companies	Analyzing patent activity to discover other companies' latest and most valuable technologies, new entrants to the market and hidden R&D opportunities with low competition.

CHAPTER 4

FINDINGS

4.1 Using PatSnap software to study the latest developments and follow end-to-end evolution of technologies from patent register in Thailand. Analyze the patents from PatSnap by qualitative and Quantitative analysis

4.1.1 Data Collection

The specific keywords are Coffee processing technology. With the Boolean operators, the keywords for searching are Coffee industrial technolog* 'OR' Coffee processing technolog* are not found any result. So The specific keyword "Coffee" is used for patent in Thailand.

Figure 4.1 show 10 patent applications from 1990-2018 related coffee in Thailand. Based on the number of patent applications, it is found that in Thailand there are relatively few innovations related to coffee.

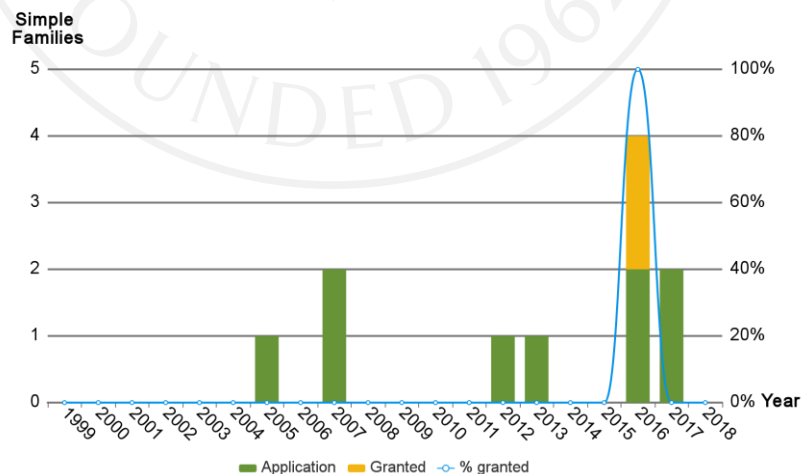


Figure 4.1: The number of coffee patent applications in Thailand from 1999-2018

The pie charts in Figure 4.2 show the percentage breakdown of the legal status and patent type in the technology field. From 10 simple families, divided into 8 inventions, 2 design and the active patents are 2 simple families.

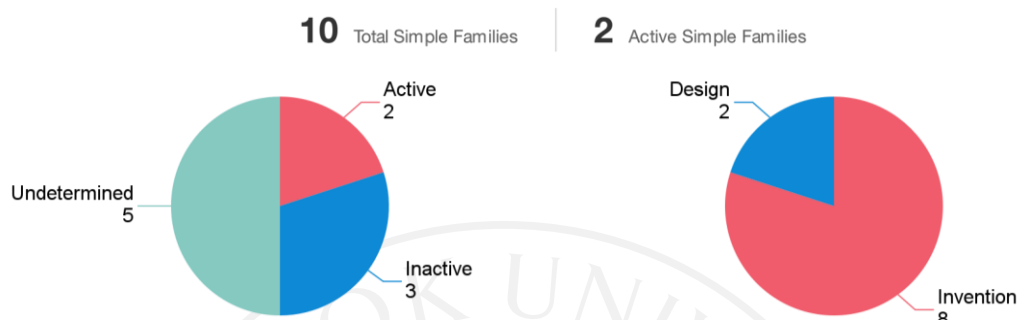


Figure 4.2: The percentage breakdown of the legal status and patent type

4.1.2 Technology Focus

Figure 4.3 visualizes the top 10 technology areas the Thailand patents within the technology field fall into, with the size of the box corresponding to the number of patents. The results are shown in Figure 4.3 and the detail in Table 4.1 retrieved from PatSnap software.

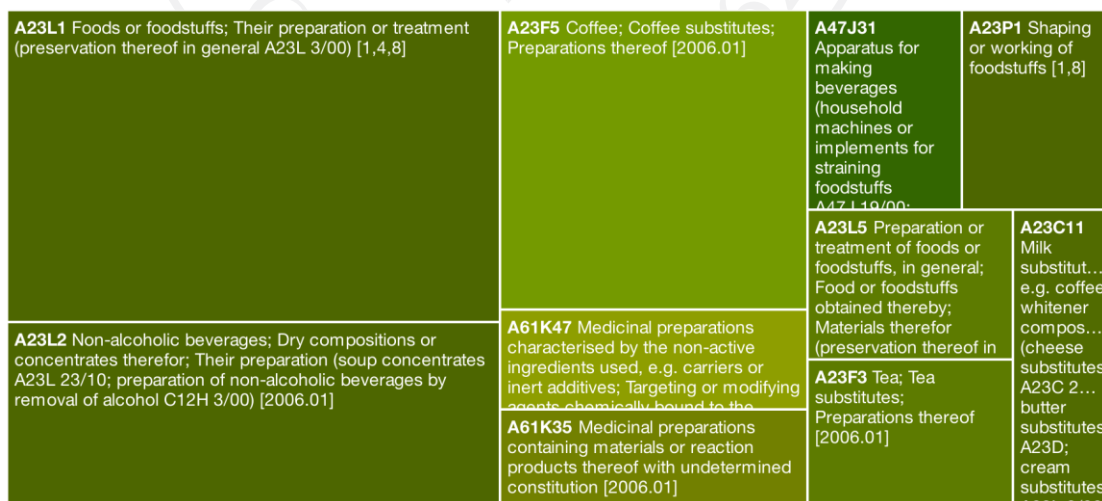


Figure 4.3: Technology Focus

Table 4.1: Technology Focus (Patent in Thailand)

IPC Code	Definition	Simple Families	Percentage
A23L1	Foods or foodstuffs; Their preparation or treatment (preservation thereof in general A23L 3/00) [1,4,8]	5	50.00%
A23F5	Coffee; Coffee substitutes; Preparations thereof [2006.01]	3	30.00%
A23L2	Non-alcoholic beverages; Dry compositions or concentrates therefor; Their preparation (soup concentrates A23L 23/10; preparation of non-alcoholic beverages by removal of alcohol C12H 3/00) [2006.01]	3	30.00%
A23C11	Milk substitutes, e.g. coffee whitener compositions (cheese substitutes A23C 20/00; butter substitutes A23D; cream substitutes A23L 9/20) [2006.01]	1	10.00%
A23F3	Tea; Tea substitutes; Preparations thereof [2006.01]	1	10.00%
A23L5	Preparation or treatment of foods or foodstuffs, in general; Food or foodstuffs obtained thereby; Materials therefor (preservation thereof in general A23L 3/00) [2016.01]	1	10.00%
A23P1	Shaping or working of foodstuffs [1,8]	1	10.00%
A47J31	Apparatus for making beverages (household machines or implements for straining foodstuffs A47J 19/00; preparation of non-alcoholic beverages, e.g. by adding ingredients to fruit or vegetable juices, A23L 2/00; coffee or tea pots A47G 19/14; tea infusers A47G 19/16; brewing of beer C12C; preparation of wine or other alcoholic beverages C12G) [2006.01]	1	10.00%
A61K35	Medicinal preparations containing materials or reaction products thereof with undetermined constitution [2006.01]	1	10.00%
A61K47	Medicinal preparations characterised by the non-active ingredients used, e.g. carriers or inert additives; Targeting or modifying agents chemically bound to the active ingredient [2006.01]	1	10.00%

4.1.3 Main Companies

Figure 4.4 shows the portfolio sizes of the top organizations in the technology field. It found that only 2 companies operate in Thailand. Ajinomoto is a big player in Thailand coffee market.

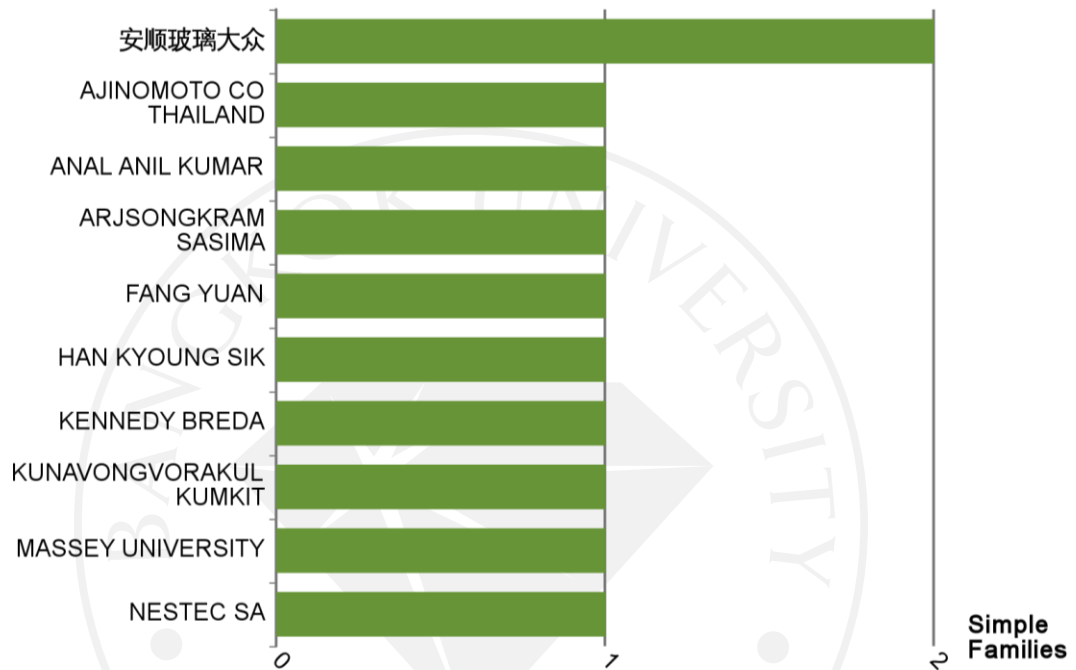


Figure 4.4: Main Companies

4.1.4 Technology field

Table 4.2 is shown the detail of Coffee Patents in Thailand. There are only 10 Publication patents and only 3 patents come from Thai Company.

Table 4.2: Coffee Patents in Thailand

No.	Publication Number	Application date	Publication Date	Name of patents	Inventor Name	Current Assignee
1	US20080131561A1	2007-09-26	2008-06-05	Formulation of supplemented carrageenan jelly and manufacturing process	Patanawongyuneyong, Surach	Sahachol Food Supplies Co., Ltd.
2	RU2007135041A	2007-09-20	2009-03-27	Композиция желе с добавлением каррагенана и способ ее получения	Патанавонгиунейонг Сурач	Сахачол Фуд Сеплайз Ко., Лтд.
3	WO2012142153A1	2012-04-11	2012-10-18	Encapsulation system for protection of probiotics during processing	Fang, Yuan Kennedy, Breda Rivera, Teodoro Han, Kyoung-Sik Anal, Anil, Kumar Singh, Harjinder	Pepsico, Inc Massey University Fang, Yuan Kennedy, Breda Rivera, Teodoro Han, Kyoung-Sik Anal, Anil, Kumar Singh, Harjinder
4	WO2006002025A1	2005-06-14	2006-01-05	Aerated creamers and processes	Pascual, Teresita, Bautista Surintrspanont, Janejira	Nestec S.A. Pascual, Teresita, Bautista Surintrspanont, Janejira
5	EP0958771A1	1998-11-02	1999-11-24	Coffee maker	Sham, John, Chun, Kuen Kunavongvorakul, Kumkit	Sham, John, Chun, Kuen Kunavongvorakul, Kumkit
6	WO2018151687A1	2017-10-17	2018-08-23	Coffee with chili ingredients	Arjsongkram, Sasima	Arjsongkram, Sasima
7	WO2018021980A1	2017-05-31	2018-02-01	A bioplastic composition comprising biomass as a component and a production process	Junkasem, Jirawut Kaabbuathong, Narin Thammongkol, Vivan Paiboolsuk, Janjira Hemmond, Supattra	PTT Public Company Limited

(Continued)

Table 4.2 (Continued): Coffee Patents in Thailand

No.	Publication Number	Application date	Publication Date	Name of patents	Inventor Name	Current Assignee
8	WO2014007388A1	2013-07-02	2014-01-09	Method for improving flavor of food and beverage, and food and beverage having flavor improved thereby	Fujitsuka, Masaaki Kawaguchi, Hirokazu Charasai, Bonggodmas Fukaya, Fuyuki Ito, Yoshihiro Nagai, Satoshi Hattori, Shoji	Ajinomoto Co., (Thailand) Ltd. Soda Aromatic Co., Ltd.
9	CN303724679S	2016-01-06	2016-06-29	Coffee cup	Sharon Kiwi Long Visal	Anshun Glass (VW) Co., Ltd.
10	CN303835575S	2016-01-06	2016-09-07	Coffee cup	Sharon Kiwi Long Visal	Anshun Glass (VW) Co., Ltd.

According to Table 4.2 Coffee Patents in Thailand, these information can analyze the information to study on the anticipate technology trends as following.

There are 2 applications applied in 2017 and published in 2018 from China. The first is Coffee with chili ingredients from Sasima Arjsongkram, which is won the gold medal from the world's most important innovation and invention contest, Invention Geneva and become a famous product now. The second is a bioplastic composition comprising biomass as a component and a production process from PTT Public Company Limited. This invention discloses a bioplastic composition comprising biomass as a component comprising a plastic compound resin comprising polybutylene succinate (PBS), polylactic acid (PLA), and additives selected from biomass from the coffee roasting processes, i.e. silver skin of coffee (SSC); and/or at least one fluoropolymer or fluoropolymer derivative as a friction reducing agent. This invention also relates to a process of pretreating the silver skin coffee for using as an additive for bioplastic resin to produce various products or using as a natural color masterbatch together with other plastics via extrusion, injection molding, compression and thermoforming processes in the industrial level. It related to coffee by-product, not directly to coffee processing technology.

In 2016, there are 2 applications from China which is claims on coffee cups.

In 2013, there is an application from Ajinomoto Co., (Thailand) Ltd. and Soda Aromatic Co., Ltd. The patent is a method for improving flavor of food and beverage, and food and beverage having flavor improved thereby. The invention claims a process for improving flavor of food and beverage which comprises bringing food and beverage containing pyridine into contact with a weakly acidic cation exchange resin to make the pyridine adsorb on the weakly acidic cation exchange resin, making

components other than pyridine desorb with alkali solution therefrom and collecting, and making pyridine desorb therefrom and collecting.

In 2012, There is an application from PEPSICO INC about Encapsulation system for protection of probiotics during processing. The method provided for the production of such encapsulated probiotics by providing ingredients consisting of sodium alginate, denatured protein and active probiotic cells. The combination of divalent cation to initiate cold gelation of sodium alginate and denatured protein. The second ingredient is sent through openings that are less than 1,000 μm in diameter to form capsules.

Although there are not many patents registered in Thailand and Thai companies, they are interesting inventions. At the same time, direct use has legal risks. Therefore, it can be used as a concept to extend the future product.

4.2. Using PatSnap software to study the latest developments and follow end-to-end evolution of technologies from worldwide patents databased. Analyze the patents from PatSnap by qualitative and Quantitative analysis.

4.2.1 Data Collection

Searching for specific keywords related to the technology in coffee products among the patents database.

This independent study uses the term coffee processing technology with the Boolean operators, the specific keywords for searching are Coffee industrial technology 'OR' Coffee industrial technolog* 'OR' Coffee processing technolog* as the query to search applied patent on the PatSnap software database

A total of 380 patents were extracted for the analysis. A preliminary assessment of the dataset found that the 169 patent applications belonging to the Russian researcher ‘Kvasenkov Oleg Ivanovich are very similar. A closer look indicated that they cannot be considered a completely invention; therefore, they were excluded from this study.

New dataset for searching is Query: (TAC:(Coffee Industrial Technolog*) OR TTL_ENTRANS:(Coffee Industrial Technolog*) OR ABST_ENTRANS:(Coffee Industrial Technolog*)) NOT IN:(Kvasenkov Oleg Ivanovich) OR (TAC:(Coffee processing Technolog*) OR TTL_ENTRANS:(Coffee processing Technolog*)) NOT IN:(Kvasenkov Oleg Ivanovich)

After excluding the Russian patent, the remaining 211 patents were analyzed. Figure 4.5 show 184 patent applications from 1999-2018. Increased global patentability shows that this invention invests in continued research, development, and patents at an ever-increasing rate every year.

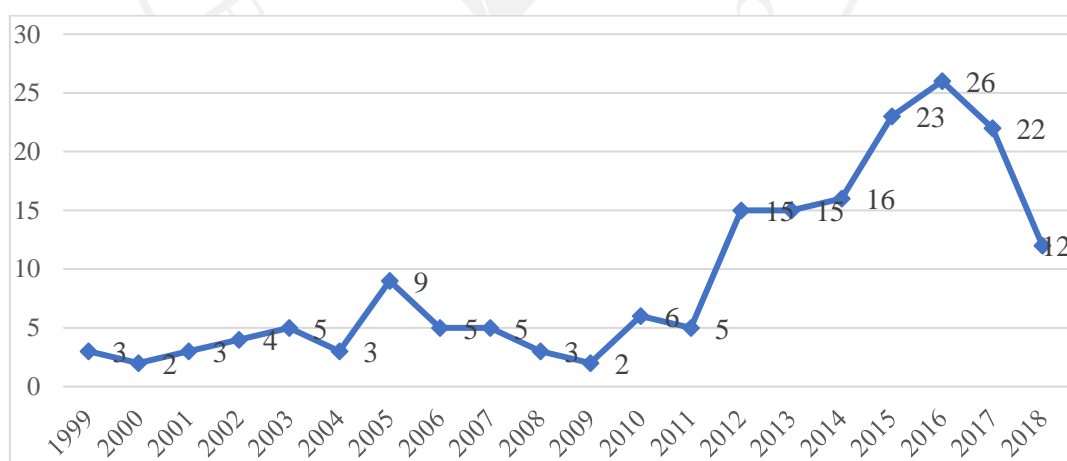


Figure 4.5: The number of patent applications in coffee processing technology from 1999-2018

The pie charts in Figure 4.6 show the percentage breakdown of the legal status and patent type in the technology field. From 211 simple families, divided into 196 inventions, 15 utilities and the active patents are 40 simple families. A pending patent is a term used to describe a patent application filed with the Patent Office, but not declared as a patent. Pending patents indicate that the inventor is taking protection.

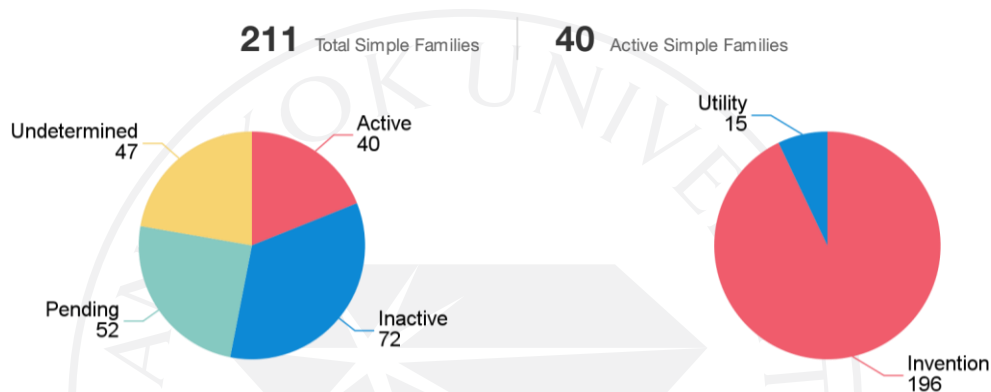


Figure 4.6: The percentage breakdown of the legal status and patent type

4.2.2 Patent number analysis: Geographic Territory Map

The geographic breakdown shows the percentage breakdown of the patents in the technology field across different jurisdictions. As can be seen on Figure 4.7 and 4.8, The applied patents on coffee processing technology in the world are mainly distributed in China, India and Australia (Not include Russia). China has the most applied patents, accounting for the world's 40.76%, India and Australia accounting for 13.74%, 11.37% respectively and other 21.80%

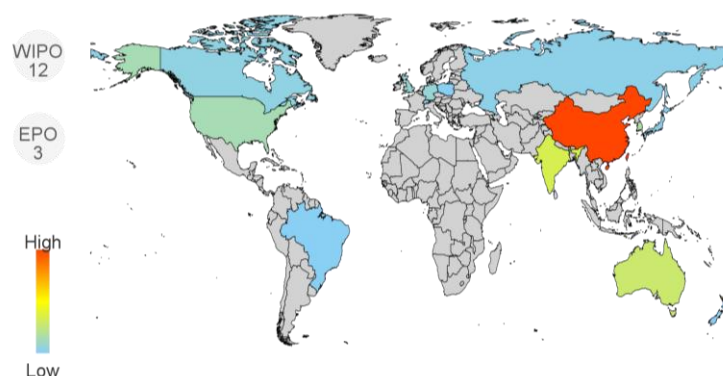


Figure 4.7: The geographic territory map of the patents in the technology field across different jurisdictions

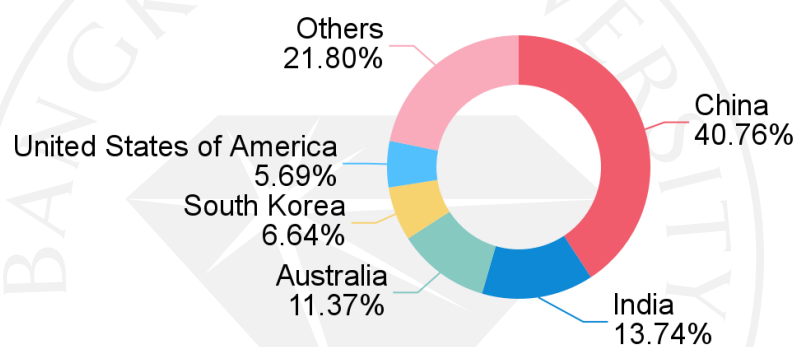


Figure 4.8: The percentage breakdown of the patents in the technology field across different jurisdictions

4.2.3 Innovation Rate

The Innovation Rate graph shows the annual patenting trend in the technology field. The trend for published patent applications are displayed in green, and the trend in published granted patents displayed in yellow. As can be seen in Figure 4.9 retrieved from PatSnap software, The percentage of granted is relatively low compared to the application. There are several causes, according to data from World Intellectual Property Organization (2018) for example the specification is not support the claims or

lack of novelty on the grounds (World Intellectual Property Organization, 2018).

Patents will not be granted:

1. Discovery of scientific theories, mathematical methods, programs and schemes.
2. Diagnosis, treatment and surgery methods for humans and animals.
3. Inventions that are exploited tend to be contrary to public order or morality or affect the environment, human life, animals or plants and health.
4. Organ, tissue, living cells, biological substances, nuclear acid and genome
5. Plants and animals, regardless of their rarity or characteristics and biological processes, are primarily for the production of plants or animals, in addition to micro-organisms, non-biological and microbial processes for the production of plants or animals.

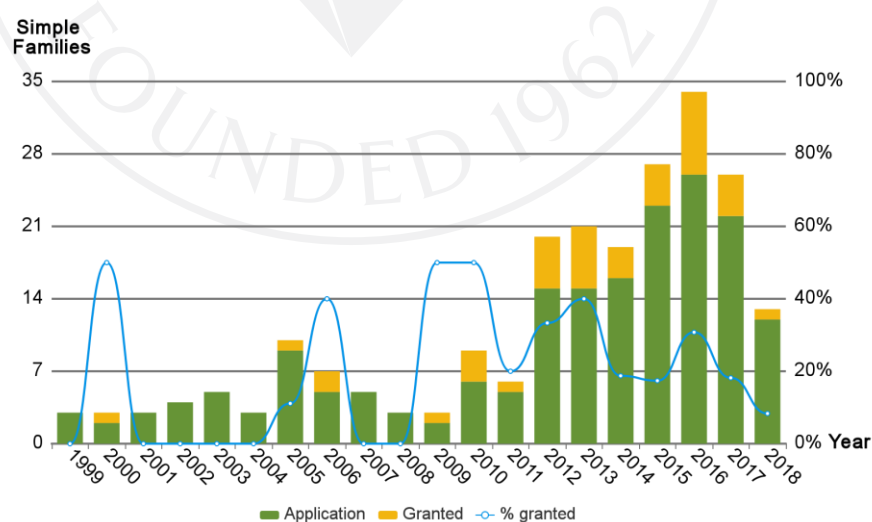


Figure 4.9: Innovation rate

4.2.4 Annual Geographic Filing Strategy

The graph shows the yearly patenting trend of the technology field within the top 10 jurisdictions. From the results of the patent data analysis in Figure 4.10, applied patents related on coffee processing technologies in the world are mainly distributed in China, India and Australia. According to Annual Geographic Filing Strategy data, China has the highest number of patents publication.

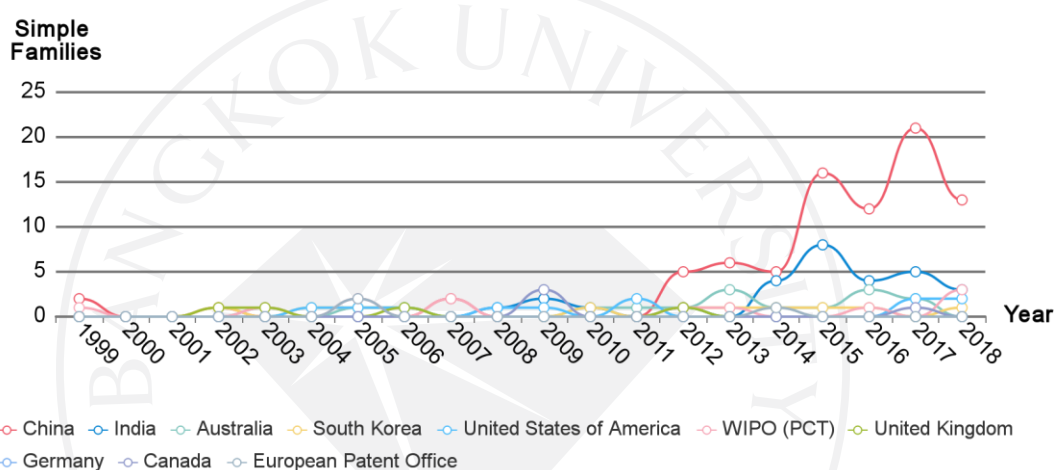


Figure 4.10: Annual Geographic Filing Strategy

4.2.5 New Companies

The new companies looks at companies that have only filed patent applications over the last 5 years in the technology. The companies are ranked based on highest number of patents. Table 4.3 shows who invested in the invention or research that is the world's top, which makes it known who its competitors or partners.

Table 4.3: New companies

Company	Number of patents	Country of original
Teango Tech Inc	7	USA
Bellinvia Silvio	6	Italy
Testa Franco	6	Italy
Torchio Giorgio	6	Italy
Indigo Ag	4	USA
Label Insight	3	USA
Baoshan Aofu Ind	2	China
Cuineng Trade Shenzhen	2	China
Agile Connects Pvt Ltd	1	India
Allbiom Soluções Em Bioprocessos Ltda Epp	1	Brazil

As can be seen from Table 4.3, we can find that Teango Tech Inc, Bellinvia Silvio, Testa Franco, Torchio Giorgio and Indigo AG have applied larger number of patents with regard to coffee processing technology.

Teango Technologies, Inc. is the most patented company. The number of patents applied is seven. The invention relates to Portable devices for preparing and transporting brewable beverages. Disclosed are methods, systems, and devices for portably brewing tea, coffee, or other beverages in a container that regulates the temperature and diffusion during and after brewing. Although this technology is not directly related to the coffee industry, these techniques can be applied at the industry level.

Bellinvia Silvio, Testa Franco and Torchio Giorgio have joint patents on AU2015381215: The Capillary proximity heater with high energy saving equipped upstream of a microfiltration apparatus for the elimination of calcareous particles present in fluids and downstream of a nozzle or closed circuit. This invention relates to the field of heating fluids, preponderantly water, though the use of electric current,

in particular is a device for heating fluids with high energy saving through the use of electrical current delivered properly after electronic control named -"fluids"-, after having been micro-filtrated, are put under pressure in one or more tube of capillary dimension, and subsequently leaving the device to the desired temperature and pressure by means of the nozzle. This technology is interesting in the development of industrial coffee processes for energy saving.

Indigo AG is a company that have applied for patents are fifth. The number of patents applied is four, with 2 applicants in 2016 and 2 applicants in 2017. This invention relates to Seed-Origin Endophyte Populations, Compositions, and Methods of Use. This is not directly related to the coffee industry by the scope of this independent study.

The prime importance information to construct technology forecasting is that can identify who are the leading experts in the field of coffee processing technologies in the world.

4.2.6 Top Inventors

Figure 4.11 shows the top inventors in the technology field. Top inventor determining the key inventors that have contributed to the generation of most patents. This information can be useful for looking to evaluate the top performers in a specific technology field and recruit inventors to innovate within the organization. It is also possible to plan cooperation in the future.

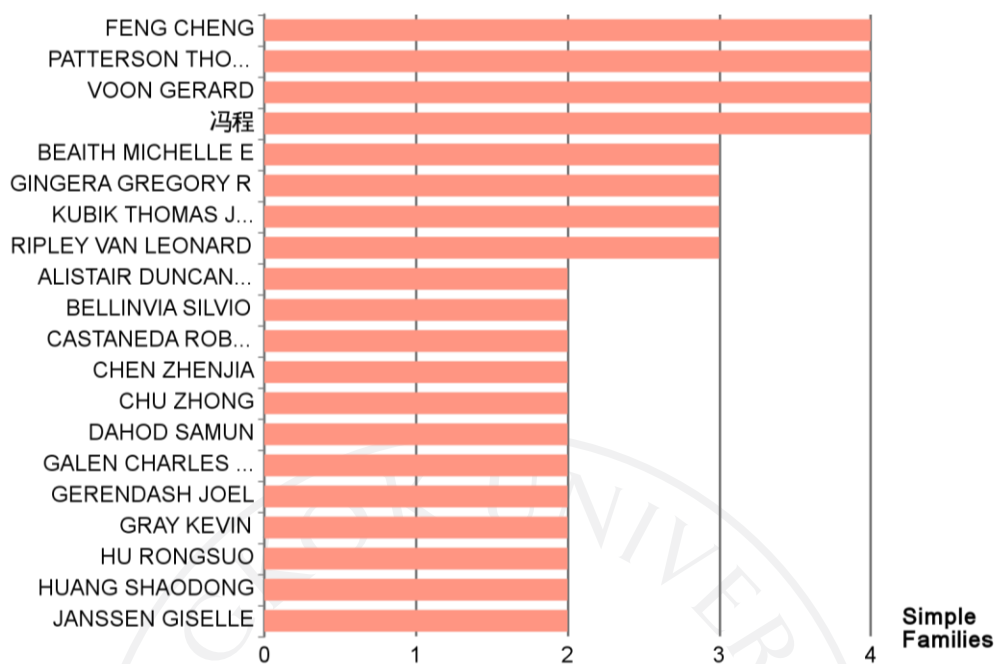


Figure 4.11: Top Inventors

4.2.7 Technology Focus

Figure 4.12 visualizes the top 10 technology areas the global patents. The results are shown in Figure 4.12 and the detail in Table 4.4 retrieved from PatSnap software.

A23F5 Coffee; Coffee substitutes; Preparations thereof [2006.01]	A23F3 Tea; Tea substitutes; Preparations thereof [2006.01]	C12N9 Enzymes, e.g. ligases (6.); Proenzymes; Compositions thereof (preparations containing enzymes for cleaning teeth	C12N15 Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or
A23L1 Foods or foodstuffs; Their preparation or treatment (preservation thereof in general A23L 3/00) [1,4,8]	A23L2 Non-alcoholic beverages; Dry compositions or concentrates thereof; Their preparation (soup concentrates A23L 23/10; preparation of non-alcoholic beverages by removal of alcohol	A21D13 Finished or partly finished bakery products [2017....	C12N1 Microorganisms, e.g. protozoa; Compositions thereof (medicinal preparations containing material from protozoa, bacteria or viruses A61K 35/66 from algae
		G06F17 Digital computing or data processing equipment or methods, specially adapted for specific functions [2006.01]	G06Q30 Commerce, e.g. shopping or e-commerce [2012.01]

Figure 4.12: Technology Focus

Table 4.4: Technology Focus

IPC Code	Definition	Simple Families	Percentage
A23F5	Coffee; Coffee substitutes; Preparations thereof [2006.01]	41	19.43%
A23L1	Foods or foodstuffs; Their preparation or treatment (preservation thereof in general A23L 3/00) [1,4,8]	28	13.27%
A23F3	Tea; Tea substitutes; Preparations thereof [2006.01]	12	5.69%
A23L2	Non-alcoholic beverages; Dry compositions or concentrates therefor; Their preparation (soup concentrates A23L 23/10; preparation of non-alcoholic beverages by removal of alcohol C12H 3/00) [2006.01]	11	5.21%
C12N1	Microorganisms, e.g. protozoa; Compositions thereof (medicinal preparations containing material from protozoa, bacteria or viruses A61K 35/66, from algae A61K 36/02, from fungi A61K 36/06; preparing medicinal bacterial antigen or antibody compositions, e.g. bacterial vaccines, A61K 39/00); Processes of propagating, maintaining or preserving microorganisms or compositions thereof; Processes of preparing or isolating a composition containing a microorganism; Culture media therefor [2006.01]	7	3.32%
C12N15	Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts therefor (mutants or genetically engineered microorganisms C12N 1/00, C12N 5/00, C12N 7/00; new plants A01H; plant reproduction by tissue culture techniques A01H 4/00; new animals A01K 67/00; use of medicinal preparations containing genetic material which is inserted into cells of the living body to treat genetic diseases, gene therapy A61K 48/00; peptides in general C07K) [2006.01]	7	3.32%

(Continued)

Table 4.4 (Continued): Technology Focus

IPC Code	Definition	Simple Families	Percentage
C12N9	Enzymes, e.g. ligases (6.); Proenzymes; Compositions thereof (preparations containing enzymes for cleaning teeth A61K 8/66, A61Q 11/00; medicinal preparations containing enzymes or proenzymes A61K 38/43; enzyme containing detergent compositions C11D); Processes for preparing, activating, inhibiting, separating, or purifying enzymes [2006.01]	7	3.32%
G06F17	Digital computing or data processing equipment or methods, specially adapted for specific functions [2006.01]	7	3.32%
A21D13	Finished or partly finished bakery products [2017.01]	6	2.84%
G06Q30	Commerce, e.g. shopping or e-commerce [2012.01]	6	2.84%

4.2.8 Main Companies

Figure 4.13 retrieved from PatSnap software, cell diagram shows the keywords and phrases of the patents belonging to the top organizations in the technology field. The relative coverage is represented by the number of cells under each organization, with each cell representing the same number of patents. Networks between organizations and technology field are illustrated. In this context, it is found that organizations who apply for patent applicants have an opportunity to be a market leader in the coffee industry technology and the way that those organizations focus on business.



Figure 4.13: Main Companies

Figure 4.13 shown Procter & Gamble focuses on technology development by adding composition. The patent titles are “A method of modifying the flavor and aroma of roasted coffee flake and ground roasted coffee blends” (1971), “Process for producing a coffee product” (1982), “Reduced calorie fat compositions containing polyol polyesters and reduced calorie triglycerides” (1990), “Compositions comprising a polyvalent cation source and a partially digestible lipid and/or a non-digestible lipid” (2002). Based on the above information, it is found that it is related to technology, but such patent documents are quite outdated. There is only one patent published in 2013, “Fiber containing compositions and methods of making and using same”, which is not directly related to the technology in the coffee industry.

安徽金钇石斛 or Anhui Jinyu Shijie is an organization focusing on a variety of technologies including preparation, coffee beans, health care, and raw materials. The patent titles are “Coffee whole-wheat healthcare biscuit” (2017), “Coffee healthcare

soft candy” (2017), “Coffee health care jelly and Coffee-flavor health-care cake and preparation method” (2017).

The remaining patents introduced by various companies focus on areas in the coffee processing, such as Preparation, Water, Coffee Beans and Composition. For example, Preparation is about preparation method. Water is about water recycling system and water in the process which effect to the product quality or taste etc.

In addition, the analysis found emerging keywords that need to be studied in detail. For example, Coffee Pulp, Nucleic Acid, and Coffee Carbon. Most importantly, an emerging trend seems to focus on the use of coffee for healthcare. For example “Processing technology for ice cream containing coffee pulp pigment powder”, “Nucleic acid sequence encoding polypeptide with pectate lyase activity”, “Coffee whole wheat healthcare biscuit”, “Coffee health care soft candy” etc.

4.2.9 Innovation Word Cloud

In Figure 4.14 retrieved from PatSnap software, the Word Cloud displays the most frequent keywords within the Simple Families in the technology field. A large number of innovations, related to preparations, water, coffee beans, composition and raw materials are mentioned. However, though these words do not represent direct technology they can provide an indication for opportunities to focus R&D on.

The technologies found in this innovation word cloud are Microcapsules by PEPSICO Inc. that has been published in 2015 totaling two applications. This patent discusses the extraction of oil from various products including coffee oil containing microcapsules.



Figure 4.14: Innovation Word Cloud

4.2.10 Landscape analysis

Patent-Based Whitespace Analysis displays patent information in the form of a 3D map as shown in Figure 4.15. All patents are included on the map and categorized by clusters. The most similar documents will be placed in the same cluster. The peak of a cluster related to the number of patent contained in the cluster. A High Peak indicates many patented are part of this cluster as compared to other areas on the map. It must be aware of the patent infringement of other rights holders. Whitespace is an area that has fewer patents. It may not be very risky if we learn the patents in this group to find a way forward or to apply for a patent to cover the area.

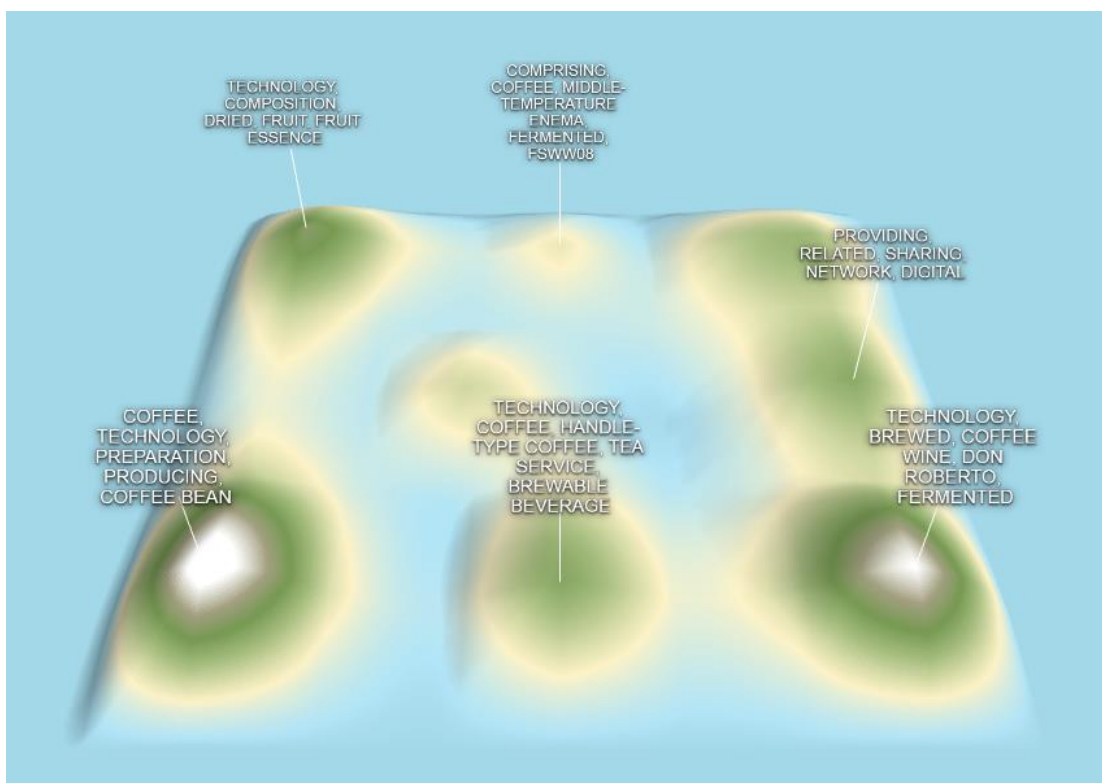


Figure 4.15: Landscape analysis

4.2.11 Technology field

According to Table 4.4 Technology focus, these information can analyze the information to study on the anticipate technology trends in last 10 years.

4.2.11.1 IPC Code A23F5

Starting from the IPC Code A23F5, Classification and description is Coffee; Coffee substitutes; Preparations thereof [2006.01] is the highest technology used in this analysis. According to the details of each patent dating back 10 years, the results is following.

There are 2 applications applied and published in 2018 from China. The first is Process for improving coffee processing efficiency and coffee beans from China Coffee Engineering Research Center and the second is Coffee bean processing

technology that can improve coffee quality from Sichuan Xingzhi Zhihui Intprop Operation Co.,Ltd.

In 2017, There are 5 applications applied and published in 2017-2018 from China. The first is Method for preparing monkey mushroom coffee from Henan Luoyang Red Peony Industry Research and Development, the second is Coffee fresh fruit processing water recycling system and process method from Ruirui Tea Tea Co., Ltd., The third is Method for preparing coffee beverage substitute by using soybean from Northeast Agricultural University, the fourth is Coffee bean and processing technology thereof for effectively improving coffee quality from Dehong Yinuo Pure Coffee Co., Ltd. and the fifth is Solid powder honey and preparation method thereof from Anhui Post Youth Industrial Design and Research Institute Co., Ltd.

In 2016, There are 4 applications applied and published in 2016-2017, three from China and one from Dominican Republic. The first is processing technology of the integral grain of coffee for the production of substances and ecologically clean products towards a sustainable agribusiness from Juan Jose Arias Dipre. The second is processing technology of coffee black tea from Li Mingxian and Wang Degui. The third is method for producing high quality coffee concentrate from Dalat Foods Guangzhou. The fourth is coffee health jelly from Anhui Jinyu Shijie.

In 2015, There are 5 applications applied and published in 2015 and 2018 from China. The first is Coffee beverage with slag sleeve and preparation method thereof from Hidden Snow Food in Sanshui District, Foshan City. The second is Food raw material process and structure from Yang Dengyu. The third is Preparation process of Yunnan small-sized coffee beans from Dehong Hougu Coffee. The fourth is Maca coffee from Gansu Light Industry Research Institute. The fifth is

Cherry coffee powder and preparation method thereof from Dalian Nationalities University.

In 2014, There are 3 applications applied and published in 2014, 2016 and 2017 from Korea, China, and Brazil. The first is whole green coffee bean product, its production method and use from Korea. The second is a kind of recovery speed solubilization production process middle fragrance physical method and system from Daejung Foods, China. The third is Integrated Technological Process for the Obtaining of Sugar and Compost Phytochemicals from Allbiom Solucoes Em Bioprocessos Ltda Epp, Brazil.

The conclusion of IPC Code A23F5 analysis found that there is an industry-level technology that is interesting to study or develop to improve the coffee industry both product and process. In addition, this analysis found a trend of new products that might be popular in the near future.

4.2.11.2 IPC Code A23L1

The analysis of IPC Code A23L1, Foods or foodstuffs; Their preparation or treatment (preservation thereof in general A23L 3/00) [1,4,8] is the second classification used in this analysis. According to the details of each patent dating back 10 years, the results is following.

There is one application in 2015 from China that discusses putting coffee powder into instant noodles.

There are 5 applications in 2014, Three from China and two from India. The patents are about making coffee jelly, adding an amino acid, a bamboo leaf extract, and an inorganic salt for inhibition of acrylamide in coffee, and one

application about Wangjiangnan health soup. The interesting is 2 applications from PEPSICO INC. for producing the microcapsules that are stable in acidic aqueous systems. The layer includes protein aggregates and a negatively charged polymer having blockwise charges such as pectin and the other on is layer includes polysaccharide glycosylated protein. However, the process of microcapsules is not directly related to the coffee production process.

Two applications in 2013, 2 of 3 applications in 2012, one application in 2011 and 2010 are not related directly to coffee processing technology. Only one application in 2012 from China is related on the methods and uses of the transgenic yeast for reducing acrylamide in a coffee product using the transgenic yeast.

The conclusion of IPC Code A23L1 analysis found that there are quite a few applications related to technology for the coffee industry. Mostly, coffee is used as a small ingredient or a process that is shared with coffee, but not primarily for coffee.

4.2.11.3 IPC Code A23F3

The analysis of IPC Code A23F3, Tea; Tea substitutes; Preparations thereof [2006.01] is the third classification used in this analysis. According to the details of each patent dating back 10 years, the results is following.

In 2016, there are 2 applications and published in 2016 and 2017 from China. The first is Method and process for processing fresh coffee fruit to become a tea by dehydration. The second is Processing technology of coffee black tea with coffee.

In 2012-2015, there are 4 applications and published in 2015 and 2016 from China. They related to Method for processing high selenium herbal coffee tea with coffee powder, instant alcohol sweet bitter tea drink with coffee powder, Highland barley compound type tea bag with Brazilian coffee cooked beans, and Nutritional coffee with Pu'er tea. So, these 4 applications are not directly related to coffee processing technology.

The conclusion of IPC Code A23F3 analysis found that there are no applications related to coffee processing technology.

4.3 Identify the key external factors that may shape the growth of technologies-based industry by industrial historical document, article reviewing to see the trend, opportunities, enablers, or barriers from market, policy and industry dynamics.

4.3.1 External Factor

Various external factors from review literature and interview industry experts found that influencing the business's ability to achieve strategic goals and objectives. The coffee industry market also has external factors that affect the business as well. As in the Table 4.5.

Table 4.5: External factor

Dimension	Key event
Competition	<p>(+) In the coffee industry uses a high investment, therefore, there are few competitors entering the market of new products.</p>
	<p>(-) The competition in the coffee market is very high, while ready-to-drink coffee is classified as a cheap product. Resulting in the development of high-priced RTD coffee products is not easy.</p>
Government policies	<p>(+)The government issued a policy to promote innovation along with a large budget. Enabling entrepreneurs to have the opportunity to receive funding for research and development of innovative products. For example, National Science and Technology Development Agency, National Innovation Agency (NIA) etc.</p>
Government policies	<p>(+) Promoting the government's coffee strategy provides an opportunity to develop better quality coffee products and have enough raw materials to meet the needs</p>
	<p>(-) Thailand has a tax quota system and conditions requiring the purchase of coffee from domestic farmers at the state guarantee price which is higher than the world market. The coffee beans organized in the agricultural product group with tariff-rate quota (TRQ). Coffee bean set a quota of 5.25 tons per year, 4% tax. There is 81% tax imported outside the quota. Instant coffee set a</p>

(Continued)

Table 4.5 (Continued): External factor

Dimension	Key event
Government policies	quota of 134 tons per year, 5.33% import tax. There is a tax of 44.1% imported outside the quota.
	(-) According to the notification of the Ministry of Public Health (No.376) B.E 2559 (2016), The strictness of the novel food and process law makes the product inspection process difficult, delay and uses a very high budget. It take about 1 year for toxicity analysis in human or animal laboratory and spend more than 1 million Baht per product.
Social and Cultural forces	(+) Current trends in health products and environmental protection are coming. Therefore, the process that promotes environmental and health issues has high market opportunities.
Social and Cultural forces	(+) Nowadays, the response of the cherry coffee or cascara products has become world famous. In addition to helping the environment, it also has good taste and high benefits.
	(+) The showpiece in society is very competitive. Choosing the best attitude makes the premium products more popular. There is a lot of product upgrading to respond to customers with a lot of paying power.

(Continued)

Table 4.5(Continued): External factor

Dimension	Key event
Demographic factors	(+) Due to the demographic trend will shift into an aging society, the trend of products for this target group will have an opportunity to expand the market.
Technological changes/Trends	(+) Technology that changes rapidly results in easier search and development of production technology and cheaper prices.
	(+) People start to focus on new things or novel, such as new products or innovations that are different from familiar things.
	(-) Although the investment will have a lower cost, but rapid changes make technology obsolete easily. Including many imitations as well

From the key external factors analysis, it found opportunities and treats in developing technology to bring new products or processes into the market. The details are following.

4.3.2 Opportunities

4.3.2.1 There are few competitors entering to the coffee industry market.

4.3.2.2 Research funding of innovative products by the Government.

4.3.2.3 Trends in environmental and health products

4.3.2.4 Trend in elderly products.

4.3.2.5 Rapid technology development with low cost.

4.3.2.6 The government's coffee strategy.

4.3.3 Threats

4.3.3.1 By the image of cheap ready-to-drink coffee, entering the market with high-priced products is a challenge.

4.3.3.2 The strictness of the novel food law makes the development of innovative products or processes in the novel food category is a challenge.

4.3.3.3 Technology is quickly imitated and obsolete.

Opportunities and obstacles arising from this key external factors analysis will be used as a part of forecasting the coffee technology development.

4.4 Forecasting the future development of technologies-based industry by using the technology analysis results.

Thailand has registered very few patents, compared to the global patent applications as Figure 4.16.

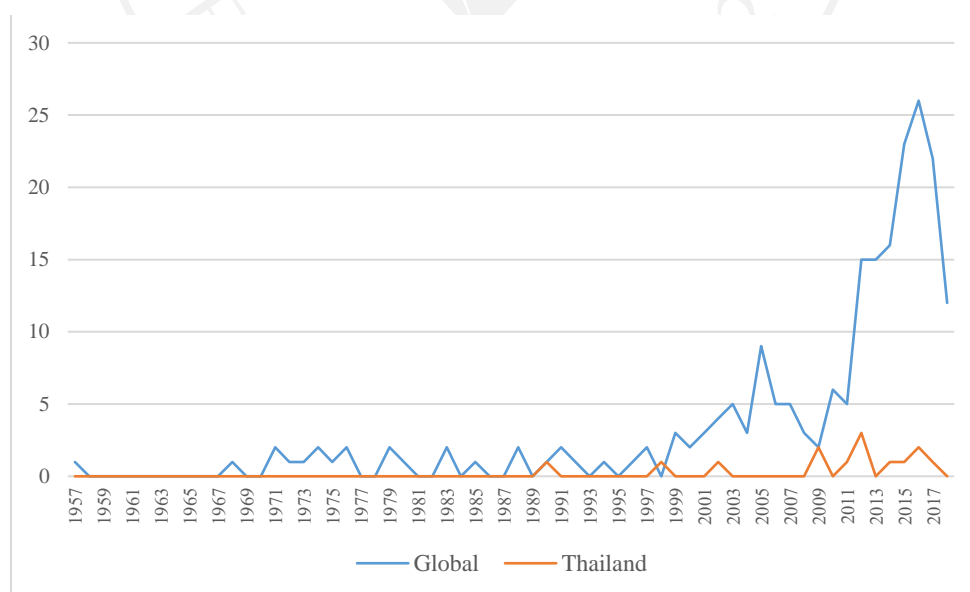


Figure 4.16: Summary of technology analysis from patent applications in 2009-2018

The percentage breakdown of the legal status and patent type in the technology field in Thailand has only 10 simple families, divided into 2 active simple families, 3 inactive and 5 undetermined. Two Thai patents are coffee with chili ingredients from Arjsongkram, Sasima and a bioplastic composition comprising biomass as a component and a production process from PTT Public Company Limited. To date there is no new technology introduced into the Thai coffee industry.

Comparing global patents, totally 211 simple families, divided into 40 active simple families, 52 pending, 72 inactive and 47 undetermined. Patent pending is the term used to describe a patent application that has been filed with the patent office, but has not issued as a patent. Patent pending indicates that the inventor is in the process of protection. For the undetermined patent it means not able to obtain the expected simple legal statuses from their corresponding patent offices.

We are interested in 40 active simple families for examination to study the trends of innovation in the coffee industry around the world. Technology assessment relies on joint decisions with industry experts to summarize the objectives, process, and technology level used, as in Table 4.6.

This study has analyzed global patent information and provides a detailed study of important patents. The analysis has been conducted by obtaining feedback from experts in food industrial technology to help plan the coffee technology development in Thailand.

Table 4.6: Technology analysis of 40 Patents Granted

Objective		Process		Technology Level	
Issues	Frequency	Issues	Frequency	Issues	Frequency
Improving Cost & Quality	21	Green coffee bean process	7	Old technology	4
Adding Value to Product	5	Roasted coffee bean process	3	Minor change technology	7
Initiate Novel Product	5	Coffee beverage process	14	Modification of known technology	14
Health Food	3	By product management	8	New/Novel process	9
Medicare Food	6	Material	3	New/Novel product	6
		Not Related to coffee	5		

Based on the information from Table 4.6, we designed the group of technology and process for the patents. In addition, we cut off unnecessary information and use technology level to mapping the technology development timeline. In finding new technologies and trends, we include related pending patents to analyze and anticipate technology trends in last 10 years. The interested technologies are following:

1. Green coffee bean process

1.1 Using the biological enzyme, Cellulase (β -1,4-glucan-4-glucan hydrolase) to improving coffee bean quality and process efficiency in the ferment-and-wash method of wet processing. This technology helps to reduce time and water in the process.

1.2 The invention provides a coffee fresh fruit processing water recycling system to improve fermentation efficiency and improve the quality of fresh coffee. Filtration and sedimentation are used for water recycling.

2. Roasted coffee bean process

2.1 Using some techniques to improve coffee quality by adding the fried sand in the continuous roasting machine, mixing the Chinese medicine granules with the green coffee beans in roasting process and rapidly cooling to $(-25)^\circ\text{C} - (-19)^\circ\text{C}$ in 3 minutes after roasting. This technique will make the coffee beans evenly heated and enhance the aroma of the coffee. The Chinese medicine granules are 20-30 parts of malt, 5-10 parts of white peony, 6-10 parts of licorice, 10-15 parts of tamping.

3. Coffee beverage process

3.1 A method for producing high quality coffee concentrate, which cold extraction, filtration, centrifugation, freeze concentration, CO₂ filling, refrigerating. The invention combines the non-thermal processing technology and the CO₂-filling to prevent oxidation of fats and oils in coffee concentrate and inhibits the growth and reproduction of microorganisms. This method produces a product called “Sparkling cold brew”, which is a new product in the coffee market and has just started selling in the European market.

3.2 A method and a system for recovering aroma components in the production process of instant coffee, which recovers the aroma substances lost during the coffee grinding process by the water spray condensation in the freezing process of the adsorption tower, by flashing, replacing, concentrating and adsorbing. The aroma substances in the extraction process and the concentration process are recovered, and

the aroma substances, which are easily lost and destroyed during the production process of the instant coffee, are recovered in an all-round manner.

4. Coffee product and process trends

4.1 Using Maillard reaction to make a coffee substitute. The trend is research on the development of coffee-like beverages using non-coffee beans as raw materials, such as wheat, cassia seed and glutinous rice, has been carried out in China. The use of soybeans to make coffee substitutes. The invention is germination treatment of soybean, and kneading wheat germ and baked soybean powder to prepare a coffee substitute. This technique will reduce the anti-nutritional from lipoxygenase and phytase trypsin inhibitor and the high nutrients in soybeans in the human body will fully digested and absorbed.

4.2 The invention relates to a coffee health jelly by adding more ingredients such as coffee beans, frangipani, corydalis, perillaceae, magnolia, gelatin powder, condensed milk, and honey. The health care functions are relieving liver and relieving depression, reducing fat and eliminating phlegm, and relieving pain and qi and relieving pain.

4.3 The extraction of the Indonesian civet cat excrement and use the technology to separate the strain, exclude other harmful, and only take out the health and hygiene bacteria for the human body. Then spray the strain on the coffee beans for special fragrance and coffee taste to make it close to the traditional musk cat to devour the original flavor of the coffee.

4.4 Adding coffee cherry extract for health function. The coffee cherry extraction process is adding 4 mL of ethanol per 1 g of cherry syrup, adding ethanol

having a volume concentration of 89 to 91%, mixing the two, and adopting a reflux extraction method. Then concentrated under reduced pressure at a temperature of 50 to 55 °C and a vacuum of 0.45 to 0.55 MPa to obtain a cherry extract.

4.5 A novel processing method for green coffee beans, which produces a new green coffee bean product. The method involves selecting fresh green, non-roasted whole coffee beans with a naturally occurring level of phytonutrients, avoiding high temperatures, sterilizing and drying them, applying repetitive milling processes and stabilization techniques. This product found to be associated with attention and attention deficit and related disorders such as attention deficit (AD), attention deficit disorder (ADD), attention deficit hyperactivity disorder (ADHD), and various related and/or comorbid disorders.

4.6 Generating products from the articulation of two microbiological treatments, with *Cerevisiae Saccharomices* and Methanogenic bacteria. This application does not have description to study in the detail of patent.

Some patents are about increasing the benefits of coffee products such as adding *Hericium erinaceus*, honey, blueberry, blackberry, black tea, Pu'er tea, maca, and bean. In addition, it is about non-industrial equipment such as slag pot. Therefore, not considered in the group of coffee production technology.

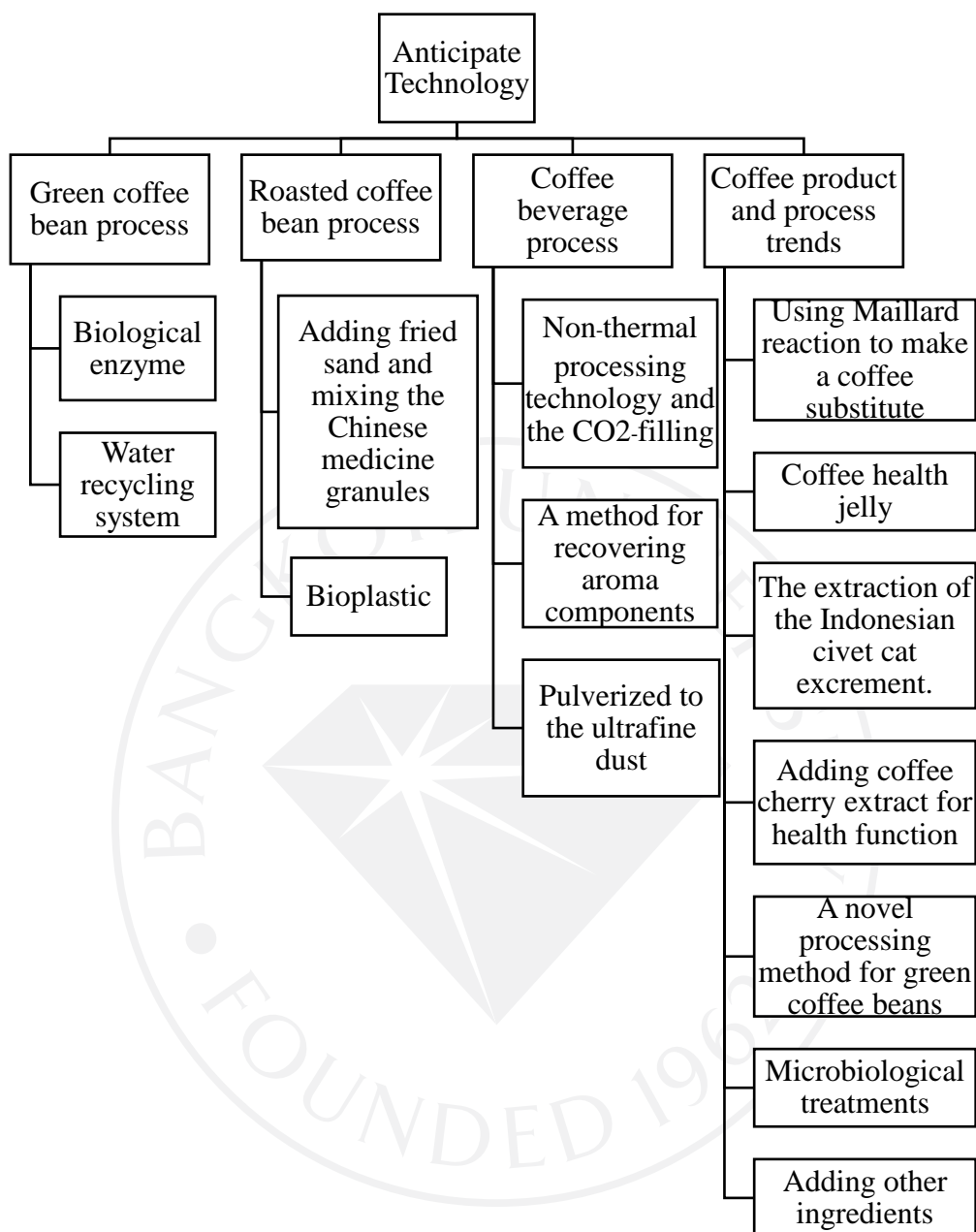


Figure 4.17: Anticipated main coffee processing technology

From the diagram in Figure 4.17 shows the analysis of technology from patents to anticipate technologies and applications that have the opportunity to develop in the future. Based on industrial experts brainstorming to focus on production and technology perspectives, the summarized experts' consensus judgments become relationship between patent and technology analysis as shown in Figure 4.18.

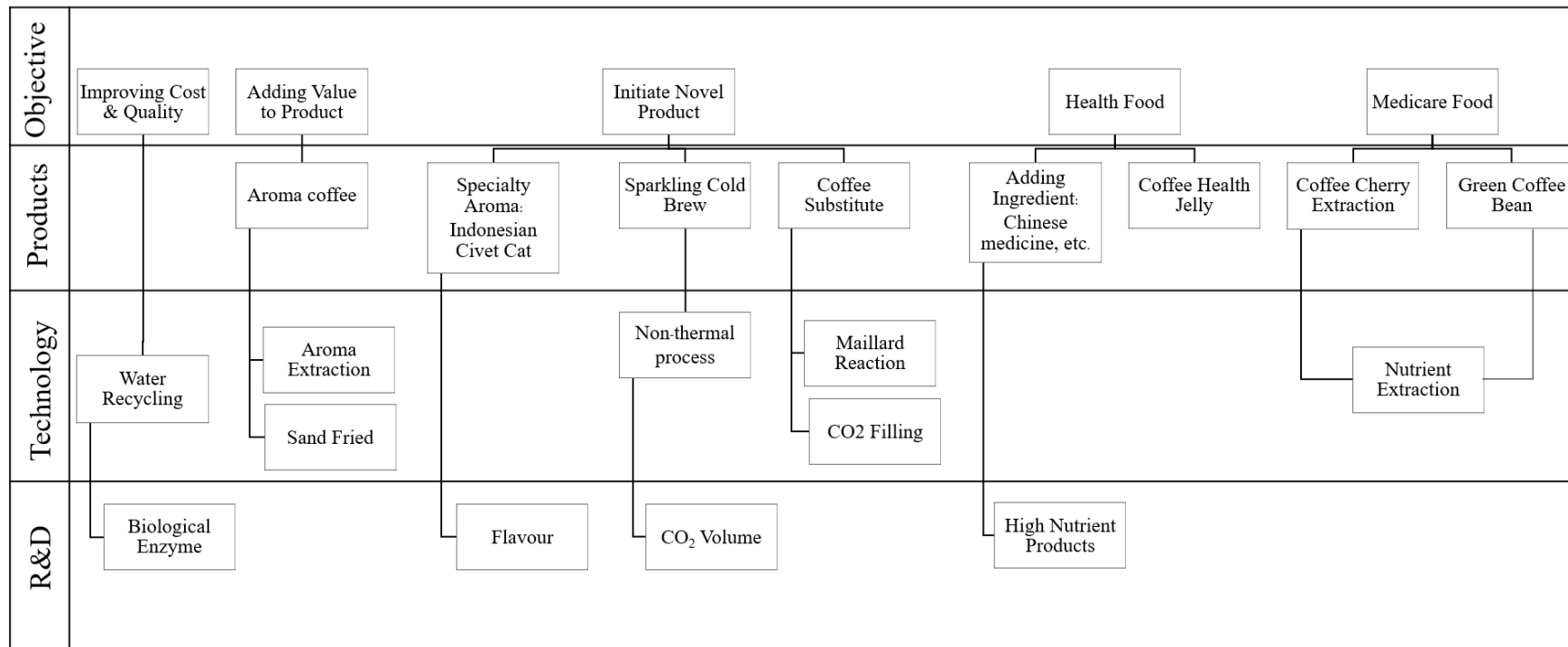
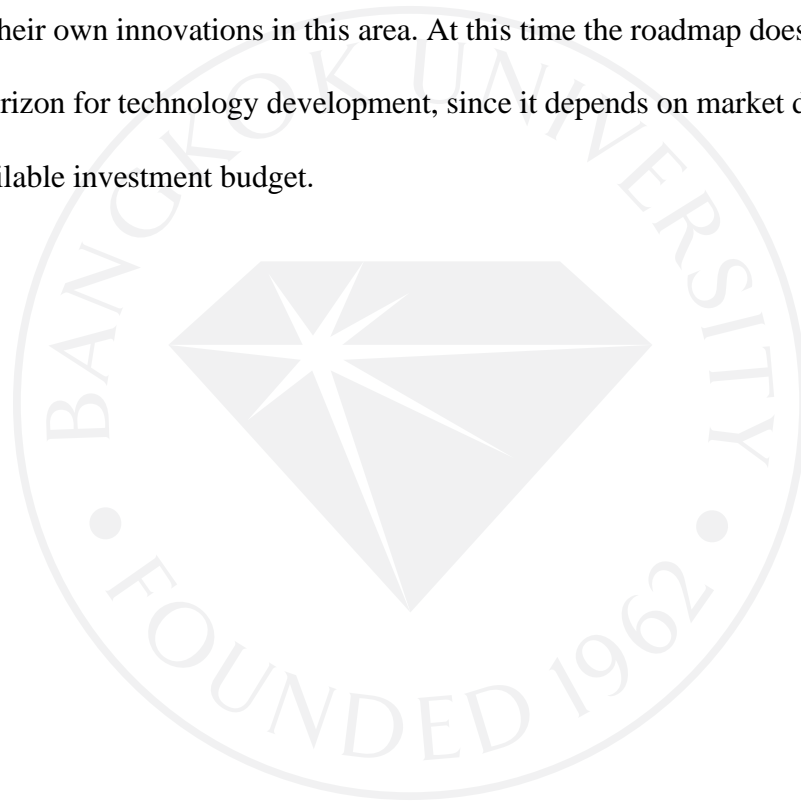


Figure 4.18: Relationship between Patent and Technology Analysis

Patent analysis shows gaps in technological development between Thailand and the rest of the world, which is an opportunity to develop coffee technology and value-added coffee products in Thailand. Based on the patent analysis the industrial experts summarized a technology roadmap as shown in Figure 4.19. The map shows the market direction from cost & quality development to medicare treatment products respectively. The R&D layer is an important part for an organization that intends to create their own innovations in this area. At this time the roadmap does not specify the time horizon for technology development, since it depends on market dynamics and the available investment budget.



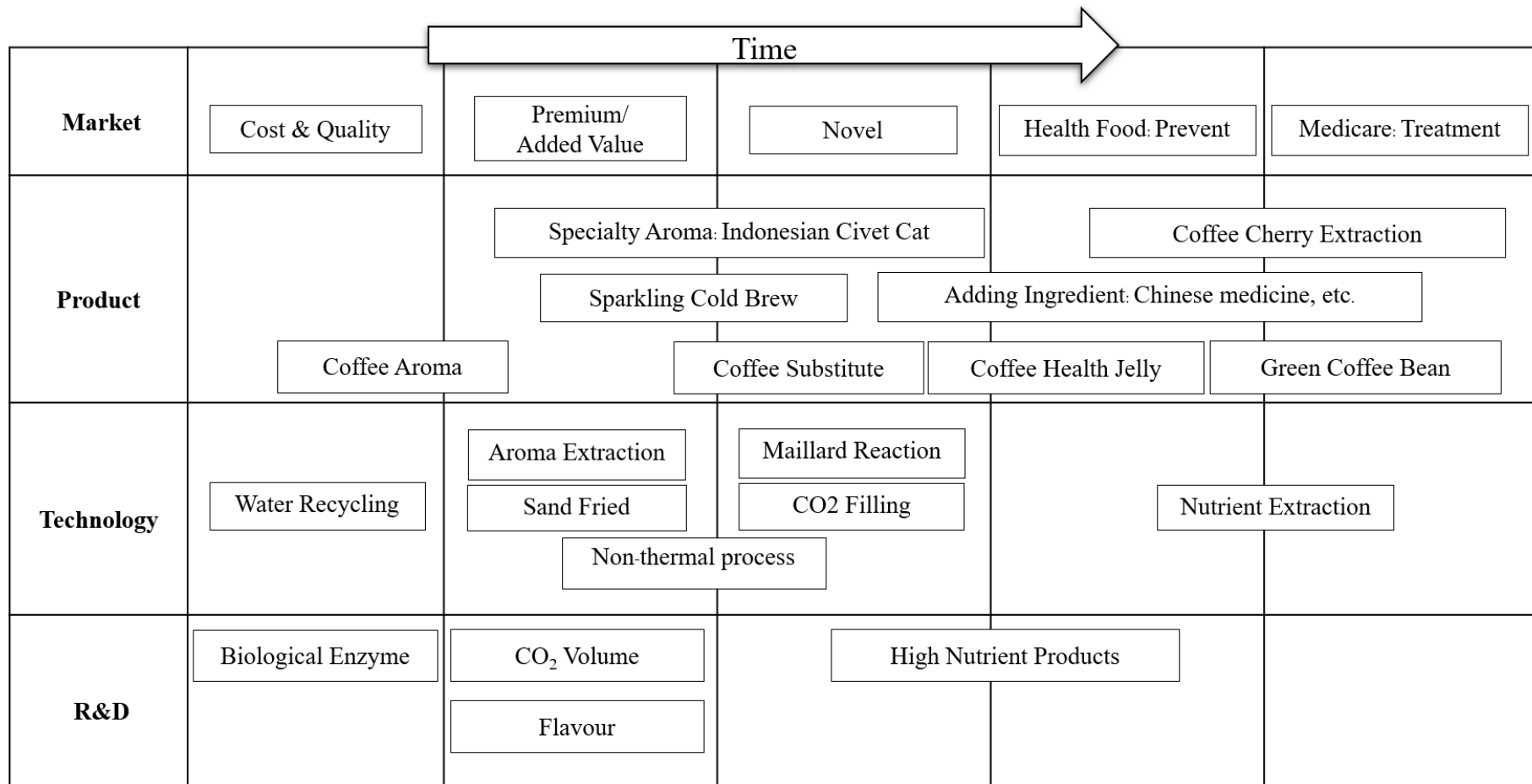


Figure 4.19: Anticipated coffee processing technology trends

Conclusion

This study attempts to anticipate technology by using patent analysis, in order to strategize and plan the future development in coffee industrial technology. Various technologies analyzed by these patents will help entrepreneurs in the coffee business or those interested in this business understand and be able to choose technologies that are in line with the organization's strategies and goals. With ethical responsibilities, we cannot directly apply patents that are regulated by law. Therefore, it is advisable to study this information only as a guideline for determining business and investment strategies only.

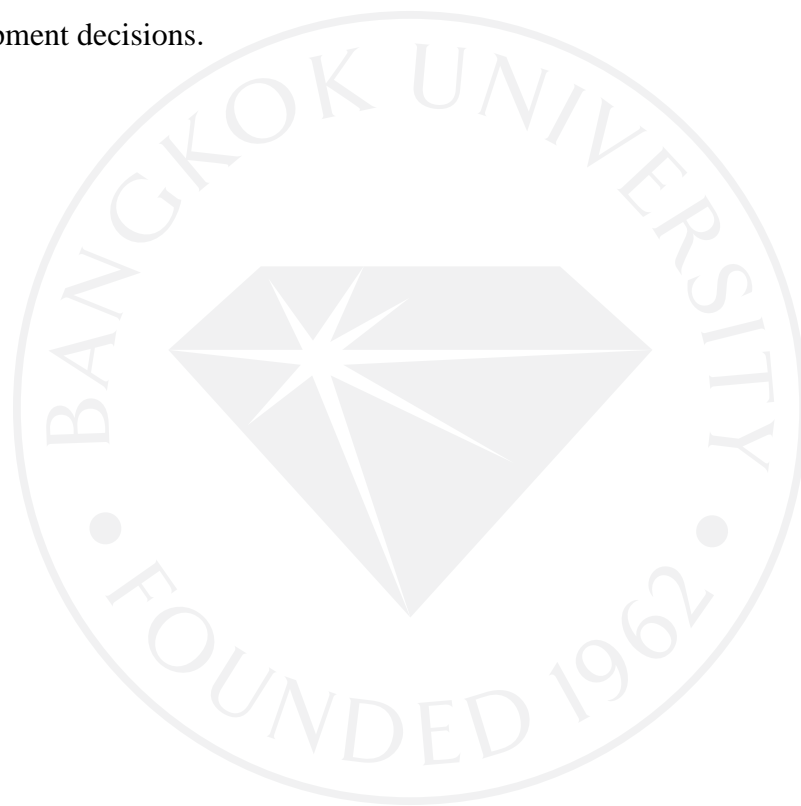
Although, the technology development plan requires other information, including domestic and international market trends, technology, policies and laws that can create both opportunities and treats.

Currently, Food and Drug Administration offices around the world are focusing on certifying emerging or novel products and process according to the trend of innovation. Although those strict measures are good for the consumer safety, they are the cause of frustration and inflated budgets to validate the innovation R&D efforts of an organization.

From the results of the patent data analysis, global patents applications that are related to coffee processing technology originate mainly in China, India and Australia. It indicates that these countries/regions have relatively strong R&D capability and interest in the field of coffee processing technology.

The patent analysis was used as a flexible method to strategize and plan future development trend of technologies to support strategic and long-term planning. The

insights gained from the research are used to assist the strategic planning of technological development paths and their possible application in the Thai coffee industry. In collaboration with industry experts an initial technology roadmap was developed to demonstrate possible development paths for R&D projects and consumer products. With a better understanding of the technological landscape, firms operating in the Thai coffee industry are better equipped to make product development decisions.



CHAPTER 5

DISCUSSION

Overall result analysis

From the results of the patent data analysis, applied patents related on coffee processing technology on the world are mainly distributed in China, India and Australia. It indicated that these countries/regions have relatively strong R&D capability in the field of coffee processing technology.

According to the study of Russian patents on the coffee processing technology, which was high in the 3 years between 2008-2010. It found that there were 169 patents is owned by Kvasenkov Oleg Ivanovich. The patent related to coffee in general, Russia has 8,042 patents granted between 1999 and 2018. However, when the patent application of Kvasenkov Oleg Ivanovich was remove, Russia would have only 1,195 patents. The number of patents issued by Kvasenkov Oleg Ivanovich is very interesting.

Kvasenkov Oleg Ivanovich's patents in the period 2001-2018 amounted to 31,333 total simple families. The study of patent details found that most of them were in A23L: Foods, Foodstuffs, OR Non-Alcoholic Beverages, Not Covered By Subclasses A23B - A23J; The Preparation or Treatment, e.g. Cooking, Modification Of Nutritive Qualities, Physical Treatment; Preservation Of Foods Or Foodstuffs.

In terms of his patents related to coffee processing technology, 169 total simple families were found in the period of 2008-2010. Almost inventions related to A23L and mention only the compote production method. Preliminary analysis found that the innovations were very similar and there are not considered a completely invention; therefore, they were excluded by this study.

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BIODATA

Name: MS. PORRUTHAI BOONSWASD

Position: Division Manager, Core Value and Business Innovation


Company: Premier Group of Companies

Nationality: Thai

Education Qualification: Master of Engineering (Engineering Management),
Kasetsart University
Bachelor of Science (Food Industrial Technology),
Maejo University

Expertise: Productivity, Knowledge Management, Organization
Development, Business Innovation

Email ID: Porruthai.B@gmail.com

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