OPEN INNOVATION LOGICS AND PRACTICES

GENERATIVE MECHANISMS IN THAI FOOD MACHINERY SMEs

NEW PRODUCT DEVELOPMENT: MULTIPLE CASE STUDIES

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DECLARATION

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ABSTRACT

The purpose of this research was to provide an appropriate academic and practical guideline for understanding open innovation (OI) in new product development (NPD) among Thai small and medium enterprises (SMEs). However, only a few studies have demonstrated that OI is used by Food SMEs. Their OI generative mechanism (GM) remains poorly understood.

To understand the role of OI in this change, specifically OI logics and practices in food SME's NPD, and the Food-Machinery framework by Bigliardi and Galati (2013a) have been chosen to analyze 109 NPDs of 2 Thai food machinery SMEs using a critical realistic (CR) perspective. Five rounds of semi-structured interview and document review methods were utilized for data collection.

This research identified evidence that dynamic capabilities (DCs) mobilized in OI NPD is the OI GM. The results also demonstrated the Food-Machinery Flexibility Model and its six distinctive patterns within the same model, were successfully implemented by the integration of 3 OI logics (i.e., coupled OI logic with outbound dominance, coupled OI logic with inbound dominance, and no OI logic) and 8 OI

practices (i.e., employee involvement, outward IP licensing, customer involvement, outsourcing R&D, inward IP licensing, insourcing R&D, supplier involvement, and regulatory body involvement) to reveal the OI knowledge in empirical domain, and consequence the analysis of 9 DCs (i.e., sensing, seizing, inventive capacity, transformative capacity, innovative capacity, absorptive capacity, connective capacity, desorptive capacity, and legally compliance capacity) revealed the underlying OI GM in the real domain. The knowledge flows have been analyzed by focusing on food recipe development at two levels of the NPD process, namely laboratory scale and industrial scale.

Finally, the identification of OI GM demonstrated the relationship between OI and DCs. The development of DCs can strengthen OI practice within the organization. They are mutually reinforcing each other. Six distinctive patterns within the same model demonstrated the ability of investigated food SMEs to develop their 14 mechanisms (DC sequences) to ensure the efficacious implementation of OI logics and practices in food NPDs, and flexibility to the nature of the collaborative strategy associated with each NPD. The results exposed Thai SMEs switching their business from generic food machinery companies to the innovation intermediary. The contribution of this research supported both academic's view on OI literature; understanding OI GM through the OI logics, OI practices and associated DCs mechanisms in the NPD process, and food practitioner's view by providing an appropriate 6 OI guidelines for the food innovation intermediary. The research had a limitation due to a comparison between 2 SMEs' NPDs. Future research could benefit from exploring additional food SMEs.

Keywords: *Open Innovation Generative Mechanisms, Open Innovation Logics, Open Innovation Practices, Dynamic Capabilities, New Product Development, Laboratory scale, Industrial scale, Innovation Intermediary, Food Industry, Small and Medium Enterprises*

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LIST OF ABBREVIATIONS

CR	Critical Realism
DCs	Dynamic Capabilities
FDA	Food and Drug Administration
FI	Food Industry
GMs	Generative Mechanisms
GMP	Good Manufacturing Practice
HACCP	Hazard Analysis Critical Control Point
HS code	Harmonized System Code
LCs	Large Corporations
MNEs	Multinational Enterprises
NSTDA	National Science and Technology Development Agency
NPD	New Product Development
OEM	Original Equipment Manufacturer
OI	Open Innovation
OSMEP	The Office of SMEs Promotion
RA	Regulation Affair
R&D	Research & Development
SMEs	Small and Medium Enterprises
TFs	Triggering Factors
WCO	World Customs Organization
WTO	World Trade Organization
UN	United Nation

CHAPTER 1

INTRODUCTION

This research is a study on investigation of the open innovation (OI) generative mechanisms (GMs) in the new product development (NPD) of Thai food machinery small and medium enterprises (SMEs). The focus of study is to identify the OI GMs favoring the flexibility of OI logics (outbound, inbound, and coupled) and practices (exploitation and exploration practices). The study stems from the researcher's attempt to explain how some Thai food industry (FI) SMEs, which are the food machinery SMEs, have effectively achieved an OI adoption in their NPD with other actors in the supply and/or value chain.

This first chapter provides an outline of the dissertation, its structure as follows: section 1.1 describes background and objectives of the study. The details of the research background are discussed in section 1.1.1 - 1.1.14. Section 1.2 describes the statement of the problem. Then section 1.3 describes rationale, significance and contribution of the research. The next is section 1.4 describes the purpose of the research. Section 1.5 describes research questions. Section 1.6 describes definition of key terminology, and finally section 1.17 is the summarization of the chapter.

1.1 Background and Objective of the Study

1.1.1 Overview of Food Industry

FI is an industry that brings agricultural products; products from plantation, livestock, and fishery as raw ingredients/materials for food machinery with various production technologies, which are generally expected to extend the product's lifetime in order to get food processing products that are easy to be consumed or to be used in the next stages (The Office of SMEs Promotion [OSMEP], 2018a). FI is one of the most essential human industries since food is one of the basic factors for human needs. Every human being has to eat to survive. However, the National Science and Technology Development Agency (NSTDA, 2018) indicated many situations have continuously affected the manufacturing sector in FI, such as,

1) Increasing demand of raw ingredients/materials for food grown by natural processes, which is the global trend of global consumers who pay more attention to the food safety that they consume (Headey, 2011; OSMEP, 2018c, 2018d). The impact of this trend is directly affected to the productivity of FI, especially the food processing and production sector, according to the fact that it is necessary to use agricultural products as raw ingredient/material for production (Arunsawadiwong, 2007; Charoenrat & Harvie, 2014; Lehtinen & Torkko, 2005). Although the need to shift to more natural methods of cultivation will result in lower agricultural output and higher prices for food products, the higher prices can not compensate for the declining food products in the global market (Dutta, Lanvin, & Wunsch-Vincent, 2018; Martinez, 2013).

2) Agricultural cultivation is difficult to be controlled because it depends on the specific geography and climate conditions for the crop (Headey, 2011). To constantly increase agricultural products for mass production, it needs to rely on other factors that can be controlled by humans, such as chemicals, insecticides, and genetically modified organisms (GMOs). The use of such factors is something that consumers want to avoid (Bigliardi & Galati, 2013b). Moreover, the incident of "Global warming" is a major factor affecting the agricultural sector causing agricultural product reduction and unpredictable cultivation (Headey,

2011). Controlling the quantity and quality of agricultural products is more difficult than the past (Tambunlertchai, 2015). NSTDA (2018) indicated the impact of the global drought crisis on 2008 – 2009 was the result of climate change and global warming. The agricultural price index was about 30% higher than usual. The world food price index, rice, wheat, corn, whole grains, sugar and meat are highly inflated as never before, affecting the FI almost all over the world. Raw ingredients/materials were scarce and production costs were higher than usual. This event had resulted in food riots in 32 countries around the world.

3) Increasing global population is another situation affecting the manufacturing sector in FI (Headey, 2011). It is predicted that the amount of food and raw ingredients/ materials for food production will not be enough for the world population in the near future (OSMEP, 2018d). It is estimated that the world's population in the year 2050 will increase to over 9,000 million people, resulting in a 70% increase in food demand compared to 2006, which is in line with anticipated agricultural output which is likely to decrease due to climate change (Craig, Allen, Feng, & Spialek, 2019; NSTDA, 2018).

The above-mentioned reasons impulse entrepreneurs and actors in FI to provide new product development (NPD) to continue their growth (Bellairs, 2010; Bigliardi, Galati, & Pavesi, 2019; Chokenukul, Sirichote, & Kaewjumnong, 2012; NSDTA, 2018; Vyas, 2014). However, FI has been often considered a conservative industrial group which is slow growing with a low research intensity sector (Bigliardi et al., 2019; Galanakis, 2016). In FI, the main factor that is always considered important in the development of new food products is the production cost optimization and improvement in customer satisfaction (Bigliardi et al., 2019;

Chaochotechuang, 2016; Lienhardt, 2004). Although there have been continuous research and developments in innovative food products and processes, the innovation is more incremental such as the use of existing technology with a variety of agricultural materials to develop greater variety of products and for the purposes of extending the shelf life of the product (Christensen, Rama, & Von Tunzelmann, 1996; Martinez & Briz, 2000; Tambunlertchai, 2015). A good example is the combination of green tea the raw ingredient with various health food products. Another case relates to a local Japanese drink maker, applying sterilization technology in the preservation and transforming the packaging from canned food to the food in retort pouch (Hongsaprabhas, 2017a).

Noticeably, in the Thai context, the nature of the food products has significant influence on customers' buying decision (Jones & Pimdee, 2017). This in turn explain why incremental innovation. FI is an industry where the products are widely consumed and on a daily basis by consumers. As such, consumers often engage in price comparison of food products in the market along with their existing knowledge which sometimes lead to unfamiliarity, unacceptance, and insecurity of the new product safety (Vyas, 2014, p.2). In addition, the cost of breakthrough innovation technology often requires a high investment (NSTDA, 2018) which influence the pricing of the food products. FI also face the risk of product rejection as consumers perceive the higher prices and alter to substitute food products instead (Vyas, 2014). As pointed out by Jeenanunta & Intalar (2016), in FI, a consumer can easily switch to buy a replacement or substitute food products, which indicates a failure in the innovation diffusion process-(Jeenanunta & Intalar, 2016). Making the situation difficult is that many food products fail to indicate the innovative elements of the products. Paticularly on the innovation process which include the significant changes in techniques, equipments and/or machines. Instead, new products development involves an extension of production line extensions that generate only low-margin and short-term benefits (Hongsaprabhas, 2017b). The above factors correspond to many researches that highlight the trend towards incremental innovation which most FI entrepreneurs consider sufficient to develop new food products (Galanakis, 2016; Knox, Parr, & Bunting, 2001; Van Trijp & Meulenberg, 1996).

On the other hand, the proportion of breakthrough innovation products to incremental innovation found in the market is considered very small (Lienhardt, 2004; Vyas, 2014). There are successful breakthrough innovative food products but very often that they are food products for specific purposes, such as liquid food for patients with specific symtoms, food for astronauts. These kind of food products are difficult to develop, need high investment and time consuming (NSTDA, 2018). Moreover, it is difficult to comply with the legal standard and registration (Hongsaprabhas, 2017b). For this reason, potential food entrepreneurs investing in breakthrough technology are often larger enterprises and multinational enterprises, which are considered the minority sector as compared to the total number in the FI (Chaochotechuang, 2016; Chokenukul et al., 2012; Hongsaprabhas, 2017b).

1.1.2 Thai Food Industry Main Characteristics

Thailand is an agricultural country with 70% of the national surface dedicated to food raw ingredient/material production and 49% of its labour force working in agriculture. Therefore, the food industry (FI), which is the processing of agricultural products, is at the core of Thai economy. It connects many related industries and represents 941,693 million Thai Baht (THB) or approximately 10.5% of the 2017

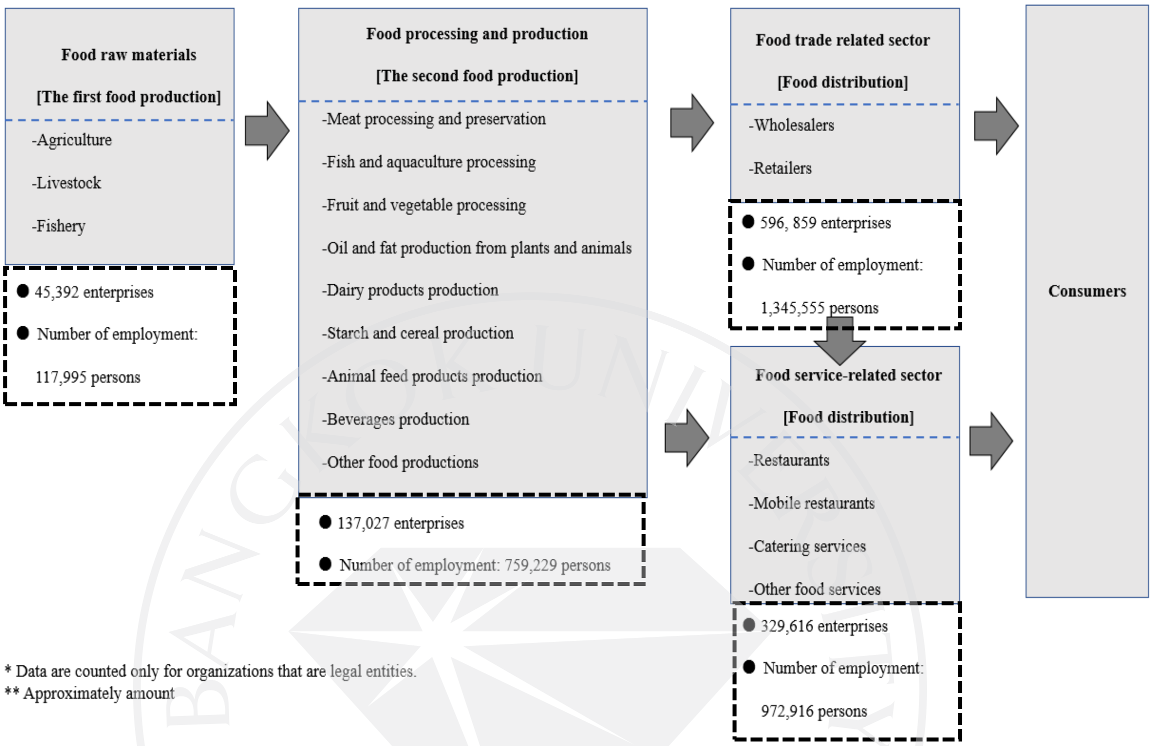
GDP. Over the last few decades, the relative contribution of agriculture to GDP has declined while exports of goods and services have increased. However, Thai FI remains at the first industrial rank compared with other industries in Thailand (OSMEP, 2018c).

Based on the Thailand Industrial Standard, OSMEP (2018a) has separated Thai FI companies into 5 categories: 1) Food raw material producers such as agriculture, livestock and fishery; 2) Food processing and production which according to OSMEP compresses of 9 sub-categories (Figure 1.1); 3) Food distribution concerns food trade related sector which comprises of the wholesalers and retailers of food supply; 4) Food distribution that oversees food service-related sector, such as restaurants, mobile restaurants, catering services, and other food services; and 5) the consumers.

Depending on their size, the actors in the FI from large enterprise, multinational enterprise and small and medium enterprise (SME), play different roles in the industry. The literature demonstrates that SMEs are very important in FI as they are one of the driving forces through their various creative developments (Bellairs, 2010; Laursen, & Salter, 2006; Minarelli, Raggi, & Viaggi, 2017; Mingmalairaks, 2011). Thus, innovation supported by FI, especially SMEs, is critical to regenerate competitiveness and sustain FI (Chaochotechuang, Daneshgar, & Mariano, 2019). However, in Thai FI, investment and expertise, relevant to its development (knowledge management as well as new food technologies) rely mainly on oversea resources and knowhow. As a result, most Thai FI companies still focus on raw ingredients/materials primary processing without seizing innovative or advanced technology opportunities (Suwannaporn & Speece 2010; Tambunlertchai, 2015).

Figure 1.1

The overview of Thai FI structure in 2017



Note. (i) Only legal entities were counted in this figure, (ii) Approximately quantity. This figure is adapted from OSMEP (2018a)

Since FI is one of the main industries in Thailand, it receives continuous support from the government as seen from the first National Economic and Social Development Plan in 1961 permitting its constant growth (Tambunlertchai, 2015). In 2018, Thailand was ranked as the world's 45th largest food security country, measured by its ability to produce and nurture its population. Food and Agriculture Organization (FAO, 2008) defined Food security as "*access of all people at all times to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life.*" (p.1). Food security encompasses 4 pillars, namely accessibility, availability, utilization and stability. The food security index has been developed to support progress in eliminating hunger and malnutrition at the global scale (FAO, 2008). From 2001 to 2011, statistics showed that Thailand's processed food growth rate had improved 10 times. In 2018, Thai Ministry of Industry reported a high export value of 1,008,425,851,118 THB. Currently, Thailand is ranked as the 14^{th} largest food exporter in the world and is 1^{st} in food export among the ASEAN countries. According to Thai export food products survey (NSTDA, 2018), the ratio between fresh products (including raw food and processed food) and ready-to-eat food items evolved from 35:65 in 1998 to 50:50 in 2016. This demonstrated the high ability of Thai FI to increase value creation, delivery and capture through its exports.

Thai OSMEP (2018a; 2007b) and NSTDA (2018) examined the strengths, opportunities, vulnerabilities and barriers of Thai FI (SWOT analysis) and the details are discussed as follows;

Strengths. Thailand has many advantages in terms of food production. Due to its geography and climate, Thailand has favorable condition for agriculture. The country has abundant farm and seafood supply for FI processing and production. As a result, Thai FI is reliant on domestic raw ingredients/materials (Tambunlertchai, 2015), Thai food entrepreneurship with its long experiences in the FI industry has generated essential knowledge in raw ingredients/materials production which is deemed as important skill. As such, the Thai labor force in the FI has been recognised and acknowledged as skilled labors and have high capacity to generate quality food products for the global market.

Opportunities. The Thai government supports sustainable FI development through a variety of projects. It provides many types of business fundings and R&D

grants to FI companies. It is part of the national development policy to encourage Thai FI companies to produce functional foods, processed foods or value-added foods through innovation, to meet customers' needs (Chaochotechuang, 2016).

Weaknesses. It has been noted that Thailand lacks the encouragement and support for NPD to increase the value of food products, while placing more emphasis on food production. As a result, Thai FI entrepreneurs are more likely to be SMEs with limited knowledge, technology, marketing and finance. Thailand also imports some food chemical materials such as food additives, as well as new food technologies such as radio frequency food processing technology. Another concern involves the rising minimum wage in the industry. The rising cost has resulted in higher production costs (Chaochotechuang, 2016; Tambunlertchai, 2015).

Threats. Non-tariff trade barriers are likely to be higher. A major force comes from the European Union (EU) which has banned some of Thai fishery products for the issue of Illegal, Unreported and Unregulated (IUU) fishing problems. This is a constant threat since 2014. This imposition has adversely affected the fishery sector in Thailand, particularly in local fishing, international fishing, processing fishery products and export fishery products. Major reforms have been implemented by the Thai government with the EU announcement that illegal and immoral labour issues attributed to the stringent policies for the Thai fishery sector. In view of the restriction, the Thai government have been seeking ways to reform and overhaul the entire fishery industry to meet international standards. Even though the European Commission has delisted Thailand from the group of "warned countries" in 2019 for the country's effort to tackle the IUU fishing problem, by now, many of the buyers have switched their fishery suppliers from Thailand in other countries in the related industries.

In addition, the reports by Thai OSMEP (2014; 2018a, 2018b) have also clearly identified 4 main challenges for Thai FI:

1) Production: The standard of finished goods is not consistent because of quality variation of raw ingredients/materials. The quality of raw food and ingredients do not always meet the required standards and production volumes due to uncontrollable elements such as seasonal fluctuations in supply, climate change and environmental factors. This situation directly affected efficiency and quality of food production (Craig et al., 2019; Tambunlertchai, 2015). Moreover, most of the Thai FI companies lack the assessment of necessary knowledge and technology to improve their products and production processes.

2) Market and distribution: Noticeably, many food companies lack the vital knowledge to identify and exploit proper distribution and marketing efforts. Adding to this is that the expansion to overseas market involves new rules and regulations which pose greater hindrance to many Thai FI companies (Chaochotechuang, 2016; Ma, Kaldenbach, & Katzy, 2014; Porananond & Thawesaengskulthai, 2014).

3) Linkage gap between national policy makers and entrepreneurs to develop initiatives for Thai FI: The followings are areas lacking in support: Inadequate product quality inspection and registration of food products, Labor shortage in the FI, and Insufficient publicity for the subsidiaries that support food entrepreneurships

Hence, many of Thai FI companies do not generate adequate profits for their business investment.

4) Absence of effective coordination among value chain players. The lack of knowledge and technology in Thai FI SMEs hinder effective new product developments (NPDs) which affects competitiveness. The situation has been made worst with the lower production costs among neighboring countries (Mingmalairaks, 2011; Tambunlertchai, 2015).

5) Slow adaptation to global market trends. The Thai FI is unable to rapidly adapt in global events concerning natural changes, new global consumer trend and new regulatory ban on food at the macro level. Under these situations, Thailand needs to increase its readiness in terms of future food security issues (FAO, 2008; NSTDA, 2018).

1.1.3 Thai FI Culture and Technology

According to Tambunlertchai (2015), most of the innovation applied in Thai FI are still incremental and the industry has exploited relatively low technologies in its production process as compared to other industries (Annosi et al., 2019). Earle (1997) and Rujirawanich, Addison, & Smallman (2011) pinpointed out that innovation in FI derived from a combination of technology and culture. Seyfang and Smith (2007) defined grassroots innovation as "*a network of activists and organizations generating novel bottom-up solutions for sustainable development and sustainable consumption; solutions that respond to the local situation and the interests and values of the communities involved*" (p. 585). Charoenrat and Harvie (2014) added that grassroots innovation is often used to meet the needs and demands of local and domestic markets. Thai producers often intregrate local wisdom and modern technology to develop new products (Rujirawanich et al., 2011; Tambunlertchai, 2015). A good example is the Thai coconut sugar industry

(Niyomrath, 2014). Coconut sugar has been used as a traditional sweetener for thousands of years in Thailand and there is an abundant supply. The locals apply traditional know how throughout the entire food production processes of cultivation, harvesting, production, primary and secondary processing, manufacturing and distribution (Wisootthipaet, 2015). However, the original way of cultivation, production and procession have been largely threatened with the urbanization and introduction of modern food processing technology (Rujirawanich et al., 2011). As the Thai coconut sugar industry is a source of grassroot innovation, the situation will eventually lead to gradual decline in local wisdom in the traditional Thai coconut sugar production (Khaokhrueamuang, 2014).

In recent years, however, the larger firms in the Thai FI and multinationals firms have expressed greater awareness regarding the importance of value creation through innovation. In spite of the higher awareness to change, many Thai FI SMEs, community enterprises and individual businesses have not yet realized the full potential and importance of innovation to the industry as a whole (Hongsaprabhas, Parisot, & Heo, 2018). From Thai FI SMEs' point of view, innovation is a waste of resources and money. They are more concerned with the food production, sales of the food products and raw materials production specialisation (Iturrioz, Aragón, & Narvaiza, 2015; Mingmalairaks, 2011; Savetpanuvong, Tanlamai, & Lursinsap, 2011). This phenomenoncan be explained by the fact that, Thai FI SMEs are reluctant to change due to their national culture and strong historical traditions.

1.1.4 National Policy and Plan for the Development of Thai FI

The Thailand government through its 12^{th} Thai National Economic and Social Development Plan (2017-2020) aimed to drive Thailand to become one of the top 10 food exporters in the world (Wu & Parkvithee, 2017). The national policy correlated with a 20-years national industrial development plan which targeted Thailand to be ranked within the world's top 5 exporters (Ali, 2019; NSTDA, 2018). Currently, Thailand has projected itself into the fourth industrial revolution. There are clear directions for the country's economic structure to be driven by innovation. Jones & Pimdee (2017) stated that the fourth industrial revolution, was a new era that created and extended the impact of digitization in new and unanticipated ways. Significantly, it describes the progress of "the cyber-physical systems" which involves the new capabilities of people and machines (Zambon, Cecchini, Egidi, Saporito, & Colantoni, 2019). The use of advanced science and technology, biotechnology, robotic devices, artificial intelligence, and the internet play dominant roles in the manufacturing sectors especially in production and distribution, and these will change all aspects of the FI (NSTDA, 2018). However, "*despite the advantages of industry or agriculture 4.0 for large enterprises, small- and medium-sized enterprises (SMEs) often face complications in such innovative processes due to the continuous development in innovations and technologies*" (Zambon et al., 2019, p.1). All actors in FI value chain including R&D agencies, universities, suppliers, and food machinery companies, are preparing themselves for this change (Ueasangkomsate & Jangkot, 2019).

It is a great challenge to make Thai FI sustainable due to the fast changing of raw food ingredients/materials, conventional production processes, weather inconsistency, changing consumer taste, and increasingly stringent food safety regulations. Understanding the need to transform, the Thai government supports its FI by encouraging food companies to innovate through the creation of new products, service innovation, innovative processes, organizational restructuring. However, to improve their production processes, faster new products launch and generating greater values, Thai FI SMEs need to be aware of the importance of alternative R&D strategies, advanced innovation logics and practices such as Open Innovation approaches (Chaochotechuang & Mariano, 2016). The change is crucial as Thai FI SMEs business strategies are often inadequate to elevate its low value-added products to high value-added products (Rujirawanich et al., 2011).

1.1.5 Structural Repartition of Thai SMEs in FI

According to the Office of SMEs Promotion (OSMEP 2019), in 2018, approximately 3 million companies were classed as SMEs in the country, comprising 99.8% of all companies. SMEs also accounted for 14 million jobs, or 86% of total employment. SMEs run in various forms namely individuals (a person or partnership that is not a juristic person), limited partnership, limited company or joint venture. It can also operate in many sectors such as manufacturing, retailing, or service providing. Agencies in Thailand often use industry-standard specifications to identify SMEs. The number of employment and revenue per year of the operators have been used as SMEs classification criteria. OMSEP (2019) has catorgized Thai SMEs into 3 sub-levels, namely medium, small and micro (Table 1.1).

Table 1.1

SMEs Characteristics under the resolution of OMSEP 2/2018

Characteristics of enterprises	Number of Employment (person)			Revenue per year (Million Baht)		
	Micro	Small	Medium	Micro	Small	Medium
Manufacturer	1 – 5	6 - 50	51 - 200	Less than 1.8	1.8 - 100	100 - 500
Service provider	1 – 5	6 - 30	31 - 100	Less than 1.8	1.8 - 50	50 - 300

Note. This table is adapted from OSMEP (2018a)

Thai Revenue Department, which is another important agency to Thai SMEs, does not explicitly define SMEs. However, the small and medium enterprises are classified as one for legislation purposes, especially in the provision of supports for SMEs. Take for instance, tax exemptions, reduction of income tax rate, and acceleration rate depreciation. The characteristics of SMEs according to the Revenue Department is by virtue of the Revenue Code, enacted the law to support the promotion of tax privileges. As such, SMEs are required to have one of the following criteria (Table 1.2).

Table 1.2

Type of SMEs the Revenue Department is authorized to support through tax incentives authorized by the Revenue Code (OSMEP, 2014)

	Criteria
1	A company or juristic partnership with a paid-up capital on the last day of accounting period not exceeding 5 million baht and revenue from sales of goods and services in the accounting period not exceeding 30 million baht.
2	A company or juristic partnership with fixed assets, excluding land, not more than 200 million baht and employs not more than 200 workers.
3	The sale of goods or services in force of value added not exceeding 1.8 million per year or per accounting period which is exempt from VAT.

Note. This table is adapted from OSMEP (2014)

As OSMEP financially supports the majority of Thai SMEs, they are more open to share information with this agency than with others. As a result, OSMEP's classification of SMEs is more accurate and appropriate. Consequently, in this study, SMEs are defined using criteria specified by the Office of Small and Medium Enterprises Promotion (OSMEP, 2019). Thus, the operational definition of SMEs is that these are manufacturing businesses with no more than 200 employees and the firms' do not exceed 500 million THB. In this study, the researcher adopts the criteria set by OSMEP (2019) for the selection of SMEs for the case study.

Table 1.3

Comparison between large enterprises and SMEs in Thai FI, in 2017

Thai FI categories	Large enterprises				Small and medium enterprise (SME)				Whole food industry	
	Number of enterprises (enterprise)	%	Number of employments (person)	%	Number of enterprises (enterprise)	%	Number of employments (person)	%	Number of enterprises (enterprise)	Number of employments (person)
(i) Food raw materials	53	0.117	53,976	45.744	45,339	99.883	64,019	54.256	45,392	117,995
(ii) Food processing and production	364	0.266	234,732	30.917	136,663	99.734	524,497	69.083	137,027	759,229
(iii) Food trade related sector	632	0.106	101,679	7.557	596,227	99.894	1,243,876	92.443	596,859	1,345,555
(iv) Food service- related sector	16	0.005	17,552	1.804	329,600	99.995	955,364	98.196	329,616	972,916
Total	1,065	0.096	407,939	12.765	**1,107,829**	**99.904**	**2,787,756**	**87.235**	1,108,894	3,195,695

Note. This table is adapted from OSMEP (2018a)

As mentioned above, FI is a very important industry in Thai economy. Thai SMEs play a very important role in driving this industry (OSMEP 2018a, 2018b, 2018c). According to OSMEP, in 2017, there were 1,108,894 FI entrepreneurs, of which 99.9% were SMEs. In 2017 (OSMEP, 2018a), 3,195,695 employees are working in the Thai FI with 87.2% in FI SMEs (Table 1.3).

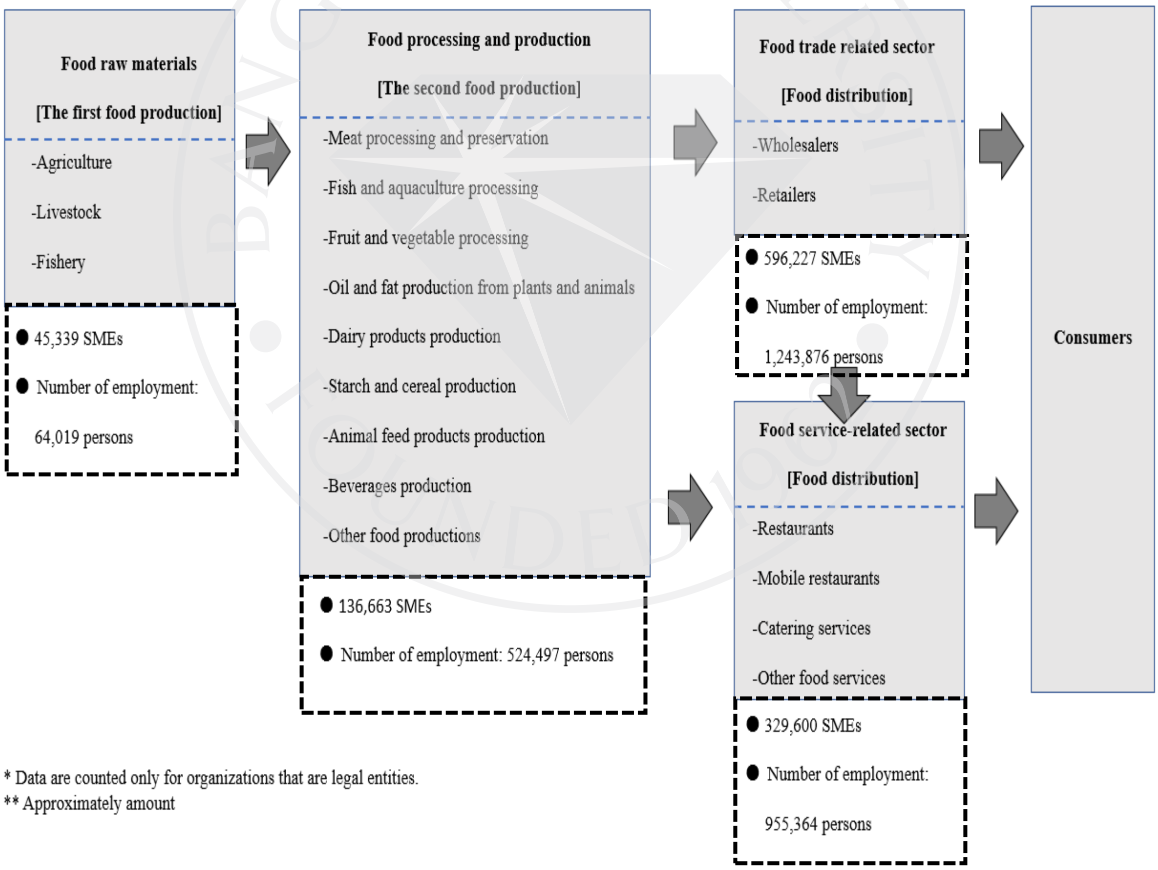
OSMEP (2018a) categorizes Thai FI SMEs in 5 groups (Figure 1.2 and 1.3):

1) Food raw material producers (e.g., agriculture, livestock and fishery)

2) Food processing and production. OSMEP has separated this 2nd group into 9 sub-categories (Figure 1.2)
3) Food distribution - food trade related sector (wholesalers and retailers)
4) Food distribution - food service sector (including restaurants, mobile restaurants, catering services, and other food services)
5) Consumers

Figure 1.2

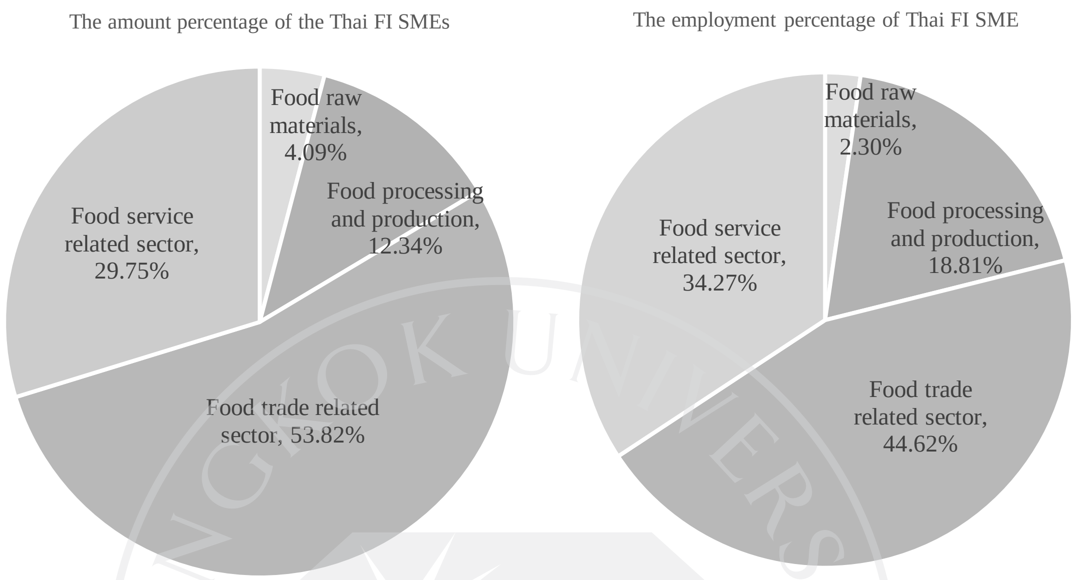
Repartition of Thai FI SMEs among OSMEP 4 main categories in 2017



Note. (i) Only legal entities were counted in this figure, (ii) Approximately quantity. This figure is adapted from OSMEP (2018a)

Figure 1.3

Repartition of Thai FI SMEs number and employees among 4 main categories in 2017



Note. This figure is adapted from OSMEP (2018a)

The majority of Thai FI SMEs is involved in the food distribution segment that is in the food trade related sector. This comprises of discount stores, supermarkets, hyper markets, groceries, and food markets. However, the group of food processing and production sectors remain important sectors in Thai FI. These sectors play significant role is value creation in the primary food production through food technologies and machinery (Hongsaprabhas et al., 2018; Mingmalairaks, 2011; NSTDA, 2018; OSMEP, 2018; Rujirawanich et al., 2011; Tambunlertchai, 2015). Thai FI SMEs in the food processing and production category also participate in the mass production as the food machinery/ manufacturing companies of this industry (Jones & Pimdee, 2017; Tambunlertchai, 2015). This category encompasses 9 sub-categories (Table 1.4).

Table 1.4

Repartition of large companies and SMEs in the 9 sub-categories of OSMEP food processing and production category in 2017

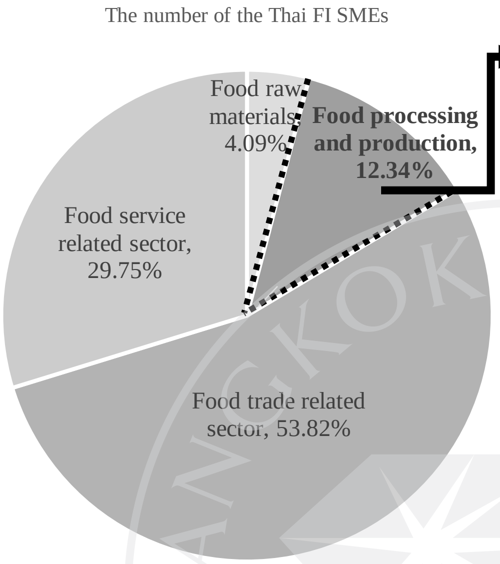
9 Sub-categories in the group of food processing and producers	Large enterprises				Small and medium enterprise (SME)				Whole food industry	
	Number of companies (enterprise)	%	Employment (person)	%	Number of companies (enterprise)	%	Employment (person)	%	Number of companies (enterprise)	Employment (person)
1. Meat processing and preservation	21	0.289	22,182	42.321	7,250	99.711	30,232	57.679	7,271	52,414
2. Fish and aquaculture processing	41	0.675	28,857	45.413	6,031	99.325	34,687	54.587	6,072	63,544
3. Fruit and vegetable processing	38	0.425	23,406	34.129	8,905	99.575	45,174	65.871	8,943	68,580
4. Oil and fat production from plants and animals	18	2.161	6,212	32.678	815	97.839	12,798	67.322	833	19,010
5. Dairy products production	14	0.833	9,031	48.593	1,667	99.167	9,554	51.407	1,681	18,585
6. Starch and cereal production	52	0.088	16,378	10.276	58,707	99.912	143,005	89.724	58,759	159,383
7. Other food productions	114	0.271	83,513	31.380	41,913	99.729	182,619	68.620	42,027	266,132
8. Animal feed products production	24	3.865	24,515	68.961	597	96.135	11,034	31.039	621	35,549
9. Beverage production	42	0.388	20,638	27.144	10,778	99.612	55,394	72.856	10,820	76,032
Total	364	0.266	234,732	30.917	136,663	99.734	524,497	69.083	137,027	759,229

Note. This table is adapted from OSMEP (2018a)

According to OSMEP (2018a), there were 137,027 active Thai FI entrepreneurs in this sector in 2017 and of which 99.7% (136,663) were working for SMEs. In the same period (OSMEP, 2018a), there were 759,229 employess working in the food processing and production category and this accounted to 69.1% (524,497) employment in FI SMEs (Table 1.4).

Figure 1.4

Repartition of Thai SMEs 9 Sub-categories of food processing and production in 2017 into 3 groups



The 9 Sub-categories in the group of food processing and production	SMEs		
	Number of SMEs (enterprise)	%	
1. Meat processing and preservation	7,250	5.31	Group 1
2. Fish and aquaculture processing	6,031	4.41	Group 1
3. Fruit and vegetable processing	8,905	6.52	Group 1
4. Oil and fat production from plants and animals	815	0.60	Group 1
5. Dairy products production	1,667	1.22	Group 1
6. Starch and cereal production	58,707	42.96	Group 1
7. Other food productions	41,913	30.67	Group 1
8. Animal feed products production	597	0.44	Group 2
9. Beverage production	10,778	7.89	Group 3
Total	136,663	100.00	

Note. This figure is adapted from OSMEP (2018a)

Since the present study focuses on food machinery in SMEs, only Thai food machinery SMEs is considered. Then the 9 sub-categories can be divided into 3 main groups as presented below:

1) Food production SMEs: This group includes meat processing and preservation, fish and aquaculture processing, fruit and vegetable processing, oil and fat production from plants and animals, dairy products production, starch and cereal production, and other food productions
2) Animal feed products production
3) Beverage production SMEs

Among these 3 groups, Thai food machinery SMEs of the first group encompasses the largest number of companies and constitutes the target of the present study. There are 125,488 Thai SMEs in this group. However, only the number of companies and/or enterprises and the employment are not enough to evaluate the value of Thai FI SMEs. The export information is also another common indicator used to consider the importance of Thai FI SMEs (Punyasavatsut, 2007; OSMEP, 2018b, 2018c).

1.1.6 Export Performance of Thai SMEs in FI

Thai economy is heavily export-dependent, with exports accounting for more than 2/3 of its GDP. Thailand's recent export performance in the global food market has improved markedly (Cheowsuwan, Arthan, & Tongphet, 2017; OSMEP, 2018c). Thai FI is of huge importance to the national economy and foods export products constitute the main driving force to equilibrate Thai commercial balance (Punyasavatsut, 2007). OSMEP (2018b) indicated that Thailand was one of the leading global food suppliers of a wide variety of food export products which include rice, rubber, cassava, sugar, poultry meat, frozen food, processed fruits and vegetables, and ready-to-eat foods. In 2017, Thailand food products were exported mainly to China, Japan, Vietnam, Indonesia, United States, Myanmar, Hongkong, Philipine, South Korea, and Malaysia (OSMEP, 2018b). The export value of Thai FI was 1,008,425.85 million THB in 2018 and of which 44.5% (448,880.73 million THB) were from SMEs (OSMEP, 2018b).

In order to measure the value of food export products, Harmonized System (HS) code is applied for this measurement. The HS (Harmonized System) code or Customs Tariff number (Pierce & Schott, 2012) is a classification system of food products for tax reporting. This system was conducted by the World Customs Organization (WCO), with the cooperation of more than 176 countries around the world (Pierce & Schott, 2009). Thailand has joined as a member in 1972 (OSMEP, 2018c). This system has been accepted by the International Trade Center, United Nation (UN), and World Trade Organization (WTO) (OSMEP, 2018b; Pierce & Schott, 2009). The membership is important for world exportation because each country has a variety of food products with different materials and/or specific names. Therefore, this classification system and mutual specified criteria enable universal understanding (Pierce & Schott, 2009). Thailand exports many food products between 2017 and 2018. According to OSMEP report (2018b, 2018c), the national export value for 23 groups of Thai food products regarding 2 digit of HS code is presented in Table 1.5 and 1.6.

Table 1.5

Export value of 23 Thai food export products, comparison between large companies and SMEs in 2017 and 2018, in 2 groups

No.	Group of products	HS code (2 Digits)	Export value from Thai Large companies			Export value from Thai SMEs			
			2017 (THB)	2018 (THB)	Growth comparison 17/ 18 (%)	2017 (THB)	2018 (THB)	Growth comparison 17/ 18 (%)	
1	Sugar and sweets made from sugar	17	5,047,820,764	4,457,607,471	-11.69	92,522,459,741	79,257,352,075	-14.34	
2	Edible fruit and nuts	08	5,913,876,059	6,402,958,300	8.27	71,500,616,483	69,291,057,729	-3.09	
3	Grains	10	110,798,016,157	99,688,178,826	-10.03	70,652,690,005	64,181,088,320	-9.16	
4	Fish or aquatic animals	03	34,378,533,791	26,301,529,040	-23.49	36,207,206,837	29,563,790,059	-18.35	
5	Root and tuber vegetables	07	19,527,134,532	14,630,757,533	-25.07	27,632,783,024	21,609,610,154	-21.80	
6	Meat and parts of edible animals	02	15,789,299,893	20,422,822,605	29.35	10,875,903,892	9,773,536,751	-10.14	GROUP 1
7	Living animals	01	129,780,579	183,720,559	41.56	4,880,056,872	7,570,731,669	55.14	
8	Seeds and fruit that can produce oil for the FI	12	1,153,296,079	1,114,390,385	-3.37	5,749,538,844	6,144,133,828	6.86	
9	Coffee, tea, chamate and spices	09	125,890,398	114,131,208	-9.34	4,826,807,876	3,903,484,167	-19.13	
10	Trees and living plants	06	158,314,282	113,854,744	-28.08	3,813,060,368	3,468,532,233	-9.04	
11	Animal products that are not being list or included elsewhere	05	261,486,607	332,730,014	27.25	1,440,516,205	1,447,132,194	0.46	
12	Ingredients made from meat, fish or aquatic animals	16	167,712,932,766	149,886,269,399	-10.63	45,283,362,775	42,831,308,537	-5.41	
13	Beverages, liquors and vinegars	22	42,138,190,021	41,987,827,685	-0.36	12,224,556,834	9,949,275,101	-18.61	
14	Dairy products, poultry eggs and natural honey	04	6,810,872,986	6,837,589,338	0.39	2,510,061,016	2,364,002,607	-5.82	
15	Fats and oils obtained from animals or plants	15	9,715,688,334	10,129,217,866	4.26	9,040,387,171	7,163,329,632	-20.76	
16	Ingredients made from vegetables, fruits, nuts or other parts of plants	20	49,393,410,118	37,742,191,396	-23.59	27,451,550,505	22,445,009,847	-18.24	
17	Miscellaneous edible ingredients	21	50,226,420,786	44,161,310,782	-12.08	23,939,070,848	22,187,045,093	-7.32	GROUP 2
18	Ingredients made from cereals, flour, starches or milk	19	25,635,748,980	22,047,179,169	-14.00	17,514,935,482	16,258,235,120	-7.18	
19	Cereal products, malt, starch, inulin and gluten from wheat	11	27,725,986,829	31,346,203,431	13.06	13,284,274,482	15,193,594,203	14.37	
20	Residues and scraps from the FI	23	39,449,433,474	40,611,616,208	2.95	13,590,655,845	12,741,166,905	-6.25	
21	Shellac, plant extracts	13	130,825,131	25,826,035	-80.26	721,760,557	757,741,323	4.99	
22	Cocoa and ingredients made from cocoa	18	529,502,248	1,005,720,902	89.94	602,835,412	518,065,034	-14.06	
23	Plant ingredients used for weaving or not being list or included elsewhere	14	115,415	1,492,494	1,193.15	224,000,480	261,503,147	16.74	
			612,752,576,229	559,545,125,390	-8.68	496,489,091,554	448,880,725,728	-9.59	

Note. This table is adapted from OSMEP (2018b)

Table 1.6

Repartition of 23 Thai food export products, comparison between large companies and SMEs in 2018, in 2 groups

No.	Group of products	HS code (2 Digits)	2018			
			Total export value (THB)	Percentage of large companies	Percentage of SMEs	
1	Sugar and sweets made from sugar	17	83,714,959,546	5.32	94.68	GROUP 1
2	Edible fruit and nuts	08	75,694,016,029	8.46	91.54	
3	Grains	10	163,869,267,146	60.83	39.17	
4	Fish or aquatic animals	03	55,865,319,099	47.08	52.92	
5	Root and tuber vegetables	07	36,240,367,687	40.37	59.63	
6	Meat and parts of edible animals	02	30,196,359,356	67.63	32.37	
7	Living animals	01	7,754,452,228	2.37	97.63	
8	Seeds and fruit that can produce oil for the FI	12	7,258,524,213	15.35	84.65	
9	Coffee, tea, chamate and spices	09	4,017,615,375	2.84	97.16	
10	Trees and living plants	06	3,582,386,977	3.18	96.82	
11	Animal products that are not being list or included elsewhere	05	1,779,862,208	18.69	81.31	
12	Beverages, liquors and vinegars	22	51,937,102,786	80.84	19.16	GROUP 2
13	Dairy products, poultry eggs and natural honey	04	9,201,591,945	74.31	25.69	
14	Fats and oils obtained from animals or plants	15	17,292,547,498	58.58	41.42	
15	Ingredients made from meat, fish or aquatic animals	16	192,717,577,936	77.78	22.22	
16	Ingredients made from vegetables, fruits, nuts or other parts of plants	20	60,187,201,243	62.71	37.29	
17	Miscellaneous edible ingredients	21	66,348,355,875	66.56	33.44	
18	Ingredients made from cereals, flour, starches or milk	19	38,305,414,289	57.56	42.44	
19	Cereal products, malt, starch, inulin and gluten from wheat	11	46,539,797,634	67.35	32.65	
20	Residues and scraps from the FI	23	53,352,783,113	76.12	23.88	
21	Shellac, plant extracts	13	783,567,358	3.30	96.70	
22	Cocoa and ingredients made from cocoa	18	1,523,785,936	66.00	34.00	
23	Plant ingredients used for weaving or not being list or included elsewhere	14	262,995,641	0.57	99.43	
			1,008,425,851,118			

Note. This table is adapted from OSMEP (2018b)

According to the report by OSMEP (2018b; 2018c), Thai FI export value declined 9.08% from 2017 to 2018. The decrease occurred in both large companies and SMEs. SMEs food product export value was down by 9.59% while large companies fell by 8.68% (Table 1.5). This fall was attributed to many factors:

1) Ongoing trade tensions between China and the United States
2) Lower demand from China and USA for Thai food product export
3) Continuous slowdown in global economy (Dutta et al., 2018)
4) Falling commodity prices in the world market placed pressures on Thai agricultural pricing and the food product exports
5) Appreciation of currency causes value of Thai baht (THB) to remain high when compared to other currencies. In fact, this was one of the key reasons for the uncertainity in Thailand's exports and cross border trade. However, Thai ministry of commerce considered the decline acceptable. when comparing the performance of other food exporter countries (Cheowsuwan et al., 2017; OSMEP, 2018c).

In spite of these challenges, Thailand was ranked top 5 exporters to China particularly in 9 food products, namely cassavas, frozen fruits, rices, starches, aquacultures, sugars, miscellaneous edible ingredients, processed fruits, and flavored fishes (OSMEP, 2018c). Furthermore, Thailand was ranked top 5 exporter to the United States in 6 food products which comprise of flavored fishes, processed fruits, rices, crustaceans, miscellaneous edible ingredients, starches and inulin (OSMEP, 2018c).

In 2018, the export value of Thai FI was 1,008,425.85 million THB, of which 55.5% is from large companies, while 44.5% is from SMEs (Table 1.5). Despite the higher number of small firms and employees working for Thai FI SMEs, the majority of Thai food export products in value is still controlled by large companies (Table 1.5). This is mainly due to the fact that many Thai FI SMEs focus more on the supply side of the value chain (OSMEP, 2018a). As shown in Table 1.5, larger companies could generate more revenue from food product export than the SMEs in both 2017 and 2018 (OSMEP, 2018b). Since the present study analyzes Thai FI from the dimension of innovative food products, the 23 groups of Thai food export products can be divided into 2 main groups (Table 1.6):

Group 1: Low processed food products. The products in this group are food ingredients/materials, primary production, low value-added products, low level technologies, knowledge and technology management.

Group 2: Processed food products. The products in this group are processed foods, secondary production, food technologies are applied and add more value than group 1.

Even though SMEs take the higher proportion in number of companies and employment (Table 1.4), they generated lower export value than large companies (Table 1.5) (OSMEP, 2018b; 2018c). Food export goods produced by large companies add more value using processing innovations and technologies than SMEs as seen in Table 1.6. Research conducted by Chaochotechuang (2016), Hongsaprabhas (2017b), NSTDA (2018), OSMEP (2007a; 2007b; 2017; 2018b; 2018c) affirmed the observation that Thai FI SMEs need to improve their value creation process from low value-added products to high value-added products (Rujirawanich et al., 2011). In addition, NSTDA (2018) pointed out that many Thai FI SMEs had the potential to be key players to enhance the country's economy through innovation improvements. Even though many Thai FI SMEs lack resources to enrich their products and production processes, they can share the needed resources and collaborate for innovation purposes in areas such as knowledge sharing, technologies, human resources, investment, market and distribution (Chaochotechuang et al., 2019). Thus, the OI approach is an appropriate option for Thai FI SMEs (Jeenanunta & Intalar, 2016; Jones & Pimdee, 2017; NSTDA, 2018).

1.1.7 Main Characteristics of Thai Food Machinery SMEs

A food machinery/manufacturing company is a food processing company, that specializes in mass production of specific food products. The transformation of food raw ingredients/ materials into processed products adds value and extends the product's lifetime duration (OSMEP, 2018a). Most of Thai food machinery SMEs are also the Original Equipment Manufacturers or OEM (Tambunlertchai, 2015). FI OEM SMEs work with partners within their supply chain (Bigliardi & Galati, 2013a; Dolan, 2001). They are responsible for the development and / or delivery of finished products and prepare goods to their business to business - B2B partners (Charoenrat & Harvie, 2014; Lehtinen & Torkko, 2005; Tambunlertchai, 2015). In the OEM context, food machinery SMEs mostly supply to larger food companies. Therefore, their main responsibilities are as follows:

1) to coordinate the production planning
2) source and allocate materials
3) prepare and maintain manufacturing operations
4) ensure product manufacturing volume and quality

The brand owners provide the needed specific packaging and branding elements, market the goods, distribute them, sell the products and manage the after-sale services (Hongsaprabhas, 2017b).

Three major reasons why majority of SMEs are OEMs (Dolan, 2001; Lehtinen & Torkko, 2005) are explained below:

1) Only large companies can fully use the production capacity of their own factories. Hence, food machinery SMEs who can not fully use their facilities and/or still have available production capacity, prefer to provide OEM services to other food companies (clients) in order to maximize profit through the full use of their production capacity and facilities (Cooper & Edgett, 2008).
2) Many of SMEs do not recognize the value of branding and focus on production instead (NSTDA, 2018). The more they produce, the more they generate profits. The food machinery SMEs are more investing and improving production rather than developing or acquiring brands. This situation contrasts with big companies who tend to believe that value is in the brand not in the machinery (Lehtinen & Torkko, 2005). Thus, this mindset leads many food machinery SMEs to adopt OEM business models.
3) Globalized companies exploit lower production and labor costs and cheap transportation from one country to another (Dolan, 2001; Dutta et al., 2018; Lehtinen & Torkko, 2005). Hence, many food machinery SMEs in the low labor cost countries work for foreign companies.

The aforementioned elements explain why food machinery SMEs are increasingly expanding in the Thai FI (OSMEP, 2017, 2018a) as OEM producers for larger and foreign companies whose investment in manufacturing facilities are no longer needed. For the larger companies, such strategy helps to broaden the scope of new food business products and mitigate the constraints inherited from technologies and capabilities (Arunsawadiwong, 2007; Savetpanuvong et al., 2011). However, for small Thai food machinery companies, they adapt with multiple strategies for survival in their highly competitive business environment (Chaochotechuang, 2016). One of the multiple approaches is for the Thai food machinery SMEs to participate in the NPD processes of larger companies in an effort to reduce their NPD failure rate (Vignoli, 2017). It also shortens the lengthy product development period (Chaochotechuang, 2016; Hongsaprabhas, 2017b) through gap closure between laboratory scale and industrial scale. Furthermore, food machinery SMEs facilitate the legal agreement of obtention to mass-produce and commercialization in the local market. Thai food machinery SMEs contribute significantly to NPD processes (especially in NPD - industrial scale) using the OI approach (Hongsaprabhas et al., 2018). However, despite the crucial role Thai food machinery SMEs in the development of the national economy (OSMEP, 2018b; Vignoli, 2017), there are very few academic studies on innovation management in these SMEs (Dhamvithee, Shankar, Jangchud, & Wuttijumnong, 2005; Tambunlertchai, 2015). The NPD improvement of Thai food machinery SMEs lacks identification and inadequate academic measurement. Hence, further study is needed focusing on the OI generative mechanism on Thai food machinery SMEs that possess characteristics of food innovation intermediary. Significantly, such studies help to identify how the Thai food machinery SMEs can increase their abilities to develop new products through OI approach with other actors in the food chain.

1.1.8 Thai FI SMEs Specific Challenges Regarding Innovation

Thai FI SMEs face similar challenges like their counterparts in other countries (Cheowsuwan et al., 2017). Undenialy, it is difficult for a SME to develop its innovation capabilities, processes, and achievments alone. Limited human resources and capital to invest in operational changes compared with large and multinational companies constitute to major difficulties (Cheowsuwan et al., 2017; Jeenanunta & Intalar, 2016). As such, FI SMEs differentiation innovation strategy development implies focusing on specific adaptations to generate unique distinctive practices and/or capabilities the larger and multinational companies could not develop such as specific new product development capabilities (Rujirawanich et al., 2011), flexible production and/or distribution processes (Tambunlertchai, 2015). To achieve such goals, SMEs have long started collaborating with other actors in their supply chains (Bigliardi & Galati, 2013a; Chaochotechuang et al., 2019; Mingmalairaks, 2011). Business sustainability comes from a strategic vision which has been implemented (Usha & Devakumar, 2019; Stančová & Cavicchi, 2019). Executive decisions implementation has led to a better management to enhance the supply chain partners relationships is of central importance in developing innovative SMEs (Bellairs, 2010; Bigliardi et al., 2019; Mingmalairaks, 2011). Structural changes are also needed and affect SME operations. They include production processes design, new distribution processes exploration and development, new business partner relationship opportunities seeking and seizing (Lee & Whang, 2000).

Although SMEs are trying to work closer with each key actor in their ecosystem to ensure the sustainability of their business, many of them does not have satisfacting outcomes that they seek to obtain for various factors (Lee & Whang, 2000) as listed below:

1) insufficient organizational adaptability (Saguy, 2011)
2) lack of strategic alignment, cultural mismatch, inability to produce expected results, rivalry or conflicting interests (Noordman & Meijer, 2013)
3) insufficient communication, time constraints (Saguy & Sirotinskaya, 2014)

All the aforementioned factors explain why the application of OI strategies (Chesbrough, 2003) and practices (Van de Vrande, Jong, Vanhaverbeke, & De Rochemont, 2009) to enhance innovation in Thai food machinery SMEs, can not be easily implemented (Jeenanunta & Intalar, 2016; Mingmalairaks, 2011).

Not many SMEs realize the types of activities they involved are related to OI practice, there are some OI practices that are familiar to Thai FI SMEs (Tambunlertchai, 2015). Some of the common OI practices are listed as follows:

1) Thai food machinery SMEs collaborate with local universities and R&D agencies to assess new food recipes or food products at the laboratory scale and / or the industrial scale (Hongsaprabhas 2017b; Ueasangkomsate & Jangkot, 2019).
2) Thai Food companies such as brand owners and / or distributors often hire external food machinery SMEs (OEMs) to mass produce their recipes when they do not have the necessary machines in their production lines. This strategy reduces their time to market and allows them to avoid having to invest in production tools. In addition, it lowers the costs associated with the acquisition of specific technologies, knowledge and expertise

(Iturrioz et al., 2015; Lehtinen & Torkko, 2005; Pholphirul, 2013; Savetpanuvong et al., 2011). Finally, it lessens the risk of failures in obtaining legal authorization of their products for commercialization (Hongsaprabhas, 2017b).

These types of work-a-rounds match specific OI practices such as outsourcing R&D and external networking (Van de Vrande et al., 2009).

1.1.9 Thai FI SMEs Performance and Food Chain Management

Every actor in food supply and/or value chain plays an important role in the development of new food products (Bigliardi & Galati, 2013a; 2013b; Galankis, 2016; Hongsaprabhas, 2017b). Supply chain Management refers to "*the degree to which an organization strategically collaborates with its supply chain partners and manages intra- and inter-organization processes to achieve effective and efficient flows of products, services, information, money and decisions, with the objective of providing maximum value to its customers*" (Zhao, Huo, Flynn, & Yeung, 2008, p.374).

The collaborations between Thai FI SMEs and their partners include all types of actors in the supply chain (Jones & Pimdee, 2017; Pholphirul, 2014). Thai FI SMEs in each category fulfil different functions according to their business and environmental contexts. Nonetheless, business and supply chain challenges affect each category differently (Jeenanunta & Intalar, 2016; Mingmalairaks, 2011). Besides the food company, several actors such as the R&D agencies and consultants, food suppliers, food machinery companies, and distributors are also vital players in the food product development (Minarelli et al., 2017). Each actor attempts to develop and compete in his or her own context, together through cooperation, they co-create unique final products as compared to their competitor's products and better meet customers' demand (Bellairs, 2010; Laursen, & Salter, 2006). Therefore, the new product development (NPD) innovation management process in the Thai FI implicitly follows the OI perspective (Chesbrough & Crowther, 2006).

However, FI SMEs in Thailand struggle to build close relationships with their upstream and downstream partners to improve supply chain collaborative relationships (Tambunlertchai, 2015). In other words, their ability to sustain and improve performance and survive in competitive environment is constantly tested by the market. Achieving a competitive supply chain network for a Thai food manufacturer implies the development of its supply chain capabilities (Chiadamrong & Sophonsaritsook, 2015). Research by Chiadamrong & Sophonsaritsook (2015) and Chiadamrong & Tham (2018) using Structural Equation Modelling approach to analyze the situation of 236 Thai FI SMEs showed that established connections and developing consistent model are keys success factors for Thai FI SMEs. Connectivity and consistency enhance supply chain strategies and improve intra- and inter-organizational management processes in Thai FI SMEs (Chiadamrong & Sophonsaritsook, 2015).

Integration is the most critical element in to enhance efficiency and effectiveness in supply chain operations management (Flint & Mentzer, 2006). Over the last decade, concerns over the integration of value management in supply chains has increased (Flint & Mentzer, 2006; Hongsaprabhas, 2017b). Supplier's value creation process becomes more customer-centric (Dekker, 2003; Martinez, 2014; Vanhaverbeke & Cloodt, 2006). This in turn gears information, support personnel, distribution, and other related services targeted towards specific customer segments

(Flint & Mentzer, 2006). Customer's appraisal offers different components for suppliers' value proposition for different circumstances (Dekker, 2003). Take for instance diabetes customers prefer to consume food products that use stevia instead of ordinary sugar. Value propositions now involve products/services, processes, customer experience, network of partners sharing the same objective of creating high value added. Value chain is defined as "*the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use*" (Kaplinsky & Morris, 2000, p.4). Hence, value chain management refers to a fully interconnected and smooth operation of supply chain (Flint & Mentzer, 2006).

Actor's knowledge in the value chain is one of the new key elements for successful food NPD (Bigliardi et al., 2019; Chesbrough & Crowther 2006; Laursen, & Salter, 2006; Mingmalairaks, 2011). However, the management of all various actors in food supply and/or value chain is complex (Bigliardi & Galati, 2016) because of its velocity and volatility which require flexibility in knowledge management and business management simultaneously (Chesbrough & Crowther 2006). The more the actors engaged in the identification process in the food chains, the greater the requirements to the product development and manufacturing. For example, the different requirements of food safety regulation from the Food and Drug Administration (FDA), legislators, oversea distributors and customers (Hongsaprabhas, 2017b; Ma et al., 2014). These different requirements affect the entire supply chain from production, processing, manufacturing to distribution (Bigliardi & Galati, 2013b; Hongsaprabhas et al., 2018).

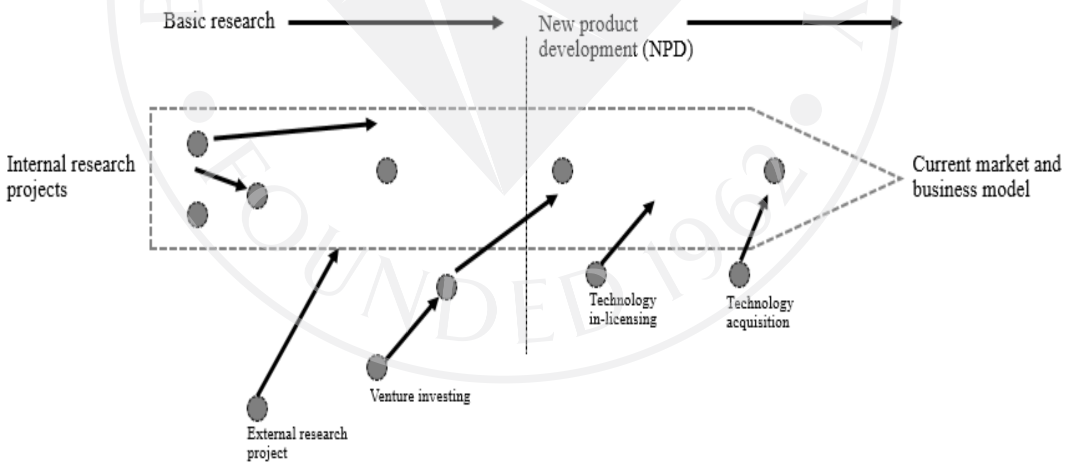
1.1.10 Open Innovation Logics Introduction

Nowadays, most of the firms realize that closed innovation approaches limit the return of firms on R&D and higher NPD expenditures. Moreover, closed innovation limits the source of new ideas, knowledge and technologies from the external which restrict growth of the firm (Chesbrough, 2003).

It is widely recognized that OI perspective has transformed organizational management, markets and social relations (Benkler, 2006). It has also been proposed as a new practitioner toolbox for innovation management (Gassmann, 2006). Chesbrough (2003) defined OI as "*both a set of practices for profiting from innovation, and also a cognitive model for creating, interpreting and researching those practices*". The definition was refined as "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively*" (Chesbrough, Vanhaverbeke, & West, 2006, p.1 as cited in Vanhaverbeke, Van de Vrande, & Chesbrough, 2008). Moreover, Chesbrough (2006) argued that the shift towards the new mode of open system involves a range of actors in the supply and/or value chain (Beckeman, Bourlakis, & Olsson, 2013). West and Gallagher (2006) elaborated OI as a systematic exploration of external and internal sources for innovation opportunities OI thus comprises both outside-in and inside-out movements of technologies and ideas (Lichtenthaler, 2008). Furthermore, Lichtenthaler (2011) proposed 2 attributes of OI which include the combination of outward and inward knowledge transfer, and the complementary character of external and internal innovation related activities in organizations. There is yet an agreed definition but based on literature, OI is a broad concept encompassing many dimensions. What OI is and what it is not, is still being debated from many authors till now. OI overlaps with other concepts such as crowdsourcing, user generation, and distributed innovation (Hossain, 2013). Worth notting, most of the knowledge and innovation management studies made distinction between the purposive inflows and outflows of knowledge that accelerate internal processes (Chesbrough et al., 2006 as cited in Van de Vrande et al., 2009). For this study, the researcher uses the Chesbrough (2006)'s OI definition. When analyzing the definitions and characteristics of OI from other authors, the key factor related to OI adoption of the organization is knowledge and practices management (Bigliardi & Galati, 2013a; Desouza, Awazu, & Jasimuddin, 2005).

Figure 1.5

Chesbrough's OI approach



Note. From "Chesbrough's OI approach" by Trott, 2008, p. 348

1.1.11 Open Innovation in Food Industry

The OI perspective has emerged to describe an innovation paradigm shift (Chesbrough, 2003). At present, OI term is widely used in all science fields (Galanakis, 2016) as well as in FI (Bigliardi et al., 2019; Vergara, Vergara, & Polo

Otero, 2015). According to the literature, OI is often implemented by large and multinational companies for decades but its application in FI SMEs remains poorly understood (Chaochotechuang, 2016; Freel & Robson, 2017; Hongsaprabhas et al., 2018). However, the literature indicated that innovations in the FI come mainly from SMEs or outside the FI (Ueasangkomsate & Jangkot, 2019). The OI approach is a core requirement for assuring the sustainability and competitiveness of the food sector, especially in SMEs (Galanakis, 2016). OI is an opportunity for SMEs in Thai FI as well.

1.1.12 Open Innovation in Thai Food Industry

The FI is important to Thailand's economy (OSMEP, 2018a). In addition to consumption for the domestic market itself, food products for export also accounted for a total of 1,008,425.85 million THB in 2018 (OSMEP, 2018c) which increasing from a total of 766,477 million THB in 2009 (OSMEP, 2007b). As a result, there is a national policy to develop the FI through product, process, and organizational innovations (NSTDA, 2018). The OI perspective is one of the government's efforts to raise awareness among all food entrepreneurs, especially for SMEs which constitute the economic basis of innovation (Jones & Pimdee, 2017; NSTDA, 2018).

Even with the widespread use of OI logics application, OI is neither easy to specify nor to identify (Galanakis, 2016). For the question that “What does OI in Thai FI truly represent?”, there is still no clear answer. Most SMEs and academics in Thai FI are not aware of the importance of knowledge and innovation management (Chaochotechuang, 2016; Rujirawanich et al., 2011). Most of Thai FI researches have no indication of what knowledge type that is being studied. The OI logic study in FI context is various based on individually focused knowledge flows: food material knowledge, food technology knowledge or food recipe knowledge flows (Stewart-Knox & Mitchell, 2003). Some OI studies are applying the mixed of all knowledge types (Chaochotechuang, 2016; Jeenanunta & Intalar, 2016; Rujirawanich et al., 2011). Thus, it is difficult to identify and follow the exact direction of knowledge flow (outbound, inbound and coupled OI logics) in the entire process of knowledge transfer in OI study of one organization. Moreover, the widespread OI study in Thai FI is mostly focused on the ultimate end result of new products to sell out in marketing view but less in knowledge management view (Hongsaprabha*s,* 2017b; Mingmalairaks, 2011). In other words, various OI disciplines in Thai FI have been aware of the phenomenon of OI without describing its mechanism. Hence, OI in Thai FI SME is not as efficient as it should be (Mingmalairaks, 2011).

Literature on the implementation of OI in the Thai FI indicates that SMEs must firstly be able to identify evolving needs of their supply and/or value chain partners and provide adaptive solutions (Saguy & Sirotinskaya, 2014). Secondly, SMEs must be able to appropriately adjust their innovation strategies to be consistent with the needs and requirements of supply and/or value chain partners (Chaochotechuang, 2016). Thai FI SMEs must be able to revise their managerial style to empower their organizational flexibility and develop their dynamic capabilities (Grimaldi, Quinto, & Rippa, 2013; Iturrioz et al., 2015). These factors described as enabling mechanisms, help SMEs to cope with internal organizational and external environmental changes. SMEs must be able to combine their internal resources with that of their partners. Simultaneously, OI logics and practices in SMEs also lead to deepen their relationships with partners which lead to the reinforcement of inter-organizational interdependency (Parisot, 2015).

Due to the increasing demand and requirement changes in the FI, Thai SMEs are forced to evolve their business model (Mingmalairaks, 2011; Vignoli, 2017). Thai FI SMEs are no longer able to sustain their businesses alone. Working with FI supply and/or value chain partners is essential and has an increasing importance in business management (Bigliardi et al., 2019). However, each actor in the FI supply and/or value chain has different needs, requirements and limitations. Some Thai FI SMEs sometimes develop their own positioning to become providers of innovative solutions that their partners are not able to achieve (Hongsaprabhas et al., 2018). These Thai FI SMEs developed new collaborative strategies which lead to extend their business ecosystem through the inclusion of some actors already present in their supply and/or value chain. Consequently, these Thai FI SMEs also had to adjust their managerial styles and mindsets to empower their innovation strategies and cultures (Saguy & Sirotinskaya, 2014). Capitanio, Coppola and Pascucci (2010) found that OI logic was of particular importance for SMEs. SMEs are often unable to provide all the necessary knowledge and resources for innovation. Knowledge and resources management are not confined in the organizational context anymore. Co-creating knowledge and co-exploiting resources with its partners involved in the supply and/or value chain are becoming key success factors for the Thai FI SME (Capitanio et al., 2010). Therefore, the driving forces of Thai FI SMEs' innovation have evolved through the development of new internal and external dynamics (Iturrioz et al., 2015; Ma et al., 2014). These Thai FI SMEs implement NPD innovative processes and create and/or apply creative technological solutions (Chokenukul et al., 2012). If these new processes were first developed in proprietary logics, external technologies, skills and knowledge, there would be greater leverage in the use of collective innovation strategies (Chaochotechuang, 2016; Powell & Coyle, 1997). It is obvious that environmental scanning is supported by networks whereby enterprises communicate with each other, among experts or with customers / consumers. This has been acknowledged by national policy makers and business operators that supportive networking especially among SMEs help to establish meeting platforms of various kinds (NSTDA, 2018; OSMEP, 2014, 2007b) including food innovation cluster's platform for food manufacturers, research institutes and government supporting organizations, and entrepreneur in the related industries. NSTDA uses such initiatives to enhance competitiveness of Thai FI. As such, the locus of innovation is no longer within the organization boundary but in the network of supply and/or value chain (Lascialfari, Magrini, & Triboulet, 2019; Parisot, 2015; Powell & Coyle, 1997).

However, there is no study on FI SMEs OI logics and practices generative mechanism. Such mechanism may follow many patterns and each pattern can involve specific factors and occur with different types of actors. This breach constitutes a research gap of central importance. Entering the blackbox of OI logics and practices implementation reveals the involved generative mechanisms. This revelation could be a major contribution for both academics and practitioners and help the Thai FI SMEs, to implement effective OI strategies.

This research comes in line with Bigliardi and Galati (2013a) statement that there was still limited empirical evidence on how OI strategies in the FI evolved. In addition, as some general studies had focused on how some of the OI barriers were overcome (Bigliardi & Galati, 2013b; Chaochotechuang, 2016), none explored innovation logics and practices generative mechanisms in Thai FI SMEs.

There have been several studies based on different perspectives on OI awareness in Thai FI SME. Some of the studies found that it was difficult to make comparison between cases as OI could be applied in many different departments and in many functions in the organization: Past case studies focused on New Product Development (NPD), Production process, Quality control (QC), Logistic, Warehouse, Organization management and Business management, etc. The present study focuses on OI logics and practices in Thai FI SMEs in the context of NPD.

1.1.13 New Product Development in FI SMEs

In the past, there were two major objectives in the development of new food products. First, it was to meet customer satisfactions. This encompasses the extension of products shelf-life, adjusting to fast changing customers' demands for more healthy food, and adding value to food products in the dimensions of exotic flavors, freshness, functional benefits (Bellairs, 2010). Second, to minimize production costs.; To do so, the firm needs to choose the right technology for the target products which relates to the features and production costs, raw material management, production process management, finished good management, and the management of product distribution to consumers (Bellairs, 2010; Lienhardt, 2004). Nowadays NPD in FI is getting more and more complicated. Entrepreneurs in the FI must face many challenges such as the difficulties in meeting simultaneously various requirements of an increasing number of actors in the supply and/or value chains of suppliers, customers, legislators (Chaochotechuang et al., 2019; Sarkar & Costa, 2008). Furthermore, entrepreneurs in FI must consider the increase in food safety awareness that are consistent with laws and regulations that are constantly being updated and developed (Chaochotechuang, 2016; Hongsaprabhas, 2017b; Ma et al., 2014). This can be said that even though FI is considered a low technology intensive industry, FI entrepreneurs still need new dynamic knowledge from external boundaries to operate their businesses (Annosi, Marzi, Martini, & Vignoli, 2019; Grimaldi et al., 2013). This new knowledge involved all dimensions of FI entrepreneurs such as NPD, production, distribution and commercialization. Interestingly, most of the knowledge attached to NPD in FI concerns legal requirements that manufacturers have to comply with. People involved in R&D, both academic and practitioner must consider the legal constraints for each NPD to reduce failures (Chaochotechuang, 2016; Hongsaprabhas, 2017b; Ma et al., 2014).

There are many NPD projects or R&D projects in FI, both from the public and private sectors (Bellairs, 2010; Bigliardi et al, 2012; Chokenukul et al., 2012; Jeenanunta & Intalar, 2016; NSDTA, 2018; Vyas, 2014). However, only effective NPD can create competitive advantage for the organization (Chaochotechuang, 2016). Most food NPDs are only prototypes and without copyrights or patents, these new products are unable to be legally commercialized (Hongsaprabhas, 2017b; Tambunlertchai, 2015) which in turn may be considered as wasted developments. In other words, if the NPD were unable to develop the final product for the consumers, the knowledge used in the NPD would not be practical for the industry (Ganlanakis, 2016; Tuomi, 2002). Unfortunately, NPD failure rates in FI are relatively high (NSTDA, 2018; van Kleef, 2006) and there are many reasons for this phomenona. Some of the reasons are stated as follows:

1) Inability of the SME to identify real consumers' demand before starting the NPD (Bigliardi et al., 2019; van Kleef, 2006),

2) Rejection of new product that consumers perceived as too innovative (Boulding, Morgan, & Staelin, 1997; Vyas, 2014),
3) Unable to up-scale from the NPD that is from laboratory scale to the industrial scale for mass production (Hongsaprabhas et al., 2018; Neubauer, Cruz, Glauche, Junne, Knepper, & Raven, 2013; Noorman, 2011),
4) The selected new agricultural materials used in the new product does not provide a continuous process for mass production (Hongsaprabhas, 2017b) For instance, some organic fruits and vegetables are seasonal agricultural ingredients. They can not produce throughout the year or maintain their quality/quantity in low season. These kinds of agricultural ingredients are usable for NPD but not suitable for continuous mass production.
5) New food products failed to be registered under FDA criteria. For example, unclear regulations for the imported new food additives used in new products. As for some cases, the regulations or standards could not provide specific information on the control in using the ingredients (Chaochotechuang, 2016). Another example is the new product causes changes to the product manufacturing classification (Hongsaprabhas et al., 2018).

Thus, the factory or production licenses does not cover the types of new food products. Last but not least, there are multiple dimensions in NPD that both academic and practitioner developers must thoroughly consider before starting any new food product development.

The first phase of the development process is mainly internal innovation logics based. However, for FI, NPD involve more on external technology, skills and knowledge which involve OI logics at both laboratory and industrial scales. Thus, the increasing application of OI logics and practices have gradually affected all actors in the supply and/or value chains of the FI and particularly SMEs that are trying to improve their flexibility and agility (Hongsaprabhas et al., 2018; Sarkar & Costa, 2008). None of the available literature on OI related to NPD in FI SMEs differentiate specific logics and practices attached to the laboratory scale and manufacturing scale. Most academic and practitioners are not aware that NPD process in these two areas are not the same and require different types of managerial practices. (Hongsaprabhas et al., 2018).

1.1.14 New Product Development in Thai FI SMEs

Tambunlertchai (2015) defined NPD in Thai SMEs as the creation of new products/services or the improvement of existing ones. Grassroot technologies are often used to meet functional needs and adjusted to local and domestic markets needs. These technologies are generated by civil society instead of business and/or government (Tang, Karhu, & Hamalainen, 2011). Hence, the technological change involves a social movement component to support its social change (Hossain, 2016). In the case of the Thai FI SMEs, local knowledge and modern technologies are often combined together to develop new products (Chokenukul et al., 2012; Niyomrath, 2014). New products are mostly of acceptable quality and at reasonable prices. Noticeably, these new products are priced lower than similar products of larger and multinational companies operating on the Thai market. Knowledge that allows new products to be successful is often integrated from many different sources which derive from indegenous knowledge, customers' knowledge, research knowledge from the universities and, the knowledge from business partners. Business partner knowledge is the most common source of knowledge sharing and transfer in Thai FI SMEs context (Mingmalairaks, 2011). Business partners may have more knowledge about new product specifications or are closer to the end consumer (Ngamkroeckjoti & Speece, 2008). Therefore, exchanging knowledge relating to new products with business partners is an essential activity in Thai FI SMEs NPD. Historically, Thai FI SMEs focused mainly on research and product development on their own to ensure business confidentiality and prevention of information leakage. Any business decision on starting NPD that depends on the owner's knowledge and experience of his or her organization, is considered as closed innovation (Chaochotechuang, 2016). Apparently, Thai FI SMEs are exchanging more necessary knowledge with their business partners that they consider trustworthy. However, according to Tambunlertchai, (2015), knowledge from other actors in the supply and/or value chain are also vital for NPD.

Charoenrat & Harvie (2014) stated that Thai FI SMEs NPD face more difficulties in mass production and legal commercialization as compared with larger and multinational enterprises. Restrictive regulations from government agencies, old technology, inadequate technological knowledge, low skill levels of employees, limited financial resources and a lack of current market data, all constitute to numerous barriers for Thai FI SMEs (Charoenrat, Harvie, & Amornkitvikai, 2014; Chokenukul et al., 2012). To overcome these barriers, several actions can be taken which include the establishment of networks for technological and business collaboration, better knowledge management, enhancement of R&D capabilities and development of employee skill (Chaochotechuang, 2016; Chesbrough & Crowther 2006).

Nonetheless, only achieving the NPD laboratory scale is not enough in FI SMEs. The result of the laboratory scale is mostly a proof of concept to propose a minimum viable product (MVP) or an early product version with limited features, that still requires customers' feedback for further product development (Hongsaprabhas, 2017b; Neubauer et al., 2013; Noorman, 2011). In addition, most MVPs at the laboratory scale, are not ready for mass production and did not obtain legal authorization for commercialization. Therefore, it is at the industrial scale that determine if the NPD can be completed or not. Significantly, this is an important factor that differentiate final products from MVPs in the Thai FI SMEs. The industrial scale is important for the following reasons:

1) Most agricultural raw ingredients/materials are highly variable. The ingredients are primary natural and it is difficult to control the consistency of the nutrients such as carbohydrates, protein, fats, fiber, vitamins and minerals in each crop. The different levels usage provides varying results in the food processing stage (Hongsaprabhas, 2017b; Niyomrath, 2014). Hongsaprabhas (2017b) research indicated that in the experimentations of NPD recipes, the laboratory scale used a small amount of experimental raw ingredients/materials which might differ from the raw ingredients/materials used for large quantity NPD production tests at industrial scale. Variations in product's texture and taste might also occur (Hongsaprabhas, 2017b).

2) Different suppliers of agricultural raw materials may influence product quality during NPD experimentations for both laboratory and industrial scale. This will also affect the optimization in the mass production process of the final version. Inevitably, the variation can affect the characteristics of the new commercialized product (Hongsaprabhas, 2017b).
3) Special agricultural raw ingredients/materials used in the NPD experimentations at the laboratory scale may not be suitable for mass production especially when the supply of the raw materials is seasonal based. There is no assurance of a steady all year-round supply nor consistency in the quality levels. Therefore, these ingredients may not be very suitable for mass production (Hongsaprabhas et al., 2017b; Niyomrath, 2014).
4) The production processes and tools applied during NPD experimentation at laboratory scale may not provide the accuracy and consistency in the mass production processes and the manufacturing tools may differ in the production facilities (Hongsaprabhas, 2017b).

This explains why most of the MVPs validated at the laboratory scale do not survive NPD experimentations at the industrial scale (Hongsaprabhas, 2017b; Neubauer et al., 2013; Noorman, 2011).

In general, the result of NPD based on laboratory scale is the the acquisition of new product prototype (Suwannaporn & Speece, 2010) to test only the concept of the new product and it still need continuous development at industrial scale. However, feedback from sensory test, price point perception, and product positioning from the end consumers for NPD experimentation at the laboratory scale help in product improvement. However, most of these feedbacks are in the context of marketing and lack the necessary contexts for mass production and legal commercialization which covers the following aspects:

1) Ability of the suppliers to actually provide agricultural raw materials matching NPD laboratory scale specifications (Grimsby & Kure 2019; Hongsaprabhas, 2017b; Iturrioz et al., 2015).
2) Machines, tools and equipment owned by the food machinery companies in the factory must be aligned with the NPD requirements at the laboratory scale and the industrial scale (Hongsaprabhas, 2017b).
3) The NPD process must lead to a final product complying with the national laws and regulations to be registered by the FDA. Any need for additional processes to be consistent with the law should also be considered. Take for instance, the results of the microbiological test must align with the FDA declaration (Chaochotechuang, 2016).
4) Both food machinery SMEs must primarily have a factory/production license that allows new products to be legally produced (Hongsaprabhas et al., 2018).

The ability of Thai FI SMEs to fulfill these additional requirements affects the NPD process at the industrial scale (Hongsaprabhas, 2017b; Neubauer et al., 2013; Noorman, 2011). As mentioned above, the industrial scale is critical to test the viability of the new product for mass production and legal commercialization. This is especially so in the context of Thai FI which rely substantially on food machinery SMEs to finalize new product development at industrial scale before mass production

(Hongsaprabhas, 2017b; Lehtinen & Torkko, 2005; Neubauer et al., 2013; Noorman, 2011; Savetpanuvong et al., 2011).

In summary, the opening of Thai FI SMEs to OI logics and practices to support their NPDs affects experimentation and management in both laboratory and industrial scale. Therefore, identifying the generative mechanisms underlying the implementation of OI practices in Thai FI SMEs in both dimensions must be taken into consideration.

1.2 Statement of the Problem

Since OI has been mainly analyzed in the knowledge intensive industries, larger and multinational enterprises, some exploratory researches have investigated the OI phenomena in FI SMEs and demonstrated empirically that they pursued OI mainly to meet customer expectations and/or to follow their competitors (Galanakis, 2016). However, the nature and sequence of the different efficaciously OI logics and practices alternation within FI SMEs is still poorly understood.

The studies related to OI in the context of knowledge and innovation management in Thai FI at SME level are scarce (Chaochotechuang, 2016; Jeenanunta & Intalar, 2016; Jones & Pimdee, 2017; Rujirawanich et al., 2011; Vignoli, 2017). When it comes to Thailand, no publication is available regarding food machinery SMEs' OI logics and practices even in the Thai publication. Most of the literature about Thai FI focus on food science and applied technologies. Studies that refer to OI in Thai FI mainly describe the superficial use of OI logics without questioning the attached practices and underlying generative mechanisms (GMs). Therefore, this research aims to understand why have some of Thai food machinery SMEs effectively achieved an OI adoption in their NPD with other actors in the value chain.

OI implementation in the NPD process is one of the organizational strategies adopted by Thai FI SMEs. It is perceived as essential for the survival of Thai FI SMEs (NSTDA, 2018; Tambunlertchai, 2015). However, many of Thai FI SMEs fail when they come to implement OI in their organizations (Jones & Pimdee, 2017). Chaochotechuang (2016) highlighted the 6 critical lacking or barriers in the implementation of OI in Thai FI SMEs. These lackings are listed as follows:

1) Limitation in resources such as personnel, finance, machinery and knowledge that are associated with new product development, and organizational culture
2) Lack of awareness among employees towards OI
3) Employees lack adaptivity to apply OI logics and practices
4) Lack of understanding of the essence of OI
5) Lack of strategies and guidelines to implement OI
6) Lack of OI applications that match organizational strategic goals and the need for business sustainability

Empirically, the success of Thai FI SMEs in innovation depends on their ability to manage knowledge rather than tangible assets. Therefore, the ability to manage relevant knowledge to develop new products and services are skills absolutely necessary for Thai FI SMEs. Unfortunately, the focus of Thai FI entrepreneurs is not on knowledge management or collective strategies (Quinn, Baruch, & Zien, 1997). Even though literature has indicated OI logics and practices application in FI SMEs, empirical data identifying the underlying GMs are not available. Even if OI Food-Machinery frameworks (Bigliardi et al., 2010) have been refined over time, the most advanced framework (Bigliardi & Galati, 2013a;

Hongsaprabhas et al., 2018; Grimsby & Kure, 2019) only reach the level of the practices and do not question the development of the GMs needed to implement these practices. Without the empirical revealing the key GMs that needs to be triggered to ensure efficaciously implementation of OI logics and practices in Thai FI SMEs, no generalization of the application of these logics and practices can really be achieved neither on the academic side nor on the practitioner side. The aforementioned issues constitute a huge research gap in the literature on OI especially for practitioners. Therefore, studying Thai food machinery SMEs who have implemented OI logics and practices in their NPD process is of critical importance to identify and share best practices among the concerned organizations. This is vital as FI SMEs developing new food products face low rates of innovation and high rates of failure in the area of new food products (Boesso, St Davcik & Favotto, 2009; Kumar, Boesso, Favotto, & Menini, 2012).

Since the beginning of the 2000s, Thai FI SMEs tend to evolve their organizational strategies and capabilities from original equipment manufacturer (OEM) to original brand manufacturer (OBM) to achieve higher profit margins and improve positions in their value chain. To achieve such goals, they need to develop new core competences to go beyond simple production management to enforce R&D, branding and international marketing (Chunhavuthiyanon & Intarakumnerd, 2014). In the context of OI, these companies also need to develop dynamic capabilities as cited by Teece, Pisano, & Shuen (1997) that "*The [...] ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.*" (p.516). Food machinery SMEs can essentially manage know-how, and OI practices through the development of dynamic capacity that focus on exploration, exploitation or retention suggested by Lichtenthaler and Lichtenthaler (2009). The Dynamic Capabilities framework for open innovation is presented in Figure 1.6.

Figure 1.6

Dynamic Capabilities - Based Framework for Open Innovation

	Knowledge exploitation	**Knowledge retention**	**Knowledge exploration**
Internal (Intrafirm)	Innovation capacity	Transformative capacity	Inventive capacity
External (Interfirm)	Desorptive capacity	Cennective capacity	Absorptive capacity

Note. This figure is adapted from "Dynamic Capabilities - Based Framework for Open Innovation" by Lichtenthaler and Lichtenthaler, 2009, p.1318.

Based on the framework, to identify OI GMs in the context of Thai FI SMEs, mechanisms attached to the specific set of OI practices must be first identified.

In parallel, some SMEs seek to become innovation intermediary / innomediary (Sawhney, Prandelli, & Verona, 2003) by leveraging their networks and / or ecosystem (Dicecca, 2016). Innomediary strategies enhance the organizations' ability to fill structural holes (Burt, 1992) in the market by identifying which opportunity to seize in the accessible social capital (Burt, 2001). Innovation intermediaries search for external knowledge and/or technological solutions that they can integrate in the products and/or services of their clients. There are different types of innovation intermediaries and the way they establish their specific services may differ from one innomediary to another (Mele & Russo, 2015; Sawhney et al., 2003). Innovation intermediaries usually support entrepreneurs to develop solutions for specific innovation needs, obtain expert information on the subject, create new products, support OI logics and practices implementation.

Again, different sets of OI practices and specific attached mechanisms are required for each particular innovation intermediary strategy. Thai food machinery SMEs develop innovation intermediary strategies to scrutinize their value chain environment (network and/or ecosystemic partners) and to identify innovation opportunities. Their clients mostly food companies will propose new prototypes of recipes in which the composition must be tested at the laboratory and/or industrial scales to demonstrate mass-production feasibility. When the possibility of mass production is demonstrated, a minimum viable product (MVP) is then available. Achieving mass production without too much alteration of the final product version's taste and texture, in most of the cases, implies to combine external knowledge from different sources: food ingredient suppliers (new suppliers and/or regular suppliers); food processing machine dealers (machinery sellers), etc. (Siriwongwilaichat & Winger, 2004). Therefore, Thai food machinery SMEs tend to become innovation intermediary and act as innovation marketplace operators. Innovation are food recipes that constitute the main intellectual property (IP) of the Thai food machinery SMEs. Development of the know-how to transform the prototype recipe into a final product is the second source of IP (Intarakumnerd, Chairatana, & Kamondetdacha, 2015; Siriwongwilaichat & Winger, 2004). All the exchanged knowledge is about food recipes and their mass production.

The lack of empirical studies on food machinery SMEs OI practices do not help in the understanding of FI SMEs evolutive process nor the sharing of the best practices for FI SMEs to become efficient innovation intermediaries.

The innovation marketplace operator maintains the balance between structure and chaos that are extremely important in managing distributed innovation. It would be very difficult to gather the data needed to qualify the set of OI practices and underlying DCs for each archetype of innovation intermediary. Therefore, the present study focuses on innovation marketplace operators (Sawhney et al., 2003).

Since OI implementation conditions the ability of FI SMEs to become innovation intermediary, (Hongsaprabhas et al., 2018), this is consistent with Brimble's (2007) which stated that proper knowledge management can increase the NPD effectiveness of Thai research agencies, universities and industries. It depends on the ability to develop internal knowledge, external knowledge, and to integrate various knowledge of the organization together, as well as, to increase the ability to apply knowledge to develop the original research effectively. Developing the NPD process by applying appropriate knowledge management principles is thus important for Thai FI SMEs (Tambunlertchai, 2015). For this reason, the researcher focuses on the perspectives of knowledge and innovation management to find out the different patterns in OI GM, the flow of knowledge and activities in NPD process, and the associated actors in NPD of the Thai food machinery SMEs.

Moreover, from the literature review, the researcher found that currently no such analytical study exists that provides explicit pairwise links between the two domains of OI logics and practices in the NPD process of FI. Therefore, in order to better understand the reason of how Thai food machinery SME can contribute to the FI through becoming a food innovation intermediary, by applying the flexibility of OI logics and practices in their NPD (Hongsaprabhas et al., 2018). Therefore, the researcher aims at identifying the OI GMs involved in their implementation and application. From a practical perspective, the theoretical and empirical outputs of the study can be used by the executive level of Thai FI SMEs in facilitating their OI management in NPDs.

1.3 Rationale, Significance and Contribution of the Research

This study will explicitly explain why OI in the FI is seen as an "opportunity" and also as a prerequisite for FI sustainability (NSTDA, 2018). The ultimate goal of this study is for anyone who wants to implement the OI approach in the FI, including academic and practical researcher and developer in Thai FI SMEs, for example: (i) the R&D related government agencies, university researchers and NPD specialists at the operational level to be aware of and understand the management of knowledge from within and outside the organization, the knowledge from all actors involved in NPD on each stage, both laboratory scale and industrial scale. This study is designed to improve the efficiency of NPD process to reach the stage of mass production and legal commercialization, and possibly reduce the failure rate of NPD. This study is also for (ii) academic and practical management level in Thai FI SMEs i.e., the innovation management related government agencies and the management level of food machinery SMEs to be aware of and understand the importance of knowledge management and OI management, and to support better understanding in OI strategy management designing which is appropriate to the NPD process and all actors in the food supply - value chain. Thoroughly comprehending OI logics and practices in the organization will facilitate the OI approach in the NPD with all other actors more effectively. By understanding the OI GM, the organization itself can develop to a food innovation intermediary eventually.

1.4 Purpose of the Research

The goal of this study is to investigate how some Thai food machinery SMEs, have effectively achieved an OI adoption in their NPD with other actors in the supply and value chain. Thus, they can develop themselves as food innovation intermediary. To attain this goal, it is important to understand the OI GM of food machinery SMEs who have efficaciously brought in the OI approach into the NPD process.

In this dissertation, research purposes are grouped into 2 main categories:

1) To develop a proper OI model for Thai food machinery SMEs' NPD, by refining the Food-Machinery framework of Bigliardi & Galati (2013a) with the interview data

2) To implement the proposed food OI model for the GM identification, by investigating OI logics and practices at the empirical domain, and then study the underlying mechanisms at the real domain.

1.5 Research Questions

Research questions (RQs) are formed from the problem statement (section 1.2), research gaps (as explained in chapter 2), research purposes (section 1.4). The linkages of problem statement, research gaps, research purposes, and RQs are summarized in Figure 1.7 as shown in the following page.

Figure 1.7

The formation of the research questions (RQs)

Problem statement

How some Thai food machinery SMEs have effectively achieved an OI adoption in their NPD with other actors in the value chain?

Research gaps

Gap area 1: OI in Thai FI SME gap(s)

- No academic result explains how some Thai food machinery SMEs efficaciously adopt OI
- No study has identified OI GM in the NPD of Thai food machinery SMEs
- Lack of studies on OI logics and practices in the Thai food machinery SMEs
- Lack of specification in the nature of the actors involved in OI studies
- No specific OI framework proposed in the Thai food machinery SMEs

Gap area 2: OI logics gap(s)

- Lack of precision regarding the dominance of the knowledge flow in coupled OI logics in the context of Thai food machinery SMEs
- Lack of specification of the nature of knowledge flowing in OI studies in Thai food machinery SMEs

Gap area 3: OI practices gap(s)

- Lack of empirical characterization of OI practices that occur in Thai food machinery SMEs
- Lack of empirical characterization of OI practices that mobilize coupled OI logics in Thai food machinery SMEs

Gap area 4: OI in NPD gap

- No OI study in the NPD context at "laboratory scale" and "industrial scale" in the Thai food machinery SMEs

Research purposes

1) To develop a proper OI model for Thai food machinery SMEs' NPD, by refining the Food-Machinery framework of Bigliardi and Galati (2013a) with the interview data,

2) To implement the proposed food OI model for the GM identification, by investigated OI logics and practices at the empirical domain, and then investigated the underlying mechanisms at the real domain.

Research questions

RQ1: Which types of actors are involved in Thai food machinery SMEs OI NPD processes? What relationships and roles actors have assumed in elaborating OI NPDs with the Thai food machinery SMEs?

RQ1.1) Who are the actor(s) involving in food NPDs with Thai food machinery SMEs both at the laboratory scale and industrial scale?

RQ1.2) What are the roles and relationships of the actors and food machinery SMEs involving in food NPDs?

RQ1.3) Whose original recipes constituted to the initiation of the food NPD?

RQ2: What OI logics and practices are implemented in the Thai FI machinery SMEs OI NPD processes?

RQ2.1) What specific activities / practices are implemented between external actors and food machinery SMEs in food NPDs both at the laboratory scale and industrial scale?

RQ2.2) What is the specific travel of the food recipe between external actors and food machinery SMEs?

RQ2.3) What is the overall direction of food recipe knowledge flow both at the laboratory scale and industrial scale?

RQ3: What generative mechanisms favor OI logics and practices implementation in the Thai Food machinery SMEs?

RQ3.1: What factors activate the ability of Thai food machinery SMEs to implement and sustain OI logics and practices?

RQ3.2: In what GM sequences are activated in Thai food machinery SMEs OI NPDs?

To achieve the objective of identification OI GM favoring OI logics and practices that are implemented in the NPD of Thai food machinery SMEs who are also the food innovation intermediaries, all research questions need to be answered. The results of this study aspire to fill in this gap by providing GM for the implementation of OI in Thai food machinery SMEs.

1.6 Definition of Key Terminology

This section defines the important key terms that are used repeatedly in this study to convey their meanings. This section enables readers to draw similar understanding of the key terms in this study. The following terms are defined and discussed.

1) Open innovation (OI). It is the purposive inflows and outflows of knowledge to accelerate internal processes, and to better benefit from innovative effort respectively (Chesbrough et al., 2006, p.xxv).

2) Open innovation logic (OI logic). It is a landscape of abundant knowledge, which must be used readily if it is to provide value to the organization that created it. The knowledge used by the organization is not limited to the organization, it can come from outside the organization (Chesbrough, 2006, p.xxv). It is important that the organization must be able to examine, explore, access and utilize these flows of knowledge within the organization's innovation process (Trott, 2008, p. 348). There are 3 alternatives of OI logic that can be deployed by the organization; namely outbound OI logic, inbound OI logic, and coupled OI logic (Chesbrough & Crowther, 2006; Gassmann, 2006; Lichtenthaler, 2008).

3) Outbound OI logic. It is the purposive outflows of knowledge, or technology exploitation, implying the use of the existing knowledge and technologies outside the boundaries of the organization (Chesbrough & Crowther, 2006; Lichtenthaler, 2008).

4) Inbound OI logic. It is the purposive inflows of knowledge or technology exploration that imply the capture and use of the external knowledge to develop the current knowledge and technologies (Chesbrough & Crowther, 2006; Lichtenthaler, 2008).

5) Coupled OI logic. It is the combination of technology exploitation and exploration to enhance technological capabilities and/or competencies for the maximum value generation delivery and capture (Chesbrough & Crowther, 2006; Lichtenthaler, 2008).

6) Coupled OI logic with outbound dominance. It is the combined utilization of technology exploitation and exploration of the organization on specific context (Chesbrough & Crowther, 2006; Lichtenthaler, 2008), This is when the organization engages in more outbound than inbound activities (Hongsaprabhas et al., 2018).

7) Couple OI logic with inbound dominance. It is the combined utilization of technology exploitation and exploration of the organization on specific context (Chesbrough & Crowther, 2006; Lichtenthaler, 2008). This occurs when the organization engages more inbound than outbound (Hongsaprabhas et al., 2018).

8) Open innovation practices (OI practices). These are the activities needed to operationalize OI logics (Van de Vrande et al., 2009; Williamson & De meyer, 2012). Van de Vrande et al (2009) described 2 types of OI practices connected to technology exploitation and exploration, and respectively to outbound and inbound OI logics.

9) New product development (NPD). It is the set of activities which begins with the market perception opportunities and ending at the legal commercialization (Zhao, 2001). The process includes FDA registration, mass production, sales, and the delivery of new products (Hongsaprabhas, 2017b). The NPD process can be divided into 2 main stages, namely the laboratory scale and industrial scale (Anderson 2012; Hongsaprabhas, 2017b; Neubauer et al., 2013; Noorman, 2011; Suomala & Jokioinen, 2003).

10) NPD - laboratory scale (or lab scale). It is a prototype or product development in the research laboratory where concept testing is carried out for new product. At this stage, continuous development is still needed at industrial scale. The 3 stages of NPD at laboratory scale comprises of ideation, concept development, and product design (Sawhney, Verona, & Prandelli, 2005; Dahan & Hauser, 2002). The result of laboratory scale is the prototype of a new product. The related parameters, techniques and tools which are necessary for up-scaling (Neubauer et al., 2013; Noormn, 2011).

11) NPD - industrial scale. It is the development of prototype products in the level of pilot plant or manufacturing factory that have been tested by the users with evidences of the trial reports which can be developed and produced on an industrial scale and mass production. The purpose of this NPD stage is to take the readiness of newly developed materials to the next level via scaling up the actual ingredients/materials for production, manufacture facilities, and the involvement of the production team. The industrial scale will ensure the prior laboratory scale process is properly implemented on mass production (Reed & Alb, 2014). The NPD at industrial scale comprises of product testing, product law and regulation compliance

(Hongsaprabhas et al., 2018), and product launch (Dahan & Hauser, 2002; Sawhney et al., 2005). The result of industrial scale is the new product which is ready for mass production and legal commercialization (Neubauer et al., 2013; Noorman, 2011).

12) Innovation intermediary. It refers to the actors in the supply and/or value chain, who facilitate and support the collaborative arrangements of OI practices for the specific innovation needs (Bakici, 2013; Iturrioz et al., 2015; Ma et al., 2014; Munkongsujarit & Srivannaboon, 2011).

13) Generative mechanisms. They are the causal structures that generate observable events (Bhaskar, 1978; 1986; 2013). The critical realists typically ascribe to such structure causal powers (Sayer 1992). In this study, the GM is the causal power that explains how and why such OI logics and practices implemented and sustained over the commercialized food NPD.

14) Food machinery company (or food manufacturer). It is an organization or company whose operate as a factory that manufactures processed food products equipped with personnel and knowledge related to the processing and production processes, as well as having food technologies, machinery, and facilities suitable for mass production (Bigliardi & Galati, 2013a; Charoenrat & Harvie, 2014; Grimsby & Kure, 2019; Tambunlertchai, 2015). It also requires proper licensing for the establishment of a production plant which can produce processed food products approved by FDA for legal commercialization of new products (Hongsaprabhas et al., 2018).

15) Food company (or Food client). It is an organization or company having business characteristics as a distributor of food products which is well equipped with personnel and knowledge related to the distribution and marketing processes, as well as having the appropriate connection and network for distribution to consumers (Bigliardi & Galati, 2013a; Charoenrat & Harvie, 2014; Grimsby & Kure, 2019).

16) Small and Medium Enterprises (SMEs). It is a business that entrepreneurs can operate in the form of individuals, groups, individuals or non-juristic partnerships, limited partnership, limited company or joint venture. In addition, it can operate in many natures, such as manufacturing business, wholesale business, retail business, or service business (OSMEP, 2007a). In this study, the focus is on the manufacturing business that produce products in FI according to the criteria specified by Small and Medium Enterprises Promotion Act 2002 (OSMEP, 2014). Under the SMEs category, the production business should employ not more than 200 people and the amount of fixed assets should not be more than 200 million baht (OSMEP, 2007a).

1.7 Chapter Summary

This chapter discusses the fundamental framework of the research. It begins with the discussion of the background and objectives of the study. The discussion presents an overview of FI, Thai FI main characteristics, Thai FI culture and technology, national policy and planning for the development of Thai FI, structural repartition of Thai SMEs in FI, export performance of Thai SMEs in FI, characteristics of Thai food machinery SMEs, Thai FI SMEs specific challenges regarding innovation, Thai FI SME performance and food chain management, an introduction to OI logics iin FI and NPD in FI SMEs. The next section discussed the problem statement, rationale, significance and contribution of the research. This is followed by research purpose, research questions and definition of key terminologies.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Introduction

This chapter provides a review of literature on OI in the FI SMEs which include OI logics (inbound, outbound and coupled), OI practices (exploitation and exploration practices), food OI adoption model (8 models), NPD (laboratory scale and industrial), and general ideas of DCs to identify OI GM in chapter 4's research finding. The purpose of this chapter is to relate the existing knowledge to this research and compare the key concept of mentioned topics in the current literature.

Literature review is a synthesis of the literature on the research problem (Creswell, 2009) with the purpose to establish benchmark for comparison between the research findings and other academic works (Bhattacherjee, 2012; Creswell, 2009). The literature review enables the researcher to situate the research within the body of literature, defines the research problem, develops the conceptual framework, establishes the objectives and determines the research's methods and procedures (Ethridge, 2004).

In this chapter, Section 2.1 introduces the chapter and discusses the goal of the literature review, while Section 2.2 describes the method of the literature review. Section 2.3 discusses the concept of OI: including foundation of OI theories, OI Definitions, Typology of OI, OI logics (outbound, inbound and coupled OI logics), the food knowledge used in the OI study, OI practices, OI practices in FI SMEs (outbound and inbound OI practices), OI implementation in the FI, and FI SMEs, OI implementation challenges in the FI, various actors in food supply and/or value chain, various model of OI adoption in the FI, and food machinery framework (Bigliardi &

Galati, 2013a). The review is important for the selection of a suitable model for the design of the theoretical framework in the research. The next section, Section 2.4 discusses NPD in the aspects of process and OI approach in FI. Section 2.5 examines the knowledge gap in the literature and identifies the originality of the study. Section 2.6 presents the theoretical framework to study the OI generative mechanism in the NPD process. The last section, section 2.7, is a summary of the chapter. The summarized topics and sub-topics of literature review are presented in Table 2.1.

Table 2.1

The summarized topics and sub-topics of literature review

Open innovation (OI)		**New product development (NPD)**
• Foundation of OI theories • OI Definitions • Typology of OI • OI logics • The food knowledge used in the OI study • OI practices • OI practices in FI SMEs	• OI implementation in the FI • OI implementation in the FI SMEs • OI struggles in the FI • Various actors in food supply and/or value chain • Various models of OI adoption in the FI • Food machinery framework	• NPD process • Food NPD • NPD with OI approach in FI
Research gaps, research direction and originality of the study		
Propose integrated framework to study OI generative mechanism in NPD process		
Chapter summary		

2.1.1 Goal of Literature Review

The goals of literature review in this study are:

1) To identify key definitions, findings, theories, and articles in the areas of OI, FI, SME.
2) To narrow the scope of study and justify promising direction of the study by providing discussion on OI logics and practices that lead to the identification of OI GMs in the NPD in Thai food machinery SMEs.
3) To describe the relationship of each related work under consideration.
4) To critically analyze and identify gaps in current knowledge.
5) To define the research questions.
6) To synthesize a theoretical framework to guide the study.

2.2 Method of Literature Review

This study adopted a systematic literature review (SLR) because of the complexity of study context. Therefore, it is necessary to use the appropriate process to select the relevant studies to obtain the sufficient number to create the quality body of research (Jones, 2004). Systematic review is a popular method for academic research (Hallinger, 2013) as it uses scientific approach to reduce biasness in the selection, collection, analysis and synthesis of the data from relevant and primary studies on the specific issue (Cook, Greengold, Ellrodt, & Weingarten, 1997).

In this study, the researcher adapted the SLR method by Jones (2004) to analyze the current study component, which comprises 5 steps, namely problem definition; searching literature for relevant research studies on the chosen topic; select studies to be included in the review; analyze and synthesize data; and reports the results.

Step 1: Problem Definition

According to the explanation in chapter 1, FI is a very important sector in the Thai economy. However, there are many challenges to the survival of the Thai food firms. Among all the challenges, adapting to fast changing customer demands and complying fast with new regulations' complexity are extremely important. Hence, it is tough for any organization, especially SMEs, to solve all these issues by themselves. To overcome the problems, Thai FI SMEs begin to collaborate more with other actors in the industry or related industries. OI approach thus becomes essential for the survival of Thai FI SMEs. However, many Thai FI SMEs still encounter problems with the implementation of OI in their organizations (Tambunlertchai, 2015). In addition, literature have shown no academic research that explain how some Thai FI SMEs have efficaciously adopted OI.

Therefore, the components of the problem emcompass (i) open innovation (OI); (ii) food industry (FI); and (iii) small and medium enterprise (SME). These 3 components are discussed in the literature review.

Step 2 :Searching the Literature to Identify Relevant Studies

Step 2 seeks to select a suitable database for the systematic review. The researcher realized the importance to search relevant studies for analysis and synthesis the information in the creation of the research body. The researcher adheres to the principle that the database used must thoroughly be comprehensive, reliable, and lack of bias (Magarey, 2001). Nevertheless, the argument needed to be studied and discussed should be based upon the up-to-date and consistent information. In this regard, the researcher searched 3 selected keywords in 4 the literature database as follows:

i. 22 Strategic Management Journals (Scimago Journal & Country Rank [SJR], 2018)
ii. 28 Agri & Aquaculture Journals (OMICS International, 2018a)
iii. Top 10 Food Authentication Journals (Georgiou, 2017)
iv. 17 Food & Nutrition Journals (OMICS International, 2018b)

(i) Strategic Management Journals (SJR, 2018). The purpose of choosing this database is to obtain the relevant papers related to the branch of the strategic management. The 22 journals are as follows:

1) Academy of Management Perspectives [AMP]
2) Academy of Management Learning & Education [AMLE]
3) Advances in Strategic Management [AISM]
4) Business Horizons [BHS]
5) Business Strategy Review [BSR]
6) California Management Review [CMR]
7) European Business Review [EBR]
8) European Management Journal [EMJ]
9) European Management Review [EMR]
10) Harvard Business Review [HBR]
11) Journal of Business Strategy [JOBS]
12) Journal of Management and Strategy [JMS]
13) Leadership & Organization Development Journal [LODJ]
14) Long Range Planning [LRP]
15) M@n@gement [M@N@]
16) Management Decision [MD]

17) Scandinavian Journal of Management [SJM]

18) Strategic Management Journal [SMJ]

19) Strategic Organization [SO]

20) Technology Analysis & Strategic Management [TASM]

21) American Marketing Association [AMA]

22) MacKinsey Quaterly [McKQ]

(ii) Agriculture & Aquaculture Journals (OMICS International, 2018a). It is a database that uses "journal to impact factor" for sorting. The purpose of using this database is to obtain the relevant papers related to the processing in the agricultural products. It also includes the technological applications in agriculture and aquaculture used to respond to the needs of humanity and animal's food.

1) Asian Journal of Plant Science and Research [AJPSR]

2) Journal of Agricultural Science and Food Research [JASFR]

3) Journal of Food Processing & Technology [JFPT]

4) Electronic Journal of Biology [EJB]

5) Journal of Aquaculture Research & Development [JARD]

6) Journal of Marine Science: Research & Development [JMSRD]

7) Journal of Plant Pathology & Microbiology [JPPM]

8) Fisheries and Aquaculture Journal [FAJ]

9) Journal of FisheriesSciences.com [JF]

10) Fungal Genomics & Biology [FGB]

11) VEGETOS: An International Journal of Plant Research [VIJRP]

12) Journal of Plant Physiology & Pathology [JPPP]

13) Journal of Horticulture [JH]

14) Advances in Dairy Research [ADR]

15) Advances in Crop Science and Technology [ACST]

16) Medicinal & Aromatic Plants [MAP]

17) Rice Research: Open Access [RROA]

18) Forest Research: Open Access [FROA]

19) Research & Reviews: Research Journal of Biology [RRRJB]

20) Agrotechnology [Agro]

21) Expert Opinion on Environmental Biology [EOEB]

22) Single Cell Biology [SCB]

23) Journal of Biodiversity, Bioprospecting and Development [JBBD]

24) Journal of Fisheries & Livestock Production [JFLP]

25) Poultry, Fisheries & Wildlife Sciences [PFWS]

26) Journal of Traditional Medicine & Clinical Naturopathy [JTMCN]

27) Research & Reviews: Journal of Botanical Sciences [RRJBS]

28) Journal of Food & Industrial Microbiology [JFIM]

(iii) Top 10 Food Authentication Journals (Georgiou, 2017). The purpose of using this database is to obtain the relevant papers related to the fields of food and application industries related to food authentication, management, analysis and regulation in FI.

1) Journal of the science of food and agriculture [JSFA]

2) Journal of Food Composition Analysis [JFCA]

3) Journal of Chromatography [JC]

4) Analytical and Bioanalytical Chemistry [ABC]

5) Food Research International [FRI]

6) Food Control [Fcon]

7) Analytica Chimica Acta [ACA]

8) European Food Research and Technology [EFRT]

9) Food Chemistry [Fchem]

10) Journal of agricultural and food chemistry [JAFC]

(iv) Food & Nutrition Journals (OMICS International, 2018b). It is a database that uses the "journal impact factor" for sorting. The purpose of using this database is to obtain relevant papers related to the fields of FI. It includes any applications related to the food and nutrition studies that examine the socioeconomic implications and specialized strategies to meet global food security. The journals consist of the followings:

1) Journal of Food Processing & Technology [JFPT]

2) Journal of Nutrition & Food Sciences [JNFS]

3) Journal of Allergy & Therapy [JAT]

4) Journal of Nutritional Disorders & Therapy [JNDT]

5) Journal of Probiotics & Health [JPH]

6) Advances in Dairy Research [ADR]

7) Vitamins & Minerals [VM]

8) Journal of Animal Research and Nutrition [JARN]

9) Journal of Food and Nutritional Disorders [JFND]

10) Journal of Food & Industrial Microbiology [JFIM]

11) Journal of Experimental Food Chemistry [JEFC]

12) Journal of Nutrition Science Research [JNSR]

13) Research & Reviews: Journal of Food and Dairy Technology [RRJFDT]

14) Journal of Food: Microbiology, Safety & Hygiene [JFMSH]

15) Journal of Clinical Nutrition & Dietetics [JCND]

16) Journal of Food Technology and Preservation [JFTP]

17) Journal of Clinical Immunology and Allergy [JCIA]

The selected title searches "OI", "OI with SME", "OI with FI", and "OI with SME and FI" to obtain research papers which relate to OI and the main focus of the study. As the OI concept was first presented by Chesbrough (2003), the search was carried out over a period of 2003 – 2018. Search data result is shown in Table 2.2.

Table 2.2

Search results of systematic review between September 1, 2017 to March 31, 2018

Keywords / Databases	▪Open innovation	▪Open innovation ▪SME	▪Open innovation ▪Food industry	▪Open innovation ▪SME ▪Food industry	Total
Google scholar (For comparison only)	82,988 (For comparison only)	10,006 (For comparison only)	2,584 (For comparison only)	713 (For comparison only)	96,291 (For comparison only)
(i) 22 Strategic Management Journals	949	144	32	10	1,135
(ii) 28 Agriculture & Aquaculture Journals	2	1	1	0	4
(iii) 10 Food Authentication Journals	12	0	1	0	13
(iv) 17 Food & Nutrition Journals	0	0	0	0	0
Total	963	145	34	10	1,152

Regarding Table 2.2, the total search results were 1,152 papers. The 22 Strategic Management Journals database provides the majority of papers at 1,135 papers. There were 13 papers from the 10 Food Authentication Journals database. For the 28 Agriculture & Aquaculture Journals database, 4 papers were retrieved. As for the 17 Food & Nutrition Journals, there were no suitable papers. In terms of the number of research papers retrieved under the keywords, "OI" had the highest number of papers at 963 papers, for "OI with SME", there were 145 papers. "OI with FI" had 34 papers and 10 papers under "OI with SME and FI".

Step 3 :Selecting Studies to be Included in the Review

In Step 2, 1,152 research papers appeared through the search. The researcher selected only the papers that used the keywords; "OI with SME", "OI with FI", and "OI with SME and FI" aligned with the research scope as presented in Table 2.3. The reason being that the contents from "OI" papers are too broad and do not relate to the research interest of the study.

Table 2.3 shows the total search results of 189 papers from the selected database. There are 186 papers from the 22 Strategic management journals and 2 papers retrieved from the 28 Agriculture & Aquaculture Journals. For the 10 Food Authentication Journals, only 1 paper is suitable. No relevant paper has been found from the 17 Food & Nutrition Journals.

Among the retrival by keywords, "OI with SME" has the highest number of papers at 145 papers. "OI with FI" has 34 papers and "OI with SME and FI" has 10. The common explanation in the 22 Strategic management journals is that OI is possibly one of the well-known topics in strategic management literature (Trott, 2008).

Table 2.3

Selecting results of the systematic review of the literature conducted between September 1, 2017 and March 31, 2018

Keywords / Databases	▪Open innovation	▪Open innovation ▪SME	▪Open innovation ▪Food industry	▪Open innovation ▪SME ▪Food industry	Total
Google scholar (For comparison only)	(For comparison only)	(For comparison only)	(For comparison only)	(For comparison only)	(For comparison only)
(i) 22 Strategic management Journals	(For comparison only)	144	32	10	186
(ii) 28 Agriculture & Aquaculture Journals	(For comparison only)	1	1	0	2
(iii) 10 Food Authentication Journals	(For comparison only)	0	1	0	1
(iv) 17 Food & Nutrition Journals	(For comparison only)	0	0	0	0
Total	(For comparison only)	145	34	10	189

Importantly in Step 3, the researcher screened all 189 relevant papers based on the following review processes:

1) Review titles and abstracts to determine if the papers are relevant to the topic of the study – Of the 189 papers, 64 are considered relevant. The selected papers are checked for unidentified number of repetitions.
2) Review full text to determine if the papers are relevant to the reserch – All selected 64 papers are reviewed. The full text review identified 44 out of 64 related papers to this study.

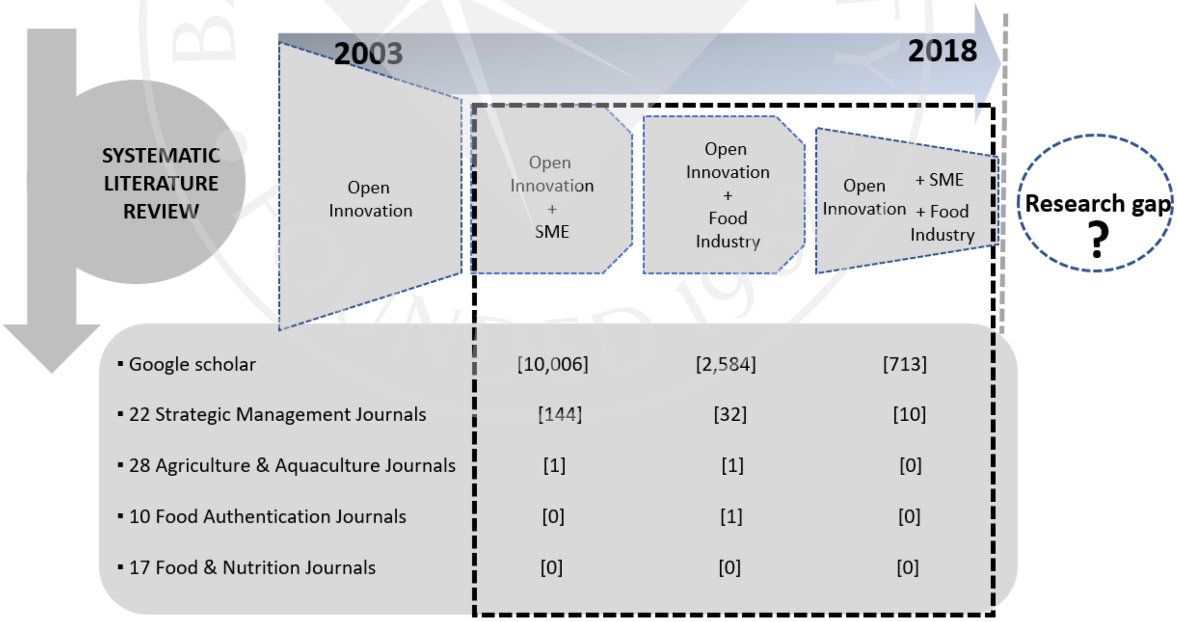
3) Review additional papers from the relevant references based on the interesting relevant references identified by the researcher, an additional 37 papers have been selected. In the third round of reviewing, a total of 81 papers have been selected to develop the body of this research.

Step 4: Analyzing and Synthesizing Data

In Step 4, the researcher identified the initial research gap to in the research. Figure 2.1 compares result among each database in the period of September 1, 2017 to March 31, 2018.

Figure 2.1

SLR plan to identify the initial research gap



When comparing the relevant papers searched from each database; the researcher found that the database from the 22 Strategic Management Journals (SJR, 2018) best fits the research interest. This is because the use of OI within the organization is the primary activity related to strategic management. As for the other databases, 28 Agriculture & Aquaculture Journals (OMICS International, 2018a), Top 10 Food Authentication Journals (Georgiou, 2017), and 17 Food & Nutrition Journals (OMICS International, 2018b), they focus in the FI area instead of the knowledge and innovation management aspects. That explain why the number of papers relating to OI is considerably low in number. Despite the present of OI studies in FI, the intensity of the studies is limited. Most of those food researches were in the NPD and other specialized knowledge such as the effect on the antioxidant activity for reconstituted orange juice pasteurized in high pressure and heat (Polydera, Galanou, Stoforos, & Taoukis, 2004).

The analyzing results of each database are shown in Figure 2.2, 2.3, 2.4 and 2.5.

Figure 2.2

Analysis of search result from 22 Strategic Management Journals

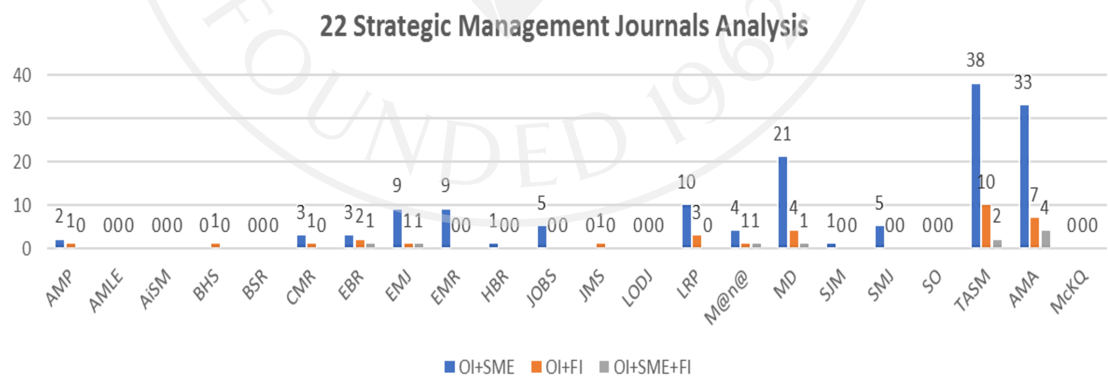


Figure 2.2 illustrates the relevant papers in "OI with SME". There are 144 selected papers. These papers appear in 3 major journals, namely Technology Analysis and Strategic Management [TASM] with 38 papers, 33 papers from American Marketing Association [AMA] and Management Decision [MD] with 21

papers. As for the keyword "OI with FI", 32 papers are found. Majority of these papers are from Technology Analysis & Strategic Management [TASM] with 10 papers, American Marketing Association [AMA] has 7 papers and 4 papers from Management Decision [MD]. There are 10 papers retrieved from the keyword "OI with SME and FI". These papers come from the American Marketing Association (4 papers), Technology Analysis and Strategic Management (2 papers), European Business Review (1 paper), European Management Journal (1 paper), M@n@gement (1 paper), and Management Decision (1 paper).

Figure 2.3

Analysis of searching result from 28 Agriculture & Aquaculture Journals

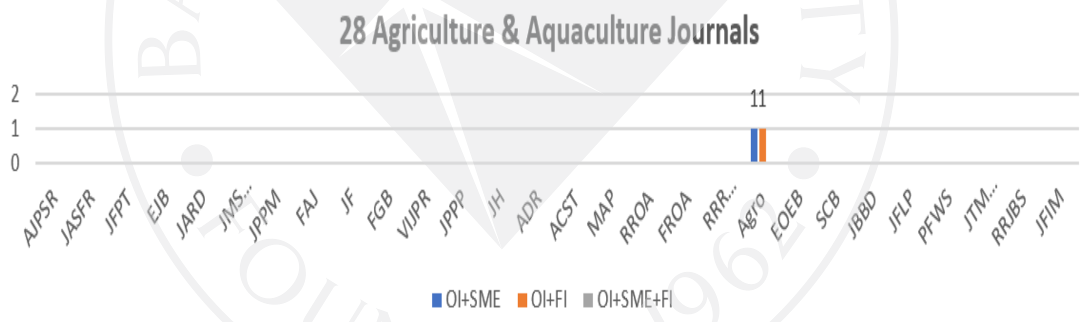


Figure 2.3 shows one relevant paper from “OI with SME” search and another paper from “OI with FI” search. The papers are from Agrotechnology & Food Sciences Group [Agro]. The 2 research papers are “The Opportunities for Dutch Biorefineries” (Annevelink, Broeze, Van Ree, Reith, & Uil, 2009) and “Knowledge base theme: Chains and Agrologistics (Kennisbasisthema: Ketens en Agrologistiek” by Simons, van der Fels-Klerx, Hermans, Haverkort, van der Fels, & Backus, 2009). However, both papers have no coordinate connection to OI, only the introductory to

OI are provided. No applicable paper in the keyword "OI with SME and FI" have been found from the database.

Figure 2.4

Analysis of searching result from Top 10 Food Authentication Journals

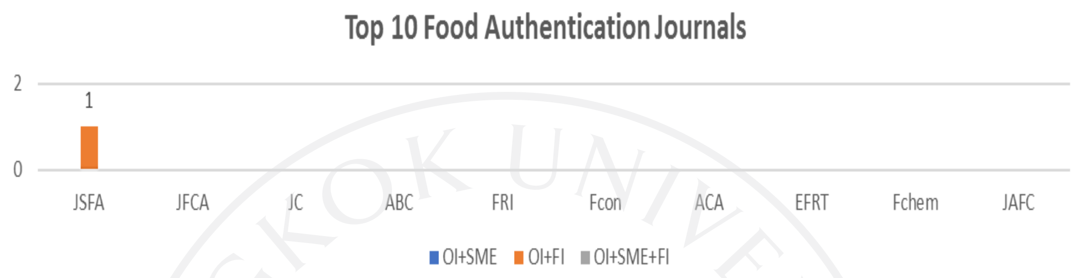


Figure 2.4 indicates the relevant papers in "OI with FI" keyword search. One paper from the Journal of the science of food and agriculture [JSFA] was retrieved. The paper is by Aguilera (2006), entitled "Seligman lecture 2005 food product engineering: building the right structures". For the other keywords, no paper has been found relevant from this database.

Figure 2.5

Analysis of searching result from 17 Food & Nutrition Journals

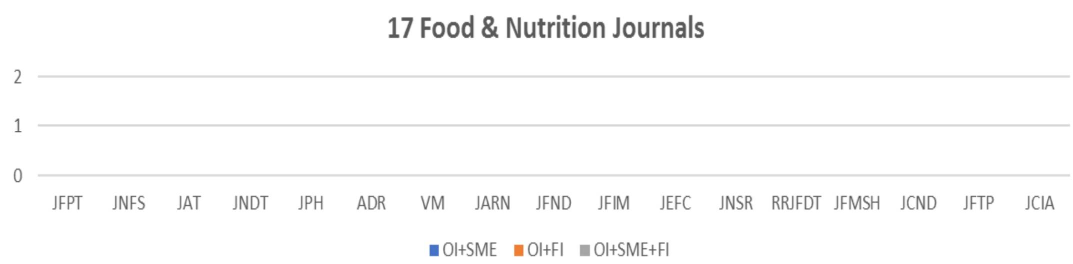


Figure 2.5 shows no relevant papers from this database.

Noticeably, based on the OI studies in Thai FI SMEs in the SLR, there is a clear lack of understanding of the mechanisms in Thai FI SMEs that hinder successful implementation (Hongsaprabhas et al., 2018). The researcher found a study tried to link OI logics and OI practices (i.e., Van de Vrande et al., 2009). However, there is too little evidence in the Thai FI SMEs context. In addition, such relationships do not cover the context of coupled OI logics, and no study identify their underlying GMs.

However, based on the SLR, the concept of OI in FI SMEs has been boardly defined and the scope of studies are generally board and superifical. The researcher therefore tries to narrow down the research scope to obtain specific results that is practically possibility and realistically reflexive. From the SLR, the researcher has identified the critical issues that indicate significant research gap and the research questions to form the premise of this study:

1) The FI SMEs sector is too broad for the study scope. Each actor in the FI supply - value chain for example the farmers, food suppliers, food machinery/ manufacturers and food distributors, have different roles and responsibilities in the FI. They also adopt different OI guidelines for their specific purposes. Therefore, to narrow the scope of FI SME study, the researcher chooses the sector of food machinery SMEs as they play an important role, and are consistent with the FI business model of Thailand (OSMEP, 2018a). Most of these Thai FI SMEs require other parties for manufacturing in a mass production process. Likewise, being unable to complete the FDA registration for the newly launched products by themselves, the Thai FI SMEs tend to rely on other parties to achieve the legal commercialization (Chaochotechuang, 2016; Chokenukul et al., 2012), as mentioned in chapter 1.

2) The entire organizational OI approach is too broad for the study scope. In general, one organization is able to adopt an OI approach with many functional units e.g., development of its product, service, and/or process (Bigliardi & Galati, 2013a). Since the literature reveals a huge gap between NPD strategy developers and the technological NPD (Beckeman et al., 2013; Neubauer et al., 2013; Suwannaporn & Speece, 2010), the researcher chooses the OI in NPD as the study context. This context is proper for in-depth investigation because individual NPD projects have clear starting and ending points for the development period of a new product. This in turn allows the researcher to observe various OI practices and their underlying GMs on what FI SMEs have done within its organization and/or joined with external organizations. It also includes how they explicitly succeed in the NPD, how the knowledge flows or how OI logics are implemented. The observation result can then be used in the identification of OI GMs, and to analyze the various factors that make FI SME efficacious in adopting OI approach in NPD context, and enable itself to become a food innovation intermediary.

3) OI studies in FI SME are limited. According to Galanakis (2016), there are 8 models for the development of OI adoption study in FI. There is only one model that corresponds to the extent of this study which is the Food-Machinery framework and the open food supply chain (Bigliardi & Galati, 2013a). This is because it is the only OI model that identifies the food machinery company as one of the studied actors and the model also identify the relationship between the OI logics and the direction of knowledge flow that occurs between the actors. For these reasons, the researcher narrows the scope of the study based on the criteria provided by the model. In

addition, the literature review found that past studies have never been linked to OI Logics with OI practice in the context of Thai FI SME.

4) The researcher conducted preliminary study to investigate the actual OI logics and practices in the NPD of 1 Thai food machinery SME by collecting NPD project data for the past 5 years in a total of 76 NPD projects. It appeared that such food machinery SME has the qualification as a food innovation intermediary. In other words, it has the competence in creating the NPD in industrial scale. Acting as a connector for each actor, the food machinery SME creates the knowledge flow through OI practice that suits the actor and the situation to allow each NPD project to complete. Hongsaprabhas et al. (2018) also stated that the investigated Thai food machinery SME has the flexibility to deploy OI logic and practices into 5 forms according to the nature of the NPD project (Hongsaprabhas et al., 2018). Such information forms the basis of the OI GMs in Thai food machinery SMEs in this study. The researcher expects that when studying OI logics and practices with another Thai food machinery SMEs, the researcher will be able to confirm various forms of OI GMs in Thai food machinery SME.

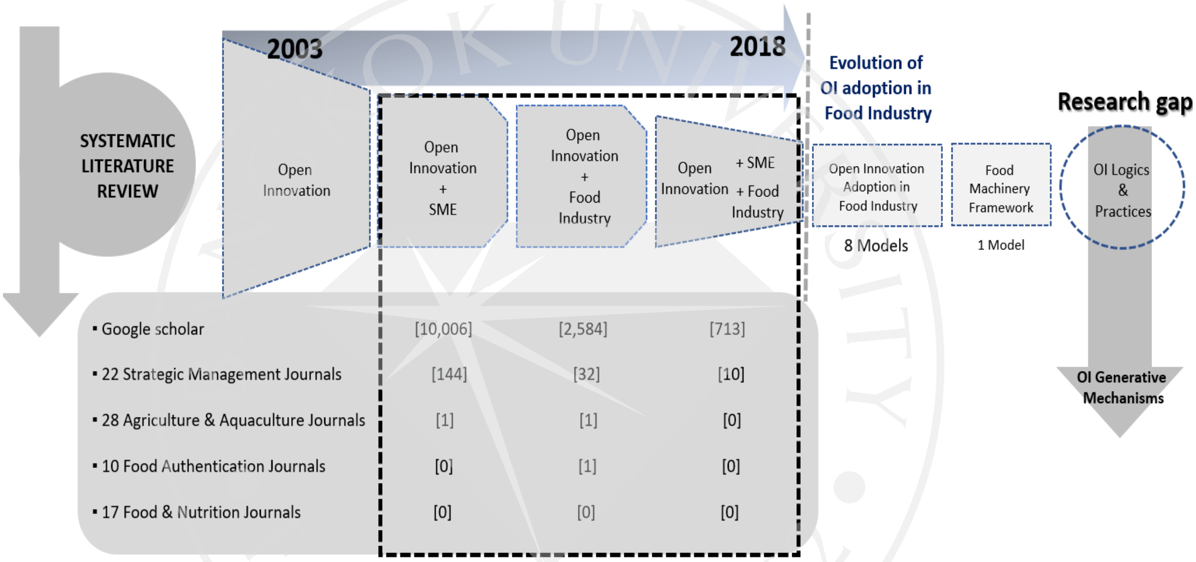
From the analysis and synthesis of information through systematic literature review, the researcher is able to scope down the research area and various factors to acquire the generative mechanisms of the actual OI in Thai FI SMEs. The topic for this study is “Open innovation generative mechanisms in Thai food machinery SMEs: the multiple case studies of NPDs toward the flexibility of OI logics and practices”.

Step 5: Reporting of the Results (Jones, 2004)

From systematic literature review in every past step, the researcher did a summary diagram as shown in Figure 2.6. of the research gap, topic, scope and context of the study.

Figure 2.6

SLR Summary for research gap, topic, scope and context of study



From the literature review, there is limited empirical evidence regarding OI in FI SME. However, according to the study of Bigliardi and Galati (2013a), it was clear that the implementation of OI approach in FI is increasingly based on the decisions and activities of the organization itself. In determining whether a food firm uses the OI approach or not, it should consider the wide number of actors involved in the NPD as well as the activities (OI practices) must be carefully coordinated.

As Chesbrough's OI definition (2003) emphasized the use of purposive inflows and outflows of knowledge. It can be said that OI logics is another fundamental factor that must be considered in the study of OI GMs. Thus, the researcher focuses on reviewing the extant literature on OI logics, OI practices and NPD in the FI context for the study of “Open innovation logics and practices generative mechanisms in Thai food machinery SMEs new product development: Multiple case studies”.

2.3 Open Innovation (OI)

OI paradigm has received increasing attention from both academia and practitioners (Radziwon & Bogers, 2019; Usman, Roijakkers, Vanhaverbeke, & Frattini, 2018). OI paradigm has been studied and developed from diverse fields of knowledge. One area includes the study of practical applications for a wide range of organizations and industries. Such studies have shown clear evidence of the need for external linkage and signified the importance of connectivity on innovation management in organizations. Trott (2008) has also established the strong linkage between internal and external of firm in driving the innovation process of a firm. As knowledge exists within and outside of the organization’s boundaries, it becomes necessary to train knowledge management for the effective OI implementation (Bercovitz & Feldman, 2007; Wallin & Krogh, 2010).

The concept of using OI in the organization is different from firm-centered innovation. OI takes a more decentralized approach focusing on both internal and external motivation (Tushman, Lakhani, & Lifshitz-Assaf, 2012). OI allows, simple collaboration among actors in supply and/or value chain which fosters strong OI relationship (Bigliardi & Galati, 2013a). Significantly, OI policy can boost R&D performance through facilitation of external collaborations (Asakawa, Nakamura, & Sawada, 2010).

2.3.1 Foundation of OI Theories

The theoretical foundations of OI was first proposed by Chesbrough (2003). However, the OI notion has evolved gradually through the work of many author over the last few decades. Its variety of applications benefit many organizations such the open-source software industry (Gruber & Henkel, 2006; West & Gallagher, 2006); toolkit for innovative designers and users, or collective innovation (Piller, 2008; Von Hippel, 2005; West, 2006); drawing the different elements in innovation economics e.g., the main user approach (user-based innovation).

2.3.2 Definitions of OI

The seminal definition of OI is established by the opposite of proprietary innovation or closed innovation (Chesbrough, 2003). It focuses on innovation logics that are implemented beyond the organization boundary. Closed innovation logics where the steering of R&D activities, and the marketing of new products and/or services stay within a single organization's boundary and is gradually replaced by interorganizational innovation logics (Parisot, 2015). These OI logics are key resources to establish and sustain the competitive advantage of organizations in turbulent markets (Natalicchio, Ardito, Savino, & Albino, 2017). Many organizations need to reduce the time period for new product development (NPD) before launching to the market (Bigliardi & Galati, 2013b). As a result, many companies adopted the OI approach but realized that it was difficult to renew the diverse innovative ideas without the emergence of the OI paradigm (Chesbrough, 2003; Parisot, 2015). Even though the OI notions have been defined differently by various authors, these definitions are complementary strategic logics in nature. According to Chesbrough, (2003), the fundamental definition either supplement one another or exploiting other theoretical perspectives in more specific dimensions (See Table 2.4 as presented on the following page).

The OI definitions in Table 2.4, share the same objective of clarifying the nature of openness. However, these definitions can either result in restrictive views (Chesbrough, 2003; Natalicchio et al., 2017; Piller, Ihl, & Vossen, 2011) or having too broad a view (Chesbrough, 2006; Henkel, 2006; Lichtenthaler, 2008, 2009; West & Gallagher, 2006; West, Vanhaverbeke, & Chesbrough, 2006). Regarding the plurality of OI notions, there is an unavoidable debate on what does or does not cover the notion of OI. However, many of these definitions make reference to the organization's aspiration to increase its value proposition by accessing to new resources, knowledge, and skills, to reduce the developing cost and shorten time to market; and value capture by optimizationg gains. To achieve such objectives, the necessary resources are sought either inside or outside the organization's boundaries, or even in these two areas (Parisot, 2015).

Table 2.4

Definitions of open innovation

Authors	Definitions
Chesbrough (2003)	*"Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. Open Innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model.*" (p.xxiv).
West et al. (2006)	"*Open innovation is both a set of practices for profiting from innovation, and also a cognitive model for creating, interpreting and researching these practices.*"
West and Gallagher (2006)	"*Open innovation systematically encourages and explores a wide range of internal and external sources for innovation opportunities, consciously integrates that exploration with firm capabilities and resources, and broadly exploits those opportunities through multiple channels.*"
Henkel (2006)	"*Openness in innovation processes reaches far beyond the market-mediated exchange, where technology is treated as a tradable good to be bought and sold on the market under suitable circumstances. Firms may make their technology available to the public in order to elicit development collaboration.*"
Chesbrough (2006)	"*The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively.*" (Supra note 22, p.1).
Leadbeater (2007)	"*There are two faces of open innovation: Open innovation IN is the basic model where ideas flow into companies from different sources (crowdsourcing). Open innovation OUT is where a group of people, a movement, sometimes a company, create a kernel or a platform, with some tools, onto which people can add their ideas and contributions. Open innovation IN narrows down a wider set of contributions into a funnel of corporate development. Open innovation OUT is designed to allow a process of evolutionary innovation that accretes and grows as each new person adds their piece of information, code or module.*"
Lichtenthaler (2008)	"*Open innovation is defined as systematically relying on a firm's […] capabilities of internally and externally carrying out the major technology management tasks […] along the innovation process*" (Lichtenthaler, 2008, p.148 quoted by Lichtenthaler & Lichtenthaler, 2009, p.1315).
Piller et al. (2011)	"*Open innovation is the formal discipline and practice of leveraging the discoveries of unobvious others as input for the innovation process through formal and informal relationships.*" (p.3).
Chesbrough and Bogers (2014)	"*A distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model.*" (p.1).

Note. The table is adapted from Parisot (2015)

2.3.3 Typology of OI

The first typology of OI was proposed by Chesbrough in 2003. It distinguishes the archetypes that constitute the various types of resource flowing across the organization boundaries and is interested in the mechanisms that govern these flows.

Beyond this first typology, several forms of openness in innovation have been proposed (Dahlander & Gann, 2010; Huizingh, 2011; Lichtenthaler & Lichtenthaler, 2009). The contrast between open and closed innovation proposed by Chesbrough (2003, 2006) is considerably extreme. Nevertheless, these representations share a common desire to encompass all OI practices associated with the various degrees of organizational openness (Dahlander & Gann, 2010). While the different visions complicate the process of OI conceptualizing, they shed light on the clarifying of all the mechanisms involved in the innovation logics and the diversity of forms that these OI logics can take.

2.3.3.1 Typology of Chesbrough (2003). For Chesbrough (2003) and its supporters, the management of spillovers-like knowledge management can take two implicit directions across the organization's boundaries (Chesbrough & Bogers, 2014). First, Outbound innovation or Inside-Out - Outbound OI and second, Inbound innovation or Outside-In - Inbound OI. Gassman and Enkel (2004) added the third typology with Coupled OI that combines outflows and inflows in both knowledge and technologies.

Outbound OI. The provision of unexploited or under-exploited resources within the organization is not always intended to generate profits (Dahlander & Gann, 2010). Nevertheless, the goal is usually to allow the organizational ideas to reach the market much quickier than through the R&D in the organization. The most common mechanisms involve licensing or partial intellectual properties (IP), the sale or granting of patents or technology, sharing skills, private investment, incubation, joint venture, and alliances (Chesbrough & Brunswicker, 2013; Chesbrough & Garman, 2009; Van de Vrande et al., 2009). The outsourcing of the development and / or commercialization locus of innovation is often made profitable by the exploitation of licensing or unexpected scientific or technological spin-offs generating positive externalities (Enkel, Gassmann, & Chesbrough, 2009). These mechanisms allow organization to expand its markets for which it does not have adequate central expertise (Enkel & Gassmann, 2010). To be attractive, the resources proposed must correspond to the needs of other actors in the supply and/or value chain. In most cases, a business model must be developed by the actor seizing ideas to the market (Chesbrough & Bogers, 2014).

Inbound OI. It is by far the most documented type of OI in academic literature, which consists commonly of three phases, namely acquisition, integration and commercialization (West & Bogers, 2014). Since the place of knowledge creation is not necessarily developed inside the organization, firms apply a wide variety of mechanisms such as exploration; access to academic research programs; obtaining a license to exploit intellectual property; the creation of start-ups; the use of confidentiality or contract agreements; collaboration with intermediaries; customers; suppliers; and communities. In practice, knowledge comes from customers, suppliers, as well as competitors of public or private research institutions (Enkel & Gassmann, 2010; NSTDA, 2018). Partners from other industrial sectors can also contribute to knowledge building (Hongsaprabhas, 2017b). Hence, innovation networks play a dominant role in localizing knowledge sought and facilitate the linkage of actors. This has made firms acknowledging the increasing importance of innovation networks (Enkel, 2010).

Coupled OI. The coupling concerns the direction of resource flows (knowledge, skill and technology) between organizations (Gassmann & Enkel, 2004). Table 2.5 summarizes the key features, objectives and processes associated with these flows. This type of OI involves two or more actors who invent, develop and / or commercialize "co-operation" (Gassmann & Enkel, 2004) of one or more innovations (Bogers, 2011; Bogers, Bekkers, & Granstrand, 2012). For Gassmann and Enkel (2004), "co-operation" is the collective development of knowledge through relationships with specific partners. Although in theory, all combinations of incoming and outgoing innovations are possible, in practice there are only a few specific combinations that can be deployed and associated with inter-firm organizational models such as joint ventures and strategic alliances (Hamel, 1991; Kogut, 1988; Mowery, Oxley, & Silverman, 1996), business ecosystems (Xiaoren, Z., Ling, D., & Xiangdong, 2014), and platforms (Isckia & Lescop, 2015).

In this context, many studies such as Allen (1977; 1983) and Mowery et al. (1996) agreed that the process of knowledge transfer between organizations should focus on tacit and explicit knowledge among the companies concerned, and their selection and learning with the associated actors. The key success factor for multi-stakeholder innovation work is the ability to integrate new knowledge and/or technologies from different organizations. The latter accelerates efficiency in open innovation.

For stakeholders, the end result is either to acquire a dominant position in the market to create monopoly, develop new standard or to significantly increase their returns on investment by multiplying projects to exploit the resources.

Table 2.5

Main characteristics, objectives and processes of different types of open innovation

	Outside-In process	Inside-out process	Coupled OI
Characteristics	- Low tech industry for similar technology acquisition - Act as knowledge brokers and/or knowledge creators - Highly modular products - High knowledge Intensity	- Classical research-driven company	- Standard setting (predominant design) - Increasing returns (mobile industry through multiplying technology) - Alliance with complementary partners - Complementary products with critical interfaces - Relational view of the firm
Objectives	- IP complementation - External knowledge and competencies acquisition	- Decreasing the fixed costs of R&D - Branding - Setting standards via spillovers	- Combining outside-in and inside-out processes
Processes	- Earlier supplier integration - Customer co-development - External knowledge sourcing and integration - In-licensing and buying patents	- Bringing ideas to market - Out-licensing and/or selling IP - Multiplying technology through different applications.	- Integrating external knowledge and competencies and externalizing own knowledge and competencies.

Note. The table is adapted from Parisot (2015)

2.3.3.2 Typology of Lichtenthaler and Lichtenthaler (2009). This typology is an integrative representation based on the capabilities / capability-based view and knowledge management / knowledge based-view (Nonaka, 1994). It specifies which dynamic interactions (DCs) between internal and external knowledge can be implemented in OI logic.

For further elaboration, the authors drew on the work of Campbell (1960), which is based on a classical evolutionist model structured in three phases: 1) random genetic variations, 2) selection of the characters most adapted to variations in environmental conditions, and 3) retention and dissemination of selected characters. This principle of variation - selection - retention is transposed and adapted to innovation processes in the form of a triptych: exploration - retention - exploitation (Table 2.6).

This principle is supported by the arguments of Zollo and Winter (2002) and March (1991) that: "*knowledge exploration is directed at variation, i.e., internally or externally generating new intuitions, and selection, i.e., choosing the most appropriate ideas through evaluation. By contrast, knowledge exploitation encompasses the replication of new approaches in various contexts and their internal or external application in different settings* "(Lichtenthaler & Lichtenthaler, 2009, p.1317). The internal or external retention of knowledge connects the exploration and exploitation stages by allowing the transfer from one to the other at any time.

This perspective also relies on the organization's ability to adapt to changing environmental conditions and explicitly mobilizes dynamic capabilities (Teece, 2007) and implicitly by the work of Polanyi (1966, 1958, and 1951) on the nature of knowledge. These authors distinguished the classic distinction between "know-how" and "know-that". "Know-how" is inarticulate and tacit in nature, incorporating non-codifiable skills and expertise (Helfat, Finkelstein, Mitchell, Peteraf, Singh, Teece, & Winter, 2009, Kogut & Zander, 1992), while "know-that" refers to the gathering of facts and information. It is codifiable in theoretical knowledge (Kogut & Zander 1992; Szulanski, 1996). According to Polanyi (1966, 1958, 1951), tacit knowledge is supra-conscious and represents the dominant form. Huerta de Soto (2008) stated that even the most complex theoretical knowledge was originally based on intuition, an act of creation, which constitutes the first manifestation of tacit knowledge.

These elements have been used by Lichtenthaler and Lichtenthaler (2009) to distinguish the different types of capacities according to the nature of the knowledge to be managed. The resulting identification and definition of dynamic capabilities (DCs) distinguishes 6 management modalities of innovation as presented in Table 2.6. These six capabilities are based on the perspective of organization and studied at micro scale. Interestingly, some of these capabilities are related to maintaining external relations of the firm.

Table 2.6

Dynamic capabilities associated with the different logics of innovation

Innovation Process	Knowledge Management Type		
	Knowledge Exploration	**Knowledge Retention**	**Knowledge Exploitation**
Internal (Intrafirm)	"***Inventive capacity*** *refers to a firm's ability to internally explore knowledge i.e., to generate new knowledge inside the firm. Starting from the perception of particular opportunities (Shane, 2000), a firm sets up knowledge exploration processes (Smith, Collins, & Clark, 2005). After generating new knowledge, firms have to integrate this new knowledge into their knowledge bases (Garud & Nayyar, 1994; Kogut & Zander, 1992). The new knowledge is embedded into a firm's knowledge base by establishing links to existing knowledge (Helfat et al., 2009; Nonaka, 1994). Following prior research, which highlighted the importance of knowledge generation and inventive activity (Khilji, Mroczkowski, & Bernstein, 2006; Smith et al., 2005), we define inventive capacity as a firm's ability to internally explore new knowledge.*" (p.1318-1319)	"***Transformative capacity*** *refers to a firm's capability of internally retaining knowledge over time (Garud & Nayyar, 1994). Knowledge retention needs to be actively managed based on assigning resources to keeping the knowledge 'alive' (Campbell, 1960; Lane et al., 2006). Otherwise, knowledge will be lost if skills and routines are not used anymore or if employees leave the firm (Szulanski, 1996; Walsh & Ungson, 1991). As a result of recognizing a business opportunity, knowledge has to be reactivated and synthesized with additional knowledge (Pandza & Holt, 2007). Moreover, it must again be internalized through experience (Nonaka, 1994). The term 'transformative capacity' indicates that knowledge is transformed if firms maintain knowledge over time and reactivate it subsequently. Building on Garud and Nayyar's (1994) definition, we therefore define transformative capacity as a firm's ability to retain knowledge inside the organization.*" (p.1320)	"***Innovative capacity*** *is associated with matching inventions with the context of their final market (Cohen & Levinthal, 1990; Khilji et al., 2006). A firm may generate many innovations from a small amount of new knowledge. By contrast, a firm may also lack the ability to exploit a large knowledge base that it has generated and maintained (Lane et al., 2006). As knowledge may be developed internally or acquired from external sources, innovative capacity also represents the realized i.e., exploitative, component of absorptive capacity (Lane et al., 2006; Zahra & George, 2002). Innovative capacity refers to the application of knowledge that has been explored and retained inside or outside the firm because it requires similar exploitation processes (Khilji et al., 2006; Lane et al., 2006). Therefore, we define innovative capacity as a firm's ability to internally exploit knowledge.*" (p.1321)
External (Interfirm)	"***Absorptive capacity*** *in the knowledge management capacity framework focuses on knowledge acquisition, i.e., potential absorptive capacity (Zahra & George, 2002) and exploratory learning (Lane, Koka, & Pathak, 2006). Because of this focus on knowledge exploration processes (Lichtenthaler, 2009), it does not guarantee successful knowledge commercialization, which is part of the knowledge exploitation processes. On this basis, we define absorptive capacity as a firm's ability to explore external knowledge.*" (p.1319)	"*As* ***connective capacity*** *refers to a firm's ability to retain knowledge in interfirm relationships, it comprises elements of alliance capability (Kale & Singh, 2007) and relational capability However, it focuses on externally maintaining knowledge, and this has often been neglected. In contrast to absorptive capacity, external knowledge retention does not assume inward knowledge transfer. Instead, firms ensure privileged access to external knowledge without acquiring it (Grant & Baden-Fuller, 2004). To gain access to external knowledge, firms often need to be open to transfer some of their own knowledge (Chesbrough, 2006). In sociology, connective capacity refers to the ability to establish links to other elements, and these connections facilitate knowledge access (Luhmann, 1995). Following this logic, we define connective capacity as a firm's ability to retain knowledge outside its organizational boundaries.*" (p.1320)	"***Desorptive capacity*** *describes a firm's capability of external knowledge exploitation, which is complementary to internal knowledge application in a firm's own products (Lichtenthaler, 2007). External knowledge exploitation refers to outward knowledge transfer, which has recently become a broader trend (Fosfuri, 2006). Because of non-rivalry of knowledge (Grant & Baden-Fuller, 2004), desorbing knowledge does not preclude its internal application. After identifying external knowledge exploitation opportunities based on the monetary and strategic motives for transferring knowledge, a firm has to transfer the knowledge to the recipient (Rivette & Kline, 2000). Thus, we define desorptive capacity as a firm's ability to externally exploit knowledge.*" (p.1321-1322)

Note. This table is adapted from Lichtenthaler and Lichtenthaler (2009)

In light of this typology, it appears that the absorption capacities mobilized by Lichtenthaler and Lichtenthaler (2009) and its supporters are only one of the categories of DCs actually exploited by organizations. Moreover, this distinction between the different DCs raises interesting questions: to what extent does the organization need to develop? Is there compensation between some of these abilities? The authors suggested the possibility for the firm to choose a differentiated innovation strategy by developing specifically some of these capabilities. Their reflections are in line with the conclusions of Dahlander and Gann (2010) for whom internal R&D is necessary for understanding and assimilating external knowledge.

2.3.3.3 Typology of Van de Vrande et al. (2009). This typology is an OI application based on Chesbrough (2003). As OI has so far been studied mainly in high-tech, large and multinational enterprises, Van de Vrande et al. (2009) investigated OI logic and practices which are applied by innovative SMEs. Questions of whether OI logics and practices really fit SMEs, exploratory study was collected the data from 605 innovative SMEs in manufacturing industry. These industries comprised of food and beverages, chemicals, rubber and plastics, machinery and equipment, and other manufacturers. The study also covered the services industry encompassing IT, business services and other services in the Netherlands. The survey further explored the apparent trend towards OI and studied the motives and perceived challenges when SMEs adopted OI practices. Van de Vrande et al. (2009) research indicated that there was an increasing number of SMEs adopting such OI practices over the past 7 years between 2002 and 2009. Many of the SMEs have pursued OI primarily for market-related motives such as meeting customer demands, keeping up with competitors in the market. The findings also showed that there were no major differences between manufacturing and services industries, but medium-sized firms were generally more involved in OI than their smaller sized counterparts. Nevertheless, most of the challenges faced by these firms were related to organizational and cultural issues when they dealt more with their external actors (Rujirawanich et al., 2011; Sadat & Nasrat 2020). Theses evidences showed the existing OI approaches in the SMEs. Van de Vrande et al. (2009) research measured the OI based on eight OI practices as illustrated in Table 2.7 reflected upon technology exploitation and exploration in the investigated SMEs. Van de Vrande et al.'s (2009) typology shows that OI practices and the knowledge basis accumulated through large and multinational enterprises' experiences are possibly transferable to the context of SMEs (Sadat & Nasrat 2020).

Table 2.7

The SMEs' OI practices and their definitions

OI practices		Definitions (Vrande et al, 2009 applied from Chesbrough et al, 2006)
Technology exploitation	Employee involvement	"*Leveraging the knowledge and initiatives of employees who are not involved in R&D, for example by taking up suggestions, exempting them to implement ideas, or creating autonomous teams to realize innovation*" (p.428)
	Venturing	"*Starting up new organizations drawing on internal knowledge, and possibly also with finance, human capital and other support services from your enterprise. It implies a Spin-off and spin-out process. Support from parent organizations may also include finance, human capital, legal advice, administrative services, etc.*" (p.428)
	Outward IP Licensing	"*Selling or offering licenses or royalty agreements to other organizations to better profit from your intellectual property, such as patents, copyrights or trademarks*." (p.428)
Technology exploration	Customer involvement	"*Direct involving customers in your innovation processes, for example by active market research to check their needs, or by developing products based on customer specifications or modifications of products similar like yours*." (p.428)
	External networking	"*Drawing on or collaborating with external network partners to support innovation processes, for example for external knowledge or human capital*." (p.428)
	External participation	"*Equity investments in new or established enterprises in order to gain access to their knowledge or to obtain other synergies.*" (p.428)
	Outsourcing R&D	"*Buying R&D services from other organizations, such as universities, public research organizations, commercial engineers or suppliers.*" (p.428)
	Inward IP licensing	"*Buying or using intellectual property, such as patents, copyrights or trademarks, of other organizations to benefit from external knowledge*." (p.428)

Note. This table is adapted from Van de Vrande et al., (2009)

2.3.3.4 Typology of Dahlander and Gann (2010). Dahlander and Gann (2010) proposed a typology using the direction of inflows or outflows, and the presence or absence of an immediate financial benefit, As shown in Table 2.8, all the archetypes are OI logics and inter-firm relationed.

Worth noting, the addition of the financial dimension in the OI categorization is a novelty compared to previous typologies. Huizingh (2011) considered this typology as a good starting point for empirical research on OI as it facilitated the identification of the activities associated with each type of the innovation management strategy and the measurement of effectiveness. These strategies depend on the nature of the organization and the context in which it involves. The two-dimensional approach is partially convergent with that of Lichtenthaler and Lichtenthaler (2009). This new approach goes beyond the ontological question by presenting a new perspective without really solving the problem raised.

Table 2.8

Typology of open innovation logics

Innovation process	Pecuniary Objective	
	Non-pecuniary	**Pecuniary**
Inbound OI	***Sourcing:*** “*This type of openness refers to how firms can use external sources of innovation. Chesbrough et al. (2006) claim that firms scan the external environment prior to initiating internal R&D work. If existing ideas and technologies are available, the firms use them. Accounts of corporate R&D laboratories show that they are vehicles for absorbing external ideas and mechanisms to assess, internalize and make them fit with internal processes (Freeman, 1974).*” (p.704)	***Acquiring:*** “*This type of openness refers to acquiring input to the innovation process through the marketplace. Following this reasoning, openness can be understood as how firms license-in and acquire expertise from outside.*” (p.705)
Outbound OI	***Revealing:*** “*This type of openness refers to how internal resources are revealed to the external environment. In particular, this approach deals with how firms reveal internal resources without immediate financial rewards, seeking indirect benefits to the focal firm.*” (p.703)	***Selling:*** “*This type of openness refers to how firms commercialize their inventions and technologies through selling or licensing out resources developed in other organizations.*” (p.704)

Note. The table is adapted from Dahlander and Gann (2010)

2.3.3.5 Typology of Huizingh (2011). Huizingh (2011) choosed to distinguish OI practices based on two criteria, Firstly, if the OI practices are at the opening or closing of management processes and secondly, whether the accessed knowledge is needed for innovation. This typology connects discussion in innovation management with those of technologies and information systems. He proposed a matrix with four boxes qualifying current archetypes of the OI integrating the open-source movement (Von Hippel, 2010). The matrix is presented in Table 2.9. However, the archetypes Huizingh (2011) proposed corresponded to macro logic specific of certain institutions such as universities, private companies, etc. or hardware and software industries. The underlying capabilities are not questioned as the emphasis is on the mechanisms of outsourcing or the internalization of resources. Thus, the model focused on the capacities without exploiting them in the typology.

Table 2.9.

Different modes of innovation based on the openness of the process and the result of innovation

Innovation Process	Innovation Outcome	
	Closed	**Open**
Closed	***Closed innovation:*** "[…] *reflects the situation, where a proprietary innovation is developed inhouse (Chesbrough, 2003), both the process and the outcome are closed.*" (p.2-3).	***Public Innovation:*** "[…] *is* [for example] *standard setting, where the original innovators do not exclude others to use an innovation in order to reap the benefits of a de facto market standard* […]" (p.3).
Open	***Private Open Innovation:*** "[…] *the outcome is closed (a proprietary innovation) but the process is opened up, either by using the input of external partners or by externally exploiting an internally developed innovation.*" (p.3).	***Open-Source Innovation:*** "[…] *refers to instances, where both the innovation process and the outcome are open. Open-source software is the best-known example of this category.*" (p.3).

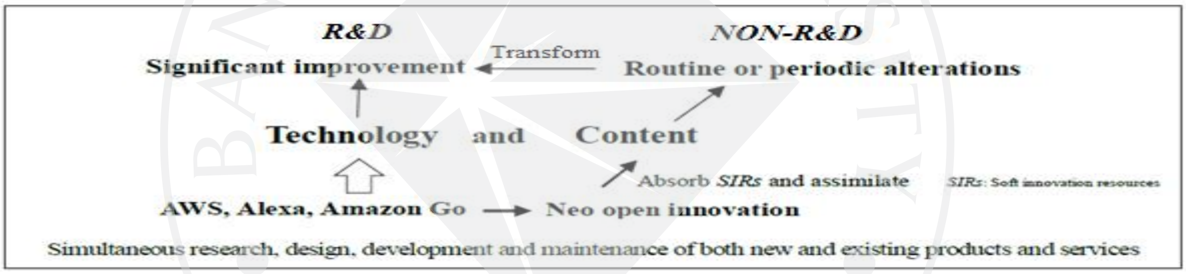
Note. The table is adapted from Huizingh (2011)

2.3.3.6 Typology of Tou, Watanabe, Moriya, Vurpillat, & Neittaanmäki (2019). "Neo open innovation" was firstly introduced in the work of Tou, Watanabe, Moriya, & Neittaanmäki (2018). This typology is the new concept of R&D in OI to provide a solution to the dilemma by many global ICT companies and digital economy between R&D expansion and productivity decline. This concept was conducted and developed by the identical R&D model of the Amazon Company (Tou et al., 2018, 2019). Tou et al. (2018, 2019) conducted an empirical analysis of Amazon Company which led to the concept of neo OI.

Amazon notable business performance is based on its unique business model that fully utilizes R&D. The approach has helped Amazon to become the world R&D leader in 2017 (Tou et al., 2018). Amazon has invested considerable resources into extremely innovative business areas so as to transform its business into digital leaders with its Amazon Web Services (AWS) and Amazon Echo and Amazon Go (Alexa). These new services reflect Amazon's assimilation capacity. Its network externally and big data collection system has enabled Amazon to absorb external innovation resources extensively or Soft Innovation Resources (SIR). The company untapped resources from external markets by constructing neo-open innovation, and then assimilate them in its indigenous model. Amazon has used the term "Technology and Content" to expand the original scope of ordinary research and development (R&D). Its investment in technology and content (Tou et al., 2018) included payroll and all related expenses for employees who were involved in R&D of new and existing products and services, development, design, maintenance and display products, services on websites, and infrastructure cost. Collectively, it is all investments that Amazon made to offer a wide variety of products and services to customers. This holistic phenomenon transforms "routine or periodic alternations" or non - R&D part into "significant improvement" or R&D part. The activities typically included in Amazon's R&D, for instance laboratory research aiming at discovering new knowledge, searching for applications of new research findings or other knowledge, conceptual formulation and design of the possible product, or process alternatives, evaluation of product or process alternatives, and design, construction, and testing of pre-production prototypes and models. The activities typically excluded in Amazon's R&D e.g., engineering follow-through in an early phase of commercial production, quality control during commercial production including routine testing of products, trouble-shooting in connection with break-downs during commercial production, ongoing efforts to refine and improve upon the qualities of an existing product. Following this cycle, Amazon develops its critical technology and invest in the human and financial resources as top priorities (Tou et al., 2018).

Figure 2.7

Neo open innovation in the scheme of Amazon's unique R&D model



Note. The figure is adopted from Tou et al. (2019)

However, Tou et al. (2018, 2019) did not provide specific meaning of neo-open innovation but make the assumption that soft innovation, unique R&D system or self-propagating R&D initiatives through soft innovation resources (SIRs) in dynamic digital ecosystem attributes to strong leadership principles. These principles consist of invent and simplify; learn and be curious; hire and develop the best; insist on the highest standards; think big; bias for action; frugality; earn trust; dive deep; have backbone, disagree and commit; deliver results, maintain the continual and timely flow of its competitive products, as well as services and technologies to the marketplace.

2.3.3.7 Synthesis. OI is a broad perspective encompassing different dimensions. Each typology questions on the OI logics according to specific perspective such as pecuniary logic (Dahlander & Gann, 2010), management of knowledge and skills (Lichtenthaler & Lichtenthaler, 2009), and accessibility to the results of innovation (Huizingh, 2011). However, OI logics still constitutes the standard ideals. In practice, one organization can apply various OI logics, that is either inbound or outbound and operate in many departments at the same time. Many existing OI logic research chose different types of knowledge to follow in one study, thus making it complicated to assume whether the OI is inbound or outbound. OI logics have been so far mainly analyzed among large and multinational enterprises in knowledge intensive industries, (Tou et al., 2019). Some exploratory papers have investigated the OI phenomenon in SMEs and demonstrated empirically that they have pursued OI to meet customer expectations or to follow their competitors (Henttonen & Lehtimäki, 2017). However, the nature and sequence of the different efficacious OI logics and practices alternation within SMEs are still poorly understood. The context and organization boundaries in the OI study is not well-defined as well.

Defining clearer scope of organizational boundaries is an important topic for OI studies (Lakhani, Lifshitz-Assaf, & Tushman, 2013; Van de Vrande, Vanhaverbeke, & Gassmann, 2010). Internal and external organizational boundaries are not just mentioned in the physical or tangible dimensions, such as the organization's building, staffs and data in a document format. In the science of organizational economics, organizational boundary is determined primarily by transaction logic (Tushman et al., 2012). This is because economists often describe things based on minimizing transaction costs between internal and external organizations (Tushman et al., 2012; Williamson, 1975, 1981). In addition, most traditional research uses “transaction” as the factor to identify and clarify relationships between each actor; the firm, its supply and/or value chains. When applied to studies related to OI, such concepts are used as criteria between open and closed boundaries (Tushman et al., 2012). What this means is that OI identifies all transaction activities from the OI practices which occur among internal organization and external actors during the OI process. Nevertheless, Tushman et al. (2012) also suggested that study related to organizational boundaries should go beyond just open and closed boundaries.

In this research, the researcher studies open boundary context, which focuses on knowledge flow (OI logics) and the set of activities (OI practices) which occurs inside and outside the organizational boundaries.

2.3.4 Open Innovation (OI) Logics

As new multi-actor organizational forms in the organization design become popular, the study of OI logics becomes more interesting (Tushman et al., 2012). The logic of OI is a landscape of abundant knowledge, whereby the knowledge gained must be used readily if it is to provide values to the organization that created it. The knowledge that the organization applies need not be limited only for the organization, but can come from outside the organization (Chesbrough, 2006, p.xxv). It is therefore important that the organization must be able to examine, explore, access and utilize these flows of knowledge within the organization's innovation process (Trott, 2008).

As OI is a broadly multi-dimensional in perspective, most studies view OI logic as purposive outflows and inflows of knowledge with the intention to accelerate innovation for the benefit of the organization (Chesbrough & Crowther, 2006; Chesbrough, Vanhaverbeke, & West, 2006). The purposive outflows of knowledge or technology exploitation are innovation activities implying the exploitation of existing technologies outside the boundaries of the organization. Likewise, the purposive inflows refer the capture and use of external knowledge to develop the current technologies. This is also known as technology exploration. Both technology exploitation and exploration can be combined to enhance their technological capabilities or competencies for maximum value (Chesbrough & Crowther, 2006; Lichtenthaler, 2008; 2011).

Therefore, it can be said that there are 3 alternatives of OI logic that can be deployed by organization (Chesbrough & Crowther, 2006; Gassmann, 2006; Lichtenthaler, 2008; Hongsaprabhas et al., 2018).

2.3.4.1 Outbound OI logic. It is the purposive outflows of knowledge, or technology exploitation which signifies the exploitation of the existing knowledge and the technologies outside the boundaries of the organization (Chesbrough & Crowther, 2006; Lichtenthaler, 2008). The organization carries out outbound activities to leverage existing knowledge and technological capabilities outside the organizational boundaries (Van de Vrande et al., 2009). Some examples of outbound activities include selling organization intellectual property rights (IPR), specific knowledge and skill, and rare technologies to the market (Lichtenthaler, 2008). It is an outward technology transfers to external organizations with suitable business models to commercialize the technology or additional to their internal application (Enkel et al., 2009; Lameck, 2013). The concept of this term derives from knowledge exploitation, which is the use and development of things already known (Levinthal & March, 1993).

2.3.4.2 Inbound OI logic. It is the purposive inflows of knowledge or technology exploration that captures and uses external knowledge to develop current knowledge and technologies (Chesbrough & Crowther, 2006; Lichtenthaler, 2008). The organization carries the inbound activities to capture and benefit from external knowledge to enhance the internal technological development (Van de Vrande et al., 2009). The organization engages in inbound activities to acquire and absorb external resources such as knowledge, technology and skills from their supply and/or value chain partners to improve internal processes. In other words, it is inward technology transferring which leverages the discoveries of others so that the firm does not need to rely solely on the internal R&D (Enkel et al., 2009; Lameck, 2013). This concept originates from the term knowledge exploration, which is the pursuit of the new knowledge of things that can come to be known (Levinthal & March, 1993).

2.3.4.3 Coupled OI logic. Technology exploitation and exploration can be combined to enhance technological capabilities and/or competencies for the maximum value generation delivered and captured (Chesbrough & Crowther, 2006; Lichtenthaler, 2008; Hongsaprabhas et al., 2018). The organization can couple the two previous logics to better collaborate with complementary partners in their supply and/or value chain (Enkel et al., 2009). Lichtenthaler (2011) indicated that OI characteristic of coupled OI logic diversed from 2 earlier approaches. First, it is the combination uses of outward and inward knowledge transfer, which differs from the two previous OI approaches that specified only one way knowledge flow in the innovation process. Second, are the complementary attributes of external and internal OI related activities with many organizations.

However, based on the systemic literature review, there is yet any studies that examine coupled OI logic indepth. Lichtenthaler (2011) briefly mentioned organization can adopt both types of OI logic, but how to go about it has not yet been fully explored. The author merely highlighted the characteristics and patterns of knowledge that transfer between actors. Hongsaprabhas et al. (2018) preliminary study supported coupled OI logic cited that it is able to reflect the reality of entrepreneurs' business operations. Nevertheless, the researcher found that the knowledge flow in NPD in Thai FI SME is more likely to apply a two-way flow among actors in the supply and/or value chain. With this observation, for this study, the researcher makes the assumption that Thai FI SME plays upon a coupled OI logic rather than applying either outbound or inbound logic. The concept judging that an organization's implementation of an outbound or inbound OI logic approach according to the OI study guidelines in the past is unable to reflect reality. Hongsaprabhas et al. (2018) research had shown that the invetigated SME can determine whether coupled OI logic in the NPD process is the result of outbound dominance or inbound dominance through the quantity of the outbound and inbound OI practices in NPD. The coupled OI logic affirms the accuracy of the analysis through the inquiry of opinions from those involved in the OI activity, which affirms the presence of coupled OI logics; both outbound and inbound dominance.

The systematic literature review has not shown any studies that relates to coupled OI logic which the researcher seeks to study. The coupled OI logic with outbound dominance is the combination of the utilization of technology exploitation and exploration of the organization in specific context, which the organization engages in outbound activities more than inbound activities. Likewise, the coupled OI logic with inbound dominance is the combining utilization of technology exploration and exploitation of the organization in the specific context, which the organization engages inbound activities more than outbound activities (Hongsaprabhas et al., 2018). When applying OI logics that is based on joint outbound and inbound dominance, the concept provides a new perspective and adds an additional dimension to the the degree of coupled OI logic in organization NPD implemention. Thus, the coupled OI logic of outbound and inbound dominance highlighted enable the study of a wide range of external and internal sources for OI opportunities as well as the flexibility of OI logic application.

2.3.5 The Food Knowledge Used in the OI Study

To better understand OI logic, its definition and scope of knowledge term are crucial for the study. In terms of knowledge, the lack of factual knowledge is often regarded as a problem and what the factual knowledge is and how it fits in the study are case. It is difficult to identify, acquire and utilize the knowledge in the real organizational processes and activities (Desouza & Pacquette, 2011). There are a variety of knowledge definitions provided by many authors. It is said that the knowledge is a fluid mix of framed experience, contextual information, values, and expert insight that offers a framework for the evaluation. In addition, it is the incorporation with the new experience and information (Desouza & Pacquette, 2011). In the organizational context, knowledge becomes embedded not only in the documents but also in the organizational practices, processes, routines, and norms (Desouza & Pacquette, 2011); Knowledge is based on the people belief and how they organized the accumulation of information. It can be integrated with other information, analyzed, interpreted and acted upon the given information (Davenport & Prusak, 1998). Therefore, knowledge becomes a collection of justified beliefs that enhances the capacity of the entity for action (Desouza & Pacquette, 2011). Polanyi (2012) classified knowledge into 2 categories according to the nature of knowledge. First, explicit knowledge and second tacit knowledge. Explicit knowledge is knowledge that can be written, transferred, and presented in the form of rules, formulas, equations, or letter substitutions for transferring. Such knowledge is quite obvious, so many scholars call this knowledge as the concrete knowledge. Tacit knowledge comes from the various senses and experiences which is difficult to explain. Knowledge come in the form of words that convey values, beliefs, craft skills, analytical thinking process, etc., Tacit knowledge is a hidden knowledge that sometimes the person does not know that this knowledge exists. Thus, many scholars call this knowledge as abstract knowledge.

However, knowledge can still be classified into many dimensions. It depends on what is used as a basis for knowledge classification. Knowledge can be classified according to the knowledge owner; individual knowledge, group knowledge and organizational knowledge, knowledge classified based on function or functional knowledge; financial knowledge, marketing knowledge and economics knowledge, and knowledge classified based on knowledge sources; internal knowledge and external knowledge. However, referred knowledge have been considered from different dimensions (Rujirawanich et al., 2011). For example, personnel in food R&D have specific knowledge in food product development which is a functional knowledge whilst the knowledge that R&D staff has been both tacit and explicit. In addition to developing a product, it is necessary to use both internal and external knowledge at the same time.

Hence, it is important to choose the type of knowledge to be used in the study. The type of knowledge must be appropriate and convenient for applying (Chiamchittrong, Sriwongkol, & Nilsook, 2007). In this research, the source of knowledge forms the basis of the study. The flow of internal and external knowledge is consistent with the objectives of OI studies which defined inflow and outflow of knowledge (Chesbrough et al., 2006, p. 1) using the organization boundaries as criteria (Bercovitz & Feldman, 2007; Wallin & Krogh, 2010).

The study of Parida, Westerberg, & Frishammar (2012) indicated that in most of the cases OI logics adopted in FI, are inbound logic (e.g., collaborative networks) and much less on outbound OI logic (e.g., licensing-out, spin-off and new venture capital). However, the researcher argued that only mentioned that OI logic in FI research was not contemplated as the specific study of OI logic as a way of knowledge and innovation management. There has been no indication on what the knowledge being studied is, what position of the studied organization is in the supply and/or value chain, or what the organization boundaries are in the study. In addition to the literature review, the researcher has not found any studies about OI logic in Thai FI SME context. In the FI, OI logic study is previously based on the individually focused knowledge flows such as food material knowledge, technology knowledge or food recipe knowledge flows (Stewart-Knox & Mitchell, 2003). These knowledge flows are regularly exchanged among involved actors in the supply and/or value chain. Therefore, it is quite a challenge to decide the knowledge flow directions: inbound, outbound or coupled OI logics. In this regard, the researcher selected the knowledge flow of food recipe as the studied knowledge because it is the only knowledge flow that has been transferred with the dynamic evolve among actors since the first step of NPD; laboratory scale, industrial scale, FDA registration, mass production until delivery to end consumers (Hongsaprabhas, 2017b; Hongsaprabhas et al., 2018). That is to say, in making NPD, the first step is to generate the idea. Necessary knowledge is then gathered from various sources that is both inside and outside of the organization. Such knowledge is essential to develop a concept idea for the new product. The results of this step will be the ideal food recipe or the original food recipe as the basis of the NPD. When there is a development of the laboratory scale that has brought technologies into use, the food recipe will be adjusted in accordance with the technology used, such as the food products that use the sterilization technology by high temperature for food preservation. While some nutrition will be lost in food products, adding the food additive in the original food recipe to compensate for the lost nutrition is required (Hongsaprabhas, 2017a). To develop the industrial scale during the mass production experiment with the using of raw agricultural ingredients from actual suppliers, it is necessary to adjust the food recipe ratio such as vegetable raw ingredients to conform the prototype from laboratory scale (Hongsaprabhas, 2017b). When the production is at numerous of 10,000 units, there will be a dehydration rate difference from the production experiment at 100 units. These factors will affect the taste and texture of the new product in actual production. In the development of food recipes at this stage, it is necessary to calculate for the ratio of ingredients in the food recipe on the mentioned issue. In addition, as the agricultural ingredients have a high variance for instance the variations in quality and yield according to the production source and harvest season, to change the supplier's source used in the experiment with the actual production used will give the alternative results (Hongsaprabhas, 2017b).

Being neglected by most R&D personals, FDA registration process is also another crucial step to be taken into consideration for the legal commercialization for the new product (Chaochotechuang, 2016; Porananond & Thawesaengskulthai, 2014). The food recipe and the type of food preservation method chosen are vital during the FDA registration process. The modification of food recipes practiced during this process helps to keep the production within the legal requirements. Take for example a regular cream soup product while registering to be a general food with Thai FDA. The requirement on salt content is none. Conversely, if the new product is the same cream soup but registered with the Thai FDA as a supplement for young children (supplementary food for infant and young children 6 months to 3 years) to add value and create innovation for the product, there will be a requirement on the quantity of salt that must not exceed the specific amount prescribed by the Thai law. Hence, the legal regulations are dynamic and updated at all times (Rimpeekool, Seubsman, Banwell, Kirk, Yiengprugsawan, & Sleigh, 2015).

Stevia, a popular sweetener substituting for sugar in Thai market, is another example of the same contradiction. Standardized by Thai FDA, the amount of sweetener allowed using in Thailand has been referred to by the regulation of other countries. On the other hand, when the luminous study has been substantiated, the new regulation then reissues to be in accordance with that study's confirmation. These issues affect all food recipe adjustments (Hongsaprabhas, 2017b). At the final stage, the food recipe is the only knowledge that is written on the product label as a part of the ingredient list because the law requires it to be disclosed as the knowledge passed to the final consumers to decide whether to buy the product. Therefore, it can be said that food recipe knowledge is the only knowledge that has remained and developed throughout each step of NPD and circulated in each involved actor, which can be utilized as one of the reliable sources contributing to the knowledge of this study (Hongsaprabhas et al., 2018). Other knowledge, such as technology knowledge, material knowledge, law and regulation knowledge, although they are important but this knowledge has little contribution to the complete NPD process and generates less flow in between various actors comparing to the food recipe knowledge. (Hongsaprabhas et al., 2018).

The most important thing when identifying the source of knowledge used to make NPDs, both internal and external knowledge, is the ability to manage such knowledge. From the knowledge management perspective, Chiamchittrong et al. (2007) explained the organization should take advantage of knowledge to create more potential and competitive advantage. Knowledge management is thus a range of practices in which individuals or organizations identify, create, represent and redistribute knowledge for awareness, reuse and learning across the organizations for various purposes. This present research studies how knowledge flows and how it is practiced in relation to NPDs in Thai food machinery SMEs who qualify as the food innovation intermediaries. The study is important because there is yet a metric system adapted to monitor the OI logics and practices in the studied context.

2.3.6 Open Innovation (OI) Practices

The activities needed to operationalize OI logics are OI practices (Williamson & De meyer, 2012). The most acknowledged taxonomy distinguishes OI practice into 2 types regarding OI logic, namely outbound and inbound OI practices (Gassmann & Enkel, 2004; Hongsaprabhas et al., 2018; Van de Vrande et al., 2009). Entrepreneurs in FI can adopt the OI approach through a variety of activities or OI practices

(Galanakis, 2016; Williamson & De meyer, 2012), such as inward-outward IP licensing, joint R&D agreements, joint ventures, acquisition, etc. (Chesbrough et., al.,2006*)*. Entrepreneurs often develop new OI practices to being used in the real work (Galanakis, 2016). Firms always use several OI practices at the same time to better effectively serve customers and the market (Van de Vrande et al., 2009). The important factors affecting the OI practices of the organization are the creation of an organizational culture that provides values to the outside competence and know-how (Grassmann et al., 2010; Katz & Allen, 1982).

2.3.7 OI Practices in FI SMEs

From the literature review, there are very few specific studies on how FI SMEs implement OI practices (Sadat & Nasrat 2020; Usman et al., 2018). There is a need to compare the OI practice with other industries and applied in this research. On the extant of the literature, the researcher found that most of the OI practice's studies could be separated in to 2 main groups, namely the study of OI practices with financial flow in the respondent organization and the study of practice pursuing OI in the respondent organizations.

2.3.7.1 The study of OI practices with financial flow in the respondent organizations. As OI has the important influencing role in the organization in monetary terms (Chesbrough, 2003a), many authors pay attention on this dimension (Chesbrough & Brunswiker, 2013; Dahlander & Gann, 2010; Michelino, Lamberti, Cammarano, & Caputo, 2015). Chesbrough and Brunswicker (2013) studied 125 large firms in Europe and the United States in OI practices with financial flow. The survey asked respondents about specific practices for "outside-in" and "inside-out" OI. The specialty of this study was that the authors linked outbound and inbound practices with financial flows (pecuniary and non-pecuniary). Four groups of OI practices have been identified by Chesbrough and Brunswicker (2013). The 4 groups are as follows:

1) Outbound practices with pecuniary. It involves cooperative business incubation, selling market-ready products, IP out - licensing, spin-offs, and joint-venture activities
2) Outbound practices with non-pecuniary. It is the participation in the standardization (public standards) and donations to commons or nonprofits
3) Inbound practices with pecuniary. These practices comprise of IP in - licensing, contracted R&D services, specialized OI intermediaries, idea & start up competition, supplier innovation awards, and university research grants
4) Inbound practices with non – pecuniary. The practices relate to customer & consumer, co-creation, crowdsourcing, publicly funded, and R&D consortia, informal networking

The findings also indicated that large firms have more OI practices than three years ago. Chesbrough and Brunswicker (2013) added that customer co-creation, informal networking, and university grants, were the three leading inbound OI practices. The crowdsourcing and OI intermediary services were rated the lowest in importance for OI practices. Likewise, joint ventures, selling market-ready products, and standardization were the major outbound OI practices. The donations to commons and spin-offs were the least frequently practiced.

Despite the extensity of the research by Chesbrough and Brunswicker (2013), the researcher has doubt over the concept of linking outbound and inbound practice with financial flows (pecuniary and non-pecuniary) and that it can apply to Thai FI SME context. Thus, Hongsaprabhas et al., (2018) conducted a preliminary experiment to apply these OI practices concept to Thai FI SMEs respondents and idemtified several arguments. The discrepancy are as follows:

1) Mismatch between some of OI practices and the logics, the researcher found that some OI practices which the authors considered inbound OI practice can be outbound practice. Take for instance contracted R&D services can be both inbound and outbound practice. Some food firms can gain new knowledge from the external through buying R&D services from other organizations. Likewise, some food firms can sell R&D services to other organizations to increase profits from the internal intellectual property, knowledge assets, R&D facilities and machinery. In addition, some food firms can buy and selling R&D service at the same time (Hongsaprabhas et al., 2018)
2) Some OI practices are rarely found in Thai FI SME context. Take for instance crowdsourcing, and donations to commons or non-profits
3) The concept of linking outbound and inbound practice with financial flows (pecuniary and non-pecuniary), probably do not match the Thai FI SMEs context. For example, the researcher argues that the participation in standardization (public standards) which the author considered as outbound OI practice with non-pecuniary, is sometimes pecuniary in Thai FI SMEs context. The researchers found that some food firms have to pay

partially to participate in public standard in the Thai FI SMEs context; and the publicly funded R&D consortia which the authors considered as inbound OI practice with non- pecuniary, is sometimes pecuniary in the Thai FI SMEs context. The researcher found that some food firms have to share partial investment (co-investment) in funded R&D consortia practice in Thai FI SMEs context as well

4) The OI practice proposed by Chesbrough and Brunswicker (2013) is also based on a very broad dimension. Some of them are the practices used in business activities (Spin-offs), and company standardization activities (participation in standardization). These researchers concluded that there was a huge gap that the concept could not be applied to link outbound and inbound practices with financial flows (pecuniary and non-pecuniary) to the Thai FI SMEs context directly due to the difficulties to identify the direction of OI logics (whether it is outbound or inbound). As these authors studied the large firm context, these firms have the capability to complete most of the OI NPD tasks in supply and/or value chain by themselves. Furthermore, these firms have their own patterns which are not difficult to determine the direction of their OI logics. On the other hand, most of the Thai FI SMEs could not complete most of the OI NPD tasks in supply and/or value chain by themselves (Jones & Pimdee, 2017; Tambunlertchai, 2015). In order to complete specific tasks, they would co-operate with many actors in the supply and/or value chain (NSTDA, 2018). Thus, the positions of the observed SMEs are important to identify

the direction of OI logics: outbound or inbound, and link to classify the type of OI practices.

Likewise, the researcher has found several studies by Bianchi, Cavaliere, Chiaroni, Frattini, & Chiesa (2011); Hung and Chiang (2010); Tranekjer and Knundsen (2012); Van de Vrande et al., (2009) that focused on (2) the practice pursuing an OI.

2.3.7.2 The practice pursuing OI in the respondent organizations. These studies interviewed participants from organizations that practiced OI. These studies provide many OI practices from different industries of various sizes that apply the dimension that each author is interested in. For example, the study of Tranekjer and Knundsen (2012) studied the outbound and inbound OI practice which has internal mechanism to foster OI adoption of the firm. Take for instance, the practice of supporting employees working on own ideas to accelerate the OI adoption. Van de Vrande et al. (2009) described 2 types of practices that linked to technology exploitation and exploration to outbound and inbound OI logics. Yet, a large part of contribution in the extant literature focuses only on outbound and inbound OI practices, neglecting the role of coupled OI logic.

The researcher found that the most suitable OI practices in extant literature to be used as the basis of this study are from Van de Vrande et al. (2009), which conducted a survey to study OI practices in 605 SMEs from varous industries. The authors classified OI practices by linking to the study of OI logics. The typology of Van de Vrande et al., (2009) specified which OI practices are connected to technology exploitation as shown in Table 2.7. Table 2.7 also consist of the OI practices that are connected to technology exploration. The authors also proposed that OI practices which are considered as exploitation groups. Activities such as employee involvement, venturing, and outward IP licensing, are attached to outbound OI logic. The organization can earn profit by bringing its internal idea, technologies, resources, patents, and other intellectual rights form to the external organizational boundaries (Bigliardi & Galati, 2013a; Lichtenthaler, 2008; Van de Vrande et al., 2009). Even though the exploitation technology group of practices are not core activities of most firms, there are still some firms that have achieved major benefits of the activities (Lameck & Hsieh, 2015). Likewise, OI practices which are considered as exploration groups: i.e., customer involvement, external networking, external participation, outsourcing R&D and inward IP licensing, are attached to inbound OI logic. The organization can engage in inbound OI practices to enrich its own knowledge, skills, and technologies by integrating with other actors such as suppliers, customer, and distributor, into the internal process (Bigliardi & Galati, 2013a; Lichtenthaler, 2008; Van de Vrande et al., 2009). The group of outbound practices are complementary to internal development, while the group of inbound practices are substitute to internal R&D activities. (Lameck & Hsieh, 2015).

The study of OI practice in SMEs has been neglected (Sadat & Nasrat 2020). As Van de Vrande et al.'s (2009) typology has been established through the surveyed of OI practices observed in SMEs from many industries such as FI, business services, chemicals, rubber and plastics. This is the only available study in the literature extant. The researcher used this typology as the fundamental OI practice of the study. The definition of each OI practice is shown in Table 2.7. The typology has been recently updated for the studied context. The observed practices in the present case study are not categorized in the typology of Van de Vrande et al. (2009), improves previous typology for the study.

The study of Van de Vrande (2009) indicated that SME's OI practices always included many new activities unlike traditional R&D activities. The venturing, external networking, and customer involvement are the complimentary OI practices to improve new product development (NPD) in SMEs. The involvement of employees is frequently used in technology exploitation practices. Likewise, customers' involvement is also the most frequently used method in technology exploration practices. This result confirms the importance of the users in the innovation process (Von Hippel, 2005).

In addition, it is also found that SMEs are not accustomed to the use of venturing, external participation, inward and outward IP licensing practices. Although it is a way to reduce the risk related to knowledge sharing, this SMEs generally use these practices less formally and in an unstructured manner (de Araújo Burcharth, Knudsen, & Søndergaard, 2014). Such practices include customer involvement, and external networking. Noticeably, the practices do not require huge investments such as a patent. In manufacturing, SME's respondents mentioned that technology exploration activities like outsourcing R&D seem to be gaining more attention. In addition, the employee involvement, customer involvement and external networking appeared to be the main types of OI practices adopted by manufacturing/machinery SMEs. In contrast, service SMEs do better on venturing practice. Most SMEs make use of several OI practices at the same time to better serve customers and their markets (Gans & Stern, 2003; Sadat & Nasrat, 2020). Based on a recent manufacturing SME's survey, Van de Vrande et al. (2009) found no significant different in terms of industries.

Majority of the literature based on theoretical OI practices and knowledge basis have been accumulated through large companies and multinational enterprise's experiences (Sadat & Nasrat 2020), with only a few SME's cases being studied (Gentile-Lüdecke, de Oliveira, & Paul, 2020; Henttonen & Lehtimäki, 2017; Sadat & Nasrat 2020; Usman et al., 2018; Van de Vrande et al., 2009). This cause doubts whether OI logics and practices are readily transferable to Thai FI SMEs. Thus, adequate approaches for capturing the full potential so far remain valid. The adoption of OI practices in FI is increasing but still needs much attention and more academic research (Bigliardi & Galati, 2013a; Grimsby & Kure, 2019). The researcher found that the study of Van de Vrande et al. (2009) and the study of OI practices thereafter has not been any studies on coupled OI logics. In spite of the fact that coupled OI logic is a form of adopting OI that most entrepreneurs have indicated that it actually occurred more than either outbound or inbound OI logic (Lichtennthaler, 2011). In this study, the researcher explored the new dimensions of outbound OI logic (technology exploitation) and inbound OI logic (technology exploration) to identify the dominant characteristics of coupled OI logic.

Nowadays, collaborative information technologies have accelerated OI practices (Feller, Finnegan, Hayes, & O'Reilly, 2012; NSTDA, 2018). Despite OI implementation with increasing successes, the wide utilization of its associated logics to large companies and multinational enterprises, the significant benefits to SMEs remains a critical question (Saguy & Sirotinskaya, 2014). The numerous limitations in the use of OI of most FI SMEs remains due to the lack of resources, too small a size, limited R&D resources (Gassmann, Enkel, & Chesbrough, 2010), insufficient organizational adaptability (Saguy, 2011), language barriers, time constraints, and the excess of other existing barriers are some of the barriers (Saguy & Sirotinskaya, 2014). The conflicting interest in establishing the academia collaborations is a barrier (Chaochotechuang, 2016; Cooper & Edgett, 2008): the main focus in academia is on basic research driven by fundamental science and knowledge, whereas most cases in the real industry, is driven by maximizing organizational profits. All these reasons may be regarded as SMEs' struggle with OI implementation (Saguy & Sirotinskaya, 2014). Furthermore, high IP investment by Thai FI SMEs either inward IP or outward IP, is also a barrier (Pholphirul, 2014; Pholphirul & Bhatiasevi, 2012).

2.3.8 OI Implementation in the FI

In the past, it was common to develope products under the paradigm of closed innovation for many FI entrepreneurs. R&D for NPD are usually performed by internal resources within the organization's boundaries (Bigliardi et al., 2010; Galanakis, 2016). However, the trend of food entrepreneurs has changed from closed to more open mindset by adjusting to the idea that "*any product development to the process of delivering the product to the consumer consists of many steps which are difficult to perform alone. We should work in areas that we are capable of and let other actors with more expertise take care of the rest of work, we will win*" (Galanakis, 2016, p.21). When FI entrepreneurs have a more open mindset, the OI concept integrates into their business operations (Galanakis, 2016; Mingmalairaks, 2011). There are many studies that support why FI entrepreneurs adopt the OI approach and rely more on external knowledge (Galanakis, 2016). It is the fact that most of the knowledge used to create food innovative products that adopt knowledge derived from multiple scientific technological industries (Galanakis, 2016). Some of the examples include many new food processing acquire knowledge from machinery industry, new food ingredients acquiring knowledge from pharmaceuticals-chemical industry. Moreover, the unique characteristic of FI is that food operators always interact with other involved actors in their business operations, not only for R&D or NPD (Acosta, Coronado, & Ferrándiz, 2013; Kijek, 2014). Thus, it can be seen that the purpose of adopting the OI approach of FI firms has wide scope ranging from recruiting cross-industry cooperation down to the interorganizational level between food actors in the FI supply and/or value chain. Even though OI approach has been considered increasingly used in FI firms (Bigliardi & Galati, 2013a), OI adoption and implementation of each actor in FI supply and/or value chain has a specific pattern according to their specific context (Beckeman et al., 2013).

However, there are mutual risks related to the adoption of OI approach. Take of instance knowledge in the organization may leak to market competitors, and negative impacts of the changing organizational culture (Gentile-Lüdecke et al., 2020), and failure to manage new knowledge (Bianchi et al., 2011). Many authors cited that one important point for the organization to adopt OI are to obtain economic values and resource capabilities from outside the organization. Nevertheless, organization have to pay attention to protect its internal knowledge as well (Alfranca, Rama, & von Tunzelmann, 2004; Bigliardi & Galati, 2013a; Gloet & Terzioovski, 2004; Islam, 2012). Knowledge sharing is considered as one of the main risks of OI because sharing of internal knowledge to external may reveal the core competencies of the organization to competitors. This is one of the reasons why many organizations choose not to adopt OI in order to avoid loss of control on its proprietary knowledge

(Gentile-Lüdecke et al., 2020). Some organizations are not successful in adopting OI because such a mindset acts as barrier for work that requires the OI approach (Bigliardi & Galati, 2013b; de Araújo Burcharth et al., 2014). From this cause, the business has to develop a way to protect its proprietary knowledge by the intellectual property rights (IPRs) or intellectual property (IP) (Bigliadi & Galati, 2013a; Gloet & Terzioovski, 2004; Van de Vrande et al., 2009).

Nonetheless, the patent of food knowledge, products and technologies mostly concentrated in few large and multinational firms (Alfranca et al., 2004; Minarelli et al., 2017; NSTDA, 2018). The smaller food firms have developed other practices to protect their proprietary knowledge which is more suitable to their business. Some of these practices include informal inward/outward IP licensing, tacit agreements, confidential agreements, non-disclosure agreements, and collaborative agreements. These practices are quite similar to IP licensing, but less formal and lower cost (Jones & Pimdee, 2017; Hongsaprabhas et al., 2018; Tambunlertchai, 2015). In this study, the IP regards food recipe as not a formal IP until an FDA number is registered. Hence, inward IP licensing practice means using/adopting food recipes from the external party (no buying IP), and outward IP licensing practice means offering its food recipe to the external party (no selling IP) (Van de Vrande et al., 2009).

Compared to other industries, the FI sector presents several specific characteristics (Acosta et al., 2013). The FI is considered as low-tech and the associated markets are mature (Bigliardi & Galati, 2013b; Christensen et al., 1996; Grunert et al., 1997; Minarelli et al., 2017). Innovation in the FI sector is mostly incremental and is managed through improvement or variation of existing products (Galizzi & Venturini, 1996; Grunert et al., 1997; NSTDA, 2018). Optimizing production costs is still considered as the main objective of FI strategies (Lienhardt, 2004). Innovation is perceived as one of the main key factors to improve competitiveness (Chaochotechuang, 2016; Rama & Von Tunzelmann, 2008). Moreover, innovation still favours production costs reduction and customer satisfaction improvement (Capitanio et al., 2010). Notwithstanding, during the last decade the focus has moved to the dimension of food safety, quality, health and new customer demands (NSTDA, 2018). Thus, the locus of innovation has shifted from within the firm to the food network (Powell et al., 1997). The firms in this sector benefit more and more from the spillovers from outside the organizational boundaries than from those within it. New innovative value is created in networks through productive working relationships or collaboration (Avermaete & Viaene, 2002). Consequently, the food firms adopt OI approach whether they notice about it or not (Ramani, El-Aroui, & Carrère, 2008). Even though there are many academic studies analyzing OI in large, multinational, and hi-tech enterprises, there are only few studies that have demonstrated OI existing in SME organization especially in FI (Bigliardi & Galati, 2013a, 2013b; Grimsby & Kure, 2019). How OI can be defined and operationalized in the FI SMEs still remains a question (Bigliardi & Galati, 2016; Chaochotechuang et al., 2019; Grimsby & Kure, 2019).

2.3.9 OI Implementation in the FI SMEs

OI has been considered as a mainstream organizational practice in FI, and FI SMEs. (Bigliardi & Galati, 2016, 2013a). FI new products are often initiated by SMEs that lack the know-how to commercialize the innovations (Fryer & Versteeg, 2008; Iturrioz et al., 2015; Maula, Keil, & Salmenkaita, 2006). Consequently, FI SMEs bring to the market innovations that have been developed upstream (Martinez & Briz, 2000; Traill & Meulenberg, 2002).

Although food entrepreneurs may not notice, OI has been applied in FI SMEs for a long time through other terms that they are more familiar with (Avermaete, Viaene, Morgan, & Crawford, 2003) Some of these examples are as follows:

1) external sensory testing as a customer involvement practice (Van de Vrande et al., 2009). This concerns the collection of information on consumer preferences through direct interaction with customers
2) networking as an external networking practice (Van de Vrande et al., 2009). Finding information about raw materials and/or technology of new industries and finding relevant laws and regulations that are necessary for new product development through interaction with other involved actors in supply and/or value chain (Jonge, Kleef, Frewer, & Renn, 2006)
3) OEM NPD as an outsourcing R&D (Van de Vrande et al., 2009). Hiring others to do NPD which is another preferable method in FI SME (Bigliardi & Galati, 2013a; Charoenrat & Harvie, 2014; Huang, Chen, Wang, Ning, Sutherland, Zhou, & Zhou, 2015; Tambunlertchai, 2015).

Although most FI entrepreneurs are known for their internal innovation effort, many of them have the tendency to develop new products through various activities that reside outside their boundaries (Bigliardi & Galati, 2013a; Sarkar & Costa, 2008). There are evidences confirming that FI SMEs have been using the OI approach in an informal way for a long time. However, there is a lack of appropriate OI management strategy (Chaochotechuang, 2016; Tambunlertchai, 2015) that is applicable to the FI SMEs.

In FI SMEs context, the academic findings support the increasing number of FI SMEs that engage in OI approach. The extant literature shows that FI SMEs take an increasing role in the contemporary innovation landscape (Chesbrough, 2003). The majority of FI SMEs were focusing on technology exploration over exploitation (Chesbrough & Crowther, 2006), signifying a heavily dependent on the innovation resources of their networks to fulfill their innovation gap in financial resource, skill workers and external technologies (Acs & Audretsch, 1990; Vossen, 1998). Thus, the changing of organizational culture becames their main challenge (de Araújo Burcharth et al., 2014). In general, the machinery/manufacturer SMEs are technology intensive, and require more R&D investment than non-machinery SMEs (Van de Vrande et al., 2009). For this reason, OI is stronger in the food machinery SMEs (Jones & Pimdee, 2017; Gassmann, 2006; Tambunlertchai, 2015; Van de Vrande et al., 2009). Even though the OI adoption in FI SMEs is increasing, it is typically less structured and professionalized as compared to other industries. However, with the maturity of FI SMEs, these firms are increasingly developing formal OI adoption and strategies (Chaochotechuang et al., 2019). Upon reaching critical maturity, they are better formalized in their OI practices (Vossen, 1998). The most important OI adoption motives for FI SMEs are market-related motives. Conversely, motives related to costs, capacity, control and focus are less frequent. Hence, it is necessary for FI SMEs to use a broad set of OI practices to meet consumer demands and prevent the organization from the competitors (Van de Vrande et al., 2009).

In conclusion, the FI SMEs seem to be adopting an OI approach, probably forced by the need of external resources to develop and commercialize their new products (Bigliardi, 2019). Costa & Jongen (2006) indicated that the changes in the nature of food demands and the food supply and/or value chain, together with a dynamic competitive environment, have led FI SMEs to adopt an OI approach inevitably. To innovate, FI SMEs are highly dependent on external resources (Archibugi, Cesaratto, & Sirilli, 1991; Martinez, 2013) and must open their innovation processes and/or NPD processes to their supply and/or value chain partners (Avermaete, Viaene, Morgan, Pitts, Crawford, & Mahon, 2004; Sarkar & Costa, 2008). To access these external resources, FI SMEs must empower their relationships, access to the research providers, and develop their collaborative infrastructures through the OI practices (Avermaete & Viaene, 2002; Bröring, 2008). These practices imply that FI SMEs improve their dynamic capabilities to capture and recombine external knowledge with their own. To enhance their absorptive capacity (Cohen & Levinthal, 1990), new knowledge management (KM) methods have become of central importance (Garcia, 2011). As "*knowledge and learning acquired in previous OI application in NPD projects is easily transferred and applied to new external collaborations*" (Galanakis, 2016, p.28), NPDs failure rates in the FI SMEs reduce when absorptive capacity is developed.

In addition, the transferability of knowledge and learning from one project to another also facilitates the adoption of collective strategies and justify the growing adoption of inter-organizational OI logics (Chesbrough et al., 2006). Simultaneously, the use of increasingly efficient collaborative information technologies (IT) has also facilitated the implementation of collective innovation strategies (Feller et al., 2012). This in turn improves the the coordination processes and simplify the alignment of the value proposition components brought by each involved partner. The limitations of SME in terms of limited budget, size of company and lacking in human resource have directly affect FI SME's capability in implementing OI approach compared to large and multinational enterprises (Galanakis, 2016). Thus, the utilization of observed OI logics and practices from Thai FI SMEs need special consideration.

2.3.10 OI Struggles in the FI

In the past, the popular challenges of firm's OI had focused in the internal organizational barriers to adopt OI practices (Chesbrough & Crowther, 2006). The examples of these barriers (de Araújo Burcharth et al., 2014) are:

1) Not-invented-here (NIH) syndrome and lacking in internal commitment. This NIH syndrome has been considered as one of the important barriers of acquiring external knowledge (Katz & Allen, 1982).
2) Only-used-here (OUH) syndrome which prohibits technology exploitation practices and limits the additional profits of utilizing internal knowledge and technologies to the market (Lichtenthaler & Ernst, 2006).
3) Time consuming and lacks in resources are also considered as the main internal barrier to almost all OI practices (Hongsaprabhas, 2017b).
4) Other potential internal barriers may arise due to organizational culture, bureaucratic element, insufficient knowledge and technology (Bigliardi, Galati, & Petroni, 2011).
5) The FI is currently facing more multiple external challenges. Take for examples, the global impact of the processed food on public health (food safety) and the growing customer demand for a healthier augmentation (rich nutrition and obesity trend) are examples of issues that the organization cannot solve by itself (Headey, 2011; NSTDA, 2018; OSMEP, 2018d).

Organizational adaptation to this institutional and public pressures requires the reinforcement of collaboration between food planters, primary and secondary processors, manufacturers and distributors, to transversely enhance the innovative capability among their supply and/or value chain (Tambunlertchai, 2015). The factor of external failure also depends on the interaction between actors. Take for instance, the interaction between food firms themselves. The failure factors can be of various nature such as the lack and limitation of their R&D resources (Gassmann et al., 2010), insufficient organizational adaptability (Saguy, 2011), incapacity to invest in IP (Pholphirul, 2014; Pholphirul & Bhatiasevi, 2012), lack of strategic alignment, cultural mismatch, inability to produce the expected results, rivalry or conflicting interests (Noordman & Meijer, 2013), insufficient communication, and time constraint (Saguy & Sirotinskaya, 2014). Another factor concerns the interaction between food firm and non-food firm. For example, among universities and government agencies. This kind of failure is much difficulty to establish efficient collaboration. The differences terms of culture, language and research orientations constitute barriers to overcome (Saguy & Sirotinskaya, 2014).

Hence, it is challenging for food firms to adopt an OI approaches. Not just aiming to reduce the NPDs cost by gathering external knowledge and technologies, but also the attention to knowledge management and integration practices that help new products to enter the market faster (Bigliardi & Galati, 2016). Most food firms do not pay attention to knowledge and innovation management (Chaochotechuang, 2016). In the view of OI adoption in FI SME, many FI SMEs have rushed into this approach without establishing clear strategies (Chaochotechuang et al., 2019). This has led to a high failure rate of OI alliances which is estimated about 40 to 70%

(Noordman & Meijer, 2013). As a measure to avoid failures, Martinez (2013), suggested that FI SMEs should better identify their business priorities, select carefully their partners and manage relationships effectively.

Despite the fact that OI logics and practices implementation seem to be increasingly successful in large and multinational companies, OI suitability to SMEs remains in a critical question (Saguy & Sirotinskaya, 2014). As partnerships are deeply embedded in the networks and ecosystems, OI practices are more intense (Martinez, 2014). To ensure effective implementation, ecosystem strategic drivers need to have high levels of coordination. Hence, FI SMEs need to improve their ability to manage their inter-organizational relationship. This may pose as a challenge as the Thai FI SMEs rarely have the necessary resources and/or skills to achieve such a goal (Martinez, 2013). In addition, majority of the literature focuses only on the exchange of food technology (Stewart-Knox & Mitchell, 2003). Tacit knowledge exchanges between partners in the supply and/or value chain remain poorly understood in the FI. Thus, the dynamic capabilities to manage all these exchanges (e.g., tacit knowledge, materials, ingredients, technologies, and food recipes) still need to be specified.

2.3.11 Various Actors in Food Supply and/or Value Chain

Based on the above information, it can be seen that actors in food supply and/or value chain play significant roles in the development of OI approach in FI as well (Bigliardi et al., 2010; Galanakis, 2016). In addition, it can be said that all OI logics and practices always occur among involved actors in the food supply and/or value chain. From the literature, there are many authors who have classified the group of actors in supply and/or value chain that relate to the OI model

1) Etzkowitz and Leydesdorff (1995) proposed the Triple Helix innovation model which focused on 3 main actors i.e., university, industry, and government. In last 20 years, the Triple Helix concept have been developed into a widely accepted conceptual framework which brings together knowledge, consensus and innovations of the three actors (Krizanovic, Lubar, & Gajos, 2014).
2) Carayannis and Campbell (2009) proposed the Quadruple Helix by embedding the Triple helix with additionally Helix (and perspectives) of the 'media-based and culture-based public' and 'civil society'. For more familiar language, some authors have described the actor in the fourth helix as citizens, or consumers, or users (Jones & Pimdee, 2017). The authors argued that the culture and values of the public should be accounted in the Triple Helix to better response the global knowledge-based economy.
3) Bigliardi and Galati (2013a) proposed the Food-Machinery framework that comprised many actors. These actors comprise of the food machinery company, food company, suppliers, other suppliers, consultant, and universities & research labs. The Food-Machinery framework is one of the most adopted OI model in the food supply chain (Galanakis, 2016). Furthermore, the study of Grimsby and Kure (2019) on the crispbread industry, added some additional actors to the original Food-Machinery framework. This study included the food distributors, competitors, NGOs, other industries, and consumers. The model has been refined by the

authors. However, the refinement is minor indicating just the knowledge interaction between food actors within supply chain.

4) Galanakis (2016) had categoried the actors in food value chain into 4 main groups. The first is the individual group which comprises of the leader, consultant, and expertise. The second group is the academic group which include universities, schools, and research institutes. The third links to the supply chain partner group whereby suppliers, distributors, wholesalers, retailers, and consumers are connected. The fourth group is the group of companies belonging to other industries. It comprises of the new machinery supplier and co-investor.

In this study, the researcher has elected all involved actors in food supply and/or value chain, guided by all mentioned typologies, to obtain a specific actor group for the Thai FI SMEs. The actors who do not match the typology enrich the previous typologies during interview. The researcher considers the actors in the context of OI and finds that the actors in food supply and/or value chain conducting through OI practices. As such, the increasing number of involved actors and complex relationships between each other, is extremely challenging for supply and/or value chain management (Galanakis, 2016) and OI management.

In the recent years, there has been increasing interest to adopt OI in the food industry in Thailand. Innovation intermediary is considered as an important part of OI in this context (Iturrioz et al., 2015) because it is one of the accelerating innovation tools (Bakici, 2013). Innovation intermediary is the actor that facilitates and supports the collaborative arrangement of OI practice among the involved actors (Bakici, 2013; Munkongsujarit & Srivannaboon, 2011). However, SMEs approach to OI differ entirely from the large and multinational firms (Bigliardi & Galati, 2013a). Hence, the mechanism of being innovation intermediary should be different as well. Although SME’s specificity and flexibility can be relevant drivers for accelerating innovation, their capacity for innovation is restricted by limited resources (Nieto & Santamaria, 2007), forcing them to focus on small-scale innovation initiatives linked with specific products or services instead of substantial strategic innovation portfolios (Iturrioz et al., 2015). Thus, the dimension of facilitation and support for collaborative arrangements of OI practice among the involved actors, need to be take into consideration to develop a appropriate definition of innovation intermediary at SME level. Normally, food machinery companies and food companies are related as supplier-customer relation. However, the preliminary study of Hongsaprabhas et al. (2018) showed that one of Thai food machinery SME acted as an innovation intermediary in the OI NPD process. Once the NPD was completed, this Thai food machinery SME transformed itself into a food company’s supplier. Thus, the researcher enlarged the investigation on 2 of Thai food machinery SMEs who position themselves as innovation intermediaries in the Thai FI NPDs in this present study.

2.3.12 Various Model of OI Adoption in the FI

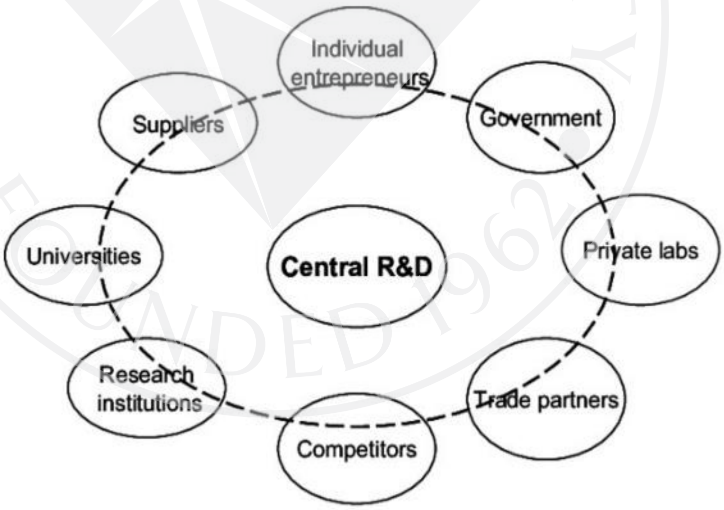
According to Galanakis (2016), it was found that many FI operators adopted and implemented OI in many ways. Some were successful while others were not. Galanakis (2016) summarized 8 main models of OI adoption in the FI over the years which have been presented by various authors. For each model, the authors concerned studied the basic information based on real case study of the organizations in FI that have efficaciously adopted and implemented OI. The 8 OI adoption model models are as follows.

1) The Connect and Develop model (Huston & Sakkab, 2006),
2) The Sharing is Winning model (Traitler & Saguy, 2009),
3) The Food - Machinery framework (Bigliardi & Galati, 2013a; Bigliardi et al., 2010),
4) The Living - lab OI model (Wolfert, Verdouw, Verloop, & Beulens, 2010),
5) The Want, Find, Get, Manage model (Garcia, 2011),
6) The Selective Sharing OI model (Lazzarotti & Manzini, 2013),
7) The Value Cocreation OI model (Martinez, 2014), and
8) The Consumer - centric OI model (Tsimiklis, Ceschin, Green, Qin, Song, Baurley, Rodden, & Makatsoris, 2015).

2.3.12.1 The Connect and Develop model (C&D). As shown in Figure 2.8, Huston and Sakkab (2006) used the case study of Procter & Gamble to study how the company developed its market for the new type of Pringles potato chips. Interestingly, the company outsourced part of its new product design by developing an innovative tool to match its Connect and Develop strategy. Procter & Gamble created technology systems to connect with many resources outside the company to gatherg data, define exact problem needed to be solved and circulated them throughout their global networks (external research institutions, suppliers, individuals, customers, and competitors) to get the best solution and idea. This case study as illustrated in Figure 2.8 shows how Procter & Gamble adopts and implements OI process by using effective communication technology in its NPD process. The result of adopt and implement this model is to acquire the valuable information on customer demands and feedback, reduce marketing research cost, shorten time to market, and reducing NPD failure rate (Galanakis, 2016).

Figure 2.8

Possible network of C&D model based on Huston and Sakkab (2006)



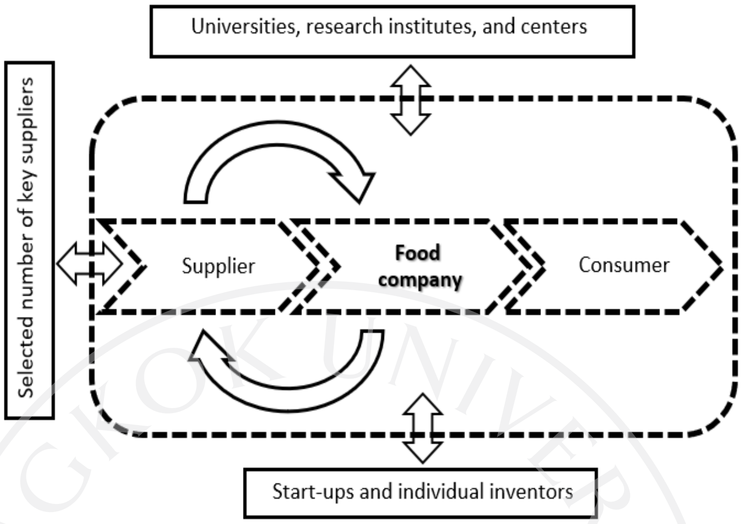
Note. The model is adopted from Del Sorbo, Ibarzabal, Lee, Chen, & Plancarte (2007)

2.3.12.2 The Sharing is Winning model (SiW model). Illustrated in Figure 2.9 is a study case of Nestle in the study by Traitler and Saguy (2009). The original main purpose of company was to boost their innovative capacity in the medical nutrition field. This case study shows how Nestle adopts and implements OI on their

NPD process by focusing on effective co-creation and involve 3 groups of co-developers. These co-develops comprises of first, the technical experts from research institutes, academia, and universities. The second group relates to the business partners. They include the individual inventors and start up enterprises. The third and last group comprises of the other key stakeholders such as the selected key strategic suppliers and consumers. In this case, among these co-developers, academia assumed a significant role in breakthrough innovation. The 3 Key elements of SiW are the value and goodwill created along the entire value chain, the building of trust, and winning respect. The SiW model extends the perspective of OI into sustainable. The sustainable benefit comes from lower risk of making financial decision too early in the NPD project. Thus, SiW model is a paradigm gears towards the acceleration of co-development with sustainable innovation process. It is also seen as a platform of co-innovation (Traitler, Watzke, & Saguy, 2011). The result of adoption and implemention of the model is to gain effective co-development with sustainable innovation process through the highly motivated and talented skilled experts (Galanakis, 2016).

Figure 2.9

SiW model and the open food supply chain by Traitler and Saguy (2009)

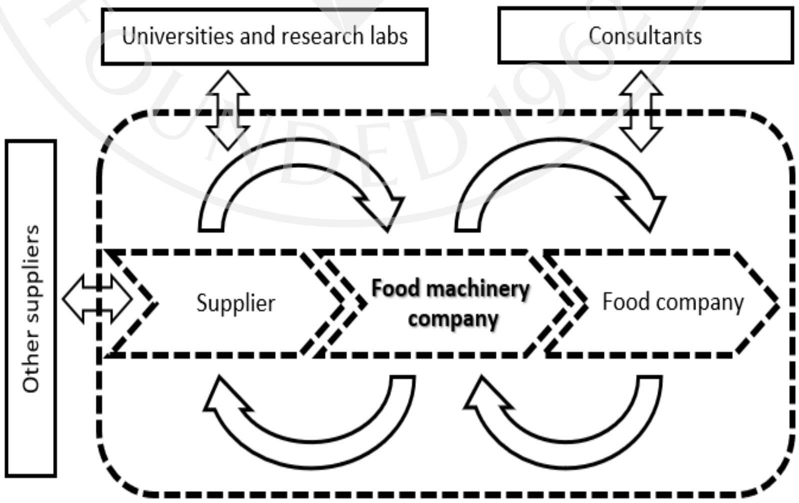


Note. The model is adopted from Bigliardi and Galati (2013a)

2.3.12.3 The Food-Machinery framework. A study presented by Bigliadi et al. (2010) as shown in Figure 2.10 highlights the case study of an Italian multinational food company. It is one of the largest pasta manufacturers in Europe. The company wanted to develop and improve the quality of their new product though acquiring external technology in response to the dynamic changes in the FI. The company needed new knowledge and technologies from the other actors in the development of new products. The company adopted and implemented the OI process by establishing a wide network of collaboration among suppliers, food clients, companies belonging to other industries, and universities. The OI practice have been carefully coordinated and the OI process become one of the most widely adoped OI model in the food supply chain (Galanakis, 2016). The model is unique with its focus on the innovative role of food supplier (food machinery company) within OI process. The model places emphasis on the establishment of relationship between client (food company) and its suppliers (food machinery company and supplier). The model indicates the reciprocal interaction and OI practices among actors in the food supply chain. The Food-Machinery framework also shows the fact that food company and its supplier (food machinery company and supplier) have the same values in new product creation. This in turn adds value to the stakeholders, quality of the product, and innovation. The adoption and implementation have positive impacts in terms of enhancing competitiveness, boosting the number of new products; higher quality of NPD, gaining better quality of raw ingredients/materials for the new product, acquisition of expertise's knowledge on the NPD and food processing, and the reduction of high failure rates for the new food product (Bigliardi & Galti, 2013a; Galanakis, 2016).

Figure 2.10

The Food-Machinery framework and the open food supply chain by Bigliardi & Galati (2013a)

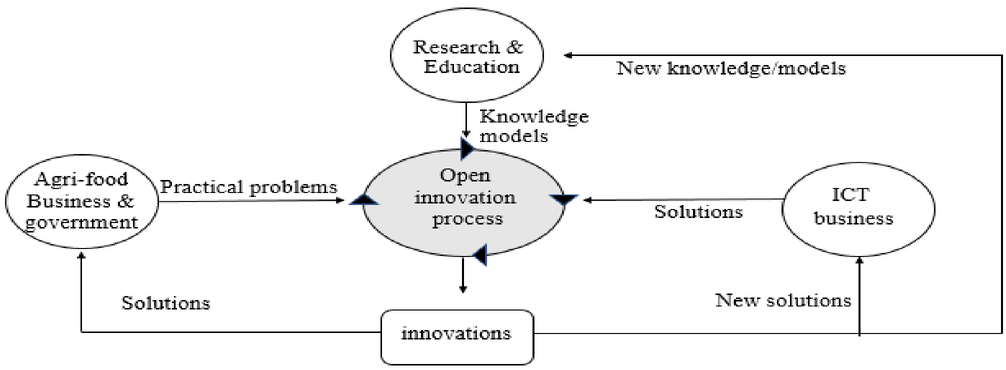


Note. The model is adopted from Bigliardi and Galati (2013a)

2.3.12.4 The Living - lab OI model. Presented in Figure 2.11 is the case study of a Dutch arable farm presented by Wolfert et al. (2010). The purpose of company was to enter the market with very high-quality food products through acquiring external technologies. The effective implementation on OI enabled the establishment of a wide network of collaboration and adoption of the Living-Lab OI model. In the Living-Lab OI model, the company is the user and the center of OI process. The innovation process from start to the end is embedded in the user's real life. All actors such as the suppliers, consumers, ICT companies, service providers and universities cooperated with each other through interactive learning networks. As they were involved in the innovation process from the beginning, the allocated tasks were gradually implemented to complete the innovation. The dinstinctive feature of this model is that it focuses on the benefits of ICT as key enabler to facilitate the user communities to co-create new products and develop service innovation. The result of adoption and implemention is the effective exchanges in terms of theoretical and practical knowledge (Galanakis, 2016).

Figure 2.11

The Living - lab OI model in the fertilizing pilot by Wolfert et al. (2010)



Note. This figure is adopted from Wolfert et al. (2010)

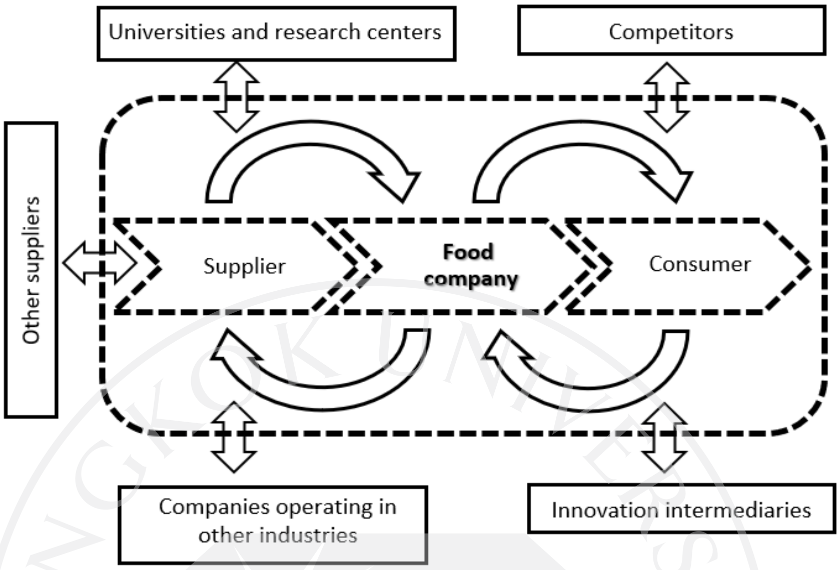
2.3.12.5 The Want, Find, Get, Manage model (WFGM model). Adapting the work of Slowinski (2004), Garcia (2011) studied the case study of Mars and developed an OI model as shown in Figure 2.12. The main purpose of company was to determine how and when the external knowledge was required in the organization for the innovation process. This model comprises of the 4 following steps:

1) The first is to identify the "Want". This is where the organization seeks to understand how the knowledge can be accessed, which knowledge should be developed internally, and which have to be sought externally. A Make/Buy/Partner decision-making protocol (Slowinski & Sagal, 2010) may be adopted to benchmark the external and internal developments.
2) At the "Find" phase, the organization selects the right partner that is the one that possesses the right knowledge. A 20-items criterion acts as the guideline to select the right partners which is based on expertise, uniqueness, trust, and relationship.
3) The third step is the "Get" phase whereby the organization acquires the knowledge identified what it wants the selected partners.
4) The fourth stage is to "Manage" and coordinate and integrate all partner's resources to meet the organizational goal.

Worthnotting, the effective implementation on OI was to reduce the high failure rate of new food products through the new knowledge management methods (Galanakis, 2016).

Figure 2.12

WFGM model and the open food supply chain by Slowinski (2004) and Garcia (2011)

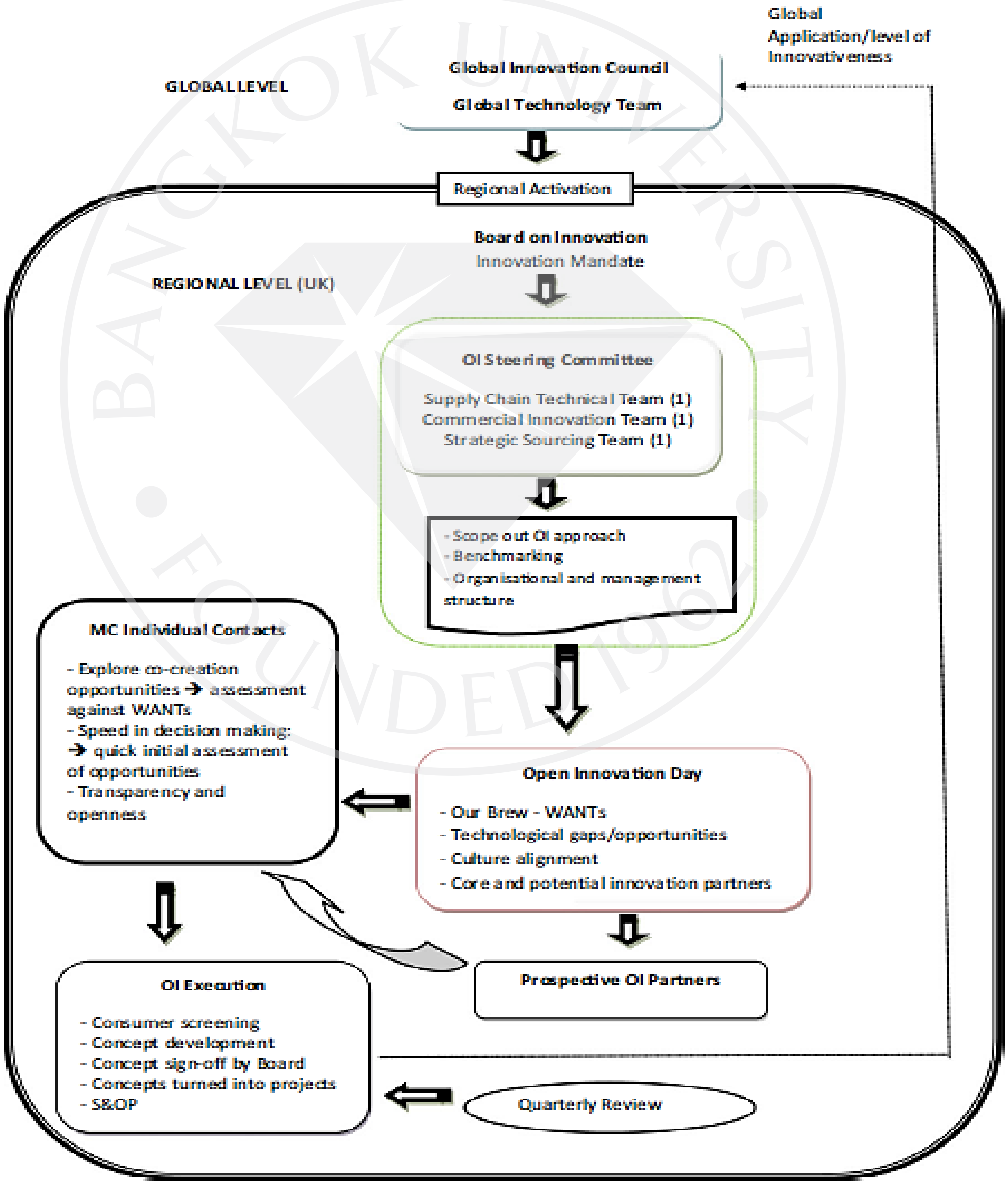


Note. This figure is adopted from Bigliardi and Galati (2013a)

2.3.12.6 The value co-creation model. Presented in Figure 2.13 is the refined OI model developed by Martinez (2014) based on WFGM model of Slowinski (2004). The assumption of this model is that the value creation is important key to every organization survival and the voices of consumers is the core factor to innovate. The organization should adopt the framework to identify product that response to different need of consumers. The key concept is that the organization must be able to determine and eliminate factors and actors who do not contribute to the value creation of the organization. The organization can implement OI process by collaborating and working with the network partners to create value to the end consumers. The challenge for organization is to find the right partners who are willing to co-create value through the OI process. A Make/Buy/Partner decision-making protocol from the WFGM model (Slowinski & Sagal, 2010) was adopted for selecting the collaborating partners. The idea of NPD must be screened with consumers which act as a co-producer as well. The result of adoption and implementation of this model helps to miminise failure rates in the new food products through precisely identification of new product's actual needs (Galanakis, 2016).

Figure 2.13

The value co-creation model by Martinez (2014)



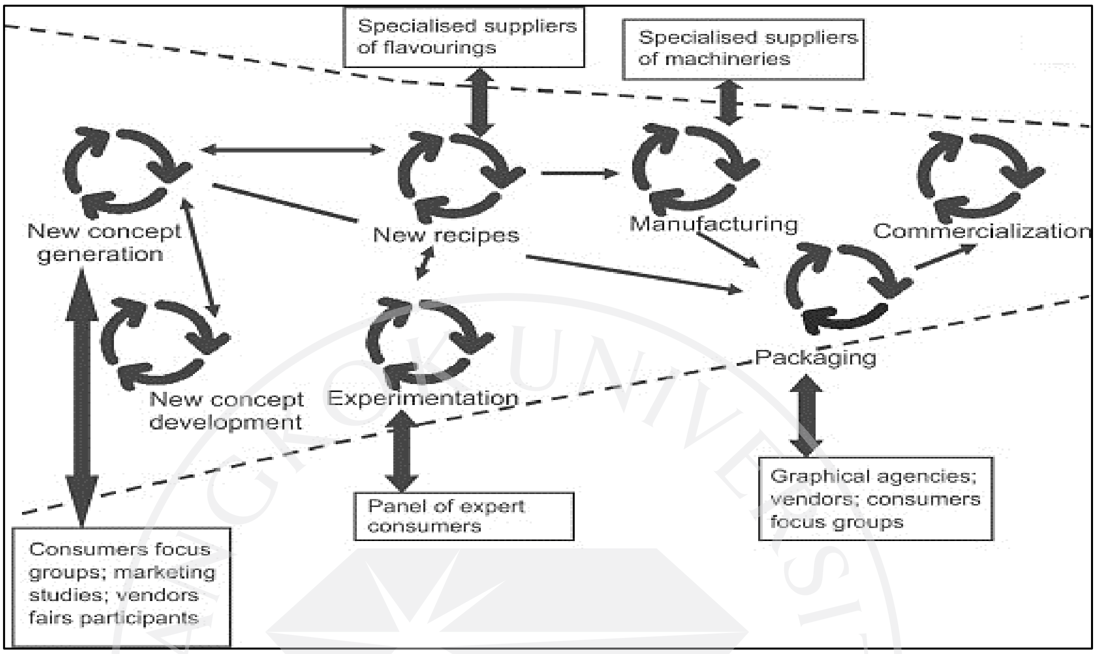
Note. This figure is adopted from Martinez (2014)

2.3.12.7 The selective sharing OI approach. Figure 2.14 is a study presented by Lazzarotti and Manzini (2013) using case studies of many companies such as Lindt, Heinz and Riso Scotti. The most cited case in this model is Lindt. The main purpose of company was to develop new product for the highly competitive market. At that time, Lindt developed complex collaboration system with its suppliers to develop new flavor. The assumption of this model was that only certain aspects of the innovation process were open for collaboration. The organization adopted this model to develop some innovation internally and avoided the risks of losing control over critical information such as the feature of new product, secret food recipe and cooking technique.

At the same time, the organization integrated outside information from external actors into the NPD process such as the consumers, suppliers, and distributors. The specialty of this model is to focus on the degree of cooperation among actors at a specific process. This model needs a clear and explicit definition of each actor's aim and scope of collaboration to ensure company's strategy. It can be used by the organization who are reluctant to adopt OI approach but understands the need of collaboration to complete its NPD (Galanakis, 2016).

Figure 2.14

The selective sharing OI approach by Lazzarotti and Manzini (2013)

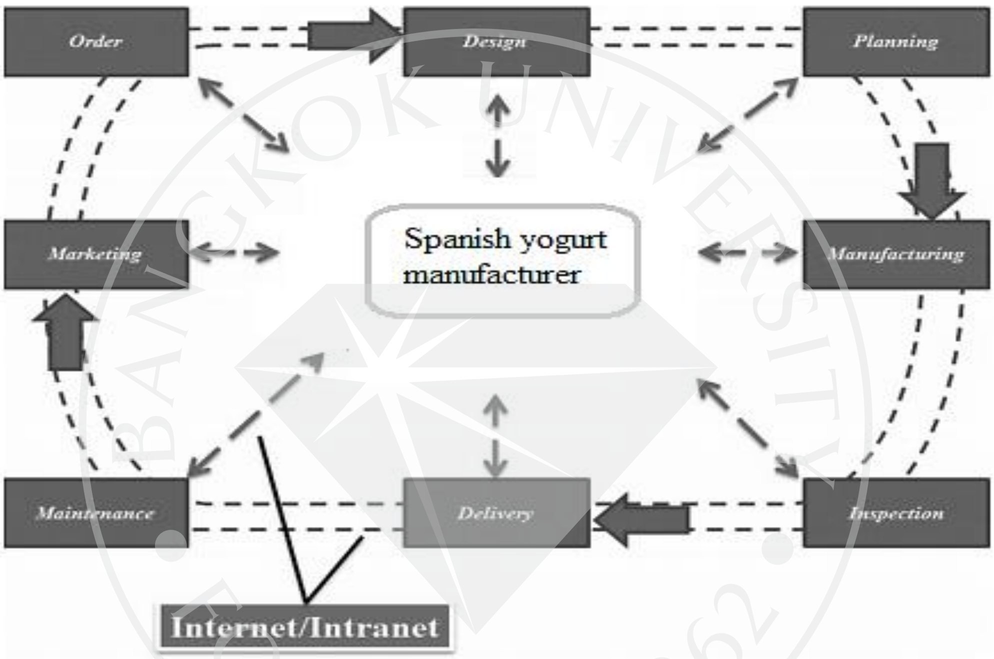


Note. The model is adopted from Lazzarotti and Manzini (2013)

2.3.12.8 The consumer - centric OI Model. Tsimiklis et al. (2015) developed a model using the case study of a Spanish yogurt manufacturer. Presented in Figure 2.15, the model indicates that the effective implementation on OI involve the use of a new ICT-base framework to incorporate consumers in the innovation process. Consumer's need, inputs and priorities are used in the ideation stage in the NPD and commercialization stage. ICT platform comprising of the intranets, websites, and blogs play key role in connecting both internal and external actors (Gagliardi, 2013). Organization's employee, consumers, selected suppliers, distributors, retailers are considered vital players in the knowledge sharing and transfer process of co-creation. The result of adoption and implemention of the model is to reduce the high failure rates of new food products through precise identification of new product's based on actual needs (Galanakis, 2016).

Figure 2.15

The consumer - centric OI Model; a scenario of using internet/intranet to support information flow in product development cycles by Tsimiklis et al. (2015)

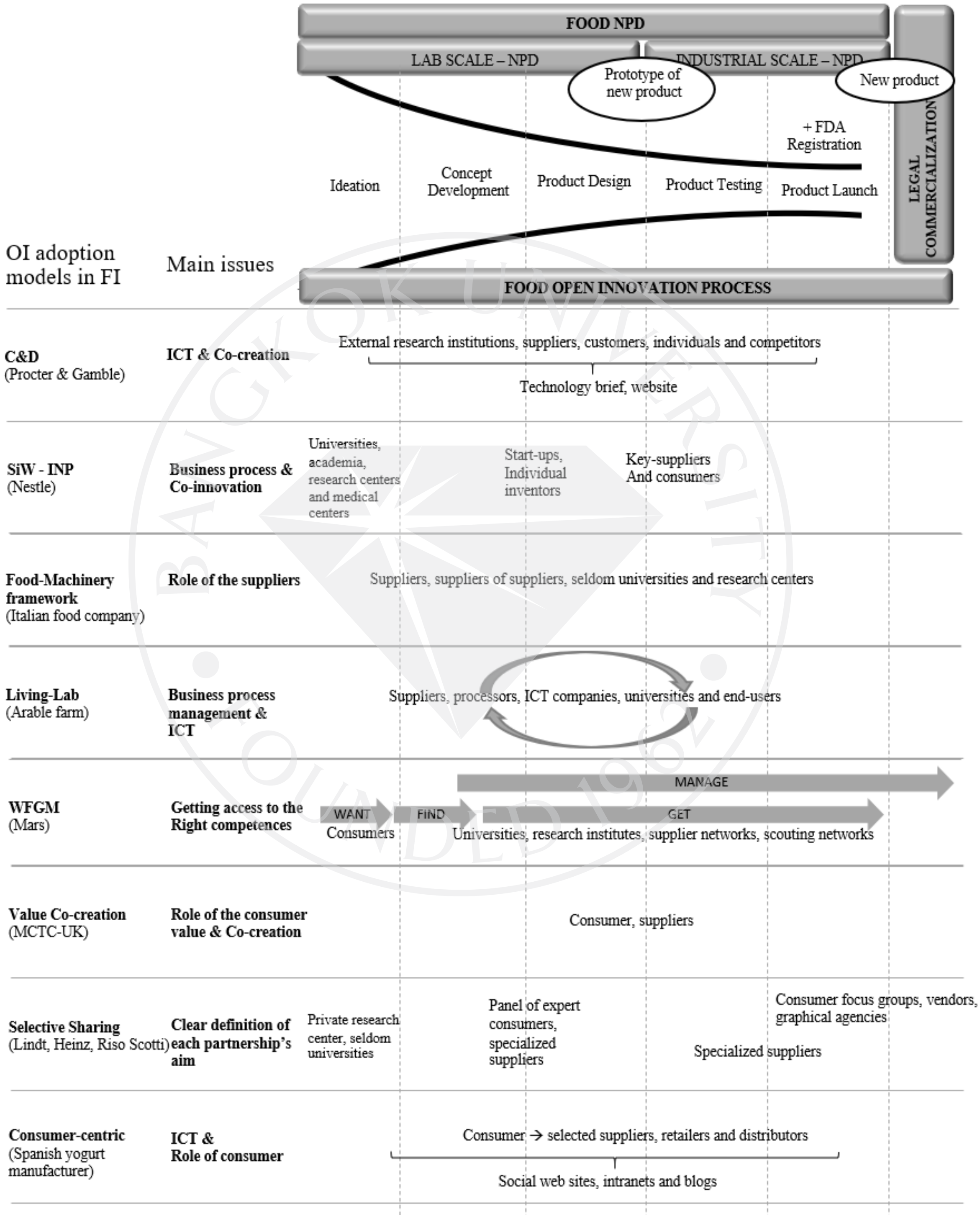


Note. This figure is adopted from Tsimiklis et al. (2015)

The overview of the main attributes and characteristics of the 8 OI adoption models in FI, in a general food NPD in terms of laboratory scale and industrial scale, is described in Figure 2.16.

Figure 2.16

The schematic of 8 OI adoption model in FI NPD



Note. This figure is adapted from Galanakis (2016)

Although there are studies indicating that entrepreneurs in FI are increasingly interested in the OI approach (Gassmann et al., 2010), how each food firm adopted the OI model depends on an organization standpoint. It seems to be an isolated initiative and specific purpose of individual food firms rather than the innovative trend of the entire FI (Giannoulidis, 2013; Henttonen & Lehtimäki, 2017). With regards to the 8 models of OI adoption in the FI, all models shared the same main purpose to implement OI on the NPDs even though the authors did not specifically mention this aspect. It can be stated that different models underline several concepts, but all of them are just different aspects of the same phenomenon. In addition, all the models have identified the knowledge transfer and sharing among actors which represent the related OI logics. As for OI practices, even though the activities used in all the models can be considered as OI practices, only 3 models, namely SiW model, Food-Machinery framework and WFGM model focus strongly on the variety of OI practices that apply to the model (Bigliardi & Galati, 2013a). Each model has adopted a variety of OI practices, ranging from simple collaboration to patenting. On the other hand, ICT is considered as important tool for OI. As the ICT trend is increasing, there are many food firms that have efficaciously implemented ICT in their NPDs (Awazu, Baloh, Desouza, Wecht, Kim, & Jha, 2009; Bigliardi, Ivo Dormio, & Galati, 2012; Gagliardi, 2013).

Interestingly, the Concept and Development Model, Living Lab Model, and the Consumer Centric Model are 3 models that have adopted the variety of ICT instruments to manage the relationship and heterogeneous requirement of each actor in the FI supply and/or value chain. However, Thai FI SMEs tend not to use ICT to facilitate their NPDs (Jones & Pimdee, 2017; NSTDA, 2018).

As the extant literature proposes 8 models of OI adoption in the FI, the researcher seeks to analyze and justify the model to study generative mechanisms of food innovation intermediary that favor OI logics and practices to enhance NPD process among other actors involved in the Thai FI SME. Through the preliminary study of by Hongsaprabhas et al. (2018), the researchers cited that OI logics and practices based on the "Food-Machinery framework" by Bigliardi and Galati (2013a), it appeared to be the best adapted model for the Thai FI SMEs context. The Food-Machinery framework is the only one model with details for the investigation, for the following reasons:

1) The Food-Machinery framework is one of the most adopted OI model in the FI (Grimsby & Kure, 2019).
2) This model enables the food machinery company to up-scaling and OEM mass production (Hongsaprabhas et al., 2018). It is the only model that focuses on the role of food machinery companies in the OI process. Most food companies establish collaboration with other actors in the supply and/or value chain. Among these actors, the supplier is considered as an important source of external knowledge for OI NPDs (Usman et al., 2018). The food machinery company is also considered as the supplier of the food company. It can provide useful knowledge as it has diverse experiences from serving many organizations or clients.
3) The model indicates the reciprocal interaction of OI logics and practices among actors in the food supply and/or value chain that is in line with the purpose of this research.

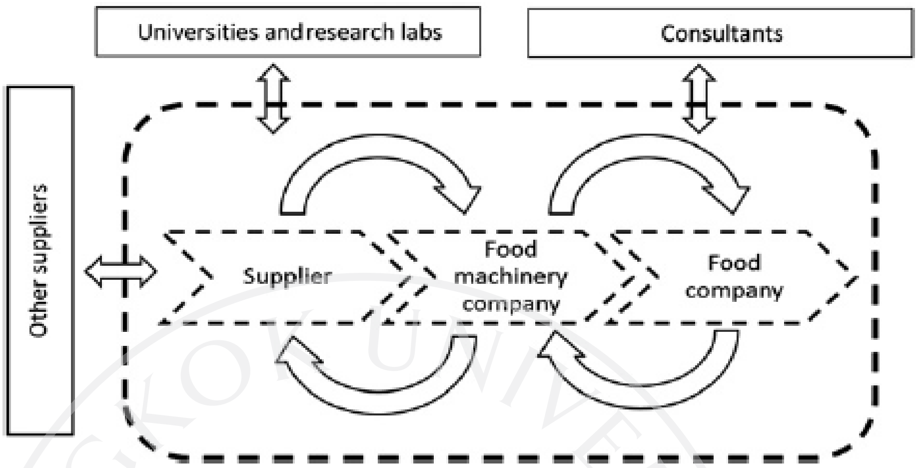
4) The benefits of this model as claimed by Bigliardi and Galati (2013a) is its ability to help to increase competitiveness and increase the number of new products. The objects are of interest to the study of this research.

2.3.13 Food - Machinery Framework

The Food-Machinery framework in open food supply chain is one of the most frequently adopted models in the food machinery industry (Bigliardi & Galati, 2013a; Galanakis, 2016; Grimsby & Kure, 2019; Hongsaprabhas et al., 2018). Its concept originated from Bigliardi et al. (2010) and turned into an explicit model after the work of Bigliardi and Galati (2013a). The authors developed the model using the case study of the Italian multinational company in Europe. Even though this model was developed from the perspective of the large and multinational company, the authors further suggested that it could be adapted to the FI SMEs. The model indicated that the surge created the need for the food firm to explore multiple external knowledge sources. This is a vital source for NPD to increase the complexity of the food supply and/or value chains. The core concept is represented by the complex actors surrounding the food machinery company, and the opportunities to use partnerships to establish OI - oriented collaborations. The model is specific to the innovative role of a supplier (the food machinery company) within the OI process. The model thus refers to a particular case of food supply and/or value chain rather than a general one.

Figure 2.17

The Food-Machinery framework and the open food supply chain



Note. The model is adopted from Bigliardi & Galati (2013a)

This model refers to 3 key actors in food supply chain: (1) The Italian multinational firm (as a food company). It is the customer of (2) the food machinery company, a larger food processing company that operates R&D and NPD, the mass production; and (3) the suppliers who provide key ingredients and materials to produce the goods. The others are supporting actors in the NPD include other suppliers, consultants, and universities and research labs. The model shows the knowledge transfer and reciprocal interaction between different actors in the supply chain. OI logics (outbound, outbound and coupled) can be identified in this framework (Hongsaprabhas et al., 2018). Furthermore, OI practice adopted by every actor can be identified as well (Bigliardi et al., 2010; Hongsaprabhas et al., 2018). The result of the Bigliardi & Galati's (2013a) study showed that food company and food machinery company collaborate with the other suppliers, universities, research labs, and consultants. The mature relationship between the supplier and the food machinery company is perceived as strategic partner. Their relationship is critical as its involvement the suppliers at the design stage in finding new technical solutions in the NPD process. Conversely, the under-developed relationship between food machinery company and food company (customer), limits the strategic roles to each other especially when partner involvement came at the later stage of the NPD.

Nevetheless, there is a possibility to establish strong relationships with each other and decrease the cost of acquiring new food factories. Another interesting issue of this study concerned IP protection. The interview of the food machinery company indicated that tacit agreements are commonly used with the suppliers rather than the patent. This approach is norm-based for the food machinery company to protect its proprietary knowledge (Bigliardi & Galati 2013a; Fauchart & Von Hippel, 2008). Conversely, the knowledge transfer to food companies (customers) is usually protected by the patents (Bigliardi & Dormio, 2009). The model also shows the innovative role of the supplier who is the food machinery company over the customer, that is the food company in the OI process. The food machinery company tries to involve food companies in the NPD process by tracking its modification in products and proactively involving in the market research stage. Despite its actively collaboration with other actors, the food machinery company is the central actor in this OI adoption model. The main benefits of this model are to increase competitiveness and having more new products. The challenge of this model is the difficulty to implement and manage within the organization as compared to other models. It requires the reorganization for the entire firm's management structure and the change in the organizational culture.

Noticeably, food machinery company needs to ensure a balance relationship between each actor in OI NPD. According to Bigliardi and Galati (2013a). the balance relationship between "food machinery and supplier" need to be stronger than relationship between "food machinery and food company". Significantly, this is because ideas and knowledge of new product usually come from the supplier side than food company side. As such, it is the task of the management team of food machinery company to handle this task. Thus, the food machinery company has to make new collaboration models accepted by both internal and external actors. The food machinery companies must continuously develop and improve their networking capability, inculcate open mindset culture, develop ability to precisely identify valuable knowledge and necessary technology, and ability to integrate externally to the internally.

Another important issue is how to protect proprietary knowledge and its intellectual property in this model. In general, even though the exceptional may exist, the competency lays in the providing partners (food machinery company) owning all tangible solutions such as ingredients and technologies, while the receiving part that is the food company owning the smart application of these solutions or the finished products.

2.4 New Product Development (NPD)

The study of OI logics and practices in Thai food machinery SME is quite a broad scope. To develop a clear study scope, the researcher focuses on the OI NPD context. The reasons are as follows:

1) NPD is an important factor affecting the survival of FI SMEs (Van der Valk & Wynstra, 2005). It is a major driver of organizational sustainable competitive advantage (Mu, Peng, & MacLachlan, 2009).
2) Even though some authors did not mention NPD directly, most of the academic researches and application of OI in FI aim to develop new products and markets.
3) The NPD project always has a clear time limit boundary which the researcher can identify as the beginning and end of each NPD project.

This allows the researcher to observe the development of food recipes in the selected knowledge flow from the beginning to the end of each NPD project. In addition, the respondents in the interviews can provide the actual OI logics and practices involved in the development of food recipes, and clearly identify the actors related to the NPD, and not just providing a general view.

The literature review has also showed that many authors who studied and provided NPD definitions cited that it is the set of activities which begins with the market perception opportunities, and ending in the production, sales, and the delivery of new product (Zhao, 2001 as cited in Chaochotechuang, 2016). Other stated that it is the activities of knowledge development and knowledge synthesizing, consisting of a stream of non-routine and routine tasks, performed by individuals and groups (Zhang, Lim, & Cao, 2004 as cited in Chaochotechuang, 2016). Ulrich and Eppinger (2007) mentioned that; NPD comprises of steps from introducing new product to the market. This includes new product sampling, testing, individual market research, related advertising and marketing campaigns (Chaochotechuang, 2016). NPD is the process of researching, thinking, designing, correcting and improving to get a good product and may be a particularly new product as true innovation, imitation, improvement, and entry into new markets (Suwannaporn & Speece, 2010). Researchers also perceived NPD as a transformation process of business opportunities into the tangible products (Trott, 2012 as cited in Chaochotechuang, 2016). It is found that even though the definitions are different, they share a common point in terms of activities (or practices) that create a new product. In this study, the researcher adopts the Zhao's (2001) definition that "*NPD is the set of activities beginning with the perception of a market opportunity and ending in the production, sales, and delivery of a new product*" (Zhao, 2001, p.1).

Since it is the only definition that describes the sequence stages in the NPD process with broad terms, it allows the diversity of various OI practices being carried out in the NPD process. Furthermore, this is the only definition which emphasizes the NPD steps to reach the extent of delivering new products to consumer's hand. It means that the new product must be able to commercialize. This issue is a big problem for the entrepreneur's NPD in every industry (Cooper, 1990; Cormican & O'Sullivan, 2004), especially in SMEs. The main problem of SMEs' NPD is that it is not on the development, but on the commercialization part (Gans & Stern, 2003; Sadat & Nasrat 2020).

Suwannaporn and Speece (2010) stated that in general, the result of NPD is the the acquisition of a new product. While, the definition of the product is goods, service, or idea that contain tangible and intangible qualities, it can be exchanged for money or other valuable things. The tangible features include color, odor, taste and texture of the product. The intangible features encompass good health, wealth, and happiness. New product is the product that has been developed through the research, thinking, designing, editing and improving process until a new product is created. The newness may be due to one of the operational approaches, such as innovation, emulation, adaption, and bringing the existing product into a new market. The scope of the newness in new product can be varies. Some of the examples include the followings:

1) The newness of product compared to existing products. If a new product has a different function than the existing product, it is considered as a new product. Take for instance the development of canned sweetened condensed milk into sweetened condensed milk in a ready to use squeeze bottle.
2) The newness of product regarding law and regulation. An example is the Thai FDA additional prescribing the supplementary food for infant and young children age 6 months to 3 years. There was no such category of food before. This is thus considered as a new food category.
3) The newness of product from the company's perspective. The newness from product line extension of the company's dairy products. The development of green tea flavored milk is a good example when the company had never produced before.

4) The newness from technology changing such as frozen pasta companies investing in sterilization technology to develop new products as canned pasta.
5) The newness from true innovation such as new sweetener substitutes.
6) The newness from the consumer's view, which is largely based on the knowledge and experience of consumers in considering of new features such as coffee cola, which may be new in the Southeast Asian market but not in the Japanese market.

In addition, Suwannaporn and Speece (2010) also identified the types of knowledge sources to create new products into 2 categories. First from internal organization. This is when company initiates research project through research, development and brainstorming from R&D specialists, salespersons, and top management. The second category of knowledge comes from the external organization. It can come in the form of patents, university's research projects, research supported by government and private agencies, resellers/middlemen, distributors, competitors, customers, and end consumers. Thus, in the context of NPD, the researcher considers both internal and external knowledge (Chesbrough, 2003). Hence, the researcher sees the possibility to explore OI logics and practices in the food NPD context.

It is commonly acknowledged in all industries, including FI that NPD is a risky process of the organization (Mu et al., 2009). It is also a costly activity as the NPD failure rate is very high (Cooper, 1990; Cormican & O'sullivan, 2004). Many authors claimed that new food product failure rates are on average 70 to 80 percent (Gresham, Hafer, & Markowski, 2006; Suwannaporn & Speece, 2010; Winger &

Wall, 2006). However, there are many authors who argued on how to measure the success of new product. Take for instance, the success of new product is generally measured by the quality of the new product, time to develop new product, the cost of the NPD (Krishnan & Ulrich, 2001), the cost to manufacture new product, new product sales, and the new product's attractiveness in the market (Peeters, 2013).

Zirger and Maidique (1990) studied 330 new products, found that there were 8 success factors for NPD. These factors are excellence in research and development, marketing and management competencies, product value, techniques, administrative support, ability to integrate capability and resource, weak competitive environment, and the market is large enough.

Another study by Henard and Szymanski (2001) indicated the product characteristics which influencing the success of new products. These product characteristics include product advantage, product meets customer needs, product price, product technological sophistication, and product innovativeness. This finding was in accordance with the study by Sereerat, Laksitanond, Sererat, and Patawanich (1998) which indicated that the higher the NPDs cost, the greater the chance of new products failure in the marketplace due to higher selling prices.

Interestingly, Lynn and Akgun (2003) study indicated that new product failure could be caused by the product itself. Most of time the failure come from lack of a good protocol of NPD. This means that there is high degree of ambiguity in terms of unclear market and target groups, undefined needs and preferences of consumers, and the weak selling point of the new product which failed to be attractive to the market. Thus, there is a need to use marketing mix for support.

In addition, Krishnan and Ulrich (2001) found that most traditional enterprises' NPD usually follow the step-by-step NPD sequence, rather than do it in parallel. It means that the development of new products starts at the research and development department or the marketing department, then forward to the engineering department to design the new product. It is then sent to the production department to evaluate the actual production process and prepare mass production. If the production department says that the production process is not possible due to any limitation or the cost of mass production is too high, then it will be sent back to the engineering department again. After that, the engineering department will adjust the model and cost of new products and send it back to the production department. When the production department finishes the product, it will then be sent to the sales department to prepare the marketing plan and commercialization which is sometimes too late for the market. In other words, NDP is time and cost consuming. Managing inefficient NPD leads to new product failure in the actual marketplace (Van der Panne, Van Beers, & Kleinknecht, 2003).

Chokenukul et al. (2012) studied the success of the new product development in 146 Thai food companies from the Federation of Thai Industries. The authors found that businesses with different fixed asset values had different successes in the development of new products. Most of the larger businesses have different forms of business operation and number of employees and tend to be more consistent and seize opportunities to succeed in the development of new products than the smaller businesses. However, this finding contradicts the study of Cuthill (2001) which indicates that organizations with fewer employees can have higher successes in developing new products than large organizations with more employees. This is because the small organization does not have a very complex structure. Moreover, Chokenukul et al. (2012) also concluded that the main obstacle in the Thai FI SME's NPD was the lack of understanding the product design step in the NPD process.

However, it is difficult to measure the success or failure of NDPs as there are many factors that go beyond the scope of NPD. Some factors are beyond the control of the developer. Take for instance changing market conditions, incoming of new competitors, changing customer behaviors, new laws and regulations, and related disruptive technology (Brown & eisenhardt, 1995; Chaochotechuang, 2016). Van Kleef (2006) argued that the definitions of NPD success and failure may differ depending on the perspective of the individual food firm or the researcher. For example, Van Kleef (2006) pinpointed that industry research shown only one-third of new fast-moving consumer goods in Dutch supermarkets were successful. The rest two-thirds of new products failed in the marketplace. The author considered this figure as high failure rates. Whilst, in the study of Boulding et al. (1997), the research on the consumer goods business in the US market, showed that new product failure is about 35 percent to 40 percent. These authors considered this figure as high failure rates. Hence, it is difficult to identify the success and/or failure rates in the NPD without a standard measurement.

Simultaneously, some authors focused on NPD management rather than how to measure its success or failure rate. Cooper and Kleinschmidt (2007) argued that a high quality of NPD process is more important than NPD strategy. Many researchers have suggested similar recommendations about the need of firms to pay attention on ensuring that the NPD process is effectively organized (Benner, 2005; Gresham et al., 2006; Van Kleef, 2006). Thus, the need of understanding how to manage NPD efficiently still prevails (Mu et al., 2009).

In this research, the study scope does not focus on the success of NPD but focuses on OI logics and practices in the NPD process of the Thai FI SME. The researcher believes that the quality of NPD process is part of effective management on OI logics and practices. In order to comply with the objectives of the study, the researcher determines the NPD scope only for the NPD project that the new product can be legal commercialized. In other words, the new product can be carried out through NPD - laboratory scale and industrial scale. It also includes mass production and FDA registration.

2.4.1 NPD Process

Studies related to NPD have evolved and changed over times. There is a need to develop new NPD definitions and a relevant new NPD process model based on the dimensions and perspectives of each author (Chokenukul et al., 2012; Najib & Kiminami, 2011). In the past, each step in the NPD process was performed internally, but today it has been recognized that exchanging activities with external environments play greater role and of significant impact on the NPD process (Chaochotechuang et al., 2019). It can be said that many firms accept the concept of OI more to the process of NPD. The ultimate aim of making the NPD is to commercialize new products in the actual marketplace (Hongsaprabhas, 2017b; Najib & Kiminami, 2011). Many authors agree that managing NPD processes is risky, challenging, investment requiring and involves complex activities. Any wrong decision making may result in failure at any stage in prototyping, mass production, FDA registration, legal commercialization, or market adoption (Millson & Wilemon, 2008; Sakellariou, Karantinou, & Poulis, 2013).

From the literature review, the researcher found various NPD process models proposed by many authors. However, it can be concluded that the NPD process comprises all activities that firms undertake since they develop and introduce new products to the market (Bhuiyan, 2013; Ulrich & Eppinger, 2007). For example: Bhattacharya, Krishnan, & Mahajan (1998), described the NPD process consists of 3 main stages. These stages are first the definition stage where the firm sets the product definition based on target consumers. The second stage is the realization stage where the firm implements' product prototypes, and the last stage is the integration stage whereby the firm optimizes the production process to develop mass production products with optimum costs; Hart and Baker (1994) described the NPD process consists of 8 stages. These stages comprise of new product strategy, idea Generation, idea Screening, develop and testing product concept, business analysis, develop and testing product, market testing, and commercialization. Guiltinan, Paul, & Madden (1997), on the other hand, described the NPD process consistings of 5 stages, namely idea generation, idea Screening, product development, product-market testing, business analysis, and commercialization. However, in recent literature, the researcher has found that NPD process is conceptualized in 5 main stages (Chaochotechuang, 2016; Dahan & Hauser, 2002; Sawhney et al., 2005). These stages are as follows:

1) Stage of ideation - the firm has to identify and evaluate the business opportunity towards the firm's targets and requirements.

2) Stage of concept development - the firm has to describe a new product idea e.g., product features, product positioning, target customer, customer benefits, and feasibility studies.
3) Stage of product design - the firm has to determine all related parameters of the new product, prototyping and tooling.
4) Stage of product testing - the firm has to test prototypes to confirm that all physical requirements are adequate and production requirements are well met.
5) Stage of product launch - the firm has to mass produce new products. This stage includes launch market plan support such as sales, advertising, and promotion activities.

It can be seen that the OI approach can comply throughout the stages in the identified NPD processes (Bigliardi & Galati, 2013a; Sarkar & Costa, 2008). Through the various OI practices such as employee involvement and external networking, the firm can shortcut in terms of new ideas acquisition, acquiring knowledge and technology from the external through some of OI practices such as customer involvement and inward IP licensing. Some firms can outsource R&D to the external party who has more NPD resources and/or capability. Some examples of outsourcing include the outsourcing of prototype development at product design stage to the universities, and outsourcing mass production at the product launch stage to the food machinery companies (Origianl Equipment Manufacturer - OEM).

However, this research only needs to study the OI logics and practices in the context of NPD. The research will not study in depth for each specific stage of the NPD process. The researcher therefore chooses a wider and non-specific NPD process classification. From the literature review, there are still many authors who have classified the stages in the NPD process using other dimensions. NPDs can be categorized into two groups, namely the front-end group and the back-end group (Cooper, 1990; Cooper & Kleinschmidt, 2007; Floren & Frishammar, 2012; Verworn et al., 2008). The front-end's activities include the idea generation, screening, preliminary evaluation and concept development. The front-end group is characterized by complexity and uncertainty. The back-end group's activities include the design and engineering, testing and launch (Chaochotechuang, 2016; Verworn et al., 2008). Some authors agree that the NPD activities in front-end groups are considered as key important steps in the NPD process (Cooper, 1990; Cooper & Kleinschmidt, 2007; Floren & Frishammar, 2012; Verworn, Herstatt, & Nagahira, 2008). While some authors argue on the belief that the important challenge of NPD is not only the design stage but implementing and replicating of an accompanying new process within the firm's operating boundaries. In so doing, the firm accomplishes industrial scale and mass production (Tambunlertchai, 2015). Many of the academic developers have neglected the NPD activities in the back-end group (Lorenz, Raven, & Blind, 2017; Pisano, 1996). The study of Gerwin and Barrowman (2002) argued that knowledge & innovation management and technology transfer literature mainly focus on product development as critical success factors in NPD. While the engineering and manufacturing literature acknowledge the efficient integration of developed NPD activities.

The practical NPD literature commonly distinguishes between product development part and production process development part (Brown & Eisenhardt, 1995; Lorenz et al., 2017). The product development part focuses on the design or discovery of new products (upstream activities), while the production process development part examines the actual production and manufacture ability of these new designs or discoveries (downstream activities). However, many of empirical studies from practical research and developers have separated the range of NPD by considering the scale of research and development as criteria (Anderson, 2012; Corke & Bhattacharya, 1999; Neubauer et al., 2013; Noorman, 2011; Suomala & Jokioinen, 2003). The NPD process can be classified as follows.

1) Laboratory scale or lab scale (Neubauer et al., 2013) is a prototype product development produced in the research laboratory. It tests the concept of the product only, and still need to continue development in the pilot scale and industrial scale. It comprises the stage of ideation, concept development, and product design (Dahan & Hauser, 2002; Sawhney et al., 2005). The result of laboratory scale is a new product prototype. The related parameters, techniques and tools are necessary for up-scaling to get from this stage.
2) Pilot scale (Corke & Bhattacharya, 1999) is a prototype product development at the laboratory level that has been tested from the users (food machinery company) with evidences of the trial report. The objective is to expand the experimental scale to be closer to the actual production conditions. Take for instance using more quantity of raw ingredients in the experiment as close to the actual production, and using NPD facilities that are near to actual production facilities. Some authors, as well as this study, have included this pilot scale together with the industrial scale (Corke & Bhattacharya, 1999)

3) Industrial scale is the development of prototype products at the factory level (Neubauer et al., 2013). It enables the firm to produce in industrial scale and mass production. The purpose of this stage is to enhance the readiness of a new product to the next level via scaling up the actual ingredients/materials for production, applying manufacturing facilities, and greater involvement of the production team. The industrial scale will ensure the laboratory scale process is properly implemented on the routine mass production (Reed & Alb, 2014). It comprises the stage of product testing and product launch (Sawhney et al., 2005). Furthermore, the preliminary study of the researcher (Hongsaprabhas et al., 2018) found an additional stage that is the 'law and regulation compliance of new product'to the industrial scale. The result of industrial scale is new products which are ready for mass production and legal commercialization.

Some studies cite the lack of concentration on the industrial scale as the gap between FI NPD and actual production (Agyei & Danquah, 2011; Hongsaprabhas, 2017b; Hongsaprabhas et al., 2018; Neubauer et al., 2013; Noorman, 2011; Reed & Alb, 2014). Achieving new product prototype from the laboratory scale is not enough for the real business sector. The literature has showed that many of the synthesis in the laboratory scale are based on academic study. The result of laboratory scale is often not suitable for actual mass production. Thus, the scale-up on an industrial scale is necessary (Anderson, 2012). The prototype of a new product from laboratory scale still needs to do more R&D at the industrial scale stage. Some parameters are needed for efficient mass production of new food products (Agyei & Danquah, 2011).

2.4.2 Food NPD

Only those food firms who are capable of transforming the prototypes from the laboratories into marketable products can gain profits from the NPD investment (Hongsaprabhas, 2017b). Thus, the link between laboratory scale and mass production, i.e., industrial scale, is another core activity in the NPD process (Neubauer et al., 2013; Noorman, 2011). Especially in the FI, the consistent development process from laboratory scale to mass production requires the consideration of many perspectives (Hongsaprabhas, 2017b). To complete the entire NPD process, the scaling-up is an unavoidable aspect in the food NPD process, which also takes time and resources as in the laboratory scale.

Product testing in the industrial scale probably takes several times to get to the final processing conditions. This stage may provide huge amount of failure samples as compared to the sample from the laboratory scale. The behavior of a NPD process in the industrial scale cannot be easily predicted (Neubauer et al., 2013; Noorman, 2011). The reasons why there are always some differences between the laboratory scale (small experiment) and the industrial scale (the large manufacturing scale) in FI (Hongsaprabhas, 2017b) are as follows:

1) Inconsistency of the agriculture ingredients/materials used in laboratory scale and industrial scale. As pointed in Chapter one, food product is really delicate. Just the changing of suppliers and/or the different quantity of ingredients for the experiment conditions may cause different results
2) Inconsistency of R&D facilities between laboratory scale and industrial scale. The changing type of machinery or just different machinery specification in laboratory scale and industrial scale may cause different

results. In addition, many food firms outsource laboratory scale to the universities to develop new product prototypes. The laboratory's facilities from universities and/or government agencies are always more advanced and complicated than the food firms.

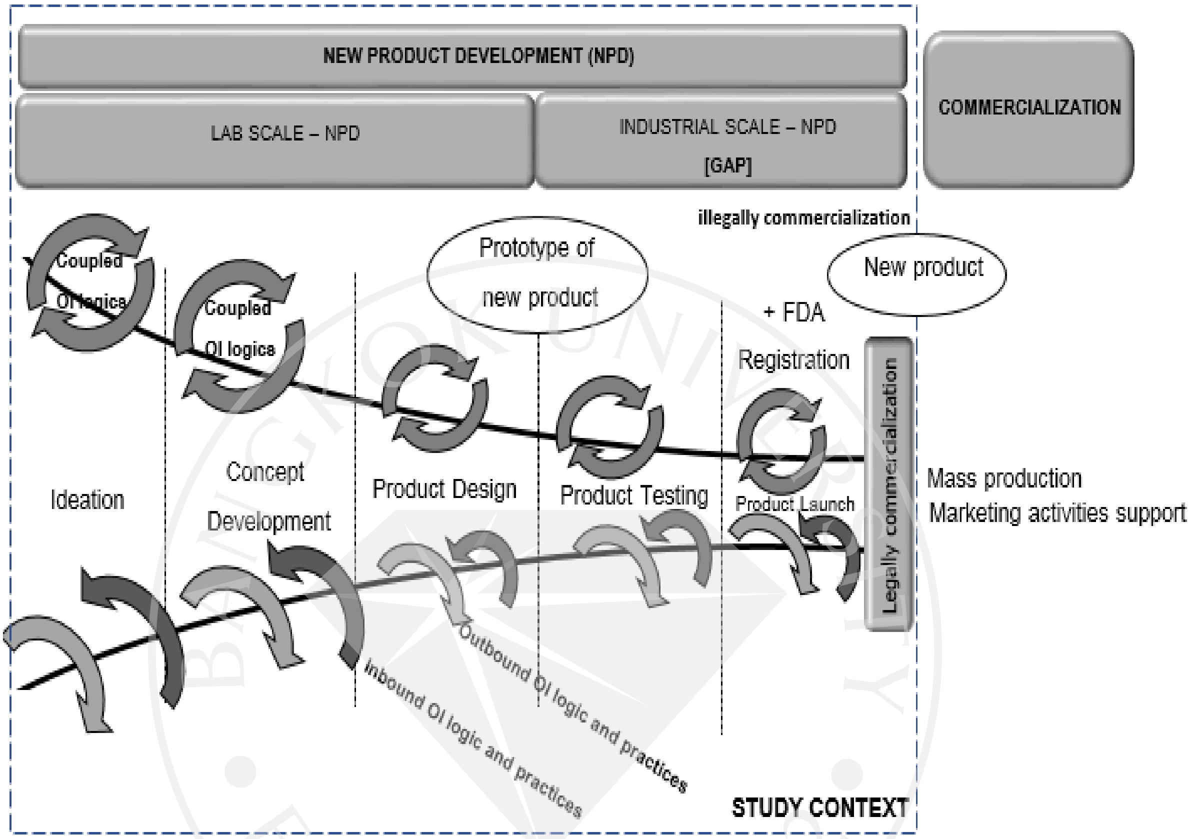
3) Different knowledge is needed for the research and developers in laboratory scale and industrial scale. Most of the laboratory scale research and developers are academic based. They expertise on the knowledge about advanced technologies, newness materials, and the application of across industrial knowledge.

In contrast to the industrial scale research and developer who have more expertise on the knowledge about actual food material, actual food production condition, and involved law and regulation. Neubauer et al. (2013) suggested that the consistency of production process development is another important factor to make NPD successful. The NPD manager should be aware of the gap between laboratory scale and industrial scale during NPD projects. Therefore, a faster scale-up is possible by implementing conditions of the industrial scale in the early development stage, preferentially on parallel small - scale systems, which needs extensive considerations and calculations. All these factors must be considered by the specific constructions for efficient NPD process.

To comply with the study objectives and to access information from the respondent (interviewee), the researcher chooses to investigate OI logics and practices in food NPD context of laboratory scale and industrial scale. The process prior to commercialization is depicted in Figure 2.18.

Figure 2.18

OI logics and practices at multiple point in food NPD process (laboratory and industrial scales)



Note. This figure is adapted from Chaochotechuang (2016)

2.4.3 NPD with OI Approach in FI

Food innovations are always understood as new products, processes and services. They are well recognized as important instrument for the food firm to survive in the competitive market (Bigliardi & Galati, 2013a; Menrad, 2004). There are many studies indicating that new food products are important factors to the food firm's survival rather than other incremental investments e.g., extend production line, increasing productivity and/or quality (Bigliardi & Galati, 2013b; Chaochotechuang, 2016; Europe Efficient Consumer Response [ECR Europe], 1999; Knox et al., 2001).

In the past, the NPDs of large and multinational companies relied mainly on internal R&D. The internal R&D knowledge, people and facilities are considered as organizational strategic assets and as entry barriers for the potential competitor (Iturrioz et al., 2015). For these reasons, large and multinational companies extend their R&D capabilities through complementary assets to over perform the smaller competitors (Teece, 1986; Van de Vrande et al., 2009). For the knowledge and innovation management perspective, this NPD approach is considered as closed innovation as the development occurs internally before the commercialization of the new products (Chesbrough, 2003). Even though the closed innovation approach worked considerably well for quite some time, the current situation has changed (Randhawa, Wilden, & Gudergan, 2019). As lifestyle changes so are the expectation of the food consumers. The need for healthy and safety food products demands more on the products to tailor to individual needs. Importantly, the demand of food products is rapidly evolving into a mass customization market (Bigliradi & Galati, 2013b; Boland, 2008; Charoenrat & Harvie, 2014). Adaptation of the food firms to respond to consumer trend is diverse. Some of the food companies apply more sophisticated marketing techniques to better gathering and understanding different consumer needs (Giannoulidis, 2013; Jonge et al., 2006), develop new radical products itself and accept the risk of the firms' investment, and adopting external knowledge and technological solutions into the organization (Bigliardi & Galati, 2013b).

Since the period before year 2000, the direction of study in NPD began to focus on customer involvement because collaborating with the customer is proved to be an important part of the success of NPD (Füller, Bartl, Ernst, & Mühlbacher, 2006; Von Hippel, 1986; Zakic, Jovanovic, & Stamatovic, 2008). FI is sector strongly market-driven. As such, rapid adaptation to the consumer becomes an important factor. The strategy and planning are less important than the ability to be flexible and be able to respond quickly to the fast changing of consumer preference (Suwannaporn & Speece, 2010). The user’s information is a vital resource for the NPD because it can offer valuable information regarding the needs of new products (Zakic et al., 2008). Prahalad and Ramaswamy (2004) argued that value must be jointly created between the firm and customers. The firm can co-develop new products with lead users. This relationship creates the competitive advantage and helps concept development which transform the product-centric to customer-centric in the NPD process. This customer-oriented concept can be perceived as a start to the OI approach in the NPD process. The increase communication with customers is supported by the advancement in communication technologies and mobile application tools (Chaochotechuang, 2016; Füller et al., 2006; Sawhney et al., 2005). However, food firm must carefully select customer's feedback because not all the customers are considered as good sources for NPD and excessive amount of customer feedbacks can lead to a bombardment of information (Lau, Tang, & Yam, 2010).

To compete in the dynamic environment in FI (societal, technological, economic, law and regulations), food firms need continuous development of new products as well as improvement of existing products (Mark-Herbert, 2002; Stewart & Martinez, 2002; Suwannaporn & Speece, 2010; Van Kleef, 2006; Winger & Wall, 2006). All involved actors in the food supply and/or value chain are significant, starting from the food growers, agricultural production, food suppliers, food processing, food distributors, to the end consumers. Some food firms may adopt a new type of NPD process deploying external knowledge in their NPD process to search for new products. Based on the literature, there is a limited but growing number of the food firms who have adopted OI approach (Bigliardi & Galati, 2013a; Chaochotechuang et al., 2019; Randhawa et al., 2019). These food firms tap onto some successful factors that reside outside their organizational boundaries and from other actors in their supply and/or value chain (Sarkar & Costa, 2008). Successful factor received from outside the organization (Stewart & Martinez, 2002) include the followings:

1) Food knowledge such as food recipes, cooking technique and nutrition information;
2) Food technology which comprises of the preservation and flavor enhancing technology,
3) Production technology
4) Marketing knowledge such as food trends, market insight, consumer needs and demands

In addition, increasing food safety concern can also lead to the requirement of law and regulation compliance. Thus, the knowledge of updated law and regulation, and global safety standards become more important for the food NPD (Dutta et al., 2018; Poratanond & Thawesaengskulthai, 2014; Rimpeekool et al., 2015). The regulatory bodies and testing laboratories are also necessary actors in the food supply and/or value chain. They enable new food products to get public acceptance and legal commercialization (Jonge et al., 2006; Vanhaverbeke & Cloodt, 2006).

To access external knowledge from other actors in the food supply and/or value chain, food firms always conduct formal or informal relationships for the collaboration (Bigliardi & Galati, 2013a; Randhawa & Gudergan, 2019). Partnership is a form of common cooperation in the FI (Bigliardi & Galati, 2013a). Food firms often choose to develop a partnership with other actors who belong in their sectors with highly overlapping knowledge, skills, and competences. The companies in the FI thus seek the partners help to fulfill knowledge, capabilities and/or other missing elements for their NPD and mass production (Knudsen, 2007). The collaboration with suppliers and other external organizations in the technical field is very important for FI SMEs who do not have sufficient internal R&D resources (Zakic et al., 2008). The collaboration with their suppliers at an early stage of the NPDs also help to improve the organizational new products (Chaochotechuang, 2016; Lau et al., 2010). The university, research center and freelance R&D are other important involved actors for food NPDs, especially in FI SMEs that lack the capability to do food NPD by themselves (Hongsaprabhas, 2017b).

However, most of the new food products that are breakthrough innovation have been developed outside the industry (Bigliadi & Galati, 2013a; Maula et al., 2006). The example of emerging knowledge and technologies outside the FI, that applications in food NPD (NSTDA, 2018) are:

1) Nanotechnology. Take for instance the application of nano-encapsulation techniques to encapsulate nutrients that are easily eliminated by high condition of food processing or creating new flavors that are becoming interesting in the modern consumer trend.
2) Biotechnology. A good example is the appropriate plant genetically modified organism (GMO). GMO helps to increase agricultural productivity by providing features, quality and quantity to meet consumer needs.

However, new food products derived from emerging food technology with nanotechnology and/or biotechnology are still in research and prototype stages, and are not aproduced for legal commercialization (NSTDA, 2018). Thus, the limitations of OI applications in FI NPDs relate to the difficulty to comply with new regulations, the lack of workers' knowledge (Bigliardi & Galati, 2013b; Juriaanse, 2006), and the high production costs of infrastructure investment in mass production of new product (Hongsaprabhas, 2017b).

The literature supports the researcher's methodology in applying OI logics and practices in food NPD context. The researcher found that many NPD strategies can be considered as the OI approach (Chaochotechuang et al., 2019). This kind of NPD activities are the same as OI practices, but many authors did not use OI terms. The examples of NPD strategies which can be considered as OI approach as presented as follows:

1) Outsourcing NPD strategy (Zhao, 2001): the firm can outsource NPD activities or mobilize its capabilities and resources beyond the firm's boundaries (Quinn, 2000; Zhao, 2001). Many firms do not possess the necessary capabilities and resources to do the entire NPD task effectively due to limited resources such as lacking in R&D facilities and/or specialist workers (Brown & Eisenhardt, 1995). To enhance organizational NPD performance, the firm can utilize external capabilities and resources to supplement their internal capabilities and resources instead (Zhao, 2001). Hongsaprabhas et al. (2018) indicated that some of Thai SMEs did not outsource the entire but partial NPD process to the external parties. Some outsource only at laboratory scale, while others outsource both laboratory and industrial scales. This NPD strategy can be considered as 'outsourcing R&D' in Van de Vrande et al.

(2009)'s OI practices. Moreover, some firms that have excess NPD capabilities and resources can propose their services to external parties as well. These kinds of NPD activities are considered as 'contract R&D services' in OI practice (Bigliardi et al., 2016).

2) R&D and marketing integration strategy (Fain, Kline, & Duhovnik, 2011): This strategy signifies the cooperation in performing NPD between 2 main departments in the organization. Take for instance the collaboration between the R&D department and marketing department. This activity supports NPD to be more effective (Fain et al., 2011; Griffin, 1997; Hillebrand & Biemans, 2004; Shah, 2010) because the knowledge needed to develop a new product should also come from the market side. In many organizations, R&D staff cannot access to customer needs directly. Thus, the cooperative work between R&D and the marketing department is necessary. Furthermore, the need for cross cooperative work among departments is increasing which is not confined to just the marketing department. Production department is another key function to support effective new products to industrial scale stage (Hongsaprabhas, 2017b). However, there are barriers to the integration among departments that have to be recognized and managed (Chaochotechuang, 2016; Shah, 2010). This NPD strategy can be acknowledged as 'employee involvement' in Van de Vrande et al. (2009)'s OI practices. The NPD strategy capitalizes and leveraging the knowledge, idea and initiatives of employees who are not involved in R&D (Van de Vrande et al., 2009; as cited in Hongsaprabhas et al., 2018).

3) External organizations' cooperation strategy (Zakic et al., 2008): Firms can enhance their NPD capabilities and resources by cooperating with the external

organizations (Hillebrand & Biemans, 2004; Zakic et al., 2008). The external actors can be suppliers, universities, food specialists, and R&D related government agencies. This strategy seems to be popular for SMEs who have limited resources as this strategy allows them to access the external capabilities and resources which they do not have. However, they have to unify internal and external participants (Koufteros, Vonderembse, & Jayaram, 2005). The ability of firms to integrate external capabilities and resources to the internal is vital to the success of NPDs (Koufteros et al., 2005). The firm who uses this NPD strategy can apply many OI practices such as external networking, external participation and venturing (Van de Vrande et al., 2009).

4) Information and communication technologies (ICT) strategies (Vilaseca-Requena, Torrent-Sellens, & Jiménez-Zarco, 2007): The utilization of ICT in the marketing section support positively the development of the NPD activities (Tou et al., 2019; Vilaseca-Requena et al., 2007). ICT plays a vital role in facilitating communication and cooperation among the NPD project team members. It can be customer databases, emails, websites, customer relationship management (CRM) programs, and network community programs (Tou et al., 2018). When considering this strategy, it is found that the use of ICT in the NPD can support activities in many OI practices, such as, the use of intranet in 'employee involvement', the use of customer database and CRM program in 'customer involvement', and the use of e-mail and communication website in 'external networking' (Gagliardi, 2013; Tou et al., 2018; Van de Vrande et al. 2009).

In addition, there are many researches that support the direction of this study on OI logics and practices in NPD context. Brown and Eisenhardt (1995) examined NPDs of over 400 firms in Europe, U.S.A., and Canada. The findings indicated that the customer involvement is one of the most important practices in new product development (Füller et al., 2006; Von Hippel, 1988; Zakic et al., 2008). The practice is also considered as one of OI practice. The study results from Suwannaporn and Speece (2010) on the NPD success factors in Thai FI SMEs, indicated the NPD success factors contrasted the job function and perception of the respondents. Hence, the information about what practice is important, was unable to distinguish higher or lower success rates. However, the respondents who are at manager level always take responsibility for overall practices in the NPD process. The study of Van der Valk and Wynstra (2005) in Dutch FI indicated continuous development of new products as operational routine in Dutch FI firms, but their food NPD had not been intensively studied. However, the increase in outsourcing for NPD and production (OEM) in Dutch FI has also been found to be substantial. The finding also showed the increasing role of supplier involvement in the food NPDs in Dutch FI.

The study of Knudsen (2007) on the relationship of interfirm and knowledge transfer for NPD success in Europe, indicated that almost all investigated food machinery companies had partnered with at least one external actor for their NPD. The result also showed the dominant role of consumers and suppliers as key actors for the NPD collaboration, and the minor role of research organizations. The study of Bigliardi et al. (2011) on the collaboration mode of R&D in one of the pasta manufacturers in Europe, indicated that this pasta manufacturer established a collaboration network with other actors in its supply and/or value chain, to acquire external technologies. It partnered with food machinery company, suppliers, companies belonging to other industries (with Japanese biosensor company; for monitoring process, considered as important stations which are additional in the new production line), and universities (with two Chinese universities for NPD of its functional foods).

The development of new food products is getting more complex with useful knowledge necessarily resides outside of the organizational boundaries (Bercovitz & Feldman, 2007; Bigliardi et al., 2019). The involved actors in supply and/or value chain are more concerned in food NPD (Bigliardi & Galati, 2013a). New food product remains a highly challenging and complex process to be managed, due to the huge number of actors involved in food NPD and actual production (Bigliardi & Galati, 2013b; Hongsaprabhas, 2017b). Subsequently, the more complex actors in food NPD, the assessment to the specific knowledge from specific actors through OI practices also increasing inevitably. This obvious evidence shows the increasing trend of OI adoption in food NPD (Giannoulidis, 2013). At the same time, OI practices must be carefully coordinated (Bigliardi & Galati, 2013a). However, it is still challenging the FI SMEs to implement an OI approach in the NPD process.

2.5 Research Gaps, Research Directions and Originalities of the Study

Based on the systematic analysis and synthsization of the data (Jones, 2004), the researcher is able to conclude the scope and purpose of the study, research gaps in each aspect, and research direction as how to narrow the research gaps. The summary of the the OI research gaps and direction in Thai FI SMEs is presented in Table 2.10. Table 2.11 highlights the research gaps on the aspects of OI logics. While Table 2.12 illustrates the aspect of OI practices, Table 2.13 pinpoints the research gaps of OI in NPDs.

Table 2.10

Research gaps and directions on the aspect of "OI in Thai FI SME"

Gap area	Identification of research gap(s)	Directions for filling the gap [originality of the study]
OI in FI SME gap(s)	● *No academic result explains how some Thai FI SMEs efficaciously adopt OI.*	Set up the objective of the study: to identify OI GMs in Thai FI SME's NPD.
	● *No study identifies OI GMs in the NPD of Thai FI SMEs context.* There are many studies on OI in the NPD process among LCs and MNEs in various industries. However, this kind of study has rarely been found in the FI, especially in Thailand SMEs context (Chaochotechuang, 2016). Moreover, the literature indicated that most of Thai FI SMEs have already adopted the OI approach for decades but not in the academic or formal pattern. They have not even realized themselves involving OI approach in their business and/or NPD process. Applying the OI approach in Thai FI SME often lacks knowledge and understanding of the actual mechanisms that make it successful (Chaochotechuang, 2016).	
	● *Lack of studies on OI logics and practices in the Thai FI SMEs context.* The literature showed that both OI logics and OI practices are the important components of the OI approach (Chesbrough & Crowther, 2006). However, only few studies found the linkage between OI logics and OI practices in the real business operations (Van de Vrande et al., 2009). Furthermore, no study in the Thai FI SMEs context. To the researcher's knowledge, only Van de Vrande et al. (2009) studied the linkage between OI logics (Inbound and outbound) and OI practices (Technology exploitation and exploration, respectively), which can be used as a basis for this study. Though, the study of such relationships has not yet covered the context of coupled OI logics (outbound and inbound dominance), and also has not yet studied in the development of such relationships to identify an OI GMs.	Identify OI GMs through the investigation of OI logics and practices in Thai FI SMEs by using the methodology and results from study of Van de Vrande et al. (2009) as guideline.
	● *Lack of specification of the nature of the actors involved in OI studies.* The involved actors in FI value chain have different roles, responsibilities and variety OI approaches. Specifying focused actors to be studied is crucial to identify OI logics and practices (Hongsaprabhas et al., 2018). Food machinery companies are one of the most interesting actors in the food value chain (Bigliardi & Galati et al., 2013), because Thai FI SME need the food machinery company for upscaling and mass production (Tambunlertchai, 2015). Thus, the researcher chose the food machinery company; in other words, the food machinery SMEs as a core focused actor to identify OI logics and practices, and OI GMs.	Thai Food machinery SMEs is the core focus of the study.
	● *No specific OI framework proposed in the Thai FI SMEs context.* The researcher explored the appropriate OI model for developing the theoretical framework of the study. Regarding the literature, 8 models of OI adoption in FI have been proposed over the last decades (Galanakis, 2016). All models refer to a particular case of a food firm and not to a general one. Moreover, no knowledge and innovation management study has previously applied to any models in order to observe OI in Thai FI SMEs.	The Food-Machinery framework (Bigliardi & Galati, 2013a) was chosen as a theoretical framework.

Table 2.11

Research gaps and directions on the aspect of "OI logics"

Gap area	Identification of research gap(s)	Directions for filling the gap [originality of the study]
OI logics gap(s)	● *Lack of precision regarding the dominance of the flow in coupled OI logics in the context of Thai FI SMEs.* Originally, studies on OI logics have focused solely on identifying either outbound or inbound OI logic. However, Lichtenthaler (2008, 2011) argued that coupled OI logics can reflect more the reality of business operations. Due to the fact that the knowledge flow in OI and NPD is often a two-way flow between actors involved in a supply and/or value chain. Thus, the concept that determines which organizations adopted either outbound or inbound OI logic might not reflect the reality. According to the literature review, the researcher has not found any studies which look deep into the details of coupled OI logic, in which it is only a matter of mentioning the characteristics of knowledge transferring between actors. In addition, the study of the relationship between OI logics and practices (Bigliardi et al., 2016; Van de Vrande et al., 2009) in the past has not yet extensively studied in the context of coupled OI logics.	The researcher added coupled OI logic in this study e.g., coupled OI logic outbound and inbound dominance. The additional logic that is not categorized will enrich previous observations.
	● *Lack of specification of the nature of knowledge flowing in OI studies in Thai FI SME context.* In FI, OI logic study is variously based on focused knowledge flows, such as food material knowledge, technology knowledge, or food recipe knowledge flows (Stewart-Knox & Mitchell, 2003). Among actors involved in the supply and/or value chain, the exchange of knowledge is regularly proceeding on. Therefore, it challenges to decide the knowledge flow direction: outbound, inbound or coupled OI logics. In this regard, a preliminary study of the researcher (Hongsaprabhas et al., 2018) found that "food recipe knowledge" is the only knowledge flow that is transferable with dynamic evolving among involved actors since the first stage of NPD until delivery to end consumers.	The researcher chose food recipe knowledge as a focused knowledge flow of the study.

Table 2.12

Research gaps and directions on the aspect of "OI practices"

Gap area	Identification of research gap(s)	Directions for filling the gap [originality of the study]
OI practices gap(s)	● *Lack of empirical characterization of OI practices which occur in Thai FI SME context.* The study of OI practice in SMEs has been neglected (Bigliardi & Galati, 2013a, 2016; Van de Vrande et al., 2009). Only a few literatures studied in OI practices in Thai FI SME context. As the OI practices from Van de Vrande's (2009) typology has been established through the survey of OI practices observed in SMEs (included FI), it is believed that these OI practices are the only available study in the extant literature. Thus, the researcher adopted this typology as the fundamental OI practice of the study.	The observed OI practices in this case study that are not categorized in Van de Vrande et al.'s (2009) typology, will enrich previous typology during the study.
	● *Lack of empirical characterization of OI practices mobilized in coupled OI logics in Thai FI SME context.* Regarding Van de Vrande et al. (2009), 2 types of OI practices have been described by linking the technology exploitation and exploration to outbound and inbound OI logics respectively. However, the preliminary study of the researcher (Hongsaprabhas et al., 2018) indicated the additional finding on this aspect. The dominant outbound practices and dominant inbound practices are connected to the exploitation and the exploration respectively. Moreover, as one NPD project comprises many OI practices, the overall NPD can be considered as coupled OI logic.	The researcher added the concept of dominant outbound practices and dominant inbound practices are connected to exploitation and exploration in this study

Table 2.13

Research gaps and the research directions on the aspect of "OI in NPD"

Gap area	Identification of research gap(s)	Directions for filling the gap [the originality of this study]
OI in NPD gap	● *No OI study in the NPD context of "laboratory scale" and "industrial scale" in the Thai FI SMEs.* OI approach can be complied at all stages of the NPD process (Bigliardi & Galati, 2013a; Sarkar & Costa, 2008). There are many NPD processes described by many authors based on the dimensions and views of each author (Chaochotechuang, 2016; Najib & Kiminami, 2011). However, among those views, one of the mutual problems in NPD is the gap between NPD strategic developers and NPD technological associates (Beckeman et al., 2013; Neubauer et al., 2013; Noorman, 2011; Suwannaporn & Speece, 2010). The literature also indicated the gap between FI NPD and the actual production as the lack of concentration on industrial scale (Hongsaprabhas et al., 2018).	The researcher applied the laboratory scale and industrial scale as a studied NPD context.

According to the mentioned research gaps and directions, this study extends the other OI studies by adopting the theoretical framework to first investigate the flexibility of OI logics and practices in the Thai food machinery SMEs which act as the food innovation intermediary in OI NPD process, and then to identify the explicit OI GMs.

Thus, the originalities and values of the study are as follows:

1) to provide OI GMs in NPD of Thai food machinery SMEs which has never been described in the knowledge and innovation management research to apply in the Food-Machinery framework (Bigliardi & Galati, 2013a) with OI logics (Chesbrough, 2006) and practices (Van de Vrande et al., 2009).

2) applying coupled OI logic: outbound and inbound dominance, to extend the OI literature on relationship of OI logics and practices (Van de Vrande et al., 2009).
3) providing the actual OI practice in FI SME through the interview and observation of the investigated Thai machinery SMEs.
4) focusing on the food recipe knowledge flow in the NPD processes at laboratory and industrial scale.

2.6 Theoretical Framework for Studying OI GMs in Food NPD Process

The systematic development of knowledge framework/model helps to capitalize tangible and intangible resources to enable better relationship management among different actors (Bigliardi & Galati, 2016). To fill the research gaps, this study provides a theoretical framework to illustrate the application of various OI implementation patterns based on OI logics and practices across the different stages in the NPD process based on the context of the Thai food machinery SMEs. For selection purposes, the researcher examined and assessed all the eight different models based on Galanakis (2016) work are can be used to describe OI implementation in FI. These models comprise of the followings:

1) Connect and Develop model (Huston & Sakkab, 2006)
2) Sharing is Winning model (Traitler & Saguy, 2009)
3) The Food machinery framework (Bigloardi & Galati, 2013a; Bigliardi et al., 2010)
4) Living-lab OI model (Wolfert et al., 2010)
5) Want, Find, Get, Manage model (Garcia, 2011)
6) Selective Sharing OI model (Lazzarotti & Manzini, 2013)

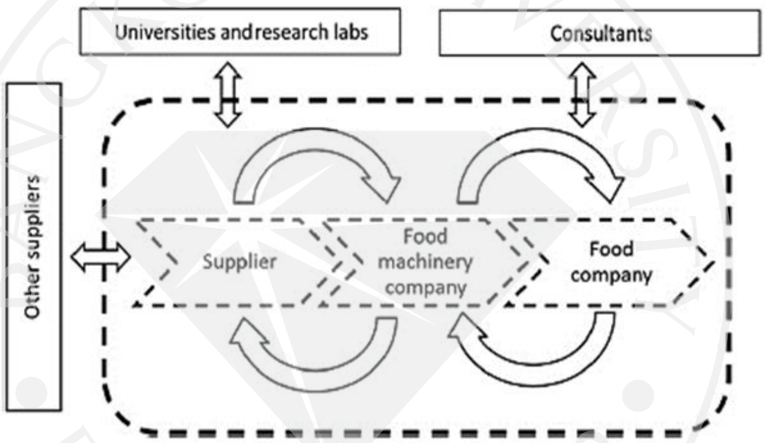
7) Value Co-creation OI model (Martinez, 2014)

8) Consumer-centric OI model (Tsimiklis et al., 2015)

Based on the evaluation, there is only one model that can be adopted to explore the specific practices attached to OI logics applied in the FI: the Food-Machinery framework (Figure 2.19).

Figure 2.19

Theoretical framework: Food-Machinery framework and the open food supply chain



Note. The framework is adopted from Bigliardi and Galati (2013a)

For that reason, the researcher chose this model as a basis to study OI logics and practices implemented in Thai food machinery SMEs. Based on the literature, the support reasons of choosing the model are as follows:

1) The Food-Machinery framework presents the most frequent OI adoption applied in food machinery SMEs (Bigliardi & Galati, 2013a; Bigliardi et al., 2010; Galanakis, 2016; Grimsby & Kure, 2019; Hongsaprabhas et al., 2018);

2) This model is consistent with many actors involved in FI supply and/or value chain. The involved actors as shown in Figure 2.19, the researcher is able to

conclude that the model is aligned with the Quadruple Helix innovation view which integrates 4 groups of actors, namely industry, academia, government/public, and citizens (Carayannis et al., 2009). As Bigliardi et al. (2010) stated that SMEs' needs multiple external sources of knowledge to sustain NPD, this situation has increased the complexity of the food supply chains. Thus, the more involved actors described in the model, the more proper models need to be chosen for the study;

3) The model shows the knowledge transfer and reciprocal interaction between different actors in the supply chain (Bigliardi et al., 2010; Galanakis, 2016). This indicate that the OI logics (outbound, inbound and coupled) and OI practices (technology exploitation and exploration) can be identified using this framework;

4) This is only model that focuses on food machinery company as the core actor of the study. The model also indicates the collaboration mechanism adopted by food machinery company with food company, its suppliers, and other involved actors;

5) The main finding of this model indicated the significant role of innovation in the food machinery company over the food company in the OI process (Bigliardi et al., 2010). Thus, it matches the researcher's purpose to answer the question of why some of Thai food machinery SMEs are able to be innovative food intermediaries.

As the scope of OI is very broad, for this study, the researcher is only interested to explore OI logics (outbound, inbound and coupled) and practices (exploitation and exploration) by using food machinery framework (Bigliardi & Galati, 2013a) as the basis for the identification of OI GMs. The scope of the study focuses on NPD process: laboratory scale and industrial scale. The definition of each key actor in the study context are followings:

2.6.1 Food machinery company

Food machinery company is company whose business is a factory that manufactures processed food products. It is equipped with personnel and knowledge related to the processing and production processes. It possesses food technologies, machinery, and facilities suitable for mass production (Arunsawadiwong, 2007; Lehtinen & Torkko, 2005), properly licensed to establish a production plant, be able to produce processed food products according to the scope of the list of permits and be able to register the FDA number for legal commercialization of new products (Hongsaprabhas, 2017b). Food machinery company is an important actor who serves to add value to food products, and has connections and networks with various actors in food supply and/or value chain to produce such food products (Bigliadi & Galati, 2013b). Take for instance a canned fish factory focusing on fish food processing by using fish and cans from its suppliers to process and pack in sealed containers as cans, and use sterilization technology to extend the shelf life of fish food without the need of preservatives or refrigerator. In food supply-value chain of each processed food product, the food machinery company could be in a position of both food company and food machinery company at the same time (Bigliardi & Galati, 2013a; Hongsaprabhas et al., 2018). In other words, for such food products, a food machinery company can act as both mass production producers and distributors. Otherwise, it may hold a status as a food machinery company that only acts as a contractor for mass production (OEM) for other food companies. In this study, the investigated food machinery companies are mainly food innovation intermediaries whereby the NPDs are scale up to the industrial scale through various OI practices.

2.6.2 Food company

A food company is an organization having a business nature as a distributor of food products which is well-equipped with personnel and knowledge related to the distribution and marketing processes. The company has appropriate distribution connection and network to consumers and have appropriate license to distribute such products for legal commercialization of new product (Hongsaprabhas, 2017b). Most food companies often own the brand and have the ownership of food products over food machinery companies. This is because most of these products are commercialized through the management and supervision of the food company. The food company may be linked to other actors in food supply and/or value chain to carry out the following activities:

1) The ordering of finished goods from food machinery companies
2) Assisting in the distribution of products to the final consumer, such as exporters, wholesalers, and retailers.

In addition to the food supply and/or value chain of processed food products, food companies can maintain their status as both food machinery company and food company simultaneously. In this case, such food products are from food companies that are both mass production manufacturers and distributors at the same time. On the other hand, the food companies may just be the distributors. In such a way, the food company outsources to other food machinery company to produce products or buy finished goods from food machinery company. A good example is the Ayam brand, a major distributor of canned fish. The company has its own manufacturing facility in Vietnam and outsourced to other local food machinery companies to produce certain types of its canned fish products. In terms of its market positioning, Ayam mainly emphasizes the role of a distributor to distribute its products. The production role is passed to the other local food machinery companies.

In this study context, the food companies can be SMEs or large enterprises. According to the preliminary study Hongsaprabhas et al. (2018), the researchers found that the food company is an actor who closely contact the market and receives market demands, trends and knowledge, necessary for the NPD.

2.6.3 Supplier

Supplier (or regular supplier) is an organization or company that conducts business by supplying products and services to other businesses. This business to business (B2B) approach allows the supplier to be a regular partner in business transactions. It is generally accepted that suppliers play important roles in the production process in FI, as well as food NPDs (Bigliardi et al., 2010; Chaochotechuang et al., 2019; Galanakis, 2016). The more suppliers are trustable and reliable, the more agricultural ingredients that are difficult to control become more stable, reducing the risk of errors in the production process from raw ingredients (Hongsaprabhas, 2017b). Therefore, having negotiated the quality and price of raw ingredients/materials in a specific period, it is normal for most food machinery companies to take services from the regular suppliers to determine the quality and cost of food products. And likewise, to offer the selling prices of finished products to the food companies. Furthermore, it is necessary for the food machinery companies to have production standard such as GMP (Good Manufacturing Practice), HACCP (Hazard Analysis Critical Control Point), and HALAL for the Muslim market. These recognised standards help to keep all suppliers' information related to their production and to track back to the source of each raw ingredients/materials in case of problems (Pierce & Schott, 2012).

Therefore, food machinery companies prefer to use the services from regular suppliers rather than changing from time to time (Hongsaprabhas, 2017b). This is critical especially when agricultural ingredients have unique characteristics and high variation. In other words, the change of suppliers during NPDs (laboratory scale and/or industrial scale) could affect adversely in terms of smell, taste and appearance of final food products.

2.6.4 Other suppliers

Other suppliers (or new supplier) are the suppliers who have never done business together before. They may have new products such as agricultural ingredients/materials and/or services which have not been presented as regular suppliers did before. Thus, other suppliers have a greater role in conducting NPD in FI. A good deal of new food innovative products is caused by the discovery or application of new food ingredients (Bigliardi & Galati, 2013b). Some of the examples are as follows:

1) The discovery of Stevia, a natural sweetener that replaces sugar or chemical sweeteners. The NPD results in the use of Stevia in many healthy food products.

2) Konjac which is glucomannan or complex carbohydrate has low calories. It was originally used in powder form as a supplementary drink for weight control. Later, Konjac was formed into various shapes, such as grain shape or spaghetti shape. The Konjac raw ingredients has been developed as daily ready-to-eat food for weight control. New suppliers in food supply and/or value chain are important to OI and NPD. Other suppliers may be come from other industries but related to FI. These

industries include packaging supplier who may present new packaging to be used with the original products. Take for instance the sweetened condensed milk in a squeeze bottle which was originally in the form of canned sweetened condensed milk (Hongsaprabhas, 2017b). Other suppliers therefore are important actors who act as good sources of new knowledge for conducting NPDs.

2.6.5 Consultants

Consultants are people, organizations, or companies that provide various consulting services. In this study context, it refers to the FI consultant that provides consulting services related to food NPD. These consultants can be private consultants, private outsource R&D services, FDA registration coordinators. The preliminary study of Hongsaprabhas et al. (2018) found only few NPD that the investigated food machinery company had outsourced their R&D on the recipe development with private consultants. This is due to the high service fees of the private consultants as compared to mentors from universities.

2.6.6 Universities and research labs

University and research lab are public or private educational organizations that focus on the context of the inventor of knowledge and technology for commercial benefits. In this study, it refers to the universities and research labs that have R&D support unit for the private sector. Universities and research labs play huge role in food OI NPDs (Bigliardi & Galati, 2013a; NSTDA, 2018). Take for instance there are plenty of new food innovative products being jointly developed between universities/national research labs and food firms, especially in FI SMEs (Galanakis, 2016; Van de Vrande et al., 2009). Because most FI SMEs have limited capabilities on

R&D (Bigliardi et al., 2019), the universities and research labs have contributed greatly to the laboratory scale for FI SMEs. However, based on the preliminary study of Hongsaprabhas et al. (2018), the researchers found that the results of NPDs from the universities and research labs are mainly prototypes at the laboratory scale. At this level, these protoypes are not ready for mass production. Laboratory scale food recipe can not be used for production in the mass production directly as the NPDs require numerial testings and improving in industrial scale.

2.7 Chapter Summary

In this chapter, the researcher begins with explaining the 3 main goals of the literature review. First is to identify key definitions, findings, theories, and articles in main areas of OI, FI, and SME in the extant literatures. Second is to critically analyze and identify the gaps in current knowledge and the third is to synthesize a theoretical framework to guide the researcher's study.

The second section discusses the method deployed in the literature review. The researcher adopted the systematic literature review (SLR) using the method by Jones (2004). The SLR comprises of 5 steps namely, problem definition, searching the literature to identify relevant research studies on the chosen topic, selecting studies to be included in the review, analyzing and synthesizing data and reporting of the results. The process supports the researcher in finding the preliminary gaps in OI in Thai FI SME context.

The third section discusses the related literatures on topic of OI in the FI SMEs. The topics include OI logics (Inbound, outbound and coupled), OI practices (exploitation and exploration practices), OI adoption models (8 models) which focuse on the Food-Machinery framework (Bigliardi & Galati, 2013a) and NPD process (laboratory and industrial scale) to identify OI GMs for the study.

The fourth section discusses the knowledge gaps from the literature. The 4 main research gaps include

1) The gap on the aspect of OI in FI SME: No academic result explains how some Thai FI SMEs efficaciously adopt OI; no study identifies OI generative mechanism in the NPD of Thai FI SMEs context; lack of studies on OI logics and practices in the Thai FI SMEs context; lack of specification of the nature of the actors involved in OI studies; and no specific OI framework proposed in the Thai FI SMEs context.

2) The gap on the aspect of OI logics: Lack of precision regarding the dominance of the flow in coupled OI logics in the context of Thai FI SMEs; Lack of specification of the nature of knowledge flowing in OI studies in Thai FI SME context.

3) The gap on the aspect of OI practices: Lack of empirical characterization of OI practices which occur in Thai FI SME context; Lack of empirical characterization of OI practices mobilized in coupled OI logics in Thai FI SME context.

4) The gap on the aspect of OI in NPD: No OI study in the NPD context of laboratory scale and industrial scale in the Thai FI SMEs.

The fifth section presents the theoretical framework: the food - machinery framework (Bigliardi & Galati, 2013a), to guide this study and identify OI GMs of Thai FI SMEs in NPDs.

From the literature review, the following conclusions can be made: the nature and sequence of the different efficacious OI logics and practices alternation within

Thai FI SMEs is still poorly understood. This study demonstrates empirically the different mindsets of the Thai FI SMEs to support their OI logics and practices adaptability in NPD process. The researcher applies OI logics of Chesbrough (2006), and connects with their associated OI practices suggested by Vrande et al. (2009) in NPD projects of the investigated Thai food machinery SMEs. The observed OI logics and practices during the study require some adjustments to the theoretical practices as described in the literature. Specifically, the development of Food-Machinery framework with food NPD process in this study, is to manage the relationship among the actual involved actors with OI logics and practices aspect, to arrange the sequence of the relationship according to the actual NPD process which can then be categorized as laboratory scale and industrial scale, to establish the food machinery SMEs as the knowledge center for studying all types of these relationships. Finally, the proposed theoretical framework and necessary information, are appropriate to apply in this study.

CHAPTER 3

METHODOLOGY

3.1 Introduction

To achieve the objectives of the study, the research design needs to adhere to the research methodology find the answers for the research problems. This chapter discusss the research methodology for the study focusing on the research paradigm and particularly on the critical realism (CR) paradigm with logical inference explanation. It furthers explain the case studies selection, determines the propositions, the design of the conceptual framework, the research method and data collection procedures. The important aspects of the ethical considerations and the role of the researchers are also included in this chapter. At the end of Chapter 3, the researcher presented a summary of the discussion.

3.2 Research Paradigm

In the discovery of the truth in social science research, Lincoln (1985) and Guba (1985, 1988) have developed research paradigms through the philosophical concepts of ontology, epistemology, and methodology (Lincoln, Lynham, & Guba, 2011; Mertens, 2010). These three concepts are closely related, irreducible, and sequential. Ontology, the motto of the source of knowledge, must come first and determines epistemology to obtain that knowledge and then decide to choose the method of acquiring appropriate knowledge in methodology (Hay, 2006).

Hammersley (2013) defined the research paradigm as frames of references that shape design and how research should be conducted. Whereas, Creswell (2009) used the term "worldview" for the same meaning. The distinction between paradigm and worldview is framed in terms of general orientation about the world, type of beliefs, and nature of research that the researcher brings to the study. Nowadays, there is an ongoing argument about what beliefs the researchers bring to the research investigation. Some authors argued that worldview suits individual researcher who embraces a qualitative and quantitative, or mixed methods approach in their research. They believe these research approaches should not be viewed as polar opposites or distinct categories. Whereas, the paradigm fits individual researcher who focuses on either quantitative or qualitative approach in their research. These research approaches represent different point of views (Creswell, 2014; Newman & Benz, 1998). As this research study adopts a qualitative approach, the researcher uses the term paradigm which is defined by Wahyuni (2012) as "*a set of fundamental beliefs and assumptions how the world is perceived which then serves as a thinking framework that guides the researcher's behavior*" (p.69). The research paradigm focuses on the philosophical dimension of social sciences in terms ontology and epistemology (Wahynuni, 2012).

OI generative mechanism is rather subjective and intangible. However, the researcher acknowledges the presence of the OI generative machanism in the commercialized NPDs of the Thai food machinery SMEs. The recognition of OI GM is perceived through the OI logics and practices in these innovation intermediaries. Importantly, the reality of the OI logics and practices are independent of human minds, observations and descriptions. As such, reality and knowledge are of different natures. In this study, the OI logics and practices embed the researcher's knowledge of reality and it represents one of the perspectives. It can easily be explained that the OI logics and practices are the cause of recognition and are the object of cognizance.

Thus, this present research is guided by the critical realism (CR) paradigm with logical inference explanation.

3.2.1 Critical Realism (CR)

Critical Realism epistemology was developed by Roy Bhaskar in the 1970s (Bhaskar, 2013). It allows for the reality of social as well as physical or biological objects. This epistemology has significant influences on social theory, sociology and organizational studies (Fleetwood, 2014). Critical Realist believes that external objects are real without the need for people to know it. What this means is that people may not be able to recognize the real object. The reason being that it concerns individuals' experiences which in reality are not accessible in reality as object in a state. However, the perception in that object can be realized through some intermediaries. Therefore, objects in our perception are not real objects, but is an object that appears to the mind that recognizes it.

The ontology of CR states that reality exists in nature which can be perceived or not perceived by the senses of human. Thus, most of the realities exist independently from human senses. As for the epistemology of CR, it focuses on looking back to find a mechanism which is the nature of reverse consideration (retroduction) to indicate the relationship between factors that are the cause and the resulting phenomenon. These are then linked to the methodology of CR which leads to the construction of a model (Sanew, 2014).

3.2.2 Ontology of CR

The main ontological hypothesis of CR states that reality realities exist independent of human senses (Sanew, 2014). To integrate this ontological hypothesis of CR, Bhaskar (2013) classified reality into three layers as depicted in Table 3.1. These layers are explained as follows:

1) Real. The first layer signifies the causal structures and mechanisms with enduring properties. It contains all physical or social objects, which possess structures, properties and causal powers. They can therefore act on other objects and phenomena to produce changes.
2) Actual. This is the realm of events that happens when causal powers operate. It included the events (and non-events) generated by the real or mechanisms. These events may or may not be observed. The layer encompasses the relationships between the observable and unobservable factors underlying the empirical.
3) Empirical. This is the domain where the incidents are actually observed or experienced. It includes what can be seized about the objects and phenomena. This layer contains the data or facts to be gathered to perform a scientific analysis. The attempt of science according to the CR is to delve from the empirical layer through the actual to the domain of the real.

Table 3.1

The attribute of 3 domains/layers of the reality in Critical Realism

Attributes	Real domain	Actual domain	Empirical domain
Mechanisms / Causal powers	✓		
Events	✓	✓	
Experience / Actions	✓	✓	✓

Note. This table is adapted from Sanew (2014)

Bhaskar (2013) categorized knowledge into 2 categories, namely natural knowledge and human explained knowledge. Bhasker subdivided human explained knowledge in 2 dimensions which comprises of Transitive and Intransitive knowledge. Transitive dimension of knowledge refers to knowledge that humans interpret and create to explain the truth that they seek. This knowledge is an important part in applying the explanations and change continuously. As for the Intransitive dimension of knowledge, knowledge relates to anything that has not changed and is a property of anything that is inherent. A good example is the properties of copper which can be electrically and heat conductive. In fact, human knowledge is not accessible to all truth. Humans then try to create an explanation through "transitive" knowledge and then make use of that truth. Therefore, the difference between transitive and intransitive is that transitive has the characteristics of the concept, while intransitive refers to what actually exists (Outhwaite, 1987). Take for instance, the social world which things are created by a society i.e., election, coup d'etat etc. the scientific world which things that exists in nature and humans can touch and recognize.

In addition to Bhaskar, another important thinker of realism is Collier (2005), who discussed the 5 principles of CR ontology. The 5 principles are as follows:

1) Considering what are the elements of the study which in this sense is all-inclusive. Although most realists believe in material objects, some such as Berkeley (1871; 2009), opened that it is about the mind and ideas. This also means common sense realism, such as people, animals, or trees. These things are real and free from human perception. It is not a thought or being created from human discourse.

2) The mechanism that is believed to be the cause of that reality which cannot be seen in both nature and society (except, some technology currently used to assist the study for some cases). CR assumes that science cannot explain the mechanism of the cause covered in every event. Things have some power within their own structure, even though these powers are not revealed, i.e., gravity affects the flight of birds, even though the birds do not fall to the ground by gravity as expected. Therefore, the mechanism is still hidden, or various possibilities that we still do not realize that are real yet or are all real and actually have impact.
3) The truth in nature is an open system, while the experiment must be done in the closed system. This shows that there are still many mechanisms (plurality of mechanisms) that are involved in determining each event. These diverse mechanisms can be explained through various sciences such as physics or social sciences. It includes the tendency to use explanations from other disciplines. The realist defends this idea that reality has many domains/layers, and each domain has its own rules which are irreducible to another layer. However, the diversity of Collier's mechanism emphasizes participation in phenomena but did not focus on creating a model as Bhaskar.
4) Similar to the third principle but with emphasis on the human mind that cannot be reduced to just a brain lump in ergonomics. That is an open awareness and does not lead to a relationship between cause and effect in doing things. This is an indispensable aspect of the transformation model of social activity consisting of 3 main ideas. Firstly, society is the result

of human actions. Secondly, all human actions imply society and relationships and institutions as a condition of possibility. Human intentions (caused by intention) lead to repeated production in society (very often unintentionally). Take for instance, laborers are willing to work and get paid in return. This resulted in repeated production, unintentionally becoming a production path in capitalism (Collier, 2005).

5) CR argues the idea that everything in reality is positive, no real disappearance and no negative reality. Bhaskar (2013) argues that lacking or missing anything can affect and that effect is real. Take for instance, overdraft in banks or negative return of stocks. In addition, in nature there is a negative truth as well, A drought occurance for example.

In this study, the researcher follows Bhaskar's (2013) ontology of CR. This is because Bhaskar (2013) focuses on creating a model (Sanew, 2014) that matches the study objectives to identified OI GMs in NPD of Thai food machinery SME, rather than Collier (2005) who emphasized the relationship of plurality of mechanism in causing phenomena. Hence, the researcher observes the empirical layer, but actual and real domains are not necessarily known to him and do not reveal themselves only through observation.

3.2.3 Epistemology of CR

The epistemology of CR is the retroduction that identifies the relevance between cause and phenomenon (Sanew, 2014). Retroduction is looking back to find generative mechanisms (GMs) that are different from the concept of positivism that emphasizes prediction, such as the cold causes the water to become frozen. Positivism is only interested in what is causing the result, but CR is interested in the process and formation of mechanism. In this example, CR focuses on studying how cold turns the water into ice. The explanation therefore must consider the mechanism and how the process of cooling affects molecules and changes the state of water from liquid to solid. It means CR emphasizes knowledge from understanding the truth. As for this study, the researcher sought to explain how OI logics and practices could lead to OI GMs and identify the casual power or mechanism that causes such phenomena.

Bhaskar (1986) suggested that the general explanations in the philosophy of CR can be categorized into 2 types

1) The theoretical explanations described by considering back to the source and make comparison (analogical-retroductive). It starts with the description to see that the behavior that is studied should be in accordance with the rules of the theory. After that, the researcher tries to go back and see what the cause of the behavior might be (retroduction) by means of comparison with already known phenomena to find a way to explain such behavior. The next step will be thorough consideration of the various explanations and eliminate explanations that are not used. The final step is identifying the mechanism that causes that behavior based on empirical evidence discovered as confirmation.
2) The practical explanation, on the other hand has the characteristic of reverse consideration to the source and distinguishing of the elements (decompository-retroductive). It explains the concrete phenomenon starting by distinguishing the elements of the complex event or the situation clearly (resolution) and then depicts these elements according to the theoretical concept again (redescription). After that, it considers what

may be the source of the elements by using the rules of proven theory or using the theory about the tendency of this phenomenon and finishes by eliminating explanation of other causes that cannot be used.

However, regardless of the nature of any explanation, the process of explaining the phenomenon along this CR consists of 3 basic steps (Outhwaite, 1987). These steps are as follows:

1) Present of theoretical concepts that illustrates the mechanism that links the cause to the outcome.
2) Collecting evidence data to prove that the mechanism exists as the theory has stated or not. The theory will guide the data collection and the characteristics of the data to prove it.
3) Eliminate the theory of other explanatory options when it is found that the theory used is able to identify mechanism that can explain such phenomena with the reason to believe that the mechanism exists and there is no other theory to explain.

In addition, CR explanation has been used in many studies (Keat & Urry, 1975; Harré, 1961) which belongs to Blaikie (2007). Hence, the researcher follows the study of Blaikie (2007) and the guidelines of the reverse method (Retroduction) into 7 items (Keat & Urry, 1975; Harré, 1961) as shown in Table 3.2.

Table 3.2

The application guidelines of retroduction to the study

Guidelines of retroduction in epistemology of CR (Blaikie, 2007)	**The application of retroduction (Blaikie, 2007) to the study**
1) The scientist must try to find an appropriate structure and mechanism to explain the observed phenomenon and consistency (regularities) of such phenomena.	The researcher proposes OI logics and practices (Van de Vrande et al., 2009) to explain OI GMs in the study.
2) As the structure and mechanism cannot be observed, the scientist therefore has to firstly create the model of the structure and mechanism.	The researcher adopted the Food-Machinery framework (Bigliardi & Galati, 2013a) as a theoretical framework of the study.
3) If the model that was created is correct, it will be able to explain the structure and mechanism which express the relationship of the cause and effect of the phenomenon	The researcher conducted a preliminary study with one food machinery SME to see the potential of this study. The preliminary study of the researcher (Hongsaprabhas et al., 2018) confirmed the relationship of OI logics and practices in food OI NPD (Empirical domain), as well as the possibility to identify OI GMs (Real domain).
4) Then the scientist tested the descriptive hypothetical model of existence and relationship which such test should be in concrete.	In this study, the researcher compared the OI NPD findings (in empiraical-real-actual domains) from the multiple NPD cases (109 NPDs) in 2 investigated food machinery SMEs.
5) If the test results are successful, it indicates a good reason to believe that the existence of this structure and mechanism	
6) Structures and mechanisms may be confirmed directly by developing and using the right tools	In this study, the researcher recurrent qualitative data collection based on the processes repetition from 5 rounds of semi-structured interviews.
7. Then repeat the process of creating the whole model to explain the structures and mechanisms that have been discovered.	

In this study, the knowledge of reality is based on empirical observations. It is possible to know context-sensitive reality through combining the empirical observations and interpretations. The analysis of these observations enables the establishment of patterns that reflect the reality through new observations. This process of refinement mobilizes a recursive loop of abduction, deduction and induction in Pierce's sense (1958). It allows the construction of models or frameworks that best reflects the studied objects structures and properties to reveal progressively the OI generative mechanisms in the food industry OI NPDs.

3.2.4 The Methodology of Critical Realism

The methodology of scientific realism is the construction of models that explain the phenomenon (Sanew, 2014). In simple term, it looks at the phenomenon of causal explanation to prove the truth of the model. If it is proven true, the law can be then obtained. The model that is often adopted to make comparison of existing things. It supposes that what is studied is similar to anything that exists. If the model can be explained, the model can actually be used. However, if the model does not work, it must be recreated by comparing new things. Hence, the methodology of CR in acquiring knowledge resulting from epistemology of CR is a method that can discover and prove the existing mechanisms that causes causal relationships. This is called the reverse description method or retroductive (Blaikie, 2010; Pawson & Trilley, 1997).

For this research, the researcher accepted the philosophical paradigm of CR assumptions. The research approach, design and method are based on the Critical Realism paradigm.

3.2.5 Limitation of Critical Realism

Although Bhaskar (2013)'s CR concept is suitable to explain the way for social science, there are some limitations in terms of the differences between natural fact and social fact. For Bhaskar, the CR concept is not applicable, if there is no tangible or intransitive object, and if there is no mechanism that shows the relationship of the cause to the effect. Therefore, it is difficult for social science whereby social action or structure depends on human thinking. Being concept dependent means that there is no intransitive object. Moreover, separating reality into different domains or layers is difficult to identify and some may not be able to tell whether it is real or not (Sanew, 2014).

3.3 Research Approach

Research approach is plans and the procedures of the research. It comprises the steps from very broad assumptions to the detailed method of data collection, analysis, and interpretation. It involves several decisions taken based on the philosophical assumptions that the researcher brings to the study that is the research design and specific research methods (Creswell, 2014). Creswell (2014) proposed 3 research approaches to the academic research. The approaches are as follows:

1) Quantitative research: It is an approach for testing objective theories through the investigating relationship among variables. These variables can be measured in numeric form. Thus, the numbered data can be analyzed by using statistical procedure. The quantitative approach is typically chosen for situation where the researcher believes the truth is clear cut, exists and is objectively measurable. Therefore, the typical results break down reality in variables (independent and dependent) and

through that investigates hypotheses and/or build theory. The generalization of results is the ultimate objective of such research (Creswell, 2014).

2) Qualitative research. It is an approach for understanding and exploring the meaning of individual or group associate with human or social problems. This approach is focusing on individual meaning and instituting the complex situation. The process of qualitative research involves indicating questions and procedures, data collection in the participant or respondent's setting, data analysis from particular to the general theme, and interpretation of the meaning of data. The qualitative approach is more typically chosen for the situation where the researcher believes there is an interpretivist dimension to the truth. He or she believes the context and the involved actors in the context shape the reality. The reality is therefore always different depending on the context and the involved actors in the study context. The generalization of the research findings is much more difficult and less likely than quantitative research (Creswell, 2014).

3) Mixed method research. This is an approach for the inquiry which involves both quantitative and qualitative data collection. The quantitative data usually are closed-ended responses and can be measured in numeric form while qualitative data comprises of open-ended questions without predictively response. This approach uses unique research design that may involve theoretical frameworks and philosophical assumptions. The combination of characteristic from the quantitative and qualitative approaches provides more understanding of research questions than either

research approach by itself. The core benefits of using mixed methods neutralizes the bias and weakness of data collection based on each form of quantitative and qualitative research. Take for instance, it increases the validity of the study as one database could be used for checking accuracy and the other support the explanation of another database when asking different types of questions. In other words, one database could build on another database and one database could contrast the other database during the study. This mixed-method is therefore sought for convergence across quantitative and qualitative approaches (Creswell, 2014).

The selection of research approach is usually based on the nature of the research problem, the audiences of the study, and the researcher's personal experience.

As for the initial research questions of the study in Chapter 1, the approach was qualitative research. The specific reasons for adopting this approach are explained below:

1) Most of the OI studies have been so far been dominated by the qualitative research approach which draws heavily on case studies and in-depth interviews (Grimsby & Kure, 2019; Usman et al., 2018). Thus, the researcher follows the same trend of study as the other authors.

2) Even though there have been extensive studies in the domains of OI and NPD, only little has been studied about OI logics and practices. Moreover, there is no study of OI generative mechanism favoring OI logics and practices in NPD of the Thai FI SME todate (Hongsaprabhas et al., 2018). The researcher sought to listen to the respondents and build an

understanding based on the theoretical framework of the Food-Machinery framework (Bigliardi & Galati, 2013a), and the experiences of practitioners. Hence, the researcher followed an exploratory approach and conducted the qualitative research for this study (Creswell, 2009).

3) The qualitative research represents the view and perspective of the respondents in the study, the context and the actors in the context shape the reality (Yin, 2011). In this study, the view and perspective of the respondents are crucial to the understanding of the OI GMs favoring OI logics and practices in NPD of Thai FI SME. Hence, this justifies the need for qualitative research (Creswell, 2014).

In this study, there are some of quantitative data collected, and mixed or combined with the qualitative data in order to provide a better understanding to the research problem. However, the researcher does not consider this a mixed method due to the fact that these quantitative data do not have closed-ended responses and none of the analysis uses statistical procedure as in quantitative analysis (Creswell, 2009). As for the preliminary study of the researcher in Hongsaprabhas et al. (2018), the researcher can identify the dominant characteristic of coupled OI logic in NPD processes (outbound dominant or inbound dominance) through counting the total number of OI practices (technology exploitation or exploration) that actually occur in each NPD. Nevertheless, the quantity of OI practice is variable that can be counted and measured in numeric form. In order to identify the dominant direction of coupled OI logics, the summation amount of OI practices in technology exploitation group over exploration group can be linked to coupled OI logic with outbound dominance. Likewise, the summation amount of OI practices in technology exploration group over exploitation group can also be associated to coupled OI logic with inbound dominance (Hongsaprabhas et al., 2018). Hence, this part of the study is considered as quantitative data, but it is not quantitative approach (Creswell, 2014).

At the same time, the researcher can confirm the accuracy of analysis through the inquiry of opinions from those involved in the OI activity which enable the confirmation of the conclusion for the coupled OI logics. Accuracy can also be matched based on the outbound and inbound dominance between observed qualiative and quantitative data. This part of the study attributes to qualitative research (Creswell, 2014). Therefore, this is the way researcher integrate the quantitative and qualitative data, such as one database could be used for checking the accuracy (validity) of another database (Creswell, 2014) but still considered as qualitative research approach, not mixed-method approach.

3.4 Research Design

After conducting a literature review and preliminary study (Hongsaprabhas et al., 2018), the researcher decided to adopt the Critical Realism paradigm (Bhaskar, 2013) and the qualitative research approach (Creswell, 2014). The researcher provides research design of the study in this section. Research design (Creswell, 2014) means planning, managing research projects and determining methods for obtaining answers that are needed from the research. It is a type of investigation or inquiry within quantitative, qualitative, and mixed-method approaches that provide specific procedures and direction of the study (Singhasenee, 2003). Whereas some of the researchers refers to this as strategies of inquiry (Denzin & Lincoln, 2011).

As there are many research designs existing in the qualitative field. Take for instance narrative research, phenomenological research, ground theory, ethnography, and case study (Creswell, 2014). The researcher has to consider the various designs in a qualitative field and choose only the most appropriate design for the study. As the main purpose of the study is to identify the OI GMs in efficacious OI NPDs in the Thai food machinery SMEs, the OI logics and practices become the focused factors. The researcher chooses the case study as a fundamental research design of the study. The specific reasons for adopting this approach are according to Yin (Yin, 2012) are explained as below:

1) The researcher considered this study as largely exploratory in nature. Case study has been widely recognized as an appropriate research design for exploratory research.
2) The focus of this study is to answer "WH" questions;
3) This case cannot be considered without the context.
4) The researcher cannot manipulate the respondent's behaviors in the studied context
5) The researcher wants to cover contextual conditions because the researcher believes that there is some relevance to the phenomenon under the study. In order to gain OI GMs favoring OI logics and practices of Thai food machinery SMEs, the context setting is developed and utilized. It would be impossible for the researcher to get OI GMs without considering the context within which it occurred.

3.4.1 Case Study

Baxter and Jack (2008) indicated that the case study is a form of qualitative research which is designed to bring out details based on the viewpoint of respondents by using multiple sources of data (Stake, 1995; Yin, 1993). This ensures the researcher' explores through a variety of lenses which allows for multiple dimensions of the phenomenon to be revealed and understood. The close collaboration between the respondents and the researcher is developed, while enabling respondents to tell their stories from their point of views (Baxter & Jack, 2008; Crabtree & Miller, 1999). It provides tools for the researcher to study complex phenomena within the study context. Moreover, it provides evidence for decision-making in both clinical and policy realms. It is a valuable method for academic research to develop theory, create interventions and evaluate programs because of its rigor and flexibility. It allows researchers to explore individuals or communities or organizations or programs, relationships, simple or complex interventions (Yin, 2003) and supports the construction and subsequence reconstruction of various phenomena (Baxter & Jack, 2008). However, Gerring (2004) argued that the case study method often practiced by both academia and practitioners with little understanding.

Different researchers have different things in mind toward the term case study (Brady & Collier, 2010; Gerring, 2001; Ragin 1987, 1997; Ragin & Becker 1992). There are many definitions of case study. Campbell & Stanley (1963) stated that it was a research which investigates the properties of a single case (p.7). According to Yin (1994), case study is a qualitative method research with small number of participants (Yin, 1994). However, Gerring (2004) argued that it was wrong to define case studies as employing more than one case. Likewise, earlier researcher's definitions were too general. These definitions describe only certain kinds or sub types of the case study, rather than the general phenomenon itself.

The definition of case study should be relatively bounded with phenomenon which none of stated definitions above have mentioned. However, there is still acceptable to continue using these definitions to refer to what case study is about (Gerring, 2004). Gerring's (2004) study needed to be clearer and narrower to eliminate the confusion about case study. He proposed a definition for case study as "*an intensive study of a single unit for the purpose of understanding and generalizing across a larger class of units or similar units*" (p.342). For this research, the researcher follows the definitionby Gerring (2004) because it captures the essential features of other extant definitions.

The next popular argument is the ambiguity of case study research. Case study method is held in low respect due to the ambiguity of research design and the ethical issue of individual researchers in this discipline. There is a perceived difference between case study and non-case study research which is still largely unjustified and regarded as misconception (Gerring, 2004). Gerring (2004) argued that many things in the real-world we know are drawn from case studies. The case study method still considered appealing to most academic output nowadays. It is solidly thriving even among the academia who is not traditionally associated with this style of research (Acemoglu, Johnson, & Robinson, 2003; Bates, Greif, Levi, Rosenthal, & Weingast, 1998; Rodrik, 2003). There is a large proportion of research generated by case study. Likewise, the practitioners continue to accept the trade off of using the case study method with difficulty to elucidate what they are doing. Gerring's (2004) study supports the idea that the uniqueness of case study is more clearly understood when confined within a broader set of methodological options. The case study relies on the same sort of correlation evidence which is used in non-case study research. All empirical evidences of causal relationship correlates in the real-world. The correlation refers to the mutual relationship between X and Y. An essence cause and effect must be found to correlation. They must disappear and appear or perform some of other transformations, more or less predictable. Conversely, the absence of correlation is considered as disconfirming evidence. If the appearance and disappearance of X and Y are not associated and cannot reasonably be explained, and predicted. Hence, the empirical evidence shows that a causal relationship does not exist in the study. However, these arguments between case study and non-case study discipline do not seem any closer to the mutual agreement when these debates arise several decades ago. The case study method still survives in a methodological sense (Gerring, 2004).

3.4.2 Determining the Case/Unit of Analysis

To consider what is appropriate to ask for the research questions, the researcher has to consider what the case is, and what it is not. The case is a phenomenon of some sort that occurs in a bounded context, or the unit of analysis (Baxter & Jack, 2008; Miles & Huberman, 1994). A case or unit of analysis conveys spatially bounded phenomenon, observed at a single point of time or over some delimited period (Gerring, 2004). In this study, the researcher wanted to identify the OI GMs by analyzing the difference between organizations, that is the individual Thai food machinery SMEs that are food innovation intermediary.

To select the cases for the study, Stake (1995) and Yin (2003) suggested that the researcher should bind the case by placing the boundaries to the case to restrain the researcher from answering broad questions or developing too many objectives for the study. The boundaries can be implicit or explicit (Gerring, 2004). It will ensure that the study still remains reasonable in study scope. The suggested boundaries are (a) by definition and context (Mile & Huberman, 1994), (b) by time and activities (Stake, 1995), and (c) by time and place (Creswell, 2003). Hence, the case or unit of analysis in this research, is the implementation of OI in a single NPD project of individual Thai food machinery SME (Table 3.3). Two main attributes or variables of the case that are relevant to the current study are OI logics and practices. The main theoretical framework replication is the Food-Machinery framework (Bigliardi & Galati, 2013a).

Table 3.3

Developing the case study research questions through case and boundary identification

Case or unit of analysis	Research questions	Boundaries
The implementation of OI in a single NPD project of an individual Thai food machinery SME.	RQ1: Which types of actors are involved in Thai food machinery SMEs OI NPD processes? What relationships and roles actors have assumed in elaborating OI NPDs with the Thai food machinery SMEs	• Thai food machinery SMEs that act as the innovation intermediary • NPD process that comprises of laboratory and industrial scale
	RQ2: What OI logics and practices are implemented in the Thai food machinery SMEs OI NPD processes?	
	RQ3: What generative mechanisms favor OI logics and practices implementation in the Thai Food machinery SMEs?	

Note: Researcher own composition

3.4.3 Determining the Type of Case Study

After deciding qualitative research as the research approach of the study and choosing the case study as the fundamental research design of the study, the researcher to consider what type of case study to be conducted. The selection of a specific type of case study will guidethe overall study purpose (Baxter & Jack, 2008).

Yin (2003) and Stake (1995) proposed that many different types of case studies. The various types of case studies are presented as follows:

1) Explanatory case study: It is used to seek answer for question that seeks to explain presumed causal linkage in real life intervention. It is more complex form of experiment or survey (Baxter & Jack, 2008; Yin, 2003).
2) Exploratory case study: This type of case study is used to explore situation whereby there is no clear evalution of an intervention, and there is no single set of outcomes (Baxter & Jack, 2008; Yin, 2003).
3) Descriptive case study: This type of case study is used to describe the phenomenon or intervention in a real-life context where it occurrs (Baxter & Jack, 2008; Yin, 2003).
4) Multiple case study (Yin, 2003) or collective case study (Stake, 1995): Such case study is used to examine the differences within and between cases. The ultimate goal is to replicate findings across the cases. Comparison will be drawn during the study. Hence, the cases must be chosen carefully so that the researcher can predict, contrasting or identify similar results across the cases based on the theory (Baxter & Jack, 2008; Stake, 1995; Yin, 2003).
5) Intrinsic case study: The kind of case study is used for better understanding of the case. Stake (1995) used the term intrinsic to suggest if the case study is suitable for the researchers who has a genuine interest in the case. The case itself is of interest including all its ordinariness and particularity. However, the purpose is not to come to understand the

generic phenomenon or some abstract construct. The results of this method have limited transferability (Baxter & Jack, 2008; Stake, 1995).

6) Instrumental case study: Instrumental case study is used for accomplishing something other than understanding a particular situation. This type of case study plays a supportive role in facilitating the understanding of something else. It provides insight into an issue or helping to refine the theory (Baxter & Jack, 2008; Stake, 1995).

In addition, there is another popular typology on the various research design which distinguish the case study in to 3 types. The distinctions are as follows:

1) Type I case studies (Gerring, 2004) or single case (Baxter & Jack, 2008) or single holistic case (Yin, 2003): This is a variation in a single unit over time. It preserves the primary case or unit of analysis. The number of cases to study is necessary to determine this type of case study. The consideration of the context is also important as well. Many researchers prefer this type of case study but they should aware that the cases must be in the one environment or context (Baxter & Jack, 2008; Yin, 2003).
2) Type II synchronically (Gerring, 2004) or single case with embedded unit (Baxter & Jack, 2008) or holistic case study with embedded units (Yin, 2003): This type of case study is a variation that breakdown the primary case or unit into sub-units and subjected to correlation analysis. It is crucial to consider sub-units that are situated within a larger case. Such case study allows the researcher to better illuminate the case when the data can be analyzed within the sub-unit separately (within case analysis),

between the different sub-units (between case analysis), or across all of sub-units (cross-case analysis) (Baxter & Jack, 2008; Yin, 2003).

3) Type III synchronically and diachronically (Gerring, 2004) or multiple case study (Baxter & Jack, 2008) or collective case study (Yin, 2003): It is a variation which the study contains more than a single case. Such case study is equivalent to the multiple experiment. The distinguishing characteristics between multiple case study and the single case study with embedded units is that the context is different for each type of case study. The multiple case study allows the researcher to explore and analyze within each setting and across settings. In addition, the several cases help the researcher to understand the difference and similarities between the cases, whilst the single case with embedded units allows the understanding of one critical/extreme/unique case only. The benefits of multiple case study include the prediction of similar results (literal replication) or predicting contrasting results as well as for predictable reasons (theoretical replication) (Yin, 2003). Furthermore, the multiple case study creates reliable and robust evidences for the study. However, it can be time-consuming and costly to conduct (Baxter & Jack, 2008).

In this study, the researcher uses the term of multiple case study when more than one case is being examined.

The research purpose is to identify OI GMs favoring OI logics and practices implementation in NPD process of Thai food machinery SME. The researcher choses multiple case studies type as a research design of the study. The specific reasons for adopting this approach are according to Yin (2003) and is explained as follows:

1) This study is about OI GMs favoring OI logics and practices in the NPD process of Thai food machinery SMEs, and it could not be considered without a context for data collection. The data collection context of the study is the NPD of Thai food machinery SMEs. Each NPD project provided different types of food ingredients-products, machine facilities, and involved actors. In other words, they are in different environments. Hence, this is not a single case or single case with embedded units. In this different context, the OI generative mechanisms favoring OI logics and practices are carried out. It would have been impossible for the researcher to have a real picture of OI GMs without considering the context within which they occur. The multiple case study emphasizes the study of the phenomenon within its real-world context and favoring the data collection in natural settings (Yin, 2012).

2) Even though single food machinery SME can provide many NPD cases for the study, the researcher considered that it is prudent to conduct multiple cases study from more than one food machinery SMEs to better understanding of the phenomenon of OI GMs favoring OI logics and practices, rather than just a single food machinery SME.

3) The data collection from multiple case studies gains from a limited number of sources in a relatively large number of cases at one point in time (Kerssens-van Drongelen, 2001). In this study, the data is collected from interviews with the few personnel at management levels of each Thai food machinery SMEs. Take for instance general manager, R&D manager, or production manager. These executives are actually

responsible for their NPD projects. The period for observation of each studied NPD project starts at the laboratory scale, then the industrial scale, and untill the new product is legally commercialized (Having FDA number).

4) The aim of the multiple case studies is to broadly explore the phenomenon in their real-world contexts and develop explanation because the cases have been selected based on the principle of theoretical replication (Kerssens-van Drongelen, 2001). As mentioned earlier of this chapter, this study is guided by CR paradigm with the logical inference made from an observation to a theoretical framework: The Food-Machinery framework (Bigliardi & Galati, 2013a), that accounts for the observation. Hence, the cases have been selected based on the principle of theoretical replication in this study.

5) The objective of multiple case studies is to replicate findings across the selected cases. It enables the researcher to explore any differences within and between cases. Hence, the researcher can predict contrasting results based on a theory or predict the similar results across the cases (Yin, 2003). In this study, the researcher can explore the various patterns of OI GMs. favoring OI logics and practices in the NPD process, through comparing various cases of NPD projects across different Thai food machinery SMEs.

3.4.4 Determining the Propositions

Propositions are the additional component required for the design and implementiation of a precise case study. Propositions are applicable to any case study types. They may or may not be present to the case study, and depending on the research purpose. The proposition can be considered as the hypothesis in quantitative approach. The more specific propositions included in the case study will help the researcher to place the limits on the study scope and increase the feasibility of completing the research. (Baxter & Jack, 2008). The data collection and discussion of the study are guided by propositions as well. Moreover, the propositions help the researcher to form the foundation for a conceptual structure or framework of the study (Miles & Huberman, 1994; Stake, 1995). Yin (2003) uses terms of “proposition” while Stake (1995) uses “issues”. Both are the same thing and lead to the development of conceptual frameworks that guide the study. To eliminate the confusion of implementing a specific term case study approach, the researcher uses proposition terms according to Yin’s (2003) study. Hence, the researcher developed several propositions to guide the study. In this study, the researcher proposed propositions from the literature, preliminary study, personal experiences, theory based on empirical data. The details are presented in Table 3.4.

Table 3.4

The case study propositions and their sources.

Propositions	Sources
The OI GMs in the NPD processes of Thai food machinery SMEs could be identified through the correlation of OI logics and practices.	**Personal experience and preliminary study** • Hongsaprabhas, Parisot, & Heo, (2018). Food Manufacturer Innovation Logics and Practices Flexibility: A Thai SME Case Study. In *ICMLG 2018 6th International Conference on Management Leadership and Governance* (p. 375). Academic Conferences and publishing limited.
The technology exploitation practices and exploration practices are connected to outbound OI logic and inbound OI logic respectively.	**Literature** • Van de Vrande., De Jong., Vanhaverbeke, & De Rochemont. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6-7), 423-437.
The technology exploitation practices and exploration practices are connected to coupled OI logic: outbound dominance and inbound dominance respectively. The summation amount of OI practices in technology exploitation group over exploration group is connected to coupled OI logic: outbound dominance. Likewise, the summation amount of OI practices in technology exploration group over exploitation group is connected to coupled OI logic: inbound dominance.	**Preliminary study and literature** • Hongsaprabhas, Parisot, & Heo, (2018). Food Manufacturer Innovation Logics and Practices Flexibility: A Thai SME Case Study. In *ICMLG 2018 6th International Conference on Management Leadership and Governance* (p. 375). Academic Conferences and publishing limited.
The involved actors in supply – value chain affect the OI GMs regarding the collective strategy theory indicated that the environmental forces prevail as driver of the organizational action.	

3.4.5 Determining Theoretical Framework

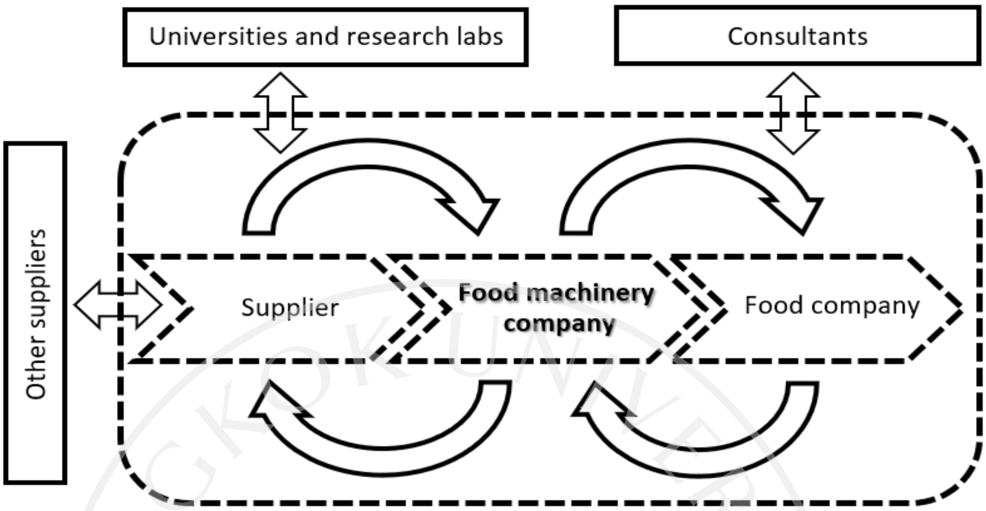
A theoretical framework (Imenda, 2014) refers to the theory that the researcher chooses to guide himself in the research study. It represents an integrated understanding of issues, within a given context, which enables the researcher to address a specific research problem. The theoretical framework evolves, or takes shape from literature review (LR) and/or the data collected. Moreover, it can be adopted and adapted from a preexisting theory or theoretical perspective. Thus, it is the application of a theory, or a set of concepts drawn from one and the same theory, to offer an explanation of an event, or a particular phenomenon or research problem.

Since innovation logics' paradigm shift has been described by Moore (1993) and has developed to the OI logic which has been described as Chesbrough (2003). These explain why the continuous development of the innovation strategy has also affected the FI ecosystem throughout the period of time. However, the study of the OI logics and practices implemented at the organizational level by FI SMEs remain poorly understood (Grimsby & Kure, 2019). During the last decade, there were studies concerning 8 OI implementation models specifically for FI presented by Galanakis (2016). Among these models, there is only one model that focuses on the food machinery companies as the center of the study. This research also explored the OI practices, which used the Food-Machinery framework (Bigliardi & Galati, 2013a). The literature shows that the Food-Machinery model is the most adopted model in the FI SMEs (Bombaywala & Riandita, 2015; Bottani, Gentilotti, & Rinaldi, 2017; Galanakis, 2016; Grimsby & Kure, 2019). This is due to the need of food machinery companies in FI supply-value chain to reach mass production and legal commercialization (Tambunlertchai, 2015). This OI Implementation model focuses on the relationship of the food machinery company (food machinery SME) with its own customers (food company) and suppliers in the deployment of OI logics and practices in NPD (Hongsaprabhas et al., 2018).

In this study, the researcher adopted the theoretical framework of the Food-Machinery Framework (Bigliardi & Galati, 2013a) as shown in Figure 3.1. The researcher linked the proposed proposition to ensure that the Food-Machinery framework is in study scope and able to provide a good structure for the final report.

Figure 3.1

The theoretical framework: The Food-Machinery framework



Note. This figure adopted from the Bigliardi and Galati (2013a)

3.5 Research Methods

Research methods are the tools or techniques which the researchers utilize for data collection (Willig & Stainton-Rogers, 2008) and build an argument for the study (Schensul, 2008). It also provides the procedures that form the overall research methodology of the study (Schensul, 2008). There are many research methods in qualitative research approach. Some of the methods include interview, participant observation, elicitation techniques, and various forms of mapping. Each of the methods can be further subdivided such as interviews with key participants or local experts, narratives with individuals or in-depth interviews, group interviews, and network interviews (Saunders, Lewis, & Thornhill, 2009).

In this study, the researcher selected the tools based on the large set of assumptions. This study adopted semi-structured interviews as the main research method. The research method is explained in the next section.

3.5.1 Data Collection

As the researcher conducted systematic literature reviews, and preliminary study (Hongsaprabhas et al., 2018), the first step in a boundary for the research. The researcher sets the following inter-related objectives:

1) Generate general ideas about the OI GMs in the Thai food machinery SMEs in terms of OI logics and practices

2) Identify the theoretical framework for the study: The Food-Machinery framework (Bigliardi & Galati, 2013a)

3) Define the study context: The context is set on the NPD process at the laboratory and industrial scale. For research paradigm on CR, research follows a qualitative approach using multiple-case study. For dara collection, semi-structured interviews help to enrich the database

Semi-structured interview method is conversational and more informal in tone. It allows for an open response in the respondent's own words rather than "yes or no" type of answer (Longhurst, 2003). The method for analyzing the data in this study is based on the method proposed by Yin (2003). It is adopted with minor modifications for further data analysis. This research method also involved note writing and audio recording during and after data collection, simultaneous data collection and analysis, double-codification, and the development of concepts through the connection of the researcher’s analysis to the related literatures (Tranfield, Denyer, & Smart, 2003).

3.5.1.1 Semi-structured interview method. It sometimes referred to informal, conversational or soft interviews, is a verbal interchange where the interviewer attempts to draw out the information from the interviewees by asking questions with a list of predetermined questions (Longhurst, 2003). This method is often preceded by observation, informal and unstructured interviewing to allow the researcher to develop a keen understanding of the study topic which is necessary for developing relevant and meaningful semi-structured questions (Cohen & Crabtree, 2006). Basically, there are 3 types of interviews based on the structure of the interview (Dunn 2005; Longhurst, 2003). The first is structured interview. This form of interviewing follows a standardized and predetermined list of questions. The questions always asked the same way and same orderly. Second, unstructured interview. The unstructed interview is actually directed by the interviewee rather than set of questions. Lastly, the semi-structured interview. This type of interview is in the middle between the first 2 continuum. It has some degree of predetermined order but more flexibility in the way issues is addressed by the interviewee. Cohen & Crabtree (2006) indicated the unique characteristics of semi-structured interviews are as follows:

1) The interviewer and interviewee engage in the formal interview.
2) Interviewer develops a list of questions and topics that need to be covered during the conversation as an interview guide. The questions and topics are usually in a particular order and open-ended questions. This interview guide provides a clear set of instructions for the interviewer and can provide comparable and reliable qualitative data.
3) The interviewer follows the interview guide but is able to follow topical tracks in the conversation that may stray from the guide when the interviewer feels this is more appropriate. This provides the opportunity for identifying new ways of understanding the investigated topic.

The specific reasons for adopting semi-structured interview method are explained as follows:

1) The semi-structured interview method allows the researcher to take a more active role in determining how the conversation will proceed. It tends to base the content of the interview on the interests of researchers (Morgan, 2008).
2) The semi-structured interview method allows the researcher to develop good will, harmoniousness, and companionship with the interviewee and increase the likelihood of learning details about their perspectives in their own words (Plano Clark, 2008). Thus, it can provide more depth and detail about each interviewee (Morgan, 2008).
3) The observations can be made during the interviews which may include key non-verbal cues used by interviewee such as finger-hand motions and head nodding. Moreover, the researcher can observe the study context, if the interviews take place in the interviewee's setting such as their working place or R&D laboratory (Plano Clark, 2008).

In this study, the data collection stage comprises of semi-structured interviews with the personnels in management position from two of the Thai food machinery SMEs who are food innovation intermediary regarding their NPD projects. The implementation of OI in the single NPD project of individual Thai food machinery SME is considered as one case. Prior to each interview, the various publicly available on both online and offline about the studied organization, are reviewed in order to obtain some general understanding about the investigated companies, food products and core production technologies. These prior findings are used as the discussion issues during the interviews as well as for analyzing the results of the interviews.

Some of the interview questions are presented in Appendix A are guided by this information. The researcher also used the results from the preliminary study (Hongsaprabhas et al., 2018) to conduct the majority of interview questions (see Appendix A). Moreover, the researcher adapted the interview guide of this research based on the studies of Chaochotechuang (2016) and Jensen (2014) whose studies related to the application of semi-structured interview method in FI. A list of questions (see appendix A) asked during each of the 5 interviews helped the researcher to explore the experiences (empirical), events (actual) and structures & mechanism (real) of each interviewee.

3.5.1.2 Interview sequence. As this data collection process attached to the CR, semi-structured interview is performed 5 times with each interviewee to be able to dig and explore successively the 3 domains/layers of reality: empirical, actual and real. To achieve such a goal, experiences, events and structures & mechanisms are successively explored during the successive interviews of the investigated Thai food machinery SMEs. During their explanation in each interview, the researcher asked the 3-research question in every single step of NPD. The original Food-Machinery framework (Bigliardi & Galati, 2013a) is used as analytical grids to discriminate between the different types of actors, to specify the flow of knowledge attached to the food recipe and to distinguish the OI logics and practices, the active factors, underlying mechanisms involved in food NPDs.

Each sequence of interview followed the same process to ensure the gathering of the needed data regarding the experiences, events, and mechanisms (Table 3.5).

Interview 1. This interview focuses on the identification of OI experiences associated with NPDs. The interviewees were first asked to qualify the NPDs implemented in an historical / chronological order. NPD cases are then selected for each SME when all the following elements are available:

1) FDA number of new products has been obtained,
2) OI logics and practices are mobilized during the NPDs,
3) the food machinery company participated in the NPDs.

Since the present study aims at identifying all the GMs involved in OI logics and practices implementation in the context of food machinery SME NPDs, the selection of commercialized new products has been preferred over NPD failures to ensure that the complete sequences of GMs could be identified.

A particular focus is given to the origin of the food recipe. This allows the researcher to identify the organizational starting point of the food recipe knowledge flow. Considering that the origin of the food recipe impacts the nature of GM sequences and implies different types of activation of these sequences, this identification is of capital importance. Adding to this, the focus is given to the identification of the organization that owns the new product (Intellectual Property Right - IPR). Once this data is collected, NPDs are grouped based on the origin of the food recipe and the recipe owner. This discrimination allows later on to distinguish the historical repartition of the selected NPDs based on the starting point of the recipe knowledge flow (the flow affirms the validity in Interview 2). It also helps to clarify later on the events attached to each group of NPDs based on the origin of the recipe (the flow confirms the validity in Interview 3). Finally, this discrimination later on also simplifies the determination of GM attached to each group of NPDs (confirming the validity in interview 4 and 5). In terms of related actors, OI logics and practices involved in each selected NPD are identifies by interviewees in the interviews.

Interview 2. During this second interview, a map of the actors involved in each selected NPD precising the nature of their relationships in the OI logics and practices is presented to the interviewee to confirm the validity of the data collected from the first interview. The particular focuses on the repartition of NPDs steps between the laboratory scale and industrial scale is applied to better understand which NPD steps are attached to what scales. At this stage, based on OI logics and OI practices experiences identified in the food NPDs, the Food-Machinery framework (Bigliardi & Galati, 2013a; Grimsby & Kure, 2019) validity is tested with the first batch of empirical evidences collected. Moreover, this interview also focuses on all NPD events affecting the selected NPDs. Events are of different nature depending on the scale, operational, managerial, strategic, and environmental. The external organizational event is distinguished from internal organizational events. However, events can be linked according to their original location in terms of scale, nature and consequences. A change in the corporate environment (external event) can lead to the set up of a new strategy (internal event) for the SMEs to survive that change. The choice to seize the opportunity to develop a new recipe/product (strategic) can cause changes in the organizational routines or operation. At this early exploratory stage, 3 main types of events are considered, namely events triggering the sensing and / or seizing of NPDs, NPD events, and external / environmental events affecting the number of NPD opportunities available on the market.

Interview 3. This third interview begins with the presentation of the Food-Machinery models refined to present the different types of OI logics and practices identified after analysis of the data collected from the 2nd interviews to confirm the explanatory power of the proposed modelizations. All remarks, clarifications, and precision of the interviewees are recorded to improve the proposed models. Then, each NPD group is explored from the stage of sensing / seizing until the final FDA registration. This sequential exploration of OI experiences in NPDs allow to reveal the OI active factors at each step of development. It also allows the qualifying of internal and external actors involved in each of the NPD step and helps to clarify the flow of knowledge attached to each food recipe developmental step. At this stage, based on the different types of events identified, their underlying / mechanisms are identified. All empirical evidence of connections between these mechanisms are considered.

Interview 4. This forth round of interview begins with the presentation of NPD events, mechanisms involved in each NPD group after analysis of the data collected during the 3rd interviews. This is to confirm the validity of the data collected from the third interview. All remarks, clarifications, and precision of the interviewees are recorded to improve the proposed models. The 4th interview focuses on the mobilization of the mechanism in the steps of NPDs. In other words, it examines how involved the mechanisms are in connection to each NPD group. This information reveals the dynamism of the activation of GMs and the mobilization of specific capabilities. At this stage, based on the suggestions of the interviewees and on the data collected, the framework combining all the involved mechanisms and their connections can be refined. Existent patterns of GMs are elaborated based on the commonalities of their sequences. As for the total number of NPDs analyzed (109), it is possible to establish the difference in GM sequences as the sequences manifest itself in similar concrete situations. A particular emphasis is applied on the manner in which GMs interact with each other at different scales under specific conditions. The goals at this stage are as to interpret the meaning of the GMs when they come into view in specific contexts; to determine to what extent these GMs contribute to explain concrete events and processes and, to distinguish accidental circumstances from structural and recurrent conditions.

Interview 5. These last interviews aim at confirming the superior explanatory power of the last version of the modelizations developed based on the data collected during the 4th interviews. All remarks, clarifications, and precision of the interviewees are recorded to improve the proposed models for each pattern of the GMs. This fifth interview begins with the presentation of a second refinement of the Food Machinery Model which includes the sequence of GMs after the analysis of the data collected during the 4th interviews to confirm the explanatory power of the proposed modelizations. Therefore, a framework combining all the involved GMs and TFs and their connections can be elaborated. This framework is compared with all previous frameworks (Bigliardi & Galati, 2013; Bigliardi et al., 2010; Grimsby & Kure, 2019; Hongsaprabhas et al., 2018) developed for the food machinery context to ensure the integration of the critical elements.

As this data collection process attached to the CR perspective, the researcher presented the research findings from data collection by following the steps in the interview (5 times interview with each interviewee) at Chapter four. Then the researcher concluded the answers to each of the research questions (RQ1-RQ3) in Chapter five.

Table 3.5

The interview sequences in an explanatory research based on critical realism

Interview sequences	Reality domain (Bhaskar, 2013)
Interview 1: -To understand the OI NPD overview of the investigated food machinery SMEs -To qualify the selected NPDs -To identify the origin of the food recipe and IPR -To identify involved actors -To identify OI logics & practices **Result of the 1st interview:** -The categorization of OI NPDs based on the original creator of recipe and IPR -The involved actors, OI logics & practices -Initial mapping of the actors involved in each selected NPD precising the nature of their relationships regarding OI logics and practices	• Empirical domain (Experiences) • Actual domain (Events)
Interview 2: -To confirm the data collected and analysis from interview 1 -To identify all NPD activities (NPD events) and the attached capabilities **Result of the 2nd interview:** -The refined food machinery models to present the different types of OI logics and practices -Initial identification of involved NPD events -Initial identification of involved OI active factors	• Empirical domain (Experiences) • Actual domain (Events) • Real domain (Mechanisms)
Interview 3: -To confirm the data collected and analysis from interview 2 -To identify the events affecting the selected NPDs (external & internal events) -Revealing the DCs mobilized at each step of NPD -To identify the first TFs which activate GMs **Result of the 3rd interview**: -The identification of OI active factors -The identification of mechanisms underlying NPD event -The initial framework to present the involved mechanisms and their connections	• Empirical domain (Experiences) • Actual domain (Events) • Real domain (Mechanisms)
Interview 4: -To confirm the data collected and analysis from interview 3 -To identify the frequency of mobilization of the GMs in the steps of NPDs -The framework combining all the involved mechanism and their connections **Result of the 4th interview:** -The refined food machinery frameworks combining all the involved mechanisms and their connections	• Empirical domain (Experiences) • Actual domain (Events) • Real domain (Mechanisms)
Interview 5: -To confirm the superior explanatory power of the last version of the modelizations developed based on the data collected during the interview 4 **Result of the 5th interview:** -The GMs model favor OI logics and practices implementation in Thai food machinery SMEs	• Empirical domain (Experiences) • Actual domain (Events) • Real domain (Mechanisms)

3.5.1.3 The semi-structured interview guide. The interview guide of this research is adapted from the studies of Chaochotechuang (2016) and Jensen (2014). Both researches applied semi-structured interview method in the FI. It is important to collect specific data of the individual NPD projects performed by the selected Thai food machinery SMEs in order to identify OI GMs favoring OI logics and practices. Thus, the interview questions should link the interviewee to answer each research question and be adapted to the practitioner's language (see appendix A). The appropriate communication language to the interviewee is a major constraint of the study. Interviewees are not familiar with the academic and technical language used at this stage. Moreover, some of OI practices are very general and broadly defined. For example, customer involvement, external networking and employee involvement. Even though, it is uncertain how the definitions have influenced the understanding of the interviewees and outcomes, the researcher tries to get the interviewees more precise views on OI logics and practices in SMEs with narrower and more specific examples. The interviewees are asked the same pattern of interview questions for each of their NPD projects and/or NPD groups, as a series of interviews.

During the interview sessions, the various answers and languages used from the interviewees may prevail. Hence, it is necessary for the researcher to keep in mind the boundary of the study. For example, the food recipe has always been considered as the key element in the exchange of knowledge flows. As for the direction of the knowledge flows of all exchanges between individual Thai food machinery SME and its partners have been specified by considering the Thai food machinery SMEs as the central actor as proposed in the theoretical framework of the Food-Machinery framework (Bigliardi & Galati, 2013a). The OI logics are established using exchange of food recipe knowledge flows. When the OI logic is coupled, the exchanged volume of resources in terms of food recipe and its related tacit knowledge and explicit knowledge, technology, and ingredients are considered as outbound or inbound dominance; the OI practices associated with each studied NPD has been qualified and classified using the typology of Van de Vrande et al. (2009) at laboratory scale and industrial scale. When the practice observed didn't match the typology, a new category of practice will be created and defined.

To comprehensively analyze the research problem, the researcher collects both quantitative and qualitative data at this stage of the research. The mixing data means that both quantitative and qualitative data are combined in some way that one of the data sets plays the key role while the another adopts an auxiliary role (Creswell, 2009).

Both quantitative and qualitative data are collected simultaneously or sequentially at the data collection phase. The researcher typically collects both forms of quantitative and qualitative data at the same time and integrates the information in the interpretation as overall findings. This is known as concurrent embedded strategy (Creswell, 2009). The contradiction findings have to explain if they are occurring (Creswell, 2014). In this study, the mixing data is used for collecting OI logics and practices data. The quantitative data plays a key role and the qualitative data plays an auxiliary role.

3.5.1.4 Determining Data Sources and Database. As the researcher adopted the multiple case study as the fundamental research design of the study, the distinctive point of this case study research is the availability of multiple data sources (Yin, 2003). This strategy also helps to enhance data credibility (Baxter & Jack, 2008; Patton, 1990; Yin, 2003). The data sources of this study are from interviews; documentation based on testing reports, nutrition facts, and FDA reports; archival records; physical artifacts (new food products); direct observation, and participant observation. Thus, the data from multiple sources are converged in the data analysis process, which help the researcher to better understand the whole phenomenon than handled individually. This convergence enhances the strength to the research findings as various strands of data are combined together.

Since semi-structured interviews often contain open-ended questions and discussion may diverge, it is generally best to record interviews and later transcript these records for the analysis and interpretation. While it is possible to jot notes to capture interviewee and participant's answers, it is difficult to focus on conducting an interview, discussion and jotting notes parallelly. The jot note only will result in poor notes and detract for the development of companionship between interviewer - interviewee, and the participants (Cohen & Crabtree, 2006). Moreover, the direct observation and participant observation are included as the researcher's technique in order to collect the data.

After gathering all the raw data, it is important to organize the data effectively (Stake, 1995; Yin, 2003). The researcher develops the case study database to organize the data from each source such as a group of key documents from literature review, notes and audio files from each interview. The database helps the researcher to improve the reliability of the case study. The main idea of this task is that the data are available for independent inspection, easy to track the data, and can retrieve at a later date (Wickham & Woods, 2005).

3.5.2 Participants

The research paradigm comprises of a qualitative approach with a research design based on multiple case study. The research method uses semi-structured interview to collect data. The researcher uses purposive sampling in this study because it involves selecting "information-rich and illuminative cases" for in depth study (Patton, 2002). The Information-rich and illuminative case helps the research to explore a great covenant about issues of the greatest significance to the aim of the study (Patton, 2002). It is necessary to select the participants who reach the minimum requirements in order to provide sufficient data for the study. There are several types of sampling in the purposive sampling approach. Some of the approaches include typical case sampling; paradigmatic case sampling; stakeholder sampling; extreme or deviant case sampling; maximum variation sampling; theory-guided sampling; criterion sampling; critical case sampling; and negative or disconfirming case sampling (Palys, 2008). The researcher adopted the purposive sampling with the criterion sampling type for this study as it involves searching for individuals or cases which meet a certain criterion (Palys, 2008).

The researcher specifies the certain criteria as follows:

1) The selected Thai food machinery SMEs must be food innovation intermediaries. To identify OI GMs favoring OI logics and practices in the NPD process of specific Thai food machinery SMEs, the researcher has to ensure that the studied Thai food machinery SMEs adopted OI

approach in their NPD. Therefore, OI logics and practices must be identified by these selected Thai food machinery SMEs.

2) The individual or interviewee must be in the management level who is responsible for the organizational NPD project of the Thai food machinery SMEs. As this study focuses on the strategic management level, that is the across internal and external organizational boundaries, the position of interviewee should be at management level. Contrast to the NPD operational level which always focuses on NPD task itself, most of the time their work confined to the R&D area boundary and this does not match the research purpose. Thus, the selected interviewee can be the general manager or R&D manager or production manager, depending on the job function of each studied Thai food machinery SMEs.

3) The selected NPD cases must be commercialied OI NPDs for the identification of OI GMs. This is based on the following criteria that they need to achieve legal commercialization (Having FDA number), involved external actors, and applied OI logics and practices.

Hence, three types of data are sampled with the mentioned criteria as stated above i.e., sampling the food machinery SMEs (type 1), sampling of the interviewees (type 2), and sampling of NPD Cases selection (type 3).

In this study, two participants, from the food innovation intermediaries and in different Thai food machinery SMEs, are recruited for the semi-structured interview. As the single case is “the implementation of OI in the NPD project of an individual SME”, the respondent may provide more than one NPD case information. To ensure that the empirical data collected are adequate for the analysis and interpretation, a series of 5 interviews with one interviewee was carried out. This enables a rich collection of progress data based on the recursive loop refinement process (Peirce, 1958). By doing so, the relevance of the information on the actual and real domain extrapolated from the data collected in the empirical domain align with reality (Bhaskar, 2013).

3.5.3 Data Analysis

In general, the type of data analysis depends on the types of the case study type. Yin (2003) proposed 6 steps for data analysis, namely pattern matching, linking data to propositions, explanation building, time-series analysis, logic model, and cross case synthesis. Stake (1995) proposed categorical aggregation and direct interpretation for analysis type. Van den Hoonaard and van den Hoonaard (2008) presented a 4 steps data analysis which consist of note-taking, coding, writing, and developing concepts. Ritchie, Lewis, and Ormston (2013) and Rabiee (2004) proposed two key stages of data analysis which comprises of managing the data, and making sense of the evidence through explanatory or descriptive accounts. Among the various types of data analysis proposed by the many authors, Baxter and Jack (2008) suggested that the researcher should choose the approach which are most appropriate for their studies.

To answer all three research questions, the appropriate data analysis is Yin's (2003) method. The researcher proposes the steps in data analysis of the semi-structured interviews (Yin, 2003) as following:

1) Conduct interview
2) Transcribe interview (intelligent verbatim transcription)

3) Pattern matching to the theoretical framework (the Food-Machinery framework by Bigliardi and Galati, 2013a)
4) Linking data to the proposed propositions
5) Explanation building through the retroduction (Blaikie, 2007)
6) Conduct Time-series Analysis. The implementation of OI in the single NPD project of individual Thai food machinery SME is considered as one case. The diachronic case study (Gerring, 2004) is adopted for study each single case.
7) Develop logic model to display the relationship among proposed construct. This helps to sequence the position of related actors reflected the reality, and emerged all the themes to the conceptual framework
8) Perform cross case synthesis to analyze patterns among cases to identify the contradictions and similarities in findings of each case. This enables the research to explain supported reasons and synthesis the proposed of OI GMs in Thai food machinery SMEs.
9) present analysis result

The distinctive data analysis of Yin's (2003) method focuses on return the analysis of the propositions during the analysis phase. This practice helps the researcher to control his analysis by maintaining to the scope of the research question. It also explores the rival propositions which attempt to provide an alternative explanation of the study phenomenon. The number of propositions and rival of propositions might increase or decrease, depending on the new addressed, accepted or rejected propositions through the research findings. However, Baxter and Jack (2008) argued that it is a pitfall in this data analysis method. As for Yin's (2003), the data analysis method treats each data source independently and the findings reports separately. For this reason, the researcher who adopted this method must be ensure that the data are converged in an attempt to understand the overall case and not just various parts of the case. Baxter and Jack (2008) also suggested that sense-making analysis will ensure that the researcher remains truthful to the original case. This strategy can be done by the presence of the researcher's supervisor (Dr. Xavier Parisot) in the analysis, synthesis, and the interpretation of results to reduce the biases. Furthermore, all analyzed and synthesized information from each interview, should be validated by the interviewee in the following interviews.

3.5.3.1 Verbatim transcription and coding. Verbatim transcription according to Eppich, Gormley and Teunissen (2019) is a method of converting spoken word (from interview) into text so that the message is captured precisely the way it has been spoken. This requires a keen ear and considerable attention to detail. In other words, it cannot be created by mindlessly listening and writing. One needs to pay close attention to each sound, tone, word and make intelligent use of punctuation to convey the correct messages. Eppich et al. (2019) suggested 3 types of verbatim transcription. The 3 types are as follows:

1) Intelligent verbatim transcription. It involves interview transcription with detailed editing, and sometimes minor paraphrasing. In this style, non-verbal communication and filler words are avoided. This style is preferred transcription for those who need error-free (Grammatical errors).
2) Verbatim transcription. This is a more detailed program than the intelligent verbatim transcription. In this style, every word on the recording is transcribed as it is, including false starts and grammatical

errors (incomplete sentences). However, extra details like irrelevant repetitions and stutters are removed.

3) True verbatim transcription. It is the most detailed account of an interview recording which include every word, sound, non-verbal communication, and ambient sounds.

In this study, 5 rounds of interviews were recorded with the consent of each interviewee. The interview records were transcribed in the word program, using intelligent verbatim transcription immediately after the completion of each interview to provide a permanent record of qualitative data and maintain research momentum (Bogdan, 2003).

The transcription analytical technique employed the cut-and-paste approach often used by qualitative researchers (Myers, 2011). It involved reading the intelligent verbatim transcripts, identifying phrases, sentences or longer extracts that are relevant to the research questions. It then inductively developing a coding system for the major themes identified, and then highlighting the parts within the verbatim transcripts that corresponded to each theme using a color-coding technique. Once the verbatim coding process is complete the color-coded copies of the transcripts are cut and sorted, so that all parts within each transcript that related to a particular theme were placed together and ready for the further analysis (Fielding & Thomas, 2008). In this study, the researcher adopts double-coding for the verbatim transcripts with another PhD candidate from Bangkok University, to minimized bias. Then coding themes were compared for reliability (Pilnick & Swift, 2011).

3.5.3.2 Retroduction. Although there are various ways to derive an answer to a research question, from the CR prespective, the only explanation of data analysis method or reasoning method is retroduction (Data & Catlett, 2013).

The epistemology of CR is the retroduction that identifies the relevance between cause and phenomenon (Sanew, 2014). Retroduction looks back to find generative mechanisms that emphasize knowledge from understanding the truth. With regard to this study, it explains how OI logics and practices can lead to OI GM identification and the casual power or mechanism that causes the phenomena. The researcher follows the CR explanation guideline provided by Blaikie (2007) on how to perform retroduction into 7 items (Keat & Urry, 1975; Harre,1961) which is presented in Table 3.2 in section 3.2.3. In this study, the knowledge of reality is based on empirical observations. It is possible to know context-sensitive reality through combining the empirical observations and interpretations. The data analysis of these observations enables the establishment of patterns that will again be confronted with reality through new observations. This process of refinement mobilizes a recursive loop in Peirce (1958). It allows the construction of conceptual frameworks that best reflect the studied objects, structures and properties to reveal the progressive of OI GMs in the food industry NPDs.

3.5.4 Reporting the Case Study

The goal of reporting the case is to engage the readers to demonstrate the study in such a complex manner as to enable the audience or reader to feel as if they were active participant of the research. Hence, they can determine whether or not to apply the research finding to their own study. Even though reporting the case study is a difficult task for any researcher due to the complex nature of this approach, there is no absolutely correct way to report the case study (Baxter & Jack, 2008). However, there are some suggestions for reporting the case study. Some of the suggestions include not showing superfluous interest on the data generated grom the research question, returning to the research propositions to avoid this pitfall (Yin, 2011), comparing and contrast research findings with existing literature (Baxter & Jack, 2008).

To simplify the analysis and the presentation of OI GMs favoring OI logics and practices, the theoretical framework: the Food-Machinery framework (Bigliardi & Galati, 2013a) is applied to demonstrate research findings in each interview. The research findings were presented by considering the investigated Thai food machinery SME as the core actor in its ecosystem. The knowledge flows have been analyzed by focusing on the development of food recipes knowledge at the laboratory scale and industrial scale of the NPD process. The 2 scales are connected most of the time but can be achieved independently. As this analysis is empirical, the OI logics and practices considered have not been limited to just the classical description (Van de Vrande et al., 2009) but enlarge to all types of observed practices that enable OI logics implementation. Furthermore, the identification of NPD events, involve OI active factors, underlying mechanisms are demonstrated by adapting the Food-Machinery framework as a fundamental model.

3.5.5 Organization of the Research Process

In terms of time frame, the researcher has provided a time schedule with details of the interview schedules of the 5 rounds of interviews. The plan also indicates the activities, the participants as well as the duration of each meeting. The details are presented in Table 3.6. The two participants, namely Interviewee A, Food

& Beverage manager of SME A and Interviewee B, the General Manager of SME B have contributed extensively to the progress and development of the research. As for the codification process, presented in Table 3.7 highlights the codings, the criteria attached to the codes, the coding themes as well as the analysis results of each reality domain (Bhaskar, 1978; 1986; 2013). As this is a complication process, the researcher has placed all the critical elements into a flow chart format for ease of understanding. The details of the coding process are discussed in Chapter 4.

Table 3.6

Summary of the interview time frame

Activities		Date	Participants	Location
Exploration for the target SMEs period: Oct - Dec 2019. Interview confirmation by the investigated SMEs on Jan 20				
Interview 1	Conducted interview 1 with SME A	18 Feb 20 (2 hours 15 mins)	Researcher and Interviewee A	R&D office at Sahapan Century Co., Ltd., Bangkok.
	Conducted interview 1 with SME B	21 Feb 20 (50 mins)	Researcher and Interviewee B	Resident of the researcher, Bangkok (Zoom video interview)
	Transcribed interview 1	24 Feb - 13 Mar 20	Researcher	-
	Double coded for interview 1 transcripts	14 - 20 Mar 20	Researcher and another researcher	-
	Comparison coding result between 2 coders	22 Mar 20 (6 hours)	Researcher and another researcher	Cafe at the Royal Bangkok Sports Club, Bangkok
	Interview 1 data analysis and synthesis	23 Mar - 19 Apr 20	Researcher and Advisor	Bangkok University
Interview 2	Conducted interview 2 with SME A	20 Apr 20 (1 hours 30 mins)	Researcher and Interviewee A	Resident of the researcher, Bangkok (Zoom video interview)
	Conducted interview 2 with SME B	22 Apr 20 (45 mins)	Researcher and Interviewee B	Resident of the researcher, Bangkok (Zoom video interview)
	Transcribed interview 2	25 Apr - 9 May 20	Researcher	-
	Double coded for interview 2 transcripts	10 - 16 May 20	Researcher and another researcher	-
	Comparison coding result between 2 coders	17 May 20 (5 hours)	Researcher and another researcher	Cafe at the Royal Bangkok Sports Club, Bangkok
	Interview 2 data analysis and synthesis	18 May - 7 Jun 20	Researcher and Advisor	Bangkok University
Interview 3	Conducted interview 3 with SME A	8 Jun 20 (1 hours 25 mins)	Researcher and Interviewee A	R&D office at Sahapan Century Co., Ltd., Bangkok.
	Conducted interview 3 with SME B	11 Jun 20 (45 mins)	Researcher and Interviewee B	Cafe at the Royal Bangkok Sports Club, Bangkok (Zoom video interview)
	Transcribed interview 3	13 - 25 Jun 20	Researcher	-
	Double coded for interview 3 transcripts	21 - 27 Jun 20	Researcher and another researcher	-
	Comparison coding result between 2 coders	28 Jun 20 (4 hours 50 mins)	Researcher and another researcher	Cafe at the Royal Bangkok Sports Club, Bangkok
	Interview 3 data analysis and synthesis	29 Jun - 12 Jul 20	Researcher and Advisor	Bangkok University
Interview 4	Conducted interview 4 with SME A	13 Jul 2020 (1 hours)	Researcher and Interviewee A	R&D office at Sahapan Century Co., Ltd., Bangkok.
	Conducted interview 4 with SME B	14 Jul 20 (35 mins)	Researcher and Interviewee B	Cafe at the Royal Bangkok Sports Club, Bangkok (Zoom video interview)
	Transcribed interview 4	15 - 26 Jul 20	Researcher	-
	Double coded for interview 4 transcripts	27 Jul - 8 Aug 20	Researcher and another researcher	-
	Comparison coding result between 2 coders	9 Aug 20 (4 hours)	Researcher and another researcher	Cafe at the Royal Bangkok Sports Club, Bangkok
	Interview 4 data analysis and synthesis	10 - 23 Aug 20	Researcher and Advisor	Bangkok University
Interview 5	Conducted interview 5 with SME A	24 Aug 20 (1 hours)	Researcher and Interviewee A	R&D office at Sahapan Century Co., Ltd., Bangkok.
	Conducted interview 5 with SME B	28 Aug 20 (45 mins)	Researcher and Interviewee B	Cafe at the Royal Bangkok Sports Club, Bangkok (Zoom video interview)
	Transcribed interview 5	29 Aug - 5 Sep 20	Researcher	-
	Double coded for interview 5 transcripts	6 - 12 Sep 20	Researcher and another researcher	-
	Comparison coding result between 2 coders	13 Sep 20 (3 hours 45 mins)	Researcher and another researcher	Cafe at the Royal Bangkok Sports Club, Bangkok
	Interview 5 data analysis and synthesis	14 - 27 Sep 20	Researcher and Advisor	Bangkok University

Note: This table is the composition of the researcher

Table 3.7

Summary of codification process

Semi-structure interview: 109 NPDs
Intelligent verbatim transcription (Eppich et al.,2019)

Double-coding for the verbatim transcripts with a PhD candidate from Bangkok University
Transcription analytical technique: cut-and-paste approach (Myers, 2011)

The focus of research attention		Actors involved in each NPD cases	OI practices involved in each NPD cases	OI logics in each NPD cases	Factors activate the ability to implement OI in each NPD case
Coding criteria	Focusing on food recipe knowledge	All actors who provided different knowledge needed for recipe development	All activities that needed for the development of food recipe across organizational boundary (Williamson & De meyer, 2012).	The knowledge direction of the exchange food recipe flow between actors (Van de Vrande et al.,2009). When the OI logic is coupled, the exchanged volume of knowledge resources are considered as outbound or inbound dominance	The terms that related the abilities to implement OI, and are answer repeatedly from the interviews.

Comparison coding result between 2 coders

Coding Result	Linking data to the literature and proposed propositions	Coding themes	External actors		Internal actors									
			External actors who involved OI NPD	External actors who are not involved OI NPD	R&D staffs	Non-R&D staffs	OI practices	Non-OI practices	Inbound logic	Outbound logic	Coupled logic Inbound dominant	Coupled logic Outbound dominant	Non-OI logic	Dynamic capabilities (Acknowledge this factor after codification)
Analysis & Synthesis		Empirical domain	The refinement of Food-Machinery framework											
		Actual domain	The overview of OI NPD of each investigated SME, to identify the related NPD events											
		Real domain	The identification of GMs (DCs sequence) underlying the food OI NPD											

Note: This table is the composition of the researcher

3.6 Rigor of the Research Study

Basically, scientific research contributes to a body of science and follow scientific methods (Bhattacherjee, 2012). In this study, the researcher develops the body of literature through a systematic review as mentioned in chapter 2, and the research process of the study strictly followed the scientific method as mentioned in earlier section of chapter 3. The researcher adopted qualitative approach as main research approach with multiple case study as the main research design of the study.

As in all scientific research, important consideration must be given to construct validity and reliability (Yin, 2012). There are many studies and frameworks such as Guba (1994, 1981) and Lincoln and Guba (1985) that have been developed to evaluate the trustworthiness or rigor of qualitative data. Furthermore, there are many general guidelines provided by researchers such as Baxter and Jack (2008); Forchuk and Roberts (1993); Mays and Pope (2000) and Sandelowski (1986) for critically evaluate qualitative research. In this study, the researcher follows the guideline provided by Baxter and Jack (2008) to enhance overall study quality, validity, and trust worthiness. Based on the guideline provided by Baxter and Jack (2008), the researcher adheres to the responsibilities to ensure that:

1) The case study research questions are clearly written, research propositions are provided (Yin, 2003). The specification of case, the unit of analysis as well as the interview questions are validated.
2) Case study design is proper to the research questions.
3) Purposeful sampling strategy to the case study.
4) Data are systematically collected and managed.

5) Data are analyzed correctly (Baxter & Jack, 2008; Russell, Gregory, Ploeg, DiCenso, & Guyatt, 2005).

In addition, the researcher adopted other strategies to promote data credibility in the study. These strategies are as follows:

1) In the interview process, the researcher concerned and paid attention to the interviewees in order to minimize biases such as personal bias, anxiety, politics, and lack of awareness that could distort the responses, (Krefting, 1991; Patton, 2002).
2) The researcher used multiple data sources to construct the validity (Yin, 2003). The data sources included in this consisted of interviews, documentation, archival records, physical artifacts, direct observation and participant observation.
3) For greater validity, the researcher compared the collected data to the literature. When the OI logics and practices observed didn't match the typology described in the literature (Van de Vrande et al., 2009), a new category of OI logic and practice would be created and defined. These observations were enriched by the researcher's empirical findings. The collection and comparison of the data enhance data quality (Knafl & Breitmayer, 1989).
4) The researcher collected both quantitative and qualitative data on the observed OI logics and practices to reconfirm the validity and correlation between the OI practices (technology exploitation and exploration) and coupled OI logics (outbound and inbound dominant).

5) The researcher checked the linkage between the research objective and the research findings from each round of semi-structure interview section through the confirmation by interviewee in the next round of interview. This will ensure that the researcher still remains true to the original case.
6) As this study is guided by CR, the researcher adopted recursive loop refinement process in Pierce's sense (1958) to the study.

To ensure that the empirical data collected have been adequate for the analysis and interpretation, the researcher conducted 5 consecutive interviews with the the interviewee to enrich progressive data collection. The data analysis of these observations enables the establishment of patterns that will again be confronted with reality through new observations. It allows the construction of conceptual frameworks that best reflects the studied objects' structures and properties to reveal development of the OI GMs of food NPD. In doing so, the relevance of the information on the actual and real domains extrapolated from the data collected in the empirical domain is aligned with the reality (Bhaskar, 2013).

3.7 Ethical Considerations

In this research, participants reserved the right to accept or deny the interviews. Importantly, they were assured that their information provided were kept confidential. In addition, the researcher took two major steps to ensure that the interviewees were well informed of the purpose, requirement and implications of the study. These steps are follows:

1) At the invitation stage, the researcher sent formal invitation letter to the organization of prospective interviewees to ask for permission to access to the organizational information from their employees. All prospective

interviewees and the investigated organizations were informed of the objectives, purposes, requirements and implications of the study, so that they could make decision if they would like to participate or deny the interview. Any questions they might have been answered truthfully. The prospective interviewees were made aware that all interviews were audibly recorded.

2) All prospective interviewees and the investigated organizations were assured that all information and data would be treated in the proper confidential manner. Measures were taken to secure the storage of all information and data. Only the researcher had the authorization to access to this information and data.

3.8 Role of Researcher

In this study, the researcher took an active role in the investigation of the work of the interviewees. The researcher had the role to carry out the semi-structured interview with the interviewees. The researcher mediated all involved information and data (Denzin & Lincoln, 2011). Thus, the personal feeling, ethical and strategic issues in the researcher process are raises (Creswell, 2009). To address these issues, the researcher has to identify his personal background, value, and biases (Creswell, 2009). The possible biases of this study could come from the following matters: the researcher interprets the research finding through his own perspective, experience and background as the practitioner in FI over 15 years. These possible biases were minimized or eliminated by the interviewees themselves and the supportive from the researcher's supervisors in the analysis and interpretation processes.

3.9 Summary

This chapter discusses the research methodology of the study. It begins with a discussion of the research paradigm which included ontology, epistemology and methodology. CR (Bhaskar, 2013) paradigm is adopted to guide this study. The next topic of discussion is the research approach. The discussion presents the rationale for selecting qualitative research approach. Then next section focuses on the research design. The discussion presents the rationale for selecting multiple case study as main research design of the study. The case or unit of analysis, propositions, and theoretical framework of the study are provided in this Chapter. The following discussion explained the research method. For this study, semi-structured interview is used as the tool to collect the vital information from the various companies. This is followed by the discussion on the rigority of the study. The final section highlights the ethical consideration issues along with the role of the researcher.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 Introduction

The focus of this study is to identify OI generative mechanisms (GMs) of OI logics (outbound, inbound, and coupled) and practices (exploitative and explorative practices) in the NPD process of the Thai food machinery SMEs. This chapter presents the results of each stage of data collection and the diachronic analysis from 2012 - 2020 (SME A) and 2015 - 2020 (SME B). Data collection consists of 5 rounds of semi-structured one to one interview with two executives from 2 Thai food machinery SMEs. To complement the qualitative data collected from interviews, internal corporate information has been collected to investigate a total of 109 cases of NPDs from the two SMEs. OI GMs are progressively revealed through the successive cycles of retroduction (Blankie, 2007; Miller & Brewer, 2003) following the successive rounds of interviews. This process allows the researcher to gradually and eventualy identify the relevant experiences (empirical), events (actual) and finally structures and mechanisms (real) of OI logics and practices in the food industry NPDs.

This chapter is structured as follows: First, an induction to the Chapter; This is followed by a detailed explanation of the data approach specifying the 3 sampling types, namely Sampling Type 1 for food machinery SMEs, Sampling Type 2 for interviewees, and Sampling Type 3 for the NPD cases. In the next section, the researcher presented the results of the data collection from the semi-structured interview. With the analysis, the researcher discussed in details the categorization of OI NPD cases as well as the involved actors in OI NPD. The cases are then examined based on the OI logics and practices. In following section, the researcher syntheized the findings to develop the Food-Machinery Flexibility Model. The next section, a diachronic overview of OI NPD is provided. In the next section, the researcher focuses on the the OI NPD generative mechanism of identification. The final section is the summary of the chapter.

4.2 Data Sampling

Based on the research objectives, a purposive data sampling method was applied. Three types of data were sampled using sampling the food machinery SMEs, sampling of the interviewees, and sampling of NPD cases selection.

4.2.1 Sampling Type 1: Food Machinery SMEs

As it is difficult to identify the Thai food machinery SMEs that are involved in OI NPD, the researcher decided to approach the state agencies related to the Thai FI companies to reach the SMEs prospects. The researcher examined the Thai FI networks that are involved in the OI NPDs process and have identified the following agencies that have contributive influences on the success of the OI NPDs. These FI networks consist of the followings:

1) National Innovation Agency (NIA)
2) Top executive SMEs consortia by National Food Institute (NFI)
3) Innovation and technology assistance program (ITAP)
4) Food Innovation Network by the Agricultural Research Development Agency (ARDA)

Five names of the Thai food machinery SMEs were provided through these networks. Purposive sampling was then applied to select the best SME candidates among these 5 SMEs (Campbell et al., 2020; Klar & Leeper, 2019).

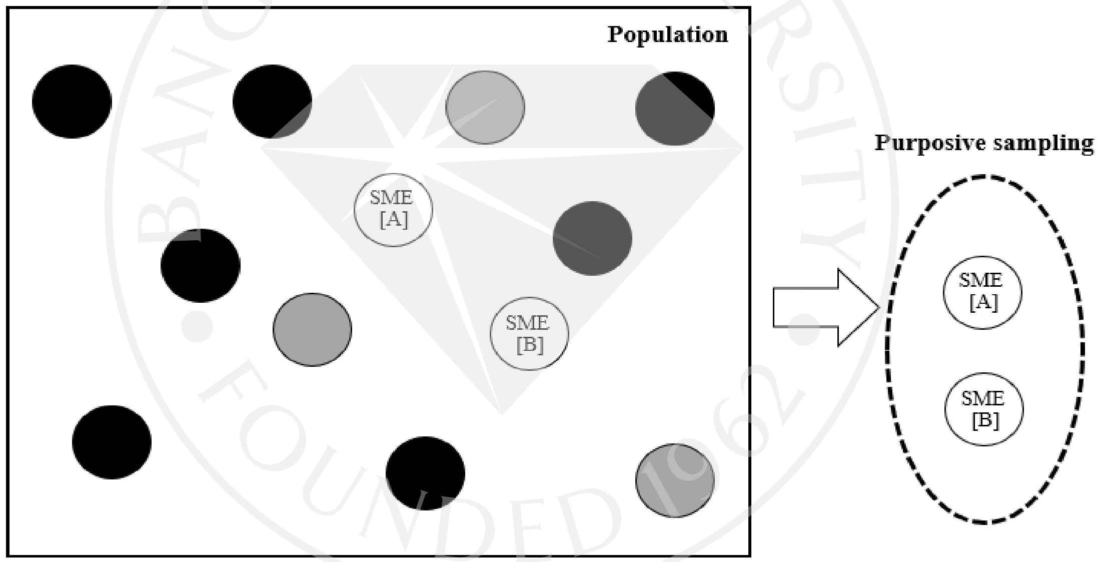
Each Thai food machinery SME had been contacted directly to obtain prior-research permission and to test its qualification for the research. The aim of the study and its criteria were explained to each SME candidate. Selection based on SME qualification revealed that only 2 SMEs fitted the qualification criteria due to the following reasons:

1) Not all of the SMEs candidates were involved in OI NPDs. Even though their company's names were recommended by the Thai FI networks, their OI activities were in the context of marketing which could not apply to this study.
2) NPD information was considered a highly confidential asset for the SMEs; most of the SMEs were relunctant to allow external parties to have access to their NPD information even for academic purposes only.
3) Research is time consuming, especially qualitative analysis using multiple interviews. As such, some of the SMEs withdrew when they became apprehensive with the long duration and extensity of the research.
4) Language barrier posed a problem for many SMEs executives. Most of the SMEs executives were not familiar with the academic terms to fully provide specific information needed. Terms such as OI, logics and practices, GMs and DCs were not words they were acquainted with. Thus, many could not fully understand the scope and expectation of the research.

As depicted in Figure 4.1, among the 5 SMEs investigated, only 2 SMEs met the criteria and agreed to participate in the study. They had allowed the research to get access to their NPDs information. The research through qualitative research was enable to collect information of 109 NPDs. Selected NPDs cover a period of 8 years for SME A and 5 years for SME B. Therefore, it was possible to apply a diachronic/historical analysis method.

Figure 4.1

The purposive sampling of the food machinery SMEs



Note. Adapted from Business Statistics: Contemporary Decision Making (p.288), by K. Black, 2010.

4.2.2 Sampling Type 2: Interviewees

When a participant agreed to be interviewed, the formal interview invitation letter and the interview guide containing all interview questions as present in Appendix A was sent to SME A and SME B a few days prior to the first interview. This enabled them to reflect on the OI NPD activities performed in their organization and to think about their answers to the questions. One executive from each SME was selected by the organization to provide the needed NPD data to achieve research goals. The executives selected for the interviews are:

1) involved in NPDs at the laboratory scale and the industrial scale
2) involved in the decision making of OI logics and practices applied

In this dissertation as presented in Table 4.1, the Food & Beverage Manager from SME A will be named as Interviewee A, and the General Manager from SME B will be named as Interviewee B.

Table 4.1

The purposive sampling of research interviewees from SMEA and B

Investigated food machinery SMEs	Interviewees	Selection criteria	
		Involved in NPDs at the laboratory & industrial scales	Involved in the OI NPD
SME A	Interviewee A: Food & Beverage manager	✔	✔
SME B	Interviewee B: General manager	✔	✔

4.2.3 Sampling Type 3: NPD Cases

Based on the goal of this research, the NPD cases were selected fellowed the criteria of:

1) They must be commercialized NPD cases.
2) The NPDs must involve external actors.
3) NPDs applied OI logics and practices.
4) NPDs were able to achieved legal commercialization and acquire a FDA number.

SME A and SME B were asked to prepare their NPD information prior to the interview. The NPD cases selection were confirmed through the first round of interviews. The selection criteria applied did have some negative consequences. Some of the impacts were as follows:

1) The participating companies decreased the number of NPDs that could be selected and analyzed. This was a clear case for SME B,
2) The data collected for SME A and SME B covered different periods. The data collected period for SME B was a shorter duration as compare to SME A. This reduced the validity of the comparison of the past innovation strategies. However, the patterns and sequences of GMs and their associated triggering factors (TFs) remained comparable. As the goal is to identify GMs and their triggering factors, if similar GMs are identified, comparison is still possible.

Thus, the present study encompassed 109 NPDs from 2 Thai food machinery SMEs. The number of NPDs for SME A and SME B were 92 and 17 respectively. The number of NPDs for both companies are shown in Table 4.2 and Table 4.3.

Table 4.2

Purposive sampling of NPD cases selection from SMEA

Period of time : 2012 - 2020				
Total Numbers of NPD: 272 NPDs				
Commercialized NPD cases: 147 NPDs				Uncommercialized NPD cases: 125 NPDs
Involving external actors: 147 NPDs			No External Actors: 0 NPDs	
Involving OI practices: 147 NPDs				
Having FDA number (Legal commercialization): 92 NPDs		No FDA number: 55 NPDs		
Involving laboratory & Industrial Scales 55 NPDs	Involving only Industrial Scale 37 NPDs			

Table 4.3

Purposive sampling of NPD cases selection from SMEB

Period of time : 2015 - 2020				
Total Numbers of NPD: 113 NPDs				
Commercialized NPD cases: 53 NPDs				Uncommercialized NPD cases: 60 NPDs
Involving external actors (OI): 53 NPDs			No external actors: 0 NPDs	
Involving OI practices: 53 NPDs				
Having FDA number (Legal commercialization): 17 NPDs		No FDA number 36 NPDs		
Involving laboratory & Industrial Scales 15 NPDs	Involving only Industrial Scale 2 NPDs			

As illustrated in Table 4.2 and Table 4.3, 54% of SME A's NPDs were commercialized while SME B had only 47%. Among these NPDs, there were 92 NPDs in SME A and only 17 NPDs from SME B that had reached the FDA registration process and acquired FDA number. Hence, a total of 109 NPDs were considered legally commercialized and qualified for this this research purpose. In summary, it was possible to collect data meeting the selection criteria for 109 cases of OI NPDs. This level of NPDs improved the validity and reliability of the patterns of GMs and TFs identified. Moreover, it better clarified the innovation strategy evolution of SME A and SME B based on the historical distribution of the patterns of GMs and their associated TFs.

4.3 Result of Data Collection

From the interview time frame presented in Table 3.6, five rounds of semi-structured interview and document review methods were utilized for the data collection. The data collected from both methods were more descriptive of the investigated OI phenomena. Prior to each interview, various document such as the food recipe at the laboratory and industrial scale; manufacturing processes at the laboratory and industrial scale; profile of associated suppliers; profile of associated clients, and FDA registration reports about the studied organization (Table 4.4) were reviewed to obtain general understanding about the investigated NPDs. These prior findings were used as the discussion issues during the interviews as well as for analyzing the results of the interviews. Moreover, the document reviewed method was used to cross-validate the interviewees for correct information provided on the research.

In each round of interview, the researcher who was also the interviewer, took an active role in determining how the conversation will proceed through observation, informal and unstructured interviewing. The researcher obtained the information from the interviewees by asking questions with a list of predetermined questions as illustrated in Appendix A. These questions were based on the purpose of each interview. Each round of the interview allowed the researcher to develop cordial relationship with both interviewee A and B. This in turns increased the likelihood of learning greater details on their perspectives and description of events and sequences from their first-hand experiences. In doing so, the researcher was able to acquire in depth and details regarding the RQs. This is crucial for the development of relevant and meaningful findings. In this research, the researcher personally conducted every round of the interviews with SME A and followed by SME B. The interviewees told the story of each NPD case from laboratory scale to industrial scale, and was asked with the same set of research questions following the guideline as depicted in Appendix A to all 109 cases. Nine main documents related to each NPD were again reviewed for cross-validation during the interview. The Food-Machinery framework (Bigliardi & Galati, 2013a) was always shown to the interviewees during the interview for better understanding.

After each round of interview, the researcher did verbatim intelligence transcription (Eppich et al., 2019) by himself. This transcript was double coded by another PhD student using the same technique of cut-and-paste approach (Myers, 2011), and applying the same criteria related to the development of food recipe knowledge to each research attention (Table 3.7). These criteria were as followings:

1) Involved actors; the actors who provided different knowledge needed for recipe development.

2) OI practices; the activities involved R&D across the organizational boundary

3) OI logics; knowledge flow of food recipes between actors. When the OI logic was coupled, the exchange volume of knowledge resources were considered as outbound or inbound dominance.

4) The factors activate the ability to implement OI; repeated keywords related to ability in implementing OI.

Lastly, the researcher did analysis and synthesis simultaneously with the advisor by linking the coded data to the literature and proposed propositions. Then the findings of each round would be confirmed by the interviewee themselves at the beginning of the next interview. In doing so, it ensured the reliability and validality of the data collected. This adhered to the general trustworthiness guideline of Baxter and Jack (2008).

4.3.1 Profile of SME A and SME B

1) SME A. SME A is a food machinery small and medium enterprise that is located in Bangkok, Thailand. It manufactures Ready-to-Eat (RTE) and Ready-to-Cook (RTC) foods in retort pouches for its own brand product as well as OEM brands for its customers. The company has 34 employees working in several departments. It has 3 staffs in the Research and Development, 20 staffs in production, 1 incharge of the Regulation Affair (RA), 1 in Quality Control (QC), two engineers at the engineering and maintenance department, 1 staff in the procurement department, 3 accountanting staffs and 3 executives. The 3 executives each plays critical role in sales, R&D and production. Marketing activities are outsourced to several marketing companies to do the advertisement, distribution function, and retailing tasks.

The main production technology of SME A is the use of retort pouch to package and preserve food products for 1 to 2 years at ambient temperature. The retort pouch is a type of packaging made from laminate materials that withstands the thermal processing or sterilization process. A retort pouch is designed as a flexible can and is lighter and more durable compared with ordinary can packaging. This production technology is not commonly among the Thai food machinery SMEs because of the relatively high investment and costs in machineries.

SME A started its business in 2012 with the purpose of producing its own brands. SME A sells its products to the retail trade especially for products where the FDA market numbers is needed as well as for the food service sector where FDA market number is not required. Besides the local market, the company is conduct business in the export market. In 2012 and 2013, the company invested heavily in its manufacturing infrastructure and worked towards establish operational standards by attaining Good Manufacturing Practice (GMP), Hazard Analysis Critical Control Point (HACCP), and HALAL Certification for food quality recognition in the Muslim market.

In 2014, the firm's production capacity was operating at less than 60%. In an attempt to turn around the situation, the company adopted a parallel OEM strategy to produce OEM brands. The additional OEM volumes made it possible to progressively fill the available production capacity in 2 years. It also provided improved cash flow and allowed expansion into new market segments. Additional profits generated by OEM activities allowed the company to invest in a small truck in 2016 to distribute its own and OEM brands products locally. In addition, during this period, the implementation of development steps, both at the laboratory and the industrial scales, for new OEM products, multiplied the NPD experiences. This in turns increased the company's NPD capabilities. This alternative OEM business model became prominent. Significantlt, the governmental policy of FI SMEs NPDs funding enabled the company to process the highest number of NPDs in 2017.

During the period 2014 - 2017, the operational coupling between laboratory scale NPD, industrial scale NPD and mass production were reinforced. This had strengthened the company ability to offer a wider range of superior NPD services and facilitiated the development of food recipes with the retort pouch technology at both laboratory scale and industrial scale. They also rented out a retort sterilization machine for NPD partners to achieve their goals. The company also helped to develop new FDA registration assistance services to offer its OEM clients. The building up of NPD experiences enhanced SME A's capabilities development. This had allowed the creation of complementary services which support greater diversity and improvement in its services to meet NPDs needs and growth. Their clients included food companies, hospital, universities, and a national research laboratory.

SME A also developed dedicated OEM business teams for Research and Development (R&D). In 2012 it established its production and procurement department. In the following years, a Quality Control (QC) team was set up. In 2017, the Regulation Affair (RA) team was formed. To improve the efficiency of these teams, more qualified employees were recruited during these periods.

Between 2012 and 2020, the R&D team developed a wide range of new food products including ordinary RTE Thai curries, RTE western foods, RTE healthy foods, RTE functional foods, RTE supplementary foods for infant and young children 6 months to 3 years. SME A has positive attitude towards NPD and OI. The interviewee A mentioned that "*Since we are SMEs, the more of new products can be commercialized, the more chances for us to compete with larger enterprises with our limited resources"*.

2) SME B. SME B is a food machinery SME located in Chanthaburi province, which is 245 kilometers east of Bangkok. This province is known for its tropical fruits such as rambutan, durian and mangosteen. This geographic location helps SME B to easily access to unique food materials for its new products, a privilege that only few SMEs have. SME B manufactures RTE (Ready-to-Eat) and RTC (Ready-to-Cook) foods in cans, sterilized glass bottles, and retort pouch with OEM brands as well as its own brand products. In 2019, it had 14 employees distributed in several positions. There are 2 staffs in the R&D department, 3 in the production, 1 staff taking care of Regulation Affairs, 1 staff in charge of Quality Control. For engineering & maintenance, procurement and accounting, there are only 1 staff for each of these functions in the company. SME B has 4 executives which play dominance roles in sales (x1), Regulation Affair (x1), R&D (x1) and production (x1). Because of lower cost of living in the upcountry area, the company can access to cheaper human resources. This in turn helps to reduce the cost of production. In fact, the cheaper labor cost has generated a lower product unit cost of 40% compared with SME A. Causal employment in the production significantly reduces the cost of operation. In addition, if SME B needs extra-workers for high volume orders, it can recruit local labours for temporary period. However, the low skilled labor force can affect the consistency of product quality. Like SME A, SME B outsources its marketing activities to marketing arm companies for advertising, distribution, and retail. SME B's deploys production technology of sterilization to ensure long term preservation of its food products for 1-2 years in ambient temperature. This technology is combined with a wider range of packaging compared with SME A. Take for instance, aluminium cans, sterilized glass bottles, and retort pouches. However, sterilized aluminium canning is most widely used.

SME B operates as a family business with two generations working in the company. The first generation founded the business (with a different company name) in 2004. At that time, they mainly applied food technology to preserve its surplus of tropical fruits during the harvest season. Its food products were either sold as unbranded fruit products, or packaged with private labels for large retail chains. Therefore, there was no specific manufacturing standards and no FDA numbers required. With this low-tech family business model, the company had relatively little investment in R&D.

The second generation joined the business in 2014. They convinced the executives of the previous generation that NPD was critical for its survival, and that OI was a key success factor for SME resulting in many changes. Subsequently, the company invested in skilled workers and experts, equiped with R&D equipment. The transformation facilitated the success recognition and award for Good Manufacturing Practise (GMP). In 2015, the organization was renamed with a company limited registration. Currently, their business and strategic management are operated by family members of the second generation. From 2015 to 2017, OEM was the dominant applied business model. They also benefited from government fundings and supports for Food SMEs NPDs in 2017. Beside the NPD funds, there were many loan schemes for FI SMEs in the rural area, such as Pracha-Rat-fund which offers an interest rate of 1% per year for a period of seven years. Hence, SME B obtained considerable amount of government support for its business as compared to SME A.

Like many other food machinery SMEs, SME B faces several critical challenges. Some of the challenges are as follows:

1) Seasonality of the fruits and vegetables affects both the production volume and cost throughout the year.
2) As an OEM food machinery for large retail chains, they must constantly offer competitive prices to avoid losing its OEM clients (food companies)
3) As food recipes are easily copied, without FDA number and proper IP protection, their OEM clients can easily switch to its competitors.

For these reasons, SME B started to produce its own brands of products in 2019. This stimulated the development of a series of NPDs. Through exploiting those ideas, it has gained in OEM products, the company was able to use it know how in terms of ingredients and recipes to develop its own brand and products. SME B offers a range of basic NPD services including the development of food recipes using sterilization processes (at both laboratory scale and industrial scale), and assistance services for FDA registration. Their main clients are local food companies. Most of its new food products are RTE fruits and vegetables, RTE local curries, and RTC chili paste. SME B has a positive attitude towards NPD and OI. The interviewee B mentioned that "*The new products significantly contributed to the organization's sale, margin, and value*" and "*OI allows us to create a stronger business relationship with the clients*".

4.3.2 Data Collection Results

To answer the research questions (RQ) and test the validity of the data, two sets of data based on the 109 NPDs were collected to investigate the OI logics and practices in the Thai food machinery SMEs.

4.3.2.1 Essential NPDs Document Collection (Explicit data). The search data as presented in Table 4.4, comprises of information from both food machinery companies collected in official documents related to the manufacturing standards that SMEs have to comply with, at the laboratory scale and industrial scale.

Table 4.4

Essential NPDs data collection from SME A and B

Explicit Data Collected	SME A (92 NPDs)	SME B (17 NPDs)
01) Recipes: ratios of ingredients at the end of laboratory scale	92	14
02) Recipes: ratios of ingredients at the end of industrial scale	92	17
03) Manufacturing processes with production parameters at the end of laboratory scale	92	14
04) Manufacturing processes with production parameters at the end of industrial scale	92	17
05) Quality control report	92	17
06) Microbial report	17	17
07) Nutrition fact sheet	68	5
08) Profile of suppliers (new and regular suppliers) for each ingredient	92	17
09) Certificate of analysis (COA) of each ingredient	92	17
10) Profile of the clients (food companies)	80	14
11) FDA registration reports and numbers	92	17

Both SMEs provided the explicit data about their NPDs. The data encompassed recipes ratios of ingredients at the end of the laboratory; recipes ratios of ingredients at the end of industrial scale; manufacturing processes with production parameters at the end of laboratory scale; manufacturing processes with production parameters at the end of industrial scale; quality control reports; microbial reports;

nutrition fact sheets; profile of suppliers (new suppliers and regular suppliers) for each ingredient; certificate of analysis (COA) of each ingredient; profile of the clients (food companies), and FDA registration reports.

For tangible data number 7 nutrition fact sheets is an optional requirement that is needed only for specific markets. The Thai FDA does not request nutrition fact sheets for the registration process. Noticeably, the tangible data number 10 in the profile of the clients (food companies) is not always relevant as some NPDs are implemented under SME A and SME B's own brands. Hence, only some NPDs had this data.

However, the information needed for the FDA registration is categorised under 02, 04, 06, 08, 09, 10, and 11 in Table 4.4. The data needed to analyze the NPD processes both at the laboratory and industrial scales encompasses categories 01, 02, 03, and 04 in Table 4.4. Unfortunately, information about the original recipes before the beginning of recipe NPDs were not kept in the organization databases. In addition, SME B was unable to provide recipe ratios of ingredients or the manufacturing process with its production parameters at the end of laboratory scale, especially in the case of own brand NPDs.

4.3.2.2 Data Collected Based on the Series of Interviews (Implicit data). This refers to the data from both food machinery companies that can not be easily transferred to another person by means of writing down in documents and forms. Implicit information was collected through 5 rounds of semi-structured interviews with an executive of SME A and SME B as shown in Table 4.5.

Semi-structured interviews were recorded and in parallel, extensive notes were taken during the interviews. Recordings were transcribed using an intelligent verbatim format omitting filler words or hesitations (Hadley, 2015). Transcripts were manually coded (Böhm, 2004) to identify emergent themes. Some data from the NPDs were reviewed during the interviews. For examples, the ingredients list and ratios, internal R&D processes, condition and production processes. However, no recording of these data was allowed. This NPD information were considered highly confidential asset between the investigated food machinery SMEs and their clients.

Combined with the interviews, the additional NPD data helped the researcher to better understand the development of food recipes during each NPD and identify the GMs and their associated TFs involved in each NPD. Data obtained from the interviews in SME A and B are presented in details in the next section.

Not all data are accessible. Some of the data such as details of new product / recipe idea origin, market & business insight collected in order to sense and seize the opportunities for NPDs; details of the original recipe composition (fresh cooked recipe); sensory results and feedback for each recipe to be adjusted at both laboratory scale and industrial scale levels, and details about product composition adjustments based on FDA requests were not available. However, since the present analysis focuses on the identification of the GMs of OI practices, this information which are attached to the recipe and its evolution, were not considered necessary.

Table 4.5

Implicit data collection from 5 rounds of semi-structure interviews with SME A and B

Implicit data collection	**Data collection from**									
	Interview1		Interview2		Interview3		Interview4		Interview5	
	SME A	SME B	SME A	SME B	SME A	SME B	SME A	SME B	SME A	SME B
OI NPD overview of each SME	✔	✔			✔	✔				
Origin of each food recipe (the food recipe creator of each OI NPD)	✔	✔	✔	✔						
Informal and formal new product intellectual property rights (IPR owner of each OI NPD)	✔	✔	✔	✔						
Presentation of the categorization of OI NPDs based on the origin of recipe and IPR for confirmation.	✔	✔	✔	✔						
Associated actors involved in each OI NPD, their roles and relationships	✔	✔	✔	✔						
OI logics involved in each OI NPD	✔	✔	✔	✔						
OI practices involved in each OI NPD	✔	✔	✔	✔						
Mapping of the involved actors regarding OI logics and practices	✔	✔	✔	✔						
Presentation of the refined food machinery models, and different patterns for confirmation.			✔	✔	✔	✔				
Identification of all OI NPD activities involved in OI NPD			✔	✔	✔	✔				
Initiative of each OI NPD identification			✔	✔	✔	✔				
Managerial / strategic decision to sense and seize each OI NPD			✔	✔	✔	✔				
Identification of dynamic capabilities involved in OI NPDs					✔	✔	✔	✔		
Identification of mechanisms / DC sequences attached to the food OI NPD events					✔	✔	✔	✔		
GM identification: mapping of the mechanisms / DC sequences to each pattern of the Food-Machinery Flexibililty model					✔	✔	✔	✔		
Presentation of the GMs that mobilized in each pattern of OI NPD, their linear sequences and their TFs for confirmation.							✔	✔	✔	✔

4.3.3 Semi-Structured Interviews Analysis Results

4.3.3.1 Semi-Structured Interview Coding Themes. Five rounds of interviews with SME A and SME B were recorded. The code assigned for SME A were Interview 1A, Interview 2A, Interview 3A, Interview 4A, and Interview 5A. For SME B, the code given were interview 1B, Interview 2B, Interview 3B, Interview 4B, and Interview 5B. An intelligent verbatim transcription was applied to this study. Everything that the interviewees said on the recording were transcribed with minor paraphrasing. All transcripts were coded twice or double-coded. The verbatim coding themes were refined using the constant comparison technique to address emerging concepts (Pope, Ziebland, & Mays, 2000). Ten transcripts were double-coded by another qualified researcher and coding themes were compared to ensure reliability (Pilnick & Swift, 2011) and to ensure that information and meaning were extracted, analyzed and synthesized qualitatively for validity confirmation by the interviewees at the next interview

The researcher presented the research findings from the data collected (including the related verbatim coding, analysis and synthesis) by following 5 rounds of interview as depicted in Table 4.6. This method allowed the researcher to explore successively the 3 domains of reality: experiences (empirical), events (actual) and mechanisms & structures (real) and applied retroductive loops. Then the researcher concluded the answers to each research question at Chapter 5.

Table 4.6

The coding themes from 5 rounds of semi-structure interview with SME A and B

Categorization(s)	Interview record (Round)	Code(s)	Analysis & Synthesis
OI NPD overview of each SME	1A, 1B, 3A, 3B		● Diachronic overview of OI NPD
Origin of each food recipe (the food recipe creator of each OI NPD)	1A, 1B, 2A, 2B	● Food machinery company ● Food company ● Food experts & consultants	● The categorization of OI NPDs
Informal and formal new product intellectual property rights (IPR; the owner of each new product)	1A, 1B, 2A, 2B	● Food machinery company ● Food company ● Food experts & consultants	
Presentation of the categorization of OI NPDs based on the origin of recipe and IPR for confirmation	1A, 1B, 2A, 2B	● Group 1: the development of a food machinery company's new product with its recipe. ● Group 2: the development of a food machinery company's new product with the food expert's recipe. ● Group 3: the development of a food company's new product with the food machinery company's recipe. ● Group 4: the development of a food company's new product with its recipe ● Group 5: the development of a food company's new product with the food expert's recipe. ● Group 6: the development of a food expert's new product with the food expert's recipe.	
Related actors involved in each OI NPD, their roles and relationships	1A, 1B, 2A, 2B	● Food machinery company ● Food company ● Food experts & consultants ● Consumers ● Other market stakeholders ● Marketing organizations, distributors, and retailers ● New suppliers ● Regular suppliers ● Regulatory bodies & testing laboratories ● Machinery sellers	● The involved actors in OI NPD
OI logics involved in each OI NPD	1A, 1B, 2A, 2B	● Outbound dominance ● Inbound dominance ● No OI logic	● The OI logics in OI NPD
OI practices involved in each OI NPD	1A, 1B, 2A, 2B	● Customer involvement ● Supplier involvement ● Regulatory body involvement ● Outsourcing R&D ● Inward IP licensing ● Employee involvement ● Insourcing R&D ● Outward IP Licensing	● The OI practices in OI NPD

Table 4.6 (Continued)

The coding themes from 5 rounds of semi-structure interview with SME A and B

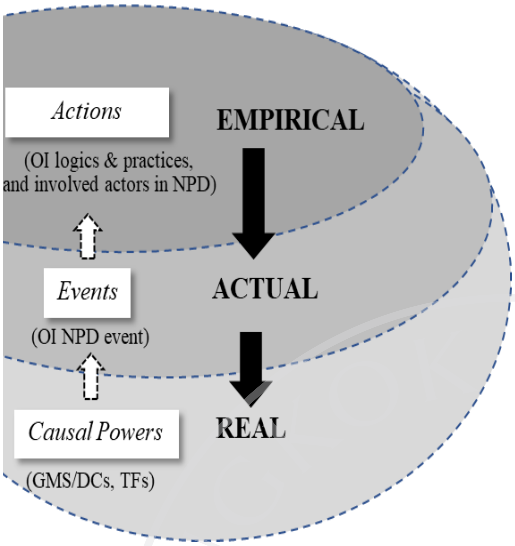
Categorization(s)	Interview record (Round)	Code(s)	Analysis & Synthesis
Mapping of the involved actors regarding OI logics and practices	1A, 1B, 2A, 2B	●Pattern 1 – the development of a food machinery company's new product with its recipe. ●Pattern 2 – the development of a food machinery company's new product with the food expert's recipe. ●Pattern 3 – the development of a food company's new product with the food machinery company's recipe. ●Pattern 4 – the development of a food company's new product with its recipe ●Pattern 5– the development of a food company's new product with the food expert's recipe. ●Pattern 6 – the development of a food expert's new product with the food expert's recipe.	● The synthesis of Food-Machinery Flexibility Model with its six patterns (Pattern1-6)
Presentation of the refined Food-Machinery models and different patterns for confirmation.	2A, 2B, 3A, 3B		
Identification of active factors involved in OI NPDs	2A, 2B, 3A, 3B	● Sensing ● Seizing ● Inventive capacity ● Transformative capacity ● Innovative capacity ● Absorptive capacity ● Connective capacity ● Desorptive capacity ● Legal compliance capacity	● The DCs involved in food OI NPDs
Identification of the mechanisms / DC sequences attached to the NPD events	3A, 3B, 4A, 4B	● 13 food NPD events ● 14 mechanisms / DC sequences	● The identification of OI NPD GMs
Mapping of the mechanisms / DC sequences attached to the NPD events regarding 6 patterns of the Food-Machinery Flexibility Model	3A, 3B, 4A, 4B	● 6 GMs and their triggering factors	
Presentation of GMs attached to 6 patterns of the Food-Machinery Flexibility Model	4A, 4B, 5A, 5B		

4.3.3.2 Overview Findings from Semi-Structured Interview in CR. To answer the main research question of "What generative mechanisms favor OI logics and practices implementation in the Thai Food machinery SMEs?", the researcher explored each domain of reality in CR perspective through the 5 rounds of semi-structured interviews. The data analysis from each round helped the researcher to discover deeper knowledge of reality regarding the OI NPD, and identified its GM (Figure 4.2).

1) The findings in the empirical domain were the knowledge of reality based on the empirical observations that were seized from the research objects (involved actors, OI logics and practices) in the OI NPD phenomena. This includes the categorization of OI NPDs, the involved actors in OI NPD, the OI logics in OI NPD, the OI practices in OI NPD, and the synthesis of a Food-Machinery Flexibility Model.
2) The findings in the actual domain consisted of the relationship between the observable (identification of OI logics and practices of the involved actors) and unobservable factors (diachronic overview of OI NPD) underlying the empirical domain. In other words, the researcher first identified the NPD events and then differentiate which of these activities are OI or not OI.
3) The findings in the real domain contained all physical and social objects which acted on the OI logics and practices to produce changes in OI NPD. This signifies the presence of DCs involvement in OI NPDs, and the identification of causal power (GMs/DCs). This in turns pinpoint the operation of OI logics and practices, and illustrates the initial triggering factors (TFs).

Figure 4.2

Research findings from semi-structured interview in CR perspective



Research findings in each reality domain

- **Empirical domain**

4.4.1) The categorization of OI NPDs
4.4.2) The involved actors in OI NPD
4.4.3) The OI logics and practices in OI NPD
4.4.4) The synthesis of the Food-Machinery Flexibility Model

- **Actual domain**

4.4.5) Diachronic overview of OI NPD

- **Real domain**

4.4.6) The identification of GMs of food OI NPD, and their initial TFs.

4.4 Research Finding

4.4.1 Categorization of OI NPD Cases

At the 1st interview stage, data from SMEs A and SME B were collected providing the required information for NPDs that had FDA numbers and had reached the commercialization stage. To clarify the direction of the knowledge flow between the involved actors in OI NPDs, the food recipe was considered the only relevant knowledge to identify the flow of knowledge meant determining whether the OI logic was inbound or outbound. In this study, the researcher found that the owner of the food recipe (IPR) was not occasionally its creator. Hence, two pieces of information were required for identification of the starting and ending point of recipe development; the identifying the creator of the food recipe, and identifying the owner of the food recipe (IPR). Based on this information, 6 groups of NPDs were created (Table 4.7) to separate them based on the inter-organizational recipe knowledge flow.

Table 4.7

The six OI NPD groups of food machinery SME A and B based on IPR and the creator of the recipe

Owner of the recipe (IPR)	Creator of the recipe	SME A		SME B		Total Involved NPD
		Case number	Amount (NPD)	Case number	Amount (NPD)	
Group 1: the development of a food machinery company's new product with its recipe						
Food machinery company	Food machinery company	A01-A10	10	B15-B16	3	13
Group 2: the development of a food machinery company's new product with the food expert's recipe						
Food machinery company	Food expert	A11-A12	2	-	-	2
Group 3: the development of a food company's new product with the food machinery company's recipe						
Food company	Food machinery company	A13-A23	11	-	-	11
Group 4: the development of a food company's new product with its recipe						
Food company	Food company	A24-A55	32	B15-B16	12	44
Group 5: the development of a food company's new product with the food expert's recipe						
Food company	Food expert	A56-A87	32	B13-B14	2	34
Group 6: the development of a food expert's new product with the food expert's recipe						
Food expert	Food expert	A88-A92	5	-	-	5
			92		**17**	**109**

Recipe owned by the food machinery company: Group 1 & 2. In the 1st and 2nd categories group of NPDs, the recipe was owned by the food machinery company. However, the origin of the recipe was different. The initial R&D development at the laboratory scale was internal in the first group but external in the second group. As reflected in the remark of interviewee A who mentioned that "*...the main difference between NPD case for example A10* (Group 1) *and case A12* (Group 2) *is the internal R&D capability. In the case of A10, my R&D team can do lab-scale* *ourself. On the other hand, for case A12, we could not be completed. That was why we had to outsource the R&D to the university A01 for NPD case A12. The expert from university A01 took care of all tasks in NPD lab-scale. For examples the new ingredient sourcing, original recipe creation, recipe development with production technology, sensory test, and lab scale recipe providing. However, this NPD process consumed so much time which is the main reason why my team do not prefer this method".*

Recipe owned by the food company: Group 3, 4, and 5. Group 3 to 6 were the NPDs of OEM brands. Noticeably, the IPR of the new product belongs to the client such as the food company, national research center, hospital and university. However, the recipes had different origins from various recipe creators. The NPD in the 3rd group had the original recipe from the food machinery company, while the 4th group was from the food company itself. The 5th group, on the other hand, was co-developed with another third party.

As revealed from the comment of Interviewee B, *"...NPD case B15 and B16* (Group 4)*, as well as B13 and B14* (Group 5) *are traditional OEM. All of these cases belong to the client's new products and the original recipes are provided by the clients. The main difference between them is the collaboration at lab scale. My factory involved lab scale for the case B15 and B16 while case B13 and B14, we do not."*

These interview transcripts were almost identical to what the researcher perceived from the interviewee at SME A. However, interviewee A referred to the 3rd group as "*...I think the case A13 and A23* (of Group 3) *are much simpler compared to other OEM NPDs. I have just approached the previous recipe to the potential clients* (food companies). *Hence, these NPDs are not difficult at both scales* (laboratory scale and industrial scale) *and the FDA registration. They are the same menu* (recipe) *with minor adjustment in taste and texture which depends on the clients' preference. This method also helps my production department to fulfill the available production capacity".*

Recipe owned by the Food experts & consultants: Group 6. The NPDs in Group 6 were quite unique because they belonged to the academic and government sectors, and the original recipe was from their internal R&D food expert. The interviewee at SME A reported that "*…NPD case A88, A89, A90, A91 and A92 are quite rare to find in the ordinary food machinery company's portfolio because most of the academic and government's NPD have ended with IP registration at the lab scale. No further development in terms of industrial scale and FDA registration process. However, the national policy towards food NPD seems to have slightly changed in the recent years. In my opinion, many of their food NPDs have reached the industrial scale more often than the past 5 years, probably due to the purpose of increasing of the IP commercialized readiness. Hence, creditability & strong company profile, academic & government connection, and the flexibility for the academic research purpose are important factors to acquire these NPDs*".

Table 4.7 reveals that there is a total of 6 NDP groups in SME A. The groups are coded as Group 1 to Group 6. SME A has more NDP groups as compared to SME B. SME B has a total 3 groups. They are Group 1, Group 4, and Group 5. For SME A, Group 4 and Group 5 showed the highest number of NPDs with a total of 32 NPDs each. Group 3 had 11 NPDs and Group 1 had 10 NPDs. For Group 6, it had 5 NPDs, and Group 2 had 2 NPDs. On the other hand, for SME B, Group 4 had the highest number of NPDs of 12 NPDs, Group 1 had 3 NPDs, and Group 5 with only 2 NPDs. This information represents that the majority NPD of SME A and SME B are for the OEM brand.

In comparing the 2 food machinery companies, SME B showed a fewer NPDs with a FDA number due to the nature of its business. Many of SME B's NPDs were excluded from this current study because many NDPs did not register with the FDA for a FDA number and were sold locally and in traditional markets. Hence, SME B's NPDs in this current study were new products that have FDA number only. On the other hand, SME A's new product was launched in the markets such as supermarkets, hyper markets, and foreign markets require an FDA number. This resulted in SME A having more study cases.

4.4.2 The Involved Actors in OI NPD

The researcher identified the OI NPD involved actors from the 1st interview, and confirmed these findings with the interviewees at the 2nd interview.

In order to answer **RQ1**: Which types of actors are involved in Thai food machinery SMEs OI NPD processes? What relationships and roles actors have assumed in elaborating OI NPDs with the Thai food machinery SMEs?, SME A and SME B were asked the same set of interview questions to each NPD (A01 - A92 and B01 - B17). The sequence of the first reseach question is as follows:

RQ1.1: Who were the actor(s) involving in food NPDs with Thai food machinery SMEs both at the laboratory scale and industrial scale?,

RQ1.2: What were the roles and relationships of the actors and food machinery SMEs involving in food NPDs?, and

RQ1.3: Whose original recipes constituted the initiation of the food NPD?

The answers of RQ1.1 and RQ1.3 helped the researcher to identify the involved actors regarding the sequence of recipe development from the starting point to the end. The actors comprised of the recipe creator, involved actors at the laboratory scale and industrial scale. As SME A and SME B were considered as focal firms' OI NPD process, there were different actors in each OI NPD group (Group 1 – Group 6), and at different levels (laboratory scale and industrial scale). The details are illustrated in Table 4.8 to Table 4.16.

4.4.2.1 The Identification of OI NPD Actors in Each NPD Group.

● ***The OI NPD actors in Group 1.***

Table 4.8

SME A's cases in Group 1 (A01-A10) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
<u>Group 1</u> the development of a food machinery company's new product with its recipe.	Case A01	Food machinery company A	Marketing organization, New supplier	2	New supplier, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6
	Case A02	Food machinery company A	Marketing organization, New supplier	2	New supplier, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6
	Case A03	Food machinery company A	Marketing organization, New supplier	2	New supplier, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6
	Case A04	Food machinery company A	Marketing organization, New supplier	2	New supplier, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6
	Case A05	Food machinery company A	Marketing organization, New supplier	2	New supplier, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6
	Case A06	Food machinery company A	Marketing organization, New supplier	2	New supplier, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization, Distributors	7
	Case A07	Food machinery company A	Marketing organization, New supplier	2	New supplies, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization, Distributors	7
	Case A08	Food machinery company A	Direct consumer, Marketing organization, New supplier	3	New supplier, Regular suppliers, FDA, Testing labs, Direct consumers, Marketing organization, Retailers	7
	Case A09	Food machinery company A	Direct consumer, Marketing organization, New supplier	3	New supplier, Regular suppliers, FDA, Testing labs, Direct consumers, Marketing organization, Retailers	7
	Case A10	Food machinery company A	Direct consumer, Marketing organization, New supplier	3	New supplier, Regular suppliers, FDA, Testing labs, Direct consumers, Marketing organization, Retailers	7

Table 4.9

SME B's cases in Group 1 (B15-B17) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
Group 1 the development of a food machinery company's new product with its recipe.	Case B15	Food machinery company B	Marketing organization, New suppliers	2	New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6
	Case B16	Food machinery company B	Marketing organization, New suppliers	2	New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6
	Case B17	Food machinery company B	Marketing organization, New suppliers	2	New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organization	6

Tables 4.8 and Table 4.9 show the involved actors in Group 1 OI NPD of SME A and SME B. The tables indicate the development of a food machinery company's new products with its recipes. The average number of actors involved in SME A and SME B NPD at laboratory scale consisted of 2 actors, namely the Marketing organization and New suppliers (Case A01-A07, and B15-B16). They are the main resources of new product ideas and knowledge for this group. Interviewee B mentioned that "*As we are SME, we don't have enough manpower to do a variety of tasks. Hence, for most of the NPD cases, we trust our sales agents* (Marketing organization) *on what kind of new products that they are able to sell. Even though their ideas are not new to the market, we can adapt, duplicate and develop the idea of trendy ingredients to ours*".

In addition, SME A had 1 extra actor in case A08-A10, the direct consumer. Interviewee A mentioned that "*I learnt from the previous experiences that I shouldn't have ignored the sound of actual customers, especially for the own brand NPD. Just a sales agent* (Marketing organization) *and new suppliers could provide us the idea and knowledge of a new product, but it still lacks the insight of consumer's needs and behaviors. This was the necessary element to achieve the creation of unique product characteristics. The more efforts we put in the ideation process, the better implementation we have in new-to-the market products"*

On the other hand, the average number of involved actors of SME A and SME B NPDs at the industrial scale was 6, New supplier, Regular suppliers, FDA, Testing laboratories, Indirect consumers, Marketing organizations (Case A01-A05, and B15-B17). Also stated by Interviewee B that "…*New supplier and regular supplier are needed for the development process, Indirect consumer are needed for sensory testing, while FDA and Testing labs are required for FDA registration.*".

However, SME A had an additional actor, distributors in case A06-A07, and retailers in case A08-A10. Both of them were needed for the sensory testing process due to its different business models and distribution channels.

● ***The OI NPD actors in Group 2.***

Table 4.10

SME A's cases in Group 2 (A11-A12) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
<u>Group 2</u> the development of a food machinery company's new product with the food expert's recipe.	Case A11	Food machinery company A	Direct consumer, Marketing organizations, University A01	3	New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organizations, Distributors, Machine seller A01	8
	Case A12	Food machinery company A	Direct consumer, Marketing organizations, University A01	3	New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Marketing organizations, Distributors, Machine seller A01	8

Table 4.10 shows the involved actors of OI NPD in Group 2 of SME A. These actors are responsible for the development of a food machinery company's new products with the food expert's recipe. SME B has no case in this OI NPD group. The involved actors of SME A 's NPD at laboratory scale consisted of 3 actors, namely the direct consumer, marketing organizations, and university A01 for case A11and A12.

Interviewee A revealed that "*I acknowledged the market opportunity of Thai desserts for the China market. The selected recipes are named by our sales agent* (marketing organization). *However, Thai dessert is difficult to apply with retort technology and transform into ready-to-eat form. Based on many internal experiments, I have noticed that the NPD case A11 and A12 could not have been completed with my own R&D capability. Hence, I get the help from the external expertise instead* (outsourcing R&D with university A01)".

On the other hand, the involved actors of SME A's NPD at industrial scale consisted of 8 actors. These actors include new suppliers, regular suppliers, FDA, testing laboratories, indirect consumers, marketing organizations, distributors, machinery seller A01 (case A11-A12). This is indicated in the interview with Interviewee A, who remarked that "*The outsourcing R&D to the university A01 were conducted at lab scale only. This was a traditional practice for co-NPD with the universities and government R&D agencies. Beside the NPD, the benefit of this outsourcing R&D is the guideline for industrial scale processes. I have noticed that we needed the additional machines to complete these NPDs with mass production processes".*

The question of outsourcing R&D was put to interviewee B during the first interview and they disclosed that *"We had tried outsourcing R&D with the university once, but the outcome was not pleasant. That new product was just a prototype for the sensory testing, with no FDA registration. Hence, it had not reached the commercialization stage yet. It's took a year to complete one project, and the market has changed already".* This answer was quite similar to the comment of interviewee A "*Even though I got a partial fund for these NPDs* (case A11-A12)*, it has taken so much time on just a lab scale development. Time consuming cost as well. Hence, after case A12, my strategy on NPD selection* (seizing) *was not the market potential only, but also the capability to complete NPD in proper time*".

● ***The OI NPD actors in Group 3.***

As presented in Table 4.11, on the following page, it shows the involved actors of OI NPD in Group 3 from SME A. These actors were involved in the development of a food company's new product with the food machinery company's recipe. SME B has no case in this OI NPD group. Food company (A01-A04) was the one involved actor at SME A 's NPD at laboratory scale. Interviewee A stated that "*These NPDs were the easiest OEM NPD because we used our previous recipe as a basis. There was just minor recipe adjustment for each food company. For examples, added 5% more spices, increased 10% thickness of curry and 15%less chicken from the original recipe*".

Interviewee A added that "*Normally, OEM projects always approached from the client side* (food company)*, but in these cases, I was the one who approached the client instead. I searched for potential food companies who could commercialize my products. I contacted them directly to propose the project. All of them preferred to commercialize these products with their brands. I was ok with the deal. Minor recipe adjustment helped me to shortcut the lab scale, and faster jump into industrial scale and FDA registration".*

On the other hand, there are 5 involved actors of SME A's NPD at the industrial scale, the food company (A01-A04), regular suppliers, FDA, testing laboratories, and indirect consumers. This group had fewer involved actors at the industrial scale compared to other groups due to the lack of new suppliers. As the investigated food machinery SMEs experienced the original recipe as a basis, no new supplier was needed. This was reflected in Interviewee A comment that "*We normally did experiments on the industrial scale 2 times for one NPD, but to these NPDs* (case A13-A23), *only 1 time. We were the experts on these recipes*".

Table 4.11

SME A's cases in Group 3 (A13-A23) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
Group 3 the development of a food company's new product with the food machinery company's recipe	Case A13	Food machinery company A	Food company A01	1	Food company A01, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A14	Food machinery company A	Food company A01	1	Food company A01, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A15	Food machinery company A	Food company A01	1	Food company A01, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A16	Food machinery company A	Food company A02	1	Food company A02, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A17	Food machinery company A	Food company A02	1	Food company A02, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A18	Food machinery company A	Food company A02	1	Food company A02, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A19	Food machinery company A	Food company A03	1	Food company A03, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A20	Food machinery company A	Food company A03	1	Food company A03, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A21	Food machinery company A	Food company A03	1	Food company A03, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A22	Food machinery company A	Food company A04	1	Food company A04, Regular suppliers, FDA, Testing labs, Indirect consumers	5
	Case A23	Food machinery company A	Food company A04	1	Food company A04, Regular suppliers, FDA, Testing labs, Indirect consumers	5

● *The OI NPDs actors in Group 4.*

Table 4.12

SME A's cases in Group 4 (A24-A55) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
Group 4 the development of a food company's new product with its recipe	Case A24	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A25	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A26	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A27	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A28	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A29	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A30	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Machinery seller A02	7
	Case A31	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Machinery seller A02	7
	Case A32	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A33	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A34	Food company A05	Food company A05, New suppliers	2	Food company A05, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A35	Food company A06	Food company A06, New suppliers	2	Food company A06, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A36	Food company A06	Food company A06, New suppliers	2	Food company A06, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A37	Food company A07	Food company A07, New suppliers	2	Food company A07, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A38	Food company A07	Food company A07, New suppliers	2	Food company A07, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A39	Food company A08	Food company A08, New suppliers	2	Food company A08, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Machiner seller A03	7
	Case A40	Food company A08	Food company A08, New suppliers	2	Food company A08, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Machiner seller A03	7
	Case A41	Food company A09	Food company A09, New suppliers	2	Food company A09, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A42	Food company A10	Food company A10, New suppliers	2	Food company A10, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A43	Food company A11	Food company A11, New suppliers	2	Food company A11, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A44	Food company A11	Food company A11, New suppliers	2	Food company A11, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A45	Food company A11	Food company A11, New suppliers	2	Food company A11, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A46	Food company A12	Food company A12, New suppliers	2	Food company A12, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A47	Food company A12	Food company A12, New suppliers	2	Food company A12, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A48	Food company A12	Food company A12, New suppliers	2	Food company A12, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A49	Food company A13	Food company A13, New suppliers	2	Food company A13, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A50	Food company A04	Food company A04, New suppliers	2	Food company A04, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A51	Food company A14	Food company A14, New suppliers	2	Food company A14, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A52	Food company A14	Food company A14, New suppliers	2	Food company A14, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A53	Food company A03	Food company A03, New suppliers	2	Food company A03, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A54	Food company A15	Food company A15, New suppliers	2	Food company A15, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A55	Food company A16	Food company A16, New suppliers	2	Food company A16, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6

Table 4.13

SME B's cases in Group 4 (B01-B11) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
Group 4 the development of a food company's new product with its recipe	Case B01	Food company B01	Food company B01, New suppliers	2	Food company B01, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B02	Food company B01	Food company B01, New suppliers	2	Food company B01, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B03	Food company B01	Food company B01, New suppliers	2	Food company B01, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B04	Food company B01	Food company B01, New suppliers	2	Food company B01, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B05	Food company B02	Food company B02, New suppliers	2	Food company B02, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B06	Food company B02	Food company B02, New suppliers	2	Food company B02, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B07	Food company B02	Food company B02, New suppliers	2	Food company B02, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B08	Food company B02	Food company B02, New suppliers	2	Food company B02, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B09	Food company B02	Food company B02, New suppliers	2	Food company B02, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B10	Food company B02	Food company B02, New suppliers	2	Food company B02, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B11	Food company B03	Food company B03, New suppliers	2	Food company B03, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6

Table 4.12 and Table 4.13 show the OI NPDs involved actors in Group 4 of SME A and SME B in the development of the food company's new product with their recipes. The involved actors of SME A and SME B's NPD at laboratory scale comprised of 2 actors, namely the food companies (food company A05-A16, B01-B03) and the new suppliers. Interviewee B stated that "*In the past, ordinary OEM clients always started business with us at the up-scaling stage or jumping to the mass production stage at the beginning. There's almost no OI and/or NPD involvement. However, these cases* (Case B01 and B02) *were a bit different. My clients* (food

companies B01, B02 and B03) *asked us to do NPD at lab & industrial scale for them. We accepted these deals and helped them to develop new products because they were my friends* (in Juntaburi province).

Contrary to the SME A, the interviewee A mentioned that "*I knew these clients from business channels* (Case A24 to A38, A41 to A45, and A49 to A54) *and food expert recommendation* (Case A39, A40, A46, A47, A48 and A55). *To this OEM business model, I had to provide better services than what the larger enterprises always did. Co-developing a new product since lab scale was a good option for us. This was my strategy at that time to acquire the potential clients* (food companies) *as much as I could*". As these NPDs were developed at the laboratory scale, the new suppliers who provided the new food ingredients based on the new product requirements were needed at this stage. Interviewee B further stated that "*After we acquired new product ideas and concepts from our clients, we knew what kind of ingredients we were looking for. Then the procurement team directly contacted the new supplier for the new ingredient information*". On the other hand, the average involved actors of SME A and SME B's NPD at industrial scale were 6 actors (Case A24 to A29, A32 to A38, A41 to A55, and B01 to B11). These actors were Food company (A05-A16, and B01-B03), new suppliers, regular suppliers, FDA, testing laboratories, indirect consumers. Only 4 cases (Case A30, A31, A39 and A40) had 7 actors at the industrial scale. The additional actor was the machinery seller (machinery seller A03 and A04) concerning the new machine installation required for the NPD. Reflecting on the company experience with its actors in NDPs, Interviewee A stated that "*...Only few OEM clients could develop into long term clients, especially SME clients. Hence, I had to carefully consider the inward new technology* *or machinery to the company. Was it worth enough for the company investment? It was true that the requirement of a new machine was from the NPD itself, but it should have benefited not only for one NPD. Hence, my procurement team and I worked so hard on sourcing new machinery sellers who could provide the specific machine that worked well with the NPD and also had multifunction, applicable to other production improvements. As SME, we preferred local machinery sellers regarding the affordable price, on site installation and maintenance service were necessary".*

● ***The OI NPD actors in Group 5.***

Tables 4.14 and Table 4.15, show the OI NPD involved actors in Group 5 of SME A and SME B. These actors are responsible for the development of a food company's new product with the food expert's recipe. There is no involved actor at the laboratory scale as the prototype of the new product and the laboratory scale recipe were prepared by the food companies (food company A17, A18, A19, A20, A21, A22, A23, A24, and B04) before introducing the NPD projects to food machinery company A and B. The laboratory scale recipes were carried out by external co-R&D between food companies and external experts for example, the recipe owners (chef/restaurant), and with food expert consultants. In some cases, such as Case A81, A82, A83, A84, and A85, the food companies (food company A20, A21 and A22) bought IP from the universities (university A02, A05, and A06) and the hospital (hospital A01). Therefore, the SME A and SME B had no involvement at the laboratory scale.

Table 4.14

SME A's cases in Group 5 (A56-A87) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s)at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
Group 5 the development of a food company's new product with the food expert's recipe.	Case A56	Food company A17	-	-	Food company A17, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A57	Food company A17	-	-	Food company A17, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A58	Food company A17	-	-	Food company A17, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A59	Food company A18	-	-	Food company A18, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A60	Food company A18	-	-	Food company A18, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A61	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A62	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A63	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A64	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A65	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A66	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A67	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A68	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A69	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A70	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A71	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A72	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A73	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A74	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A75	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A76	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A77	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A78	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A79	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A80	Food company A19	-	-	Food company A19, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A81	Food company A20	-	-	Food company A20, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Machinery seller A04	7
	Case A82	Food company A20	-	-	Food company A20, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Machinery seller A04	7
	Case A83	Food company A21	-	-	Food company A21, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A84	Food company A21	-	-	Food company A21, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A85	Food company A22	-	-	Food company A22, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A86	Food company A23	-	-	Food company A23, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A87	Food company A24	-	-	Food company A24, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6

Table 4.15

SME B's cases in Group 5 (B13-B14) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
Group 5 the development of a food company's new product with the food expert's recipe.	Case B13	Food company B04	-	-	Food company B04, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case B14	Food company B04	-	-	Food company B04, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6

The average number of involved actors at SME A and SME B's NPD at industrial scale were 6 actors (case A56-A80, A83-A87 and B13-B14); the food company (A17-A19, A21-A24, and B04), new suppliers, regular suppliers, FDA, testing laboratories and indirect consumers. Only 2 cases (Case A81 and Case A82) had 7 actors at the industrial scale. The additional actor was the machinery seller (A04) required for a new machine installation for the NPD.

Sharing the company experience on NPD in industrial scale, Interviewee A stated that "*these new products* (referring to case A56 to Case A87) *took a shorter time on the overall NPD process as compared with other NPDs. We involved only the industrial scale. Moreover, new suppliers of specific ingredients for the NPD, were introduced to us by the experts. Besides income from clients, we gained a lot of knowledge regarding NPD, such as, new food ingredient trends, guideline on production, qualified machinery seller and new supplier connection*".

● ***The OI NPD actors in Group 6.***

Table 4.16

SME A's cases in Group 6 (A88-A92) and its related actors

NPD Group	Case number	The original recipe creator **[RQ1.3]**	Involved actor(s) at the laboratory scale **[RQ1.1]**	Laboratory scale actors	Involved actor(s) at the industrial scale **[RQ1.1]**	Industrial scale actors
<u>Group 6</u> the development of a food expert's new product with the food expert's recipe.	Case A88	Hospital A01	-	-	Hospital A01, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers, Machinery seller A05	7
	Case A89	National research lab A01	-	-	National research lab A01, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A90	University A03	-	-	University A03, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A91	University A04	-	-	University A04, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6
	Case A92	University A04	-	-	University A04, New suppliers, Regular suppliers, FDA, Testing labs, Indirect consumers	6

Table 4.16 shows the involved actors OI NPD in Group 6 of SME A. These actors are engaged in the development of a food expert's new product with the food expert's recipe. SME B had no cases in this OI NPD group. There was no involved actor at the laboratory scale because the prototype of the new product and the laboratory scale recipe were prepared by food experts (hospital A01, national research laboratory A01, and university A03 and A04) before introducing the NPD project to SME A.

On the other hand, there were 6 actors of SME A who had participated in the NPD at industrial scale. These actors include food experts (hospital A01, national research laboratory A01, and university A03 and A04), new suppliers, regular suppliers, FDA, testing laboratories, and indirect consumers. Only case A88 had an additional actor which was Machinery seller (A05).

In the routine OEM NPD cases, most of the key actors owning the IP rights of a new product were the food company. However, the actor who owned the rights of new products in this group was the food expert from the government and/or academic sectors, hospital A01, national research laboratory A01, and university A03 and A04. Interviewee A mentioned that "*These NPDs* (Case A88, A89, A90, A91 and A92) *were rare cases to Thai FI that the IP of public sectors covered the industrial scale and FDA registration. Normally they did just the lab scale*".

4.4.2.2 The Summary of Involved Actors in Food OI NPD. Tables 4.8 to Table 4.16 show the various actors involved within the food machinery company's OI NPD to different degrees and nature in each group. The evidence from these findings concluded that there were 9 groups of actors in the investigated food OI NPDs. As illustrated on Table 4.17, these actors are (1) food machinery company, (2) food company, (3) food experts & consultants, (4) marketing organizations, distributors, and retailers, (5) new suppliers, (6) regular suppliers, (7) regulatory bodies and testing laboratories, (8) consumers, and (9) machinery sellers. Besides these 9 groups, the researcher discovered another involved actor, (10) other market stakeholders for the completion of all input resources for the new product.

In addition, the answers of RQ1.2 helped the researcher to identify the roles and relationships of the various OI NPD involved actors.

Table 4.17

The categorization of involved actors in the investigation of Thai FI SMEs OI NPDs

Involved actors	SME A @Total 92 NPDs			SME B @Total 17 NPDs			Total 109 NPDs	
	Involved NPDs	Amount of the involved actor	Remarks	Involved NPDs	Amount of the involve d actor	Remarks	Involved NPDs	Amount of the involve d actor
1. Food machinery company	92	1	Food machinery SME A	17	1	Food machinery SME B	109	2
2. Food companies	75	24	Food company A01-A24	14	4	Food company B01-B04	89	28
3.Food experts & consultants	7	5		-	-		7	5
-Universities	5	3	University A01, A03, A04	-	-		5	3
-Hospital	1	1	Hospital A01	-	-		1	1
-National laboratories	1	1	National research laboratory A01	-	-		1	1
4. Marketing organizations, distributors and retailers	12	12		3	3		15	15
5. New suppliers	81	81		17	17		98	98
6. Regular suppliers	92	92		17	17		109	109
7. Regulatory bodies and testing laboratories	92	92		17	17		109	109
-Thai FDA	92	92		17	17		109	109
-Testing laboratories	92	92		17	17		109	109
8. Consumers	87	87		17	17		104	104
9. Machinery sellers	9	4	Machinery seller A01-A04	1	1	Machinery seller B01	10	5
10.Other market stakeholders	92	-	Indirect involvement	17	-	Indirect involvement	109	-

1) Food machinery company. The main OI NPD roles of the food machinery company were to implement R&D and organize the external and internal parties to achieve NPD at the laboratory scale and/or industrial scale, until the new product reached the legal commercialization stage. Beside their internal R&D practices, the variety of OI practices with external actors were crucial. In this section, the researcher showed only the OI practice of food machinery company at the intra-organizational level which was the “employee involvement”, the leveraging knowledge and initiatives of employees who were not directly involved in R&D department (Van de Vrande el al., 2009). Take for instance the business manager, procurement team, regulation affair, and production team. The OI logic connected to the employee involvement is coupled OI: outbound dominance. The other roles and OI practices of food machinery company at the inter-organizational level are presented in the next section of other involved actors.

2) Food companies. Their main OI NPD role were to create new product ideas and concepts. The ideas include unique selling points, ideal cost, and brand identity to satisfy their target market and to transfer them to the food machinery company through “Inward IP licensing”. They focused on marketing the new product, and hand over to the R&D of the food machinery company, through “customer involvement” and “insourcing R&D”. In some cases, for example, for Group 3, the food company took a lesser role within new recipe creation because they received the new recipe from the food machinery company, that is through “outward IP licensing” by interacting with the food machinery company’s manager. The OI logic surrounding customer involvement and inward IP licensing practices were regarded as coupled OI with inbound dominance, while the outward IP licensing and insourcing R&D practice were considered coupled OI with outbound dominance.

Interviewee A suggested that "*Only the client* (food company) *who provides us a more precise new product concept and recipe, the more success the NPD will be as would expect", "We have charged the lab scale fee but, in some cases, we provided the service without a fee. It depended on the difficulty of NPD. These could develop another business model, as R&D service. On the other hand, we have charged industrial scale fees to all cases because the upscaling took a huge expense. Moreover, I could approach and sell my existing recipe to others*". Contrary to SME B, the interviewee B stated "*I did free lab scale to all OEM cases because the clients were my friends. But I charged them at the industrial scale stage*". The common comments of interviewees A and B were "*The client participates in OEM NPD at the sensory testing process*" and "*the insourcing R&D service encompassed many sub activities. For example, my procurement team acquired the ingredient knowledge from suppliers, internal R&D, sensory testing with client and indirect consumer, acquiring new product's testing result from accredited testing labs, and FDA registration*".

3) Food experts & consultants. For this group of involved actors, the researcher combined the universities, hospitals, and national research laboratory because they served the same purpose that is the source of external R&D at the laboratory scale. Their main OI NPD roles were sourcing external R&D laboratory scale through "outsourcing R&D" (Group 2), clients who carried out OEM NPD at an industrial scale through "insourcing R&D" (Group 6), and the laboratory scale co-developed with the food companies (Group 5) which was beyond the scope of this research study as there were no OI logics and practices in place. The OI logic connected to the outsourcing R&D practice was coupled OI: inbound dominance, while the insourcing R&D practice was coupled OI: outbound dominance.

4) The group of Marketing organizations, distributors, and retailers. For this group of involved actors, the researcher combined the marketing organizations, distributors, and retailers because they served the same purposes. Their main OI NPD role was the sourcing of new product ideas, gain market insights, and to provide feedback of new products during the NPD at both scales, through "customer involvement". They interacted with the food machinery company's manager. The OI logic connected to the practice were inbound, and coupled OI: inbound dominance.

Interviewee A suggested that "*most of the SMEs had limited marketing resources. We could not connect or reach the foreign consumers directly. Hence, we relied more on the trusted sales agents* (marketing organizations, distributors, and retailers) *for the market side. We were sharing with each other regarding a new product*".

5) New suppliers and 6) Regular suppliers. The researcher did not combine these 2 involved actors together because they served the same purpose but present differently at the laboratory and industrial scales. However, their roles and relationships with the food machinery company were the same.

Their main OI NPD role was to be the new / regular ingredient provider and their related knowledge through "supplier involvement (inward ingredients fitness)". They interacted with the food machinery company's procurement team, sharing their knowledge of new ingredient characteristics, minimum order quantities (MOQ) and discussed pricing. They also provided the required supporting documents such as the Certificate of Analysis - COA for new/regular ingredients, the FDA number/ imported number of ingredients, and listing components inside the ingredients. These documents were provided when the actual purchase order occurred. This was at the industrial scale for all cases. These documents were necessary for FDA registration and compliance with factory standards. The OI logic connected to the supplier involvement practice was coupled OI with inbound dominance.

This observation is based on the interview from Interviewee B. Interviewee specifically stated that "*it seemed that we were the only side that gained ingredient knowledge from suppliers but we actually had to share the specific ingredient spec, preferable cost and order amount regarding the new product requirement and our existing production process as well. For example, the bone less black chicken material needed to be half boiling and chill before delivery to us. It could not be frozen due to the different texture and smell after our production process*".

7) Regulatory bodies & Testing laboratories. The researcher combined the grouping of the Food and Drug Administration (FDA) with the Accredited testing laboratory because they served the same purpose; to reach the legal commercialization stage of the new product by providing supporting documents for the FDA number. The accredited testing laboratory provided the analysis for new products, the documentation of nutrition fact, thermal processing (or sterilizing value, usually referred to as F_0. It describes the level of microbial destruction obtained by thermal treatment in the sterilizing process), and a Microbial report. On the other hand, FDA provided the factory/production license corresponding to the new products, evaluated new products in respect of food law and regulations, and provided the FDA number for a new product. If new products do not meet the legal criteria, the FDA provides new product adjustment feedback would help to enable the food machinery company to adjust ingredient ratio and/or label content to comply with regulations. The FDA role as a regulator in the OI NPD, gave them the authority to provide the legal documents supporting the FDA number for new products, and to evaluate the new product to establish whether it met the legal criteria or not. This is a significant part of the "Regulatory body involvement". They interacted with the food machinery company's Regulatory Affair (RA) staffs whose role was to ensure that their companies comply with all of the laws and regulations pertaining to the commerce of the new products. The OI logic connected to the regulatory body involvement practice was coupled OI: inbound dominance.

Interviewee A stated that "*For the Testing labs, we shared only food recipes and new product samples for analysis. Then, we got full analysis reports and all necessary information back. They are critical to the FDA registration process"* and *"Before the actual FDA registration, my RA team always contacted the FDA One-Stop Service for prior evaluation of new products, understand the regulation guidelines and adhere to any suggestion for the new product for compliane so as to ensure and achieve an FDA number".*

8) Consumers. For the consumer group, the researcher combined the direct consumer with the indirect consumer because they were difficult to separate them in the context of this study. In some cases, they were the same group of consumers, whilest some cases, they were not.

In general, the direct consumer is the creator of food trend & demand. However, there was no OI practice relating to this activity as there was no interaction between the food machinery company and the direct consumer. The food machinery company's manager seizes consumer trends from marketing sources. For example, the use of the internet, and perception of related knowledge as the inbound logic.

On the other hand, the cases that had direct interaction for OI NPD resulting in the role of a direct consumer as the creator of a new product idea, and the sensory feedback provided at both the laboratory scale and industrial scale, through "customer involvement". Indirect consumer involvement was preferred for the OEM NPD because the food machinery company could not reach the consumer directly. The role of indirect consumer was sensory feedback provided through "customer involvement". The OI logic connected to the customer involvement was coupled OI with inbound dominance. The researcher considered the direct consumer and indirect consumer to be within the same group of consumers in this study.

9) Machinery sellers. Their main OI NPD role is providing new machines and the machinery knowledge to complete new product development, especially at the industrial scale, through "supplier involvement (inward machinery fitness)". They interacted with the food machinery company's procurement team as a main contact. The OI logic connected to the supplier involvement practice was coupled OI with inbound dominance.

The observation is based on the information provided by Interviewee A. Interviewee A stated that "*during the machine installation, we gained a lot of knowledge. Not only the machinery setting for the new product itself but for the other product applications as well*", and "*Machinery sellers supported us on the machine installation with the basis on new product, process, and our existing production facilities. We used new product materials for a trial production with new machine*".

10) Other market stakeholders. This group of involved actors were not directly mentioned in the interview procedure, but they did exist. The researcher combined the direct/indirect competitors, and other related industries into this group because they served the same purpose that is to partially create food trends and demands.

In general, the actors in this group had no actual contact with the food machinery company but its role was the creator of food trend & demand, and sometimes new product ideas. The Food machinery company's manager based on personal intuition or senses and seizes consumer trends from marketing source (e.g., market survey) and perceived the related knowledge as inbound logic.

Beside these 10 actors, Interviewee A suggested another actor quite often during the interview, that is the "Certified Organizations". For FI, certification was a useful tool to add credibility, by demonstrating that a certified food product or service met the expectations of the clients and/or consumers. Some certification matters were legal, for example the Good Manufacturing Practice (GMP), some were a contractual requirement for the client such as the Hazard Analysis Critical Control Point (HACCP), Organic Certification, and International Organization for Standardization (ISO), while some such as HALAL, and the British Retail Consortium (BRC) were relevant to specific markets. Hence, authorized certified organizations were an important group of actors in the food industry.

This evidence prevailed in the interview with Interviewee A who reported that "*my factory had HALAL standard. All of my food products are certified by the Central Islamic Council of Thailand. That is why my new products can commercialize to the Muslim markets, such as, UAE. In my opinion, the new products could add more* *value through these certification*". However, in contrast with SME B, Interviewee B cited that "*I have very low involvement with the Certified Organization. Most of my OEM clients were local entrepreneurs. Their new products sold at local markets did not need certification. Hence, my factory had only GMP standards as a legal requirement*".

For this study the researcher concluded that a Certified Organization was not related to the OI NPD. It was more concerned with the manufacturing and commercialization processes which does not form part of the study.

4.4.3 The OI Logics & Practices

The researcher identified the OI logics and practices from the 1st interview, and confirmed these findings with the interviewees at the 2nd interview. As the specific OI logics are only attached to the OI practices implemented by the investigated food machinery companies (Van de Vrande et al., 2009), the identification of the OI logics and the OI practices had to be explored as a parallel process. Hence, the researcher combined the finding results of these factors and presented as below.

To answer **RQ2**: What OI logics and practices are implemented in the Thai FI machinery SMEs OI NPD processes?, Interviewee A and Interviwee B were asked the same set of interview questions to each NPD explanation (A01-A92 and B01-B17). Three sub-questions were also asked. The first sub-question **(RQ2.1)** was the question that asked "What specific activities / practices are implemented between external actors and food machinery SMEs in food NPDs both at the laboratory scale and industrial scale?". The second sub-question **(RQ2.2)** asked "What is the specific travel of the food recipe between external actors and food machinery SMEs?". The third sub-question **(RQ2.3)** asked "What is the overall direction of food recipe knowledge flow both at the laboratory scale and industrial scale?".

Furthermore, the researcher also applied the time-series analysis of a diachronic case (Gerring, 2004) in the interview. The questions RQ2.1 and RQ2.2 were answered in chronological order about the NPD events (this includes the stage of ideation until FDA registration). This method helped the researcher to better understand the development of each OI NPD at the organizational level, and the identification of OI NPD framework and its generative mechanism.

Regarding the OI logics questions (RQ2.2), OI logics were established through the exchange flow of knowledge between actors. The interviewees A and B were asked to identify the direction of knowledge flow among the external actors and their food machinery company as a focal firm, by following the development of the food recipe throughout the NPD process. The starting point of OI logic or the origin of the food recipe was asked in the RQ1.3. The choice of OI logics that applied to this study were as follows: inbound logic, outbound logic, coupled logic: inbound dominance, coupled logic: outbound dominance, and no OI logic.

When coupled logic was identified by the interviewee, the exchanged volume of resources regarding the recipe (the development of recipe, ingredients, tacit knowledge, explicit knowledge, technology, production condition and processing, and legal compliance) is considered to define the inbound or outbound dominance by the interviewee.

Regarding the OI practices questions (RQ2.1), all practices associated with each NPD have been classified using the typology of Van de Vrande et al. (2009) at the laboratory scale and the industrial scale. When the OI practice observed did not match with the typology, a new category of OI practice would be created and defined. Some of the NPD practices that were not considered OI practice, were replaced into another group. Contrary to the OI logic question, the researcher did not provide the specific name of an OI practice and definition in advance to the interviewees. The participants independently answered the OI practices questions by naming all involved in each of the NPD activities.

The researcher took responsibility for qualifying and categorizing the OI practice in academic terms. If the identified NPD activities did not correspond to the OI practice definition (Williamson & De meyer, 2012), the researcher categorized the activities as the ordinary NPD activity. To validate the interpretation of OI logic and practice categorization, the presence of the researcher's supervisor in the interpretation of the results enhanced the credibility within a double-coding of the interview transcripts, to make sure that the biases have been reduced.

4.4.3.1 The Identification of OI Logics & Practices Implemented by Each Actors. As SMEs A and SME B were considered to be focal firm in the OI NPD process, there are different OI logics and practices relating to each involved actor as shown in tables 4.18 to 4.27.

● *OI Logics & Practices of the Food Machinery Companies.*

Table 4.18

Involvement of the food machinery company in OI NPD at the intra-organizational level; NPD activities, OI practices and logics identification

1) Food machinery company				
Involved NPD activities (*Intra-organizational level)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Acknowledged the market opportunities of new product e.g., food trend, new ingredient [by manager]	Direct & indirect consumers, competitor, Mkt orgs, distributors & retailers, Food company, Food experts & consultants	1,2,3,4,5,6	Employee involvement	Inbound
• Gathering the ideas of new product [by manager]	Mkt orgs, distributors & retailers, consumer	1,2	Employee involvement	Inbound
• Address the current situation of its organization and providing suitable strategies for NPD [by manager]	-	1,2,3,4,5,6	Marketing/business practice (Non-OI practice)	-
• Client analysis [by manager]	Food company, Food experts & consultants	3,4,5,6	Employee involvement	-
• Approaching NPD project to the external parties [by manager]	Food experts & consultants, Food company	2,3	Employee involvement	Outbound dominance
• Exchanging technology knowledge with the external party before starting NPD (sharing limitation, NPD requirement) [by Manager]	Food experts & consultants, Food company	2,3,4,5,6	Employee involvement	Outbound dominance
• Preparing related samples & knowledge [by R&D]	-	1,2,3	Internal R&D (non-OI practice)	-
• Assessing prior-NPD feasibility [by manager]	-	1,2,3,4,5,6	Employee involvement	-
• Transferring new product ideas to the team [by manager]		1,2,3,4,5,6	Employee involvement	-
• Pre-screening the recipe & materials with technology [by R&D]	-	1,2,4,5,6	Internal R&D (non-OI practice)	-
• Assessing overall NPD feasibility [by R&D]	-	1,2,3,4,5,6	Internal R&D (non-OI practice)	-
• Developing new product concept & original recipe [by R&D]	-	1,3	Internal R&D (non-OI practice)	-
• Acquiring new ingredient knowledge (Spec / MOQ / Price /COA) [by procurement]	New suppliers, Regular supplier	1,2,3,4,5,6	Employee involvement	Inbound dominance
• Organizing overall NPD at laboratory scale [by manager]	-	1,2,3,4	Employee involvement	-
• Facilitating laboratory scale sensory test & communication between internal & external organization [by manager]	Mkt orgs, distributors, & retailers Food company Food company, Food experts & consultant, Indirect consumer	1,2 3 4	Employee involvement Employee involvement Employee involvement	Inbound dominance Outbound dominance Inbound dominance
• R&D at the laboratory scale [by R&D]	-	1,3,4	Internal R&D (non-OI practice)	-
• Prototype providing with laboratory scale recipe [by R&D, manager]	-	1,3,4	Internal R&D (non-OI practice), Employee involvement	Outbound dominance

(Continued)

Table 4.18 (Continued)

Involvement of the food machinery company in OI NPD at the intra-organizational level; NPD activities, OI practices and logics identification

1) Food machinery company				
Involved NPD activities	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm **OI practices coding [RQ2.1]**	**OI logics [RQ2.2]**
• Provide the sensory feedback of prototype [by manager]	Food experts & consultants	2	Employee involvement	Outbound dominance
• Approving prototype & laboratory scale recipe [by R&D]	-	1,2	Internal R&D (Non-OI practice)	-
• Acquiring the new machine & machinery knowledge [by procurement team, manager, R&D, and Production team]	Machinery sellers	2,4,5,6	Employee involvement Managerial decisions making (Non-OI practice)	Inbound dominance -
• Organizing overall NPD at the Industrial scale [by manager]	-	1,2,3,4,5,6	Employee involvement	-
• Facilitating industrial scale sensory test & communication between internal & external organization [by manager]	Mkt orgs, distributors, & retailers Food company Food company, Food experts & consultant, Indirect consumer Food experts & consultant	1,2 3 4,5 6	Employee involvement Employee involvement Employee involvement Employee involvement	Inbound dominance Outbound dominance Inbound dominance Inbound dominance
• R&D at the Industrial scale [by R&D and production]	-	1,2,3,4,5,6	Internal R&D (Non-OI practice)	-
• New product providing with its industrial scale recipe [by R&D, production, manager]	-	1,2 3,4,5,6	Internal R&D (non-OI practice), Employee involvement Internal R&D (non-OI practice), Employee involvement	- Outbound dominance
• Approving new product & recipe [by R&D and production, manager]	- Food experts & consultant	1 2	Internal R&D (non-OI practice), Employee involvement Internal R&D (non-OI practice), Employee involvement	- Inbound dominance
• Coordinating with accredited testing laboratories to provide all related documents for FDA registration (Nutrition fact / F0 / Microbial report) [By RA]	Regulatory bodies & testing laboratories (Testing labs)	1,2,3,4,5,6	Employee involvement	Inbound dominance
• Coordinating with FDA for FDA number (Submitting documents, communicating the adjustment feedback to R&D) [By RA]	Regulatory bodies & testing laboratories (FDA)	1,2,3,4,5,6	Employee involvement	Inbound dominance
• Adjusting the ingredient ratio / label content according to FDA requested [By R&D]	-	1,2,4,5	Internal R&D (Non-OI practice)	-
• Coordinating with FDA for new production license corresponding to new products [RA, Manager]	Regulatory bodies & testing laboratories (FDA)	4,5,6	Employee involvement Marketing/business practice (Non-OI practice) Managerial decisions making (Non-OI practice)	Outbound dominance - -

In this section, the researcher revealed the NPD practices of food machinery company at the intra-organizational level only. The inter-organizational practices were identified at the other involved actor's section (Table 4.19 to Table 4.27). The findings from Table 4.18 shows one category of the OI practice followed the Van de Vrande et al's (2009) typology; employee involvement. However, this practice is implemented by various types of the non-R&D employee of the investigated food machinery companies:

1) Based on the interviews, employee involvement of the manager involved extensive functions such as the acknowledgment of the market opportunities for new products; gathering ideas for new products; addressing the current situation and providing dynamic strategies; client (food company) analysis; introducing a NPD project to external parties (food company, food experts & consultants); exchanging technology knowledge with the external party before starting NPD (sharing limitation, NPD requirement); assessing prior-NPD feasibility; transferring new product ideas to the team; organizing overall NPD at laboratory scale; facilitating laboratory scale sensory tests for communication between internal and external groups; providing sensory feedback of a prototype; acquiring new machine & machinery knowledge; organizing overall NPD at the industrial scale; facilitating industrial scale sensory testing; communicating between internal and external groups, and approving new products and recipes.

The OI logic connected to this practice by the manager are diverse and can be inbound, coupled OI with inbound dominance, coupled OI with outbound dominance, and no OI logic in some activities.

2) For employee involvement of the procurement team, the tasks embedded activities such as acquiring new ingredient knowledge (Specification / MOQ / Price /COA), and acquiring new machine & machinery knowledge. The OI logic connected to this practice by procurement team was coupled OI with inbound dominance.

3) As for employee involvement of the Regulation Affair team (RA), the OI activities encompass the co-ordination with accredited testing laboratories to provide all related documents for FDA registration (nutrition fact / F_0 / microbial report), coordinating with FDA for an FDA number (submitting documents, communicating the adjustment feedback to R&D), and coordinating with FDA for a new production license corresponding to new products. The OI logic connected to this practice by the procurement team was clearly coupled OI with inbound dominance.

Contrary to Van de Vrande et al's (2009) typology, the OI logic of the employee involvement did not always reflect outbound logic and/or coupled OI logic with outbound dominance. The findings showed that the employee involvement sometimes operationalized inbound dominance.

On the other hand, some of food machinery company's activities were considered as internal R&D practices. They were not the OI practices because no knowledge transferring across the organization boundary, but are necessary to achieve the NPDs.

4) Internal R&D practices by R&D team include preparing related samples & knowledge for other departments; pre-screening recipes and materials with production technology; assessing overall NPD feasibility; developing new product concept and original recipes; R&D at the laboratory scale (including ideal cost provision, prototyping for laboratory scale recipes, prototype approval for laboratory scale

recipes); R&D at an industrial scale (including mass production cost providing); new product provision with industrial scale recipes; approving new product & recipes; and adjusting ingredient ratio / label content according to FDA requests.

5) As for the Internal R&D of the production team, the practices include R&D at industrial scale, new product provision with industrial scale recipes, and approving new products and recipes.

● ***OI Logics & Practices Implemented with the Food Experts & Consultants.***

Table 4.19

Involvement of the food experts & consultants in OI NPD; NPD activities, OI practices and logics identification

2) Food experts & consultants				
Involved NPD activities (*the view of the food experts & consultants)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding **[RQ2.1]**	**OI logics** **[RQ2.2]**
• Accessing the prior-NPD feasibility before accepting the outsourcing R&D	Food machinery company [through manager]	2	Outsourcing R&D	Outbound dominance
• Developing the original recipe for outsourcing R&D	-	2	Outsourcing R&D	-
• R&D at the laboratory scale	-	2	Outsourcing R&D	-
• Prototype providing with the laboratory scale recipe	Food machinery company [through manager]	2 6	Outsourcing R&D Inward IP licensing	Inbound dominance Inbound dominance
• Approaching the new product idea while exchanging technology knowledge, NPD process, and budgeting/ Accessing NPD feasibility & risks / Making decision to start NPD	Food machinery company [through manager]	6	Customer involvement	Inbound dominance
• Contract R&D service at the industrial scale -Approving the adjusted industrial scale recipe & process -Providing initial knowledge for prototype developing	Food machinery company [through manager]	6	Insourcing R&D Inward IP licensing	Outbound dominance Inbound dominance
• Provide the sensory feedback of prototype	Food machinery company [through manager]	6	Customer involvement	Inbound dominance
• Approving the new product & recipe	Food machinery company [through manager]	6	Customer involvement	Inbound dominance
• Providing the packaging label for FDA registration	Food machinery company [through manager]	6	Customer involvement	Inbound dominance
• External Co-R&D at the laboratory scale -Developing the original recipe of new product -R&D at the laboratory scale -Prototype providing with recipe	Food company	5	External R&D (Non-OI practice)	-

The findings from Table 4.19 shows 4 categories of the OI practices that the investigated food machinery companies have implemented with the food experts and consultants. Three of the OI practices followed the Van de Vrande et al's (2009) typology were outsourcing R&D, customer involvement and inward IP licensing. A new finding for OI practice that improved the typology of Van de Vrande et al. (2009) is the insourcing of R&D.

All of the OI logics attached to the mentioned OI practices wer coupled OI logic, and followed the Van de Vrande et al's (2009) typology. The outsourcing R&D practice in NPD Group 2 comprises of many involved NPD activities of the food experts and consultants. Some of the NPD activities comprises of the access to prior-NPD feasibility studies before outsourcing its R&D (Outbound dominance), developing the original recipe for outsourcing R&D (No OI logic), R&D at the laboratory scale (No OI logic), and prototyping to provide a laboratory scale recipe (Inbound dominance). Hence, the outsourced R&D practice was coupled OI logic. To identify the dominance of knowledge flow, interviewees considered the exchanged volume of resources in this practice, and considered it to be inbound dominance.

The findings also showed some activities that involved the investigated NPD but it was not the OI practices. Take for instance, the external R&D practices. Hence, this practice has no OI logic as there is no knowledge transferring among the food experts and the investigated SMEs.

● *OI Logics & Practices Implemented with the Food Companies.*

Table 4.20

Involvement of the food company in OI NPD; NPD activities, OI practices and logics identification

3) Food companies				
Involved NPD activities (*the view of the food companies)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
● Acknowledged the market opportunities of new product e.g., food trend, new ingredient	Direct & indirect consumers, competitor, Mkt orgs, distributors & retailers,	4,5	External R&D (Non-OI practice)	-
● Being approached new product by the Food machinery company -Assessing New Product's market Opportunities -Assessing the consistency with Org. strategies -Accessing NPD feasibility	Food machinery company [through manager]	3	Customer involvement	Outbound dominance
● Receiving food recipes & samples for its internal consideration.	Food machinery company [through manager]	3	Outward IP licensing	Outbound dominance
● Developing original recipe	-	4	External R&D (Non-OI practice)	-
● Approaching new product idea (including original recipe) while exchanging technology knowledge, NPD process, and budgeting/ Accessing NPD feasibility & risks / Making decision to start laboratory scale	Food machinery company [through manager]	4,5	Inward IP licensing	Inbound dominance
● Contract R&D service at laboratory scale -Co-development e.g., sharing market insight, preferable product concept and ideal cost -Approving the adjusted lab scale recipe & process	Food machinery company [through manager]	4	Insourcing R&D	Outbound dominance
● Provide sensory feedback of prototype at the laboratory scale	Food machinery company [through manager]	4	Customer involvement	Inbound dominance
● External R&D at laboratory scale -Developing new product idea -Developing original recipe of new product -R&D at Lab scale -Prototype providing with recipe	Food experts & consultants	5	External R&D (Non-OI practice)	-
● Approaching the new product idea (including laboratory scale recipe) while exchanging technology knowledge, NPD process, and budgeting/ Accessing NPD feasibility & risks / Making decision to start industrial scale	Food machinery company [through manager]	5	Inward IP licensing	Inbound dominance
● Contract R&D service at industrial scale -Co-development e.g., developing marketing concept for new product, packaging, and brand identity -Approving the adjusted industrial scale recipe & process	Food machinery company [through manager]	4,5	Insourcing R&D	Outbound dominance
● Provide sensory feedback of prototype at industrial scale	Food machinery company [through manager]	4,5	Customer involvement	Inbound dominance
● Approving new product & recipe	Food machinery company [through manager]	4,5	Customer involvement	Inbound dominance
● Providing packaging label for FDA registration	Food machinery company [through manager]	4,5	Customer involvement	Inbound dominance

The findings in Table 4.20 shows 4 categories of the OI practices that the investigated food machinery companies had implemented with the food companies. Three of the findings in OI practices that followed Van de Vrande et al's (2009) typology are customer involvement, outward IP licensing, and inward IP licensing. The new findings OI practices that enriched the typology of Van de Vrande et al. (2009) was the insourcing R&D.

Almost all of the OI logics attached to the above OI practices are coupled OI logics following Van de Vrande et al's (2009) typology. Only the customer involvement practice was not always coupled OI logic with inbound dominance as it should be. The presence of customer involvement practice in NPD group 3 is considered coupled OI logic with outbound dominance. This was due to the nature of NPD in this group, and the development of a food company's new product by using the food machinery company's recipe. For the OI logic of insourcing R&D practice, the interviewees identified it as coupled OI logics with outbound dominance.

The findings also showed some activities that involved the investigated NPD but it was not the OI practice, that is the external R&D practice. Hence, this practice had no OI logic because there was no knowledge flow among the food companies and the investigated food machinery companies.

● OI Logics & Practices Implemented with the Group of Marketing Organizations, Distributors, and Retailers.

Table 4.21

Involvement of the group of marketing organizations, distributors, and retailers in OI NPD; NPD activities, OI practices and logics identification

4) Marketing organizations, distributors, and retailers				
Involved NPD activities (*the view of the group of marketing organizations, distributors, and retailers)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Providing the market insight, sharing new product ideas, new ingredient suggestion, and ensuring new product opportunity	Food machinery company [through manager]	1,2	Customer involvement -	Inbound
• Providing sensory feedback at the laboratory scale	Food machinery company [through manager]	1,2	Customer involvement	Inbound dominance
• Providing sensory feedback at the industrial scale	Food machinery company [through manager]	1,2	Customer involvement	Inbound dominance
• New product commercialization	Food machinery company [through manager]	1,2	Commercialization (Beyond the scope of study)	-

The findings in Table 4.21 showed one category of the OI practices (Van de Vrande et al., 2009) that the investigated food machinery companies implemented with the group of marketing organizations, distributors, and retailers; the customer involvement.

The OI logics attached to the mentioned OI practice was coupled OI logics with inbound dominance (Van de Vrande et al., 2009).

The findings also showed the activities carried out in the investigated NPD but were not an OI practice, such as commercialization of new product. This practice was beyond the study scope (NPD context).

● ***OI Logics & Practices Implemented with the New Suppliers and Regular Suppliers.***

Table 4.22

Involvement of the new suppliers in OI NPD; NPD activities, OI practices and logics identification

5) New suppliers				
Involved NPD activities (*the view of the new suppliers)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Providing new ingredient knowledge (Spec / MOQ / Price) and ingredient sample for the laboratory scale experiment	Food machinery company [through procurement]	1,4	Supplier involvement (Inward ingredient fitness)	Inbound dominance
• Providing the new ingredient knowledge (Spec / MOQ / Price / COA) and selling new ingredients at the optimum quantity for the industrial scale experiment	Food machinery company [through procurement]	1,2,3,4,5,6	Supplier involvement (Inward ingredient fitness)	Inbound dominance

Table 4.23

Involvement of the regular suppliers in OI NPD; NPD activities, OI practices and logics identification

6) Regular suppliers				
Involved NPD activities (*the view of the regular suppliers)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Providing the regular ingredient knowledge (Spec / MOQ / Price / COA) and selling regular ingredients at the optimum quantity for industrial scale experiment	Food machinery company [through procurement]	1,2,3,4,5,6	Supplier involvement (Inward ingredient fitness)	Inbound dominance

The findings at Tables 4.22 and Table 4.23 showed that the new categories of the OI practices that the investigated food machinery companies had implemented with both new and regular suppliers. Specifically, it was the supplier involvement; the involvement of new/regular suppliers in terms of inward ingredients fitness that were best suited to complete the development of food recipes. The OI logic attached to this practice was coupled OI logic with inbound dominance. This new finding OI logic & practice enriched the typology of Van de Vrande et al (2009).

● ***OI Logics & Practices Implemented with the Regulatory Bodies & Testing Laboratories.***

Table 4.24

Involvement of the regulatory bodies & testing laboratories in OI NPD; NPD activities, OI practices and logics identification

7) Regulatory bodies & testing laboratories				
Involved NPD activities (*the view of the regulatory bodies & testing laboratories)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Providing related documents for FDA registration (Nutrition fact / F0 / Microbial report)	Food machinery company [through RA]	1,2,3,4,5,6	Regulatory body involvement	Inbound dominance
• Providing the new product adjustment feedback (to adjust ingredient ratio and/or label content of new product complying the regulation)	Food machinery company [through RA]	1,2,3,4,5,6	Regulatory body involvement	Inbound dominance
• FDA registration and providing FDA number for new product	Food machinery company [through RA]	1,2,3,4,5,6	Regulatory body involvement	Inbound dominance
• Registration of the new production license corresponding to new products	Food machinery company [through RA]	4,5,6	Regulatory body involvement	Inbound dominance

The findings in Table 4.24 showed new categories of the OI practices that the investigated food machinery companies implemented with the regulatory bodies and testing laboratories; the regulatory body involvement. The OI logic attached to this practice was coupled OI logic with inbound dominance. This new findings in OI logic & practices enrich the typology of Van de Vrande et al (2009).

● *OI Logics & Practices Implemented with the Consumers.*

Table 4.25

Involvement of the consumers in OI NPD; NPD activities, OI practices and logics identification

8) Consumers				
Involved NPD activities (*the view of the consumers)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Generating the consumer trends	No direct contact	1,2,3,4,5,6	-	Inbound
• Generating new product idea -Sharing market insight -Confirming consumer trend -Sharing idea of new product	Food machinery company [through manager]	1,2	Customer involvement	Inbound dominance
• Providing sensory feedback at the laboratory scale	Food machinery company [through manager]	1,2,3,4	Customer involvement	Inbound dominance
• Providing sensory feedback at the industrial scale	Food machinery company [through manager]	1,2,3,4,5	Customer involvement	Inbound dominance

The findings in Table 4.25 showed 1 category of the OI practices (Van de Vrande et al., 2009) that the investigated food machinery companies implemented with the consumer; customer involvement.

The OI logics attached to the mentioned OI practice was coupled OI logics with inbound dominance (Van de Vrande et al., 2009).

● *OI Logics & Practices Implemented with the Machinery Sellers.*

Table 4.26

Involvement of the machinery sellers in OI NPD; NPD activities, OI practices and logics identification

9) Machinery sellers				
Involved NPD activities (*the view of the machinery sellers)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Providing the new machine & machinery knowledge (Machine installation with the basis on new product, process, and existing production facilities)	Food machinery company [through procurement manager, R&D and production]	2,4,5,6	Supplier involvement (Inward machinery fitness)	Inbound dominance

The findings as shown in Table 4.26 indicates new categories of OI practices that the investigated food machinery companies have implemented with the machinery sellers. Specifically, it was the supplier involvement; the involvement of the machinery sellers in term of inward machinery fitness. Take for instance the completion of NPD at the industrial scale which required the purchase of a new machine to achieve a better new product quality and/or better production efficiency by optimizing the machine setting to achieve the desired goals. The OI logic attached to this practice was coupled OI logic with inbound dominance. This new finding OI logic & practice enriches the typology of Van de Vrande et al (2009).

● ***OI Logics & Practices Implemented with the Other Market Stakeholders.***

Table 4.27

Involvement of the other market stakeholders in OI NPD; NPD activities, OI practices and logics identification

10) Other market stakeholders				
Involved NPD activities (*the view of the other market stakeholders)	**Interact with whom**	**Occurring in NPD group**	*Identification by considered the Food machinery company as a focal firm	
			OI practices coding [RQ2.1]	**OI logics [RQ2.2]**
• Providing new product ideas • Providing food trends	No tangible interaction No tangible interaction	1,2,4,5,6 1,2,4,5,6	- -	Inbound Inbound

The findings illustrated in Table 4.27 showed no OI practices were implemented with the other market stakeholders because there was no direct interaction between the actors. However, the flow of knowledge could be considered as inbound logic.

4.4.3.2 The identification of OI Logics & Practices in each group of NPDs. At the 2nd interview, the extracted OI practices of each involved actor were confirmed by the interviewees again, for each NPD case at laboratory and industrial scales. The research question RQ2.3, was asked to identify the overall direction of OI logic at the laboratory and industrial scale of each NPD (Tables 4.28 and Table 4.29).

Table 4.28

OI logics and practices of 109 NPDs of SME A

SME A	Case number	NPD - laboratory scale												NPD - industrial scale											
		Overall OI logics [RQ2.3]			OI practices [RQ2.1]								**Sum of OI practices**	Overall OI logics [RQ2.3]			OI practices [RQ2.1]								**Sum of OI practices**
		Coupled OI: Outbound dominance	Coupled OI: Inbound dominance	No participation in NPD	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body involvement	Outsourcing R&D	Inward IP licensing		Coupled OI: Outbound dominance	Coupled OI: Inbound dominance	No participation in NPD	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body involvement	Outsourcing R&D	Inward IP licensing	
GROUP 1	Case A01		∘		2			1	1				4		∘		5			2	2	1			10
	Case A02		∘		2			1	1				4		∘		5			2	2	1			10
	Case A03		∘		2			1	1				4		∘		5			2	2	1			10
	Case A04		∘		2			1	1				4		∘		5			2	2	1			10
	Case A05		∘		2			1	1				4		∘		5			2	2	1			10
	Case A06		∘		2			1	1				4		∘		5			2	2	1			10
	Case A07		∘		2			1	1				4		∘		5			2	2	1			10
	Case A08		∘		2			2	1				5		∘		5			2	2	1			10
	Case A09		∘		2			2	1				5		∘		5			2	2	1			10
	Case A10		∘		2			2	1				5		∘		5			2	2	1			10
					20			13	10				43				50			20	20	10			100
GROUP 2	Case A11		∘		2			1			1	1	5		∘		6			2	3	1			12
	Case A12		∘		2			1			1	1	5		∘		6			2	3	1			12
					4			2			2	2	10				12			4	6	2			24
GROUP 3	Case A13	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A14	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A15	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A16	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A17	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A18	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A19	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A20	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A21	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A22	∘			1		1	1					3		∘		4	1		2	1	1		1	10
	Case A23	∘			1		1	1					3		∘		4	1		2	1	1		1	10
					11		11	11					33				44	11		22	11	11		11	110

(Continued)

Table 4.28 (Continued)

OI logics and practices of 109 NPDs of SME A

SME A Case number		NPD - laboratory scale												NPD - industrial scale											
		Overall OI logics [RQ2.3]			OI practices [RQ2.1]									Overall OI logics [RQ2.3]			OI practices [RQ2.1]								
		Outbound dominance	Inbound dominance	No participation	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body inv.	Outsourcing R&D	Inward IP licensing	**Sum of OI practices**	Outbound dominance	Inbound dominance	No participation	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body inv.	Outsourcing R&D	Inward IP licensing	**Sum of OI practices**
GROUP 4	Case A24		◦		2			1	1			1	5		◦		6	1		2	2	2		1	14
	Case A25		◦		2			1	1			1	5		◦		6	1		2	2	2		1	14
	Case A26		◦		2			1	1			1	5		◦		6	1		2	2	2		1	14
	Case A27		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A28		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A29		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A30		◦		2			1	1			1	5		◦		6	1		2	3	1		1	14
	Case A31		◦		2			1	1			1	5		◦		6	1		2	3	1		1	14
	Case A32		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A33		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A34		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A35		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A36		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A37		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A38		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A39		◦		2	1		1	1			1	6		◦		6	1		2	3	1		1	14
	Case A40		◦		2	1		1	1			1	6		◦		6	1		2	3	1		1	14
	Case A41		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A42		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A43		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A44		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A45		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A46		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A47		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A48		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A49		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A50		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A51		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A52		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
	Case A53		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A54		◦		2			1	1			1	5		◦		5	1		2	2	1		1	12
	Case A55		◦		2	1		1	1			1	6		◦		5	1		2	2	1		1	12
					64	12		32	32			32	172				167	32		64	68	35		32	398
GROUP 5	Case A56			◦									0		◦		5	1		2	2	1		1	12
	Case A57			◦									0		◦		5	1		2	2	1		1	12
	Case A58			◦									0		◦		5	1		2	2	1		1	12
	Case A59			◦									0		◦		5	1		2	2	1		1	12
	Case A60			◦									0		◦		5	1		2	2	1		1	12
	Case A61			◦									0		◦		5	1		2	2	1		1	12
	Case A62			◦									0		◦		5	1		2	2	1		1	12
	Case A63			◦									0		◦		5	1		2	2	1		1	12
	Case A64			◦									0		◦		5	1		2	2	1		1	12
	Case A65			◦									0		◦		5	1		2	2	1		1	12
	Case A66			◦									0		◦		5	1		2	2	1		1	12
	Case A67			◦									0		◦		5	1		2	2	1		1	12
	Case A68			◦									0		◦		5	1		2	2	1		1	12
	Case A69			◦									0		◦		5	1		2	2	1		1	12
	Case A70			◦									0		◦		5	1		2	2	1		1	12
	Case A71			◦									0		◦		5	1		2	2	1		1	12
	Case A72			◦									0		◦		5	1		2	2	1		1	12
	Case A73			◦									0		◦		5	1		2	2	1		1	12
	Case A74			◦									0		◦		5	1		2	2	1		1	12
	Case A75			◦									0		◦		5	1		2	2	1		1	12
	Case A76			◦									0		◦		5	1		2	2	1		1	12
	Case A77			◦									0		◦		5	1		2	2	1		1	12
	Case A78			◦									0		◦		5	1		2	2	1		1	12
	Case A79			◦									0		◦		5	1		2	2	1		1	12
	Case A80			◦									0		◦		5	1		2	2	1		1	12
	Case A81			◦									0		◦		6	1		2	3	1		1	14
	Case A82			◦									0		◦		6	1		2	3	1		1	14
	Case A83			◦									0		◦		5	1		2	2	1		1	12
	Case A84			◦									0		◦		5	1		2	2	1		1	12
	Case A85			◦									0		◦		5	1		2	2	1		1	12
	Case A86			◦									0		◦		5	1		2	2	1		1	12
	Case A87			◦									0		◦		6	1		2	2	2		1	14
													0				163	32		64	66	33		32	390

Table 4.28 (Continued)

OI logics and practices of 109 NPDs of SME A

SME A Case number		NPD - laboratory scale											NPD - industrial scale											
		Overall OI logics [RQ2.3]			OI practices [RQ2.1]								Sum of OI practices	Overall OI logics [RQ2.3]			OI practices [RQ2.1]							Sum of OI practices
		Outbound dominance	Inbound dominance	No participation in NPD	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body involvement	Outsourcing R&D	Inward IP licensing		Outbound dominance	Inbound dominance	No participation in NPD	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body involvement	Outsourcing R&D	Inward IP licensing	
GROUP 6	Case A88			•									0		•		5	1		1	3	1		1	12
	Case A89			•									0		•		4	1		1	2	1		1	10
	Case A90			•									0		•		4	1		1	2	1		1	10
	Case A91			•									0		•		4	1		1	2	1		1	10
	Case A92			•									0		•		5	1		1	2	2		1	12
													0				22	5		5	11	6		5	54

Table 4.29

OI logics and practices of 17 NPDs of SME B

SME B Case number		NPD - laboratory scale											NPD - industrial scale											
		Overall OI logics [RQ2.3]			OI practices [RQ2.1]								Sum of OI practices	Overall OI logics [RQ2.3]			OI practices [RQ2.1]							Sum of OI practices
		Outbound dominance	Inbound dominance	No participation in NPD	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body involvement	Outsourcing R&D	Inward IP licensing		Outbound dominance	Inbound dominance	No participation in NPD	Employee involvement	Insourcing R&D	Outward IP Licensing	Customer involvement	Supplier involvement	Regulatory body involvement	Outsourcing R&D	Inward IP licensing	
GROUP 4	Case B01		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B02		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B03		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B04		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B05		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B06		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B07		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B08		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B09		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B10		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B11		•		2			1	1			1	5		•		5	1		2	2	1		1	12
	Case B12		•		2			1	1			1	5		•		6	1		2	3	1		1	14
					24			12	12			12	60				61	12		24	25	12		12	146
GROUP 5	Case B13			•									0		•		5	1		2	2	1		1	12
	Case B14			•									0		•		5	1		2	2	1		1	12
													0				10	2		4	4	2		2	24
GROUP 1	Case B15		•		2			1	1				4		•		5			2	2	1			10
	Case B16		•		2			1	1				4		•		5			2	2	1			10
	Case B17		•		2			1	1				4		•		5			2	2	1			10
					6			3	3				12				15			6	6	3			30

The OI Logics and Practices in Group 1. As seen in Table 4.28 and Table 4.29, Group 1 illustrated the development of the food machinery company's new product with its recipe, the origin of the food recipe knowledge flow starts from the food machinery company SME A and SME B for all cases in this group (Case A01-A10, and Case B15-B17). In terms of the overall OI logics at each NPD scale, SME A and SME B indicated the same result - coupled OI: inbound dominance at the laboratory scale and the industrial scale, for all cases in this group.

For OI practices, most of the Case A01 to A07, and Case B15 to B17 highlighted the same result at the laboratory scale which consisted of two employee involvement practices (once by the manager, and one time with a member of procurement team), one supplier involvement practice (once with the new suppliers), and one customer involvement practice from the group of marketing organizations, distributors and retailers.

Only cases A08, A9 and A10 of SME A showed two customer involvement practices. The additional actor being the consumer. Thus, the NPD in Group 1 had on average four OI practices at the laboratory scale. On the other hand, the OI practices at the industrial scale, as in Cases A01, A2, A3, A4, A5, A7, A8, A9, A10, B15, B16 and B17 showed the same result which comprised of five employee involvement practices (performed twice by the manager, two times by the procurement team and once by the RA team), two of customer involvement practices (performed once with the consumer, and one time by the group of marketing organizations, distributors and retailers). There were two supplier involvement practices (once with the new suppliers and one time by the regular suppliers). In addition, there was one regulatory involvement practice which was performed once by the group of regulatory bodies and testing laboratories. Thus, all the NPD cases in Group 1 implemented ten OI practices at industrial scale. In comparison with the two scales, the results for Group 1 showed a higher degree of OI practice at the industrial scale than the laboratory scale in all cases.

In comparison between SME A and SME B, the result demonstrated no significant difference in OI logics and practices at both scales. Only the cases in A08-A10 of SME A, had one more practice at the laboratory scale, customer involvement with a direct consumer. Interviewee A1 advised "*I learnt from the previous experience that I shouldn't ignore the sound of actual customers to own brand NPD. Just a sales agent* (Marketing organization) *and new suppliers could provide us the idea and knowledge of a new product, but still lacks the insight of consumer needs and behaviors. This is a necessary element to achieve the unique characteristic creation. The more efforts we put in the ideation process, the better implemented in new-to-the market products*".

The OI Logics and Practices in Group 2. As seen at Tables 4.28 and Table 4.29, SME B had no case in this OI NPD group. Group 2 was concerned with the development of the food machinery company's new product with the food expert's recipe, and the origin of the food recipe knowledge flow started from the food experts & consultants (the university A01) at all cases in this group (Case A11 and A12).

For overall OI logics at each NPD scale, SME A showed coupled OI: inbound dominance at laboratory scale and industrial scale in all cases in this group.

For Group 2 OI practices, in all cases signified the same result at the laboratory scale and the industrial scale. At the laboratory scale, there were three employee involvement practices (performed twice by the manager, and once by a member of procurement team), one customer involvement practice (performed one time with the group of marketing organizations, distributors and retailers), and one outsourcing R&D practice (with the university A01). Thus, all the NPD cases in Group 2 implemented five OI practices at the laboratory scale. On the other hand, for the OI practices at the industrial scale, all the cases showed the same result of six employee involvement practices (by the manager 2 times, the procurement team 3 times, performed once by the RA team), two of the customer involvement practices (with the consumer 1 time, and the group of marketing organizations, distributors and retailers 1 time), three of the supplier involvement practices (once time each for the new suppliers, the regular supplier, and the machinery sellers), and one of the regulatory body involvement (once with the group of regulatory bodies and testing laboratories). Thus, all the NPD cases in Group 2 implemented thirteen OI practices at the industrial scale. In comparing the 2 scales, the result of Group 2 showed a higher amount of OI practice at the industrial scale over the laboratory scale in all cases.

The OI Logics and Practices in Group 3. As depicted in Tables 4.28 and Table 4.29, SME B had no cases in this OI NPD group. As Group 3 focused in the development of the food company’s new product with the food machinery company's recipe, the origin of the food recipe knowledge flow started from the food machinery company (SME A) for all cases in this group (Cases A13 to CaseA23).

Overall OI logics for each NPD scale indicated that all cases in this group demonstrated coupled OI: outbound dominance at the laboratory scales, while coupled OI: inbound dominance at the industrial scale.

For OI practices, all cases demonstrated the same result at the laboratory and industrial scale. At the laboratory scale, there was one employee involvement (one time by the manager), one of outward IP licensing (performed one time each by food company A01, A02, A03 and A04), and one of customer involvement (one time each by food company A01, A02, A03 and A04). Thus, all the NPD cases in Group 3 implemented three OI practices at the laboratory scale.

Conversely, for OI practices at the industrial scale all cases showed the same result of four employee involvement practices (twice by the manager, one time by the procurement team, and once by RA), one insourcing R&D practices (once by each food company A01, A02, A03 and A04), two of customer involvement practices (once by each food company A01, A02, A03 and A04, and once by the consumer), one of supplier involvement practice (one time with the regular supplier), and one of the regulatory body involvement practice (one time with the group of regulatory bodies and testing laboratories).

Thus, all the NPD cases in Group 3 implemented ten OI practices at the industrial scale. In comparison with the 2 scales, the result of Group 3 showed a higher amount of OI practice at the industrial scale over the laboratory scale to all cases.

The OI Logics and Practices in Group 4. As reported in Table 4.28 and Table 4.29, Group 4 was involved in the development of the food company's new product with its recipe. In this task, the origin food recipe knowledge flow started from the food company that is food company A05 to A16, and B01 to B03, to all cases in the group. These cases comprised of Case A24 to A55, and B01 to B12.

As noted in the OI logics at each NPD scale, SME A and SME B showed the same result of experiencing coupled OI where inbound dominance at the laboratory and industrial scale prevailed in all cases in this group.

For OI practices at the laboratory scale, the results illustrated a variety set of practices implemented within this group. These practices are as follows:

1) Six OI practices at the laboratory scale with 12 cases (Case A35, A36, A39, A40, A42, A46, A47, A48, A49, A51, A52, and A55) encompassing two employee involvement practices (performed once by the manager and once by a member of the procurement team); one insourcing R&D practice with food companies (performed once by each food company A06, A08, A10, A12, A13, A14, A16); one customer involvement practice with food companies (performed once by each food company A06, A08, A10, A12, A13,A14, A16); one supplier involvement practice (performed once with a new supplier); and one inward IP licensing practice with the food company (carried out once by food company A06, A08, A10, A12, A13, A14, A16). Worthnotting for the case of SME A as compared to SME B, the larger number of practices at the laboratory scale is the result of the insourcing R&D practices that provide new business model for the food machinery as well as the R&D laboratory scale service fee for the external parties.
2) Five OI practices were implemented at the laboratory scale with 20 cases (Case A24, A25, A26, A27, A28, A29, A30, A31, A32, A33, A34, A37, A38, A41, A43, A44, A45, A50, A53, A54, B01, B02, B03, B04, B05, B06, B07, B08, B09, B10, B11, and B12) encompassing two employee

involvement practices (performed once by the manager, and once by a member of the procurement team), one of customer involvement practice with the food companies (accomplished once by food company A03, A04, A05, A07, A09, A11, A15, B01, B02 and B03); one customer involvement practice (performed once by the new supplier), and one inward IP licensing practice with the food companies (carried out once with food company A03, A04, A05, A07, A09, A11, A15, B01, B02and B03).

In summary, all the NPD cases in Group 5 had an average on five OI practices implemented at the laboratory scale.

On the other hand, OI practices at the industrial scale showed a different set of practices performed. Some of the practices acted upon are as follows:

1) Fourteen OI practices were found at the industrial scale with 5 cases involving new machinery installation. The 5 cases involved Case A30, A31, A39, A40, and B12. The OI practices comprises of six employee involvement practices (performed twice by the the manager, thrice by the procurement team and once by the RA team); one insourcing R&D practice with the food companies (performed once by food company A05, A08, and B03); two customer involvement practices (performed once with each food company A05, A08, B03, and and once with the consumers); three supplier involvement practices occurred once with the new supplier, another time with the regular supplier, and one time each with the machinery sellers A02, A03 and B01; one regulatory body involvement practice with the group of regulatory bodies and testing laboratories; and

one inward IP licensing practice with the food companies (achieved once with food company A05, A08 and B03).

2) Fourteen OI practices were indicated at the industrial scale with 3 cases (A24, A25 and A26) involving new factory license registration. The 14 OI practices consisted of six employee involvements (performed twice by the manager, twice by the procurement team, two-time by the RA team); one insourcing R&D with a food company (performed once by food company A05); two consumer involvement practices (once with consumers and another time with the food company A05), two of supplier involvement practices (once with the new supplier, and one time by the regular supplier), two of regulatory body involvement practices (performed twice by the group of regulatory bodies and testing laboratories), and one of inward IP licensing practice (with the food company A05).

3) Twelve OI practices were found at the industrial scale with 36 cases comprising of Case A27, A28, A29, A32, A33, A34, A35, A36, A37, A38, A41, A42, A43, A44, A45, A46, A47, A48, A49, A50, A52, A53, A54, A55, B01, B02, B03, B04, B05, B06, B07, B08, B09, B10, and B11. Among the OI practices were five employee involvement practices (performed twice by the manager, two time by the procurement team and once by the RA team); one insourcing R&D practice with 19 food companies (performed once by food company A03, A04, A05, A06, A07, A09, A10, A11, A12,A13, A14, A15, A16, B01, B02 and B03); two customer involvement practices involving once with the consumers and once with 18 food companies (performed once by each food company

A03, A04, A05, A06, A07, A09, A10, A11, A12, A13, A14, A15, A16, B01, B02 and B03); two supplier involvement practices (once with new suppliers, and one time with regular suppliers); and one regulatory body involvement practice (performed once for the group of regulatory bodies and testing laboratories); and one inward IP licensing practice with 16 food companies (consisting of food company A03, A04, A05, A06, A07, A09, A10, A11, A12, A13, A14, A15,A16, B01, B02 and B03).

In total, the number of NPD cases in Group 4 had an average of 12 OI practices implemented at the industrial scale.

In comparison with the 2 scales, the result of Group 4 showed a greater number of OI practice implemented at the industrial scale over the laboratory scale in all cases.

The comparative results between SME A and SME B in this group showed no difference in OI logics. All of them are coupled OI that is inbound dominance at both scales. On the contrary, there are significant differences in OI practices, particularly at the laboratory scale, the majority of cases in SME A indicate 5 OI practices (with a maximum of 6 OI practices). As for all cases in SME B, there are 5 OI practices. On the other hand, at industrial scale, the majority of SME A highlighted 12 OI practices (with a maximum of 14 OI practices). Noticeably, the majority case of SME B involves 12 OI practices (at a maximum of 14 OI practices). Hence, SME A had applied a greater variety and quantity of OI practice than SME B in some NPD cases.

The OI Logics and Practices in Group 5. As presented in Table 4.28 and Table 4.29, Group 5 is concerned with the development of the food company's new product with the food expert's recipe. The origin of the food recipe was externally co-developed by the food company with the food experts and consultants (University A02, A05, and A06, and Hospital A01) for all cases in this group. Hence, both SME A and SME B showed no OI logics and practices at the laboratory scale. This was because the prototype of the new product and the laboratory scale recipe were prepared by the food companies from the beginning (food company A17, A18, A19, A20, A21, A22, A23, A24, and B04).

For overall OI logics at each NPD scale, SME A and SME B demonstrated the similar result, with no OI logic at the laboratory scale, and coupled OI: inbound dominance at the industrial scale. This is the same for all cases in this group.

For OI practices, at the industrial scale, the results showed a variety of practices were implemented by this group:

1) Fourteen OI practices were implemented at the industrial scale with 2 cases that involved new machinery installation (cases A81-A82); encompassing six employee involvement practices (practiced twice by the manager, three-time by the procurement team, and once by the RA team); one insourcing R&D practice (performed once by food company A20); two customer involvement practices (carried out once by food company A20, and once by consumers); three supplier involvement practices (performed once with new suppliers, once with regular suppliers and once with each machinery sellers A02-A03, and B01); one regulatory body involvement practice (once with the group of regulatory bodies and testing laboratories), and one inward IP licensing practice (once with the food company A20).

2) Fourteen OI practices were implemented at the industrial scale with 1 case involving new factory license registration (Case A87), encompassing six employee involvement practices (twice by the manager, two times by the procurement team and twice by RA team), one insourcing R&D practice (once with the food company A24), two of consumer involvement practices (once with the consumers, and once by the food company A24), two of supplier involvement practices (once with a new supplier, and once by regular supplier), two regulatory body involvement practices (two times with the group of regulatory bodies and testing laboratories), and one of inward IP licensing (once with the food company A24).

3) Twelve OI practices were implemented at the industrial scale with 31 cases (Case A56-A80, A83-A86, B13-B14) encompassed five employee involvement practices (twice by the manager, two times by the procurement team, and once by the RA team), one insourcing R&D practice (with the food company A17, A18, A19, A21, A22, A23 and B04), two customer involvement practices (performed once with the consumers, and once with each of the food company A17, A18, A19, A21, A22, A23 and B04), two supplier involvement practices (practiced once with the new suppliers, and one time by the regular suppliers), and one regulatory body involvement practice (once with the group of regulatory bodies and testing laboratories), and one inward IP licensing practice (once with each of the food company A17, A18, A19, A21, A22,A23 and B04).

Thus, the NPD cases in Group 5 had an average of 12 OI practices implemented at the industrial scale.

In comparison between SME A and SME B, the results illustrated no significant difference in OI logics and practices implemented at the industrial scale. Only cases A81 and A82 had more practices of employee involvement and supplier involvement, and Case A87 had more practices in terms of employee involvement and regulatory involvement.

The OI Logics and Practices in Group 6. Group 6 represent the development of food expert's new product with its own recipe. The OI activities of Group 6 are presented in Tables 4.28 and Table 4.29. The origin of the food recipe was internally developed by their food experts & consultants (Hospital A01, National research laboratory A01, University A03 and A04) for all cases in this group. There was no case for SME B in the OI NPD group. SME A did not engage in OI logics and practices at the laboratory scale. This was due to the fact that the prototype of the new product and the laboratory scale recipe were prepared by the food experts & consultants (Hospital A01, National research laboratory A01, University A03 and A04) for all cases in this group.

As for overall OI logics at each NPD scale, SME A showed same result, coupled OI: inbound dominance at industrial scale, for all cases in this group.

For OI practices at the industrial scale, the results showed a variety of practices were implemented by this group:

1) Twelve OI practices were implemented at the industrial scale with 1 case that involved new machinery installation (Case A88). The OI practices encompassed five employee involvement practices (performed once by

the manager, thrice by the procurement team, and once by the RA team), one insourcing R&D practice (once with Hospital A01), one customer involvement practice (Hospital A01), three supplier involvement practices (one time each with the new suppliers, regular suppliers and the machinery sellers A05), one of regulatory body involvement practice (one time with the group of regulatory bodies and testing laboratories), and one inward IP licensing practice (once by Hospital A01).

2) Twelve OI practices at the industrial scale with 1 case that involved a new factory license registration (Case A92); encompassed five employee involvement practices (performed once by the manager, twice by the procurement team, and once by the RA team), one the insourcing R&D practice (once with the University A04), one consumer involvement practice (once with the University A04), two supplier involvement practices (one time each with new suppliers, and regular suppliers), two regulatory body involvement practices (performed twice with the group of regulatory bodies and testing laboratories), and one of inward IP licensing (once with the University A04).

3) Ten OI practices at the industrial scale with 3 cases (Case A89-A91); encompassing 4 employee involvement practices (performed twice by the manager, one time for both the procurement and RA team), one insourcing R&D practice (one time each with National research laboratory A01, University A03 and A04), two customer involvement practices (Once with the consumers, and one time each with National research laboratory A01, and University A03 and A04), two supplier

involvement practices (one time with new suppliers and once by regular suppliers), one regulatory body involvement practice (once with the group of regulatory bodies and testing laboratories), and one inward IP licensing practice (once time each by National research laboratory A01, and University A03 and A04).

Thus, the NPD cases in Group 6 have average of ten OI practices at industrial scale.

Thus, the NPD cases in Group 6 have average of ten OI practices at industrial scale.

4.4.3.3 Summary of OI Logics & Practices in the Food OI NPD. In total, 109 cases of food NPD were investigated with 92 performed by SME A and 17 performed by SME B. The researcher found that each investigated OI practice led to the identification of the OI logic. All the investigated food OI NPDs combined exploitation and exploration OI practices, and eventually towards inbound and outbound (dominance) OI logics. The findings showed the different nature of OI logics and practices at different level of NPD (laboratory scale and industrial scale). However, it was observed that it was not always the case that there was a relationship between the OI practices and logics according to Van de Vrande et al's (2009) typology.

The OI Practices' Finding. The researcher used the typology of Van de Vrande et al. (2009) as a seminal study to compare the findings for OI practices. From the 109 food OI NPDs investigated, three OI practices were absent based on Van de Vrade et al (2009) typology, namely venturing, external networking, and external participation. Five of Van de Vrande et al's (2009) OI practices of employee involvement, outward IP licensing, customer involvement, outsourcing R&D, and inward IP licensing, were found in this research study. Interestingly, three new OI practices were found, namely insourcing R&D, supplier involvement, and regulatory body involvement as presented in Table 4.30.

As the OI practices findings confined to 2 Thai food machinery SMEs' NPD projects, two OI practices were absent from Van de Vrande et al's (2009) typology, external participation, and venturing. This was evident in the interview with Interviewee A, who stated that "*the joint business on the NPD* (external participation and/or venturing) *had not surfaced based on our cases so far. However, I can tell you that some of my business friends* (SMEs) *survived through this kind of activity. Some of the larger companies have joint investment in the SMEs' new product that has opportunities*".

Contrary to the external networking, the researcher noticed the ambiguity of its definition. The definition drew on the collaboration with external network partners to support organizational innovation processes (Van de Vrande et al., 2009). This encompassed the other OI practices by definition. All OI practices always required the involvement of different external partners.

Moreover, the findings indicated a difference in the categorization of OI practices when compared with the Van de Vrande et al's (2009) typology. Van de Vrande et al. (2009) categorized 2 groups of OI practice, exploitation practices (venturing, outward IP licensing, and employee involvement), and exploration practices (customer involvement, external networking, external participation, outsourcing R&D, and inward IP licensing). In this research study, it was established that 2 of the OI practices, employee involvement, and customer involvement, shown the ambidexterity characteristics. They could perform as an exploitation or exploration practice depending on the nature of each NPD and on the nature of the partners involved. The distinction is listed out on Table 4.30.

Table 4.30

The finding OI practices in the investigated food OI NPDs

<table>
<tr><th rowspan="2">OI practices</th><th rowspan="2">Finding in the current study</th><th colspan="4">Sources (Typologies)</th></tr>
<tr><th colspan="2">From Van de Vrande et al's (2009) typology</th><th colspan="2">Identification from thcurrent study</th></tr>
<tr><td>Venturing</td><td>X</td><td rowspan="4">Exploitation practices</td><td>X</td><td rowspan="3">Exploitation practices</td><td>X</td></tr>
<tr><td>Outward IP Licensing</td><td>✔</td><td>✔</td><td></td></tr>
<tr><td>Insourcing R&D</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td>Employee involvement</td><td>✔</td><td>✔</td><td rowspan="2">Ambidexterity practices</td><td></td></tr>
<tr><td>Customer involvement</td><td>✔</td><td rowspan="7">Exploration practices</td><td>✔</td><td></td></tr>
<tr><td>Outsourcing R&D</td><td>✔</td><td>✔</td><td rowspan="6">Exploration practices</td><td></td></tr>
<tr><td>Inward IP licensing</td><td>✔</td><td>✔</td><td></td></tr>
<tr><td>Supplier involvement</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td>Regulatory body involvement</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td>External networking</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>External participation</td><td>X</td><td>X</td><td>X</td></tr>
</table>

Exploitation Practices:

This group of OI practices implied the leverage of existence technological capabilities outside the boundaries of the organization via the innovation activities (Van de Vrande et al., 2009). In this study, two activities related to the exploitation practices were distinguished, namely outward IP licensing, and insourcing R&D.

Outward IP Licensing. This OI practice concerned the selling or offering licenses or royalty agreements to other organizations to gain more revenue from the existing intellectual property (as represented by Group 3) through patents, copyrights and/or trademarks (Van de Vrande et al., 2009). SME B had no outward IP licensing practice resulting in no involvement in the NPD Group 3.

In all cases, SME A implemented only 'informal' outward IP licensing by offering its intellectual property of food recipe knowledge, and food technology knowledge to external parties (Just offering but not selling the recipe for the client's NPD). The confidential agreements, tacit agreements, non-disclosure agreements, or collaborative agreements were required in some NPD cases. However, there was no evidence of anyone buying IP in the investigated cases.

Similar to Van de Vrande et al's (2009) typology, the findings demonstrated that outward IP licensing could be considered as exploitation practice and outbound dominance practice.

Insourcing R&D. This OI practice consists of selling R&D services to other organizations to gain more revenue from the existing internal knowledge, skills, intellectual property, and/or machinery (Group 3, Group 4, Group 5 and Group 6).

The utilization of internal R&D facilities alone might limit profit earning. As such, to offer other organizations with its R&D services enabled additional profit earning and a variety of path for new product commercialization. Most organizational decisions suggested they had adopted insourcing R&D subject to the effect of profit-dissipation and anticipated revenues. At the industrial scale, the insourcing R&D practice was implemented in all Group 3 to Group 6 cases, as part of up-scaling the experimental phase. It was a common practice within the food machinery companies studied to charge an industrial scale R&D service fee. At the laboratory scale, SME A implemented insourcing R&D for some cases as its new business model. While SME

B had no insourcing R&D at the laboratory scale, it experimented during laboratory scale phase free of charge for inward IP licensing followed by the internal R&D.

The findings highlighted the evidences of insourcing of R&D becoming an exploitation practice that signified outbound dominance practice.

Exploration Practices:

This group of OI practices implied that innovation activities capture and benefit from external sources of knowledge to enhance current technological developments (Van de Vrande et al., 2009). In this study, four activities related to the exploitation practices were distinguished; outsourcing R&D, inward IP licensing, supplier involvement, and regulatory body involvement.

Outsourcing R&D. This OI practice is related to the buying of R&D services from external network partners. This is symbolic of Group 2 as the OI activities of the universities, public research organizations, food experts, commercial engineers or suppliers (Van de Vrande et al, 2009). SME B had no outsourcing R&D practices. This resulted in SME B does not having any involvement in the NPD Group 2.

Similar to Van de Vrande et al's (2009) typology, the findings supported the notion that outsourcing R&D could be considered as an exploration practice (inbound dominance practice).

Inward IP Licensing. This practice relates to buying or using intellectual property as presented in Group 3, Group 4, Group 5 and Group 6. OI activities include the task of obtaining patents, copyrights and/or trademarks of other organizations to gain more revenue from external knowledge (Van de Vrande et al, 2009).

In all cases, the investigated SME A and SME B implemented only 'informal' inward IP licensing, by only using the intellectual property from external parties (Just using and not buying recipe from client for the NPD). Take for instance the using of food recipe and ingredient knowledge. The confidential agreements, tacit agreements, non-disclosure agreements, or collaborative agreements were required for some NPD cases. However, in the investigated cases no IP was bought. This was revealed in the interview with Interviewee B, who stated that "*the formal IP licensing is considered time consuming and expensive. It's a worthier investment to the larger enterprise or the academic or the government R&D sector, but not to the SMEs like us*".

Similar to Van de Vrande et al's (2009) typology, the findings illustrated that inward IP licensing could be perceived as an exploration practice or inbound dominance practice.

Supplier Involvement. This OI practice relates to directly involving suppliers in the innovation process. The knowledge provided here concerned either raw materials or machine settings. For instance, the inward ingredient fitness where a regular supplier or new supplier specified the ingredients that best suited to complete the development of the food recipe (Present in Group 1 to Group 6).

As for inward machinery fitness, a good case example was the completion of the NPD at the industrial scale that required the buying of a new machine to achieve higher product quality and/or better production efficiency, with supplier optimizing the settings of the machine to achieve such goals. This observation was seen in Case A12 and A13 of Group 2, Cases A30, A31, A39, A40 and B12 of Group 4, Case A81-A82 in Group 5, and Case A88 in Group 6. The machinery seller (supplier) involvement was not confined only to the purchase of new machines and/or software by the organization. Knowledge transfer was critical for new machine installation. This observation was based on the interview of Interviewee A, who commented that *"my procurement team worked so hard on sourcing new machinery sellers who could provide the specific machine that works well with the NPD and also has multifunction, applicable to other production improvements as well. New machinery knowledge was transferred among our team and the machinery seller for the machine installation setting. The various production parametters need to be set by the machinery seller according to the requirement of new products*" and "*As SME, we prefer local machinery sellers regarding the affordable price, on site installation and maintenance service are necessary".*

The findings supported the observation that supplier involvement related to the exploration practice and an inbound dominance practice.

Regulatory Body Involvement. This OI practice directly involved regulatory bodies in the innovation process to fulfil legal commercialization of new product requirements. The knowledge provided here concerned law and regulation to achieve FDA registration of food products. In these cases, tangible knowledge in the form of explicit documents that were critically needed:

1) FDA supported documents (microbial reports, nutrition fact sheets) from the accredited testing laboratories (Group 1 to Group 6).
2) FDA registration report (FDA number) from FDA (Group 1 to Group 6). In some cases, the FDA requested recipe adjustment and/or label content adjustment to comply with food laws and regulations. The adjustment was compulsory to meet legal commercialization purposes.

3) Factory/Production licenses that corresponded with the new product from the FDA. Only some cases needed a new registration of factory/production licenses as evident in Group 4 (Case A24, A25 and A26), Group 5 (Case A87), and Group 6 (Case A92). As some of the new products were developed beyond the current scope of their factory/production licenses it became necessary for the SME to apply for an updated factory/production license to legally produce and commercialize the new products. This concern was expressed by Interviewee A, when he remarked that "*Some of the new products are developed beyond the current scope of the current factory license. Hence, we can't do FDA registration unless we got this new scope first"* and *"Normally we consolidated many NPD to make sure that the new factory license investment is worthy*".

The regulatory body involved with SME B had no activities related to new registration of factory/production licenses. The findings showed that regulatory body involvement could be considered as an exploration practice (inbound dominance practice).

Ambidexterity Practices:

This new group of OI practices comprised of 2 of the Van de Vrande et al's (2009) OI practices; customer involvement and employee involvement. However, these two involvements were categorized into the new group due to its ambidexterity characteristic from the research findings. Ambidexterity practices could switch characteristics from the exploitation into the exploration and/or exploration into exploitation phases depending on the nature of each NPD and the partners involved.

The flexibility and agility of these practices created maximum value for organizational capabilities and/or competencies (Chesbrough & Crowther, 2006; Lichtenthaler, 2008).

Customer Involvement. This OI practice directly involve customers in the innovation process (Van de Vrande et al, 2009). Take for instance, the involvement of marketing organizations, distributors, and retailers to provide market demand analysis through market research (as reflected in the OI activities of Group 1 and Group 2), the involvement of the consumers to provide feedback of a new product through a sensory testing process (evident in Group 1 to Group 5), the involvement of food companies to provide new product ideas and original recipes (as seen in Group 4 to Group 6), the involvement of food companies to accept new product ideas and existing recipes of food machinery company (observed in Group 3).

Contrary to Van de Vrande et al's (2009) typology, the findings show that customer involvement can be an exploitation practice (outbound dominance practice) and/or an exploration practice (inbound dominance practice), depending on the nature of each NPD and the partners involved. However, the majority of customer involvement in this research study was found to be exploration practice as suggested by Van de Vrande et al (2009, p.428).

Employee Involvement. This OI practice leverages the knowledge and initiatives of employees who are not directly involved in NPD or R&D (Van de Vrande et al, 2009, p.428). For examples, the involvement of sale person (as seen in SME A - manager, and SME B – General Manager) to acquire new product ideas from marketing organizations, distributors, and retailers (Group 1 to Group 2) and/or introduce its existing recipe to the food companies (Group 3); the involvement of the procurement team to acquire ingredient knowledge and/or new machinery knowledge from its suppliers (present in Group 1 to Group 6), the involvement of RA team to acquire food laws and regulation knowledge from FDA (witnessed in Group 1 to Group 6).

Employee involvement in this study focused on the inter-organizational level across organizational boundaries. Its performance was quite similar to the response practice to the other OI practices such as customer involvement with the food companies required the involvement of an internal salesperson, the supplier involvement with the new suppliers needed the involvement of the internal procurement team, and the regulatory body involvement with the FDA necessitated the involvement of the internal RA team. The employee involvement levels put forward by Van de Vrande et al. (2009) was more focused at an intra-organizational level, crossing internal department boundaries by utilizing employee comments and suggestions or creating autonomous teams to realize innovation from non-R&D employees.

Contrary to Van de Vrande et al's (2009) typology, the findings indicate that employee involvement can be an exploitation practice (outbound dominance practice) and/or an exploration practice (inbound dominance practice), depending on the nature of each NPD and partners involved. However, the majority of employee involvement in this research study were exploration practice at inter-organizational level.

Furthermore, the researcher argues that the categorization of employee involvement in the Van de Vrande et al's (2009) typology concerned outbound or inbound OI by considered at the intra-organization boundary as main boundary criteria, while their other OI practices are considered at the inter-organization boundary instead. Hence, employee involvement practice in the Van de Vrande et al's (2009) typology was categorized by different perspective from the other OI practices.

The OI Logics' Findings. By observing laboratory scale and industrial scale NPD, three categories of OI logics were identified. These OI logics included coupled OI logic with outbound dominance, coupled OI logic with inbound dominance, and no OI logic (Enkel et al., 2009; Hongsaprabhas et al., 2018; Lichtenthaler, 2008). Most of the findings were coupled OI logic with inbound dominance. The choice of inbound or outbound dominance of the applied OI logic depended on the purpose of each NPD project and partners involved.

Observation at the OI practice level meant the direction of knowledge flow (OI logic) connected to the OI practice identified by the interviewees was similar to Van de Vrande et al's (2009) typology. The outbound logic connected to the exploitation practice (insourcing R&D, outward IP licensing), while the inbound logic connected to the exploration practices (supplier involvement, regulatory body involvement, outsourcing R&D, inward IP licensing). Only two OI practices were not consistent with the Van de Vrande et al's (2009) typology. These two practices comprised of customer involvement and employee involvement which could be classified as exploitation and exploration practices, the connected OI logics could be the outbound and inbound logic, respectively. The researcher considered them to be the ambidexterity OI practice:

Customer involvement is not always connected to inbound / inbound dominance logic. The presence of customer involvement in the NPD Group 3 found coupled OI logic with outbound dominance, while the customer involvement in other

NPD groups were inbound dominance (Van de Vrande et al., 2009). This was due to the specific characteristics of NPD in Group 3. An example from Group 3 related to the development of a food company's new product with the food machinery company's recipe. Because the company used its own recipe as a fundamental base for product development, the majority of knowledge flow transfer out to the food company through the customer involvement practice.

Employee involvement is not always connected to the outbound / outbound dominance logic. The findings indicated this practice adopted either outbound and/or inbound dominance to all NPD groups. Take for instance the employee involvement by the procurement team to contact new suppliers for ingredient knowledge, was considered to be coupled OI logic with inbound dominance. This involvement prevailed in all groups of OI NPDs. On the other hand, employee involvement by the manager to introduce its recipe to the client (as seen in the case of NPD in Group 3). The activity was considered to be coupled OI logic with outbound dominance. This was due to the specific characteristics of employee involvement practices performed together with other OI practices. The supplier involvement and the employee involvement performed by the procurement team showed inbound dominance, and the outward IP licensing and the employee involvement performed by the manager showed outbound dominance.

Comparison of OI Logic & Practices at Laboratory and Industrial Scale. As shown in Table 4.31, this diachronic case study demonstrated that OI logics and practices implemented at the laboratory scale and the industrial scale differ in characteristics. The investigated SMEs involved both laboratory scale and industrial scale at 70 NPDs in Group 1 to Group 4. There were only 39 NPDs at industrial scale in Group 5 and Group 6.

OI Logic Comparison. At the laboratory scale, there were 59 NDPs that required coupled OI logic inbound dominance. These 59 NDPs were from Group 1, Group 2, and Group 4. However, for Group 3, there were 11 NPDs that were coupled OI logic outbound dominance. In addition, there were 39 NPDs that the SMEs were not involved at the laboratory scale (Group 5 and Group 6).

At the industrial scale, OI logics implemented were coupled with inbound dominance in all 109 cases (as evident in Group 1 to Group 6). The knowledge provided by the food machinery SMEs' partners included food recipe knowledge, agricultural material knowledge from new suppliers and regular suppliers, sensory feedback from consumers, and legal constraints from the regulatory bodies & testing laboratories to adjust the mass production process.

In summary, all the NPD groups showed coupled OI logics at both laboratory scale and industrial scale (only the cases in Group 5 and Group 6 showed no OI logic at the laboratory scale). Thus, these results propose the followings:

1) There is no absolutely inbound or outbound logic in the NPD process at laboratory or industrial scale. The coupled OI with inbound and outbound dominance is more accurate in this studied context.
2) The majority of OI logics adopted in the investigated cases reflected coupled OI with inbound dominance. Only 11 NPDs applied outbound dominance (as seen in the laboratory scale of Group3).

OI Practice Comparison. At the laboratory scale, a total of 329 OI practices were implemented, of which 11 were exploitation practices, 116 exploration practices, and 202 ambidexterity practices. Employee and customer involvement practices were applied in all the investigated NPDs with the exception of 39 NPDs from Group 5 and Group 6 in which the food machinery companies had no involvement in the laboratory scale.

At the industrial scale, a total of 1,269 OI practices were implemented, of which 80 were exploitation practices, 428 were exploration practices, and 757 were ambidexterity practices. The "supplier involvement", "regulatory body involvement", "employee involvement", and "customer involvement" were implemented in all investigated NPDs. Noticeably, the food machinery SMEs were hired to carry out the NPD for clients that were OEM NPDs (in Group 3, Group 4, Group 5 and Group 6), and to implement "insourcing R&D" and "inward IP licensing".

When comparing the laboratory scale to the industrial scale, the finding revealed a greater quantity of OI practices in the industrial scale in all NPD groups. Without doubt, this was due to the requirement for more involved actors and the greater activity levels for NPD achievement at an industrial scale. The variety of OI NPD practices was correspondingly increased by the number of actors involved.

Table 4.31

OI logics and practices found in the laboratory and industrial scale

Group of NPD project (109 NPDs)		Laboratory scale (70 NPDs)		Industrial scale (109 NPDs)	
		OI logics	**OI practices (SMEA/SME B)**	**OI logics**	**OI practices (SMEA/SME B)**
Group 1: 13 NPDs (Case A01-A10, B15-B17)	**The 1st pattern** – the development of a food machinery company's new product with its recipe.	Coupled OI: Inbound dominance	**Exploration practices**: 13 practices Supplier involvement (10/3 practices) **Ambidexterity practices:** 42 practices Employee involvement (20/6 practices) Customer involvement (13/3 practices)	Coupled OI: Inbound dominance	**Exploration practices**: 42 practices Supplier involvement (20/6 practices) Regulatory body involvement (10/3 practices) **Ambidexterity practices:** 91 practices Employee involvement (50/15 practices) Customer involvement (20/6 practices)
Group 2: 2 NPDs (Case A11-A12)	**The 2nd pattern** – the development of a food machinery company's new product with the food expert's recipe.	Coupled OI: Inbound dominance	**Exploration practices**: 4 practices Outsourcing R&D (2/0 practices) Inward IP licensing (2/0 practices) **Ambidexterity practices:** 6 practices Employee involvement (4/0 practices) Customer involvement (2/0 practices)	Coupled OI: Inbound dominance	**Exploration practices**: 8 practices Supplier involvement (6/0 practices) Regulatory body involvement (2/0 practices) **Ambidexterity practices**: 16 practices Employee involvement (12/0 practices) Customer involvement (4/0 practices)
Group 3: 11 NPDs (Case A13-A23)	**The 3rd pattern** – the development of a food company's new product with the food machinery company's recipe.	Coupled OI: Outbound dominance	**Exploitation practices**: 11 practices Outward IP licensing (11/0 practices) **Ambidexterity practices:** 22 practices Employee involvement (11/0 practices) Customer involvement (11/0 practices)	Coupled OI: Inbound dominance	**Exploitation practices**: 11 practices Insourcing R&D (11/0 practices) **Exploration practices**: 33 practices Supplier involvement (11/0 practices) Regulatory body involvement (11/0 practices) Inward IP licensing (11/0 practices) **Ambidexterity practices:** 66 practices Employee involvement (44/0 practices) Customer involvement (22/0 practices)
Group 4: 44 NPDs (Case A24-A55, B01-B12)	**The 4th pattern** – the development of a food company's new product with its recipe	Coupled OI: Inbound dominance	**Exploitation practices**: 12 practices Insourcing R&D (12/0 practices) **Exploration practices:** 88 practices Supplier involvement (32/12 practices) Inward IP licensing (32/12 practices) **Ambidexterity practices**: 132 practices Employee involvement (64/24 practices) Customer involvement (32/12 practices)	Coupled OI: Inbound dominance	**Exploitation practices**: 32 practices Insourcing R&D (32/12 practices) **Exploration practices**: 184 practices Supplier involvement (68/25 practices) Regulatory body involvement (35/12 practices) Inward IP licensing (32/12 practices) **Ambidexterity practices**: 316 practices Employee involvement (167/61 practices) Customer involvement (64/24 practices)
Group 5: 34 NPDs (Case A56-A87, B13-B14)	**The 5th pattern** – the development of a food company's new product with the food expert's recipe.	No OI logic	No OI practice	Coupled OI: Inbound dominance	**Exploitation practices**: 32 practices Insourcing R&D (32/2 practices) **Exploration practices**: 139 practices Supplier involvement (66/4 practices) Regulatory body involvement (33/2 practices) Inward IP licensing (32/2 practices) **Ambidexterity practices**: 241 practices Employee involvement (163/10 practices) Customer involvement (64/4 practices)
Group 6: 5 NPDs (Case A88-A92)	**The 6th pattern** – the development of a food expert's new product with its own recipe.	No OI logic	No OI practice	Coupled OI: Inbound dominance	**Exploitation practices:** 5 practices Insourcing R&D (5/0 practices) **Exploration practices**: 22 practices Supplier involvement (11/0 practices) Regulatory body involvement (6/0 practices) Inward IP licensing (5/0 practices) **Ambidexterity practices**: 27 practices Employee involvement (22/0 practices) Customer involvement (5/0 practices)

4.4.4 The Synthesis of the Food-Machinery Flexibility Model

The 10 actors involved in OI NPDs reflect the nature of their relationships regarding OI logics and practices. The researcher confirmed the validity of the data collected and analyzed with the interviewees at SMEs A and SME B in commencing the second interview.

The researcher repeated qualitative data collection from the involved actors (as discussed in Section 4.4.2), empirical OI logics and practices (Section 4.4.3) were based on the processes repetition (from 1st and 2nd interview). The involved actors, OI logics and practices that were not categorized served to strengthen and improve previous observations. To achieve this the researcher refined the Food-Machinery framework (Bigliardi & Galati, 2013a; Bigliardi et al., 2010; Grimsby & Kure 2019) and proposed "The Food-Machinery Flexibility Model" as presented in Figure 4.3.

Within the Food-Machinery framework proposed by Bigliardi and Galati (2013), there were 2 missing actors, the government institutions and the consumers. The revised framework better reflects NPD projects in the Thai FI context by adding those actors. This is consistent with the Quadruple Helix Innovation concept which encompasses industry, academic, government, and citizens (Carayannis et al., 2009). Consequently, the Thai FDA, regulatory bodies, and testing laboratories were added to this research study to incorporate legal commercialization which could not be avoided. Many food NPDs failed or their legal commercialization were delayed due to non-compliance with such regulations. To claim new functional benefit or extra nutritional value, an FDA accredited testing laboratory becomes critical. In alignment with the Quadruple Helix Innovation concept, the citizen has been categorized as "consumer".

Table 4.32

The classification of associated actors for refining the Food-Machinery framework

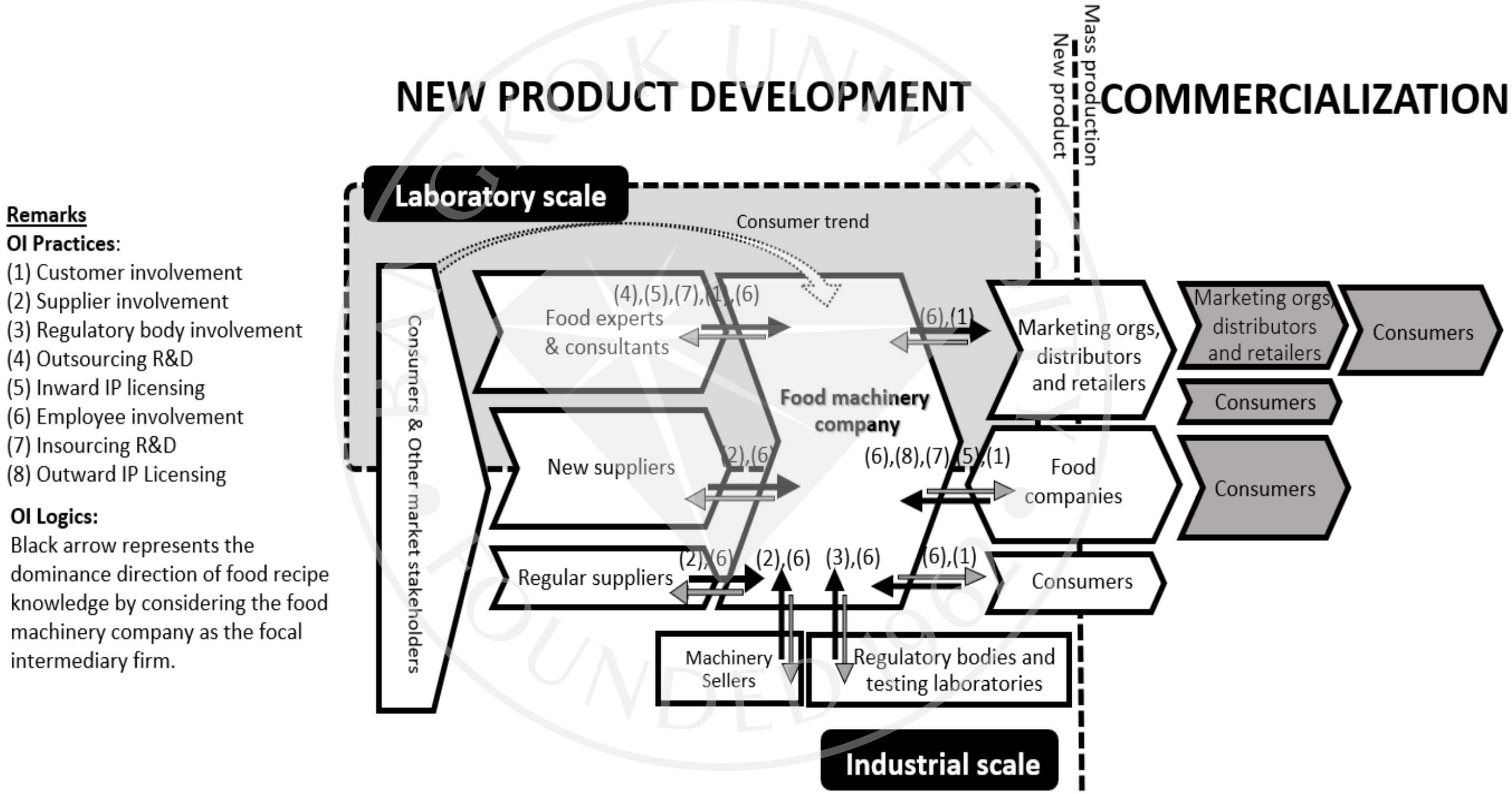
Actors from Quadruple Helix Innovation (Carayannis et al., 2009)	Actors from the food - machinery framework (Bigliardi & Galati, 2013a)	Actors in the FI (Galanakis, 2016, p.22)	Actors from the OI supply chain in the FI (Grimsby & Kure, 2019, p.959)	Actors from the interview with investigated Thai food machinery SMEs	The proposed actors to refine the food machinery framework
Industry group	-Food machinery company	**[GAP]**	-Food machinery suppliers	-Food machinery SME	(1) Food machinery company
	-Food company	**[GAP]**	-Food distributors	-Food company	(2) Food company
	-Suppliers	-The supply chain partner group (suppliers)	-Food and food ingredients suppliers	-Routine suppliers -New suppliers	(3) Regular suppliers (4) New suppliers
	-Other suppliers	-The group of company belong to other industries (e.g., machinery suppliers)	-Official instruments	-Machinery sellers	(5) Machinery sellers
	[GAP]	**[GAP]**	-Food distributors	-Sale agents -Distributors -Wholesalers -Retailers	(6) Marketing organizations, distributors and retailers
	[GAP]	**[GAP]**	-Competitors -NGOs -Other industries	-Competitors -Other industries	(7) Other market stakeholders
	-Consultant	-Individuals group (e.g., consultant and expertise)	-R&D suppliers	-Food expertise (e.g., famous chefs)	(8) Food experts & consultants
Academic	-Universities & research labs	-The academic group (e.g., universities and school)		-Universities -National research laboratories (BIOTEC)	
Government/Public	**[GAP]**	**[GAP]**	**[GAP]**	-Food & Drug Administration (FDA) -Public/Private testing laboratories -Certification bodies	(9) Regulatory bodies & testing laboratories
Citizens	**[GAP]**	**[GAP]**	-Consumers	-Consumers	(10) Consumers

The researcher listed in accordance the actors involved in the Food-Machinery framework with regard to knowledge sequence of producing new product as presented on Table 4.32. The core focused actor is still the food machinery company based on the purpose of the study. The researcher maintained 3 keys main actors in the framework, namely new/regular suppliers, food machinery company and food company. The researcher also added other actors which surfaced during the investigation of the OI NPDs.

With the observation and prevailing evidences, the researcher incorporated the new elements and adjusted the framework into the NPD context of laboratory and industrial scale. The researcher adapted the NPD process to match the sequence with that of the food NPD process. This process covers the initial stage of the NPD to the commercialization stage. The direction of knowledge flows or OI logics (outbound, inbound and coupled) were indicated by the arrows. The coupled OI logic is presented by reverse grey and black arrows (if has). The dominance direction was presented by black arrow, and inferiority direction was presented by grey arrow. The food recipe knowledge is the focus knowledge in the study. As food machinery company is the core of the framework and main actor of the study, the researcher thus focuses only food recipe knowledge flows which transfer in and out of the food machinery company's boundary during the NPD process. The researchers further classified the 109 OI NPD projects into 6 sub patterns as depicted in Figure 4.4 to Figure 4.9, within the same model, following the IPR of the new product and the original recipe creator. Each OI NPD pattern requires the implementation of different OI logics and practices.

Figure 4.3

The Food-Machinery Flexibility Model



Note. The arrows represent the flow of food recipe knowledge (OI logics). Modified from the Food-Machinery framework and the open food supply chain, by Bigliardi and Galati, 2013a, p.21.

Categorization and Preliminary Insights. To better describe the Food-Machinery Flexibility Model, 6 patterns have been identified and discussed in the following section. The 6 patterns are created based on the origin food recipe (the original recipe creator) and IPR. Each OI NPD pattern requires the implementation of different connections between the OI logics and practices implemented as illustrated in Table 4.31, and the types of involved actor in each stage of the NPDs processes.

Pattern 1 of the Food-Machinery Flexibility Model. This pattern belongs to the NPDs in Group 1, the development of a food machinery company's new product with its recipe. As illustrated in Figure 4.4, the findings revealed 13 NPDs of which 10 were from SME A and 3 from SME B. The concept of new products and original recipes were created by the food machinery company which resulted in the IPR belonging to them.

In the OI NPDs pattern, the OI practices related to the laboratory scale were employee involvement (by the manager and the procurement team of the food machinery company), customer involvement (with the group of marketing organizations, distributors and retailers), and supplier involvement (with the new suppliers).

For Pattern 1 of the Food-Machinery Flexibility Model, the OI practices related to industrial scale are as follows:

1) Employee involvement (manager, procurement team, and RA of the food machinery company)
2) Supplier involvement (with new supplier and regular suppliers)
3) Customer involvement (with consumers and the group of marketing organizations, distributors and retailers)

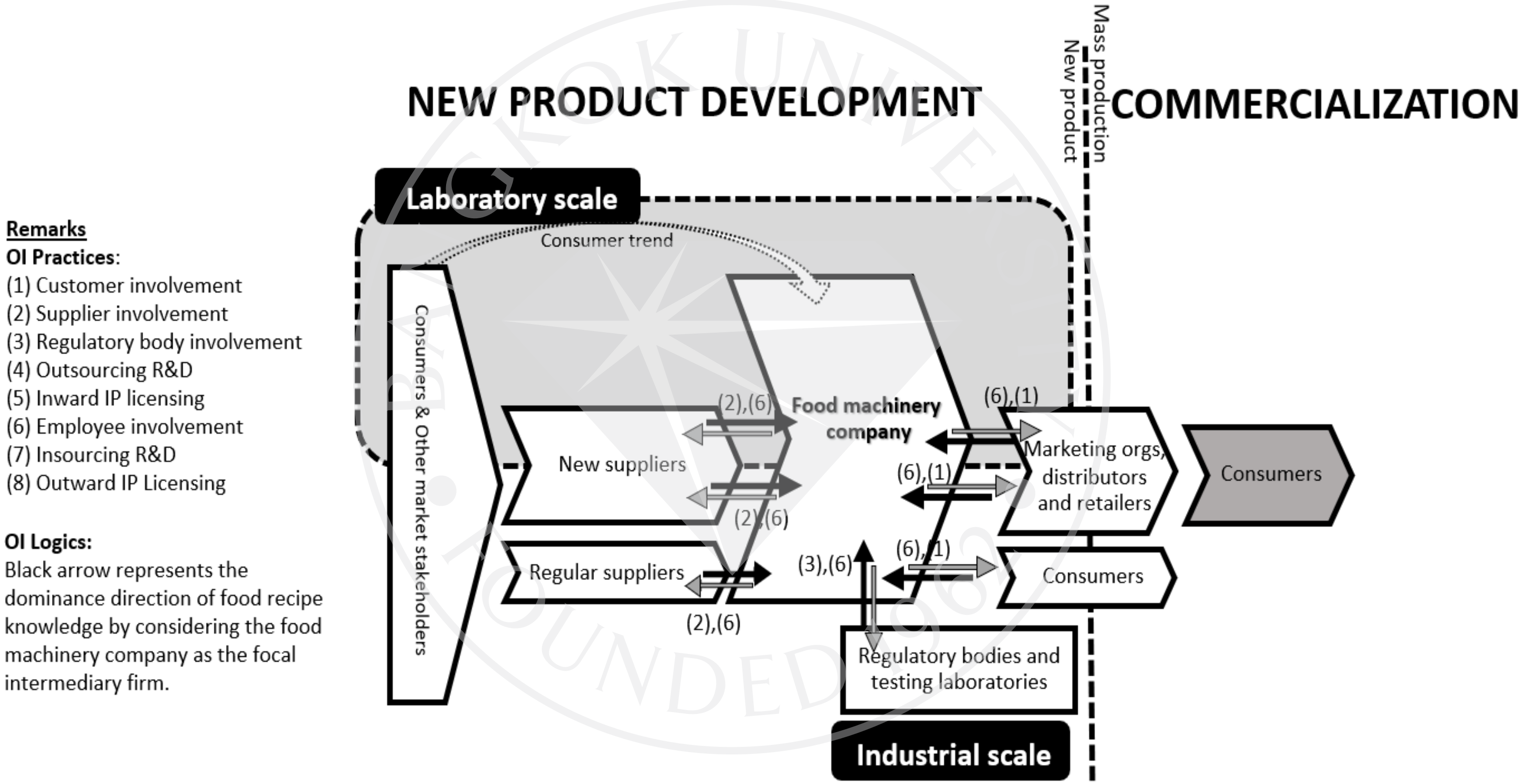
4) Regulatory body involvement (with regulatory bodies and testing laboratories)

This pattern is suitable for a food machinery company with an internal R&D capability to develop new products with their own brands. This pattern suggested that the laboratory scale was almost similar to closed innovation. However, it was not in reality. Even though, the practice was almost done internally in the food machinery company, the new food ingredient / material knowledge (such as special feature, characteristic, limitation, harvest season for planning purposes, order quantity and cost) for the NPDs were provided by the new suppliers.

In addition, the insights needed for new products were acquired from the group of marketing organizations, distributors, and the consumers. The majority of OI practices and the extent of actors involved occured at the industrial scale. The food machinery company took the dominant role in organizing the overall OI NPDs until the new products reached the legal commercialization stage.

Figure 4.4

The Food-Machinery Flexibility Model: Pattern 1



Note. The arrows represent the flow of food recipe knowledge (OI logics). Modified from the Food-Machinery framework and the open food supply chain, by Bigliardi and Galati, 2013, p.21.

Pattern 2 of the Food-Machinery Flexibility Model. This pattern belongs to the NPDs of Group 2 that signified the development of a food machinery company's new product with the food expert's recipe. The findings as shown in Figure 4.5 reflected 2 OI NPDs. Noticeably, this pattern surfaced only for SME A. The concepts for new product development were created by the food machinery company but it lacked the internal R&D capability. Hence, although an external food expert (University A01) was hired to create the original recipe, the IPR of the new product still belonged to the food machinery company.

In NPD Pattern 2, the OI practices related to laboratory scale are as follows:

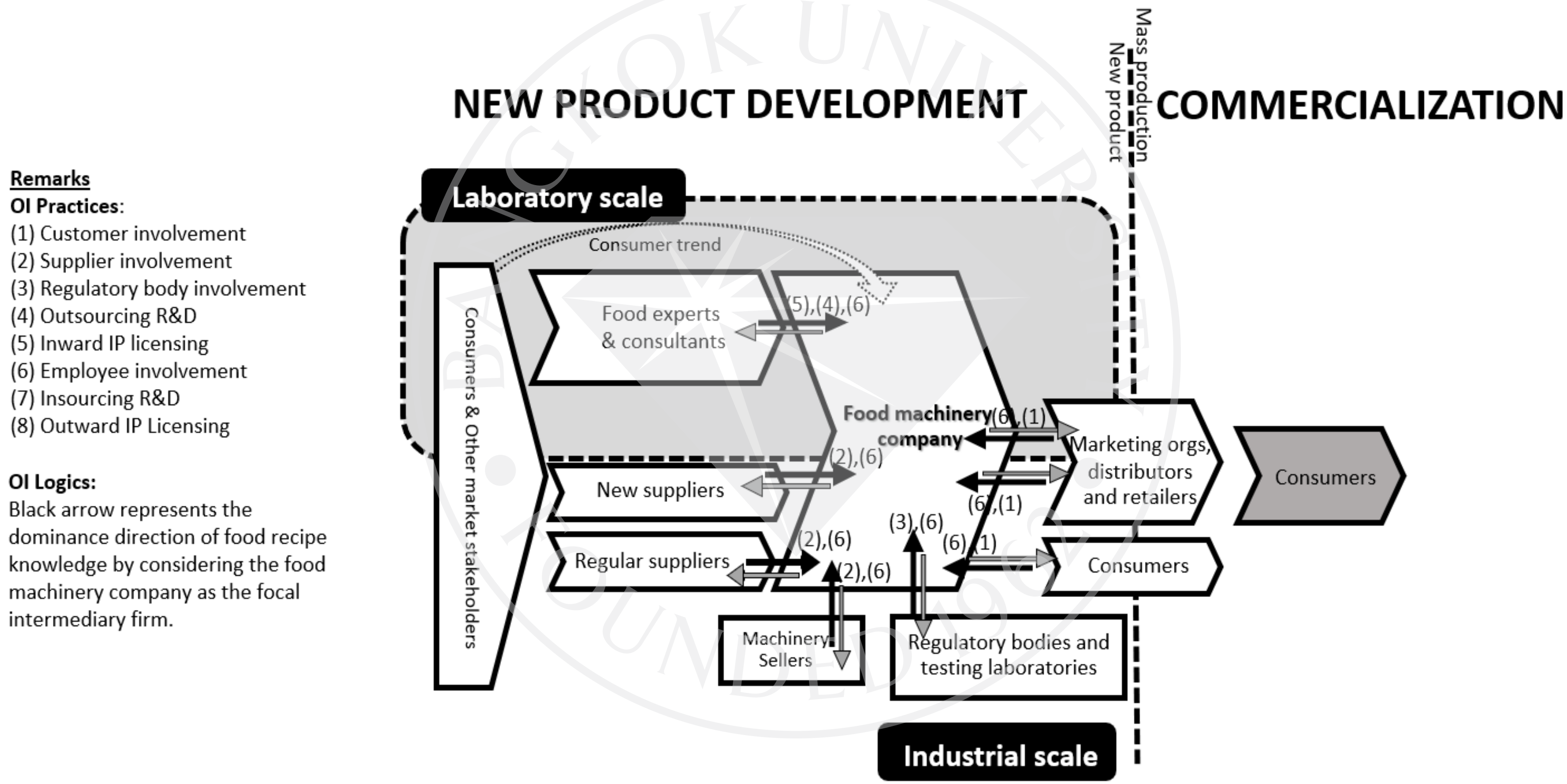
1) Employee involvement (manager of the food machinery company)
2) Customer involvement (with the group of marketing organizations Distributors and retailers)
3) Outsourcing R&D
4) Inward IP licensing (with the food experts & consultants)

The OI practices related to industrial scale are as follows:

1) Employee involvement (manager, procurement team, and RA of the food machinery company)
2) Supplier involvement (with new suppliers, regular suppliers, and machinery sellers)
3) Customer involvement (with consumers and the group of marketing organizations, distributors and retailers)
4) Regulatory body involvement (with regulatory bodies & testing laboratories)

Figure 4.5

The Food-Machinery Flexibility Model: Pattern 2



Note. The arrows represent the flow of food recipe knowledge (OI logics). Modified from the Food-Machinery framework and the open food supply chain, by Bigliardi and Galati, 2013, P.21.

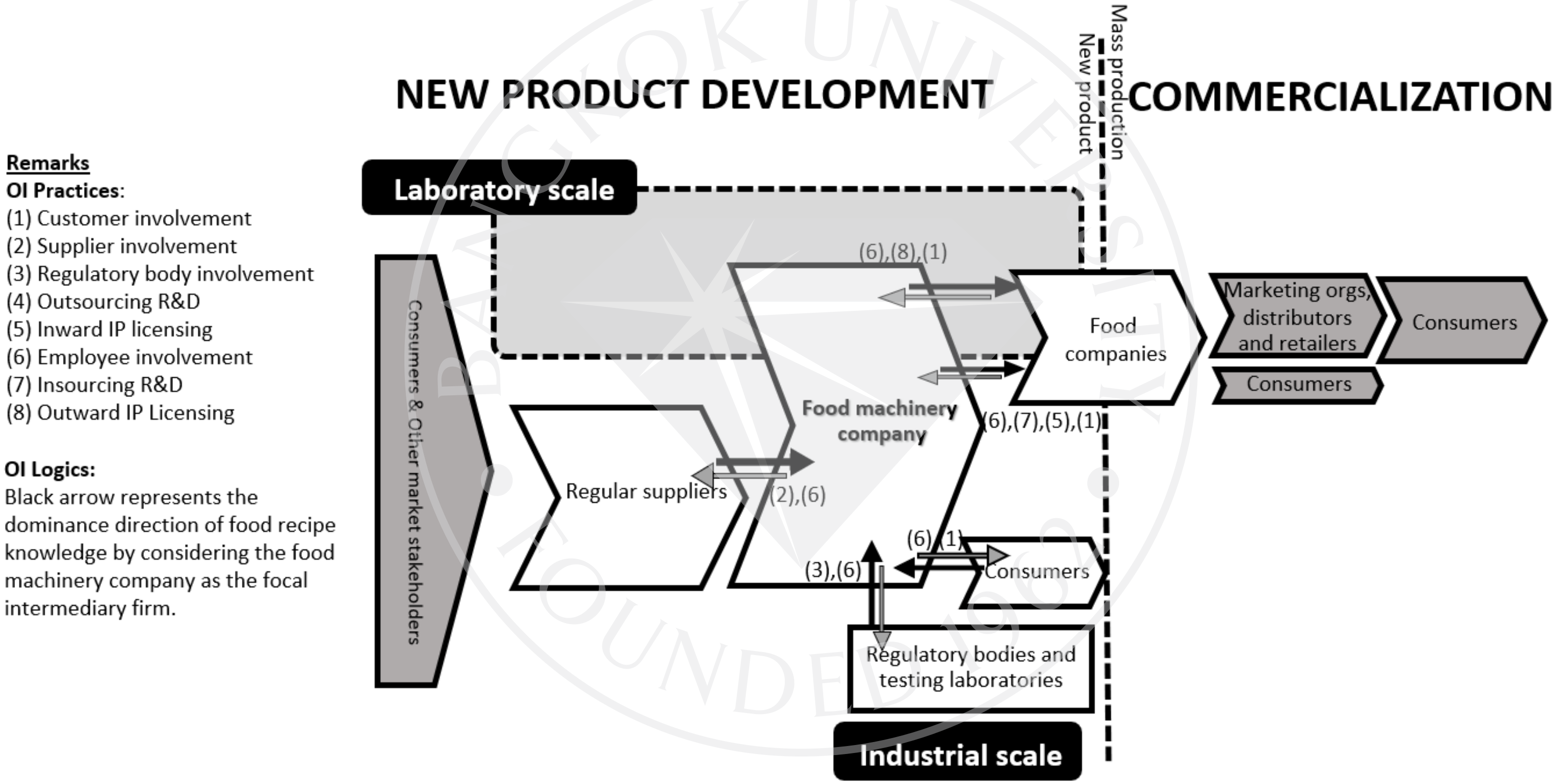
Pattern 2 is most suited to a food machinery company with the ability to make own brand products, but it lacks the internal R&D capability to complete laboratory scale itself. Hence, this pattern suggests outsourcing R&D with the food experts and consultants for example, a university academic researcher. The external food experts and consultants should provide the prototype for a new product, the food recipe, new ingredient knowledge, and suggested production techniques for laboratory scaling. The critical factor to achieving OI NPDs is to decide the requirements of new products from a market perspective, and communicate this to the external food experts and consultants. The precision with which new product requirement is delivered (new product scope, market preference, special features, ideal cost, the limitation of production facility, mass production condition, the related law and regulation of new product), the greater the NPD success rate.

The main obstacle for this pattern is that they are relatively time consuming and costly. Additionally, new machinery may be required to achieve OI NPD in terms of mass production.

Pattern 3 of the Food-Machinery Flexibility Model. Pattern 3 concerns the NPD in Group 3, the development of a food company's new product with the food machinery company’s recipe. As shown in Figure 4.6, the findings revealed 11 NPDs within this pattern and were the NDPS of only SME A, with the original recipe and the creation of a new product were completed by the food machinery company. However, the IPR of the new product belonged to the food company.

Figure 4.6

The Food-Machinery Flexibility Model: Pattern 3



Note. The arrows represent the flow of food recipe knowledge (OI logics). Modified from the Food-Machinery framework and the open food supply chain, by Bigliardi and Galati, 2013, p.21.

In NPD Pattern 3, the OI practices were related to laboratory scale and it involved employee involvement (of the manager of the food machinery company), outward IP licensing and customer involvement (with the food company A01-A04).

As for the OI practices that were related to industrial scale, it included employee involvement (by manager, procurement team, and RA of the food machinery company), insourcing R&D, customer involvement, and inward IP licensing (with food company A01, A02, A03 and A04, and consumers), supplier involvement (with regular suppliers), and regulatory body involvement (with regulatory bodies & testing laboratories).

This pattern is suitable for the food machinery company who wants to exploit its existing food recipes to other food companies by offering the NPD of OEM brand products. As food recipes are the organizational asset of the food machinery company, this pattern benefits the food machinery company through better utilization of its food recipe by other food companies. The new products are slightly adjusted compared to the original food recipe. For example, by the ratio of ingredients or minor taste factors to meet the ideal price point to satisfy the food company's target market.

This pattern is convenient for the other food machinery companies to implement. However, the new product from this pattern tends to possess less unique characteristics. The initiation of this type of OI NPD is generated from the food machinery company (supply side), not from the consumer side (demand side). The food company also benefits from Pattern 3 as it extends their new product range with low initial investment. This is a win-win situation for the food machinery company and the food company.

Pattern 4 of the Food-Machinery Flexibility Model. Pattern 4 reflected the NPDs in Group 4, which focused on the development of the food company's new product with its recipe. Figure 4.7 reveals 44 NPDs within this pattern. There were 32 NPDs from SME A and 12 from SME B. The original recipe was completed by the food company, which resulted in the IPR belonging to the company.

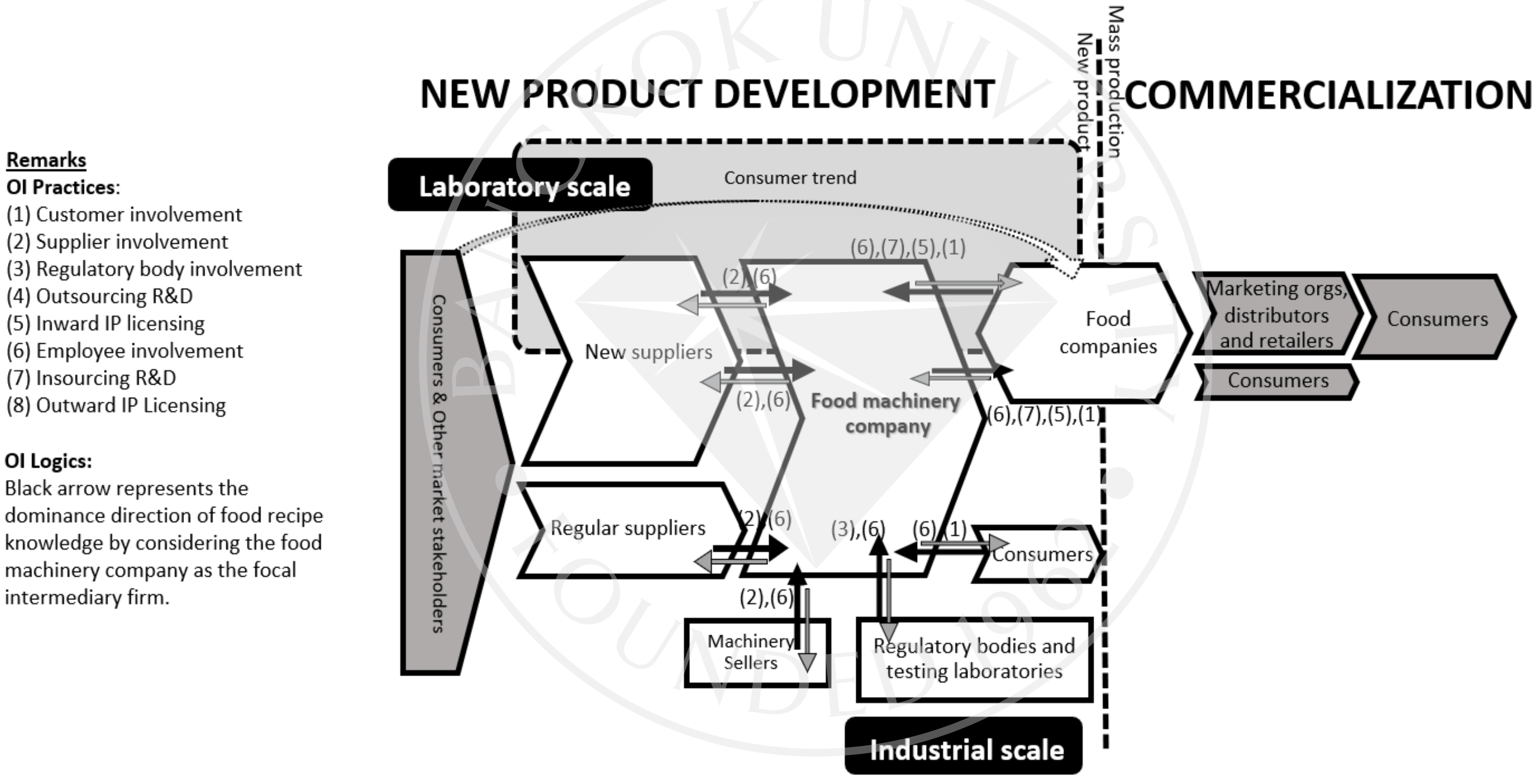
In Pattern 4, the OI practices were related to laboratory scale. The related OI practice comprised of the followings:

1) Employee involvement (by manager and procurement team of the food machinery company)
2) Insourcing R&D (with the food company A06, A08, A10, A12, A13, and A16)
3) Customer involvement and inward IP licensing (with food company A05-A16, B01, B02 and B03)
4) Supplier involvement (with the new suppliers)

The OI practices related to industrial scale were employee involvement (by the manager, procurement team, and RA of the food machinery company), supplier involvement (with new supplier and regular suppliers; with the machinery sellers in some cases), insourcing R&D, customer involvement and inward IP licensing (with food companies A05 to A16, and B01 to B03), and regulatory body involvement (with regulatory bodies and testing laboratories).

Figure 4.7

The Food-Machinery Flexibility Model: Pattern 4



Note. The arrows represent the flow of food recipe knowledge (OI logics). Modified from the Food-Machinery framework and the open food supply chain, by Bigliardi and Galati, 2013, p21.

This pattern is suitable for the food machinery company aiming to position itself as a superior OEM for variety of food company's NPDs. The diversification of many new food product categories is considered to be a paradigm shift for the food OEM business.

The pattern benefits the food machinery company by increasing the S-curve of product availability, developing competitive advantage, and reducing the risk within uncertain and/or competitive business environments. The main task of the food machinery company is to implement the food company's recipe with its production technology at the laboratory scale and industrial scale. This pattern suggests the food machinery company has flexibility with the overall NPD process and the adjustable mass production line. A static working process and production line are the main obstacle to this pattern implementation.

Adding to this, the food machinery company needs to be aware that its production license to add to the scope of new products. Without it, the new product could not be registered with an FDA number resulting in illegal commercialization. The food machinery company must therefore be prepared to response to the different requirements of each food NPD project from the different food companies. The critical factor to achieve such OI NPDs is the ability to identify a suitable food company as a strategic partner and work towards developing a long-term relationship. This is because the adjustable process and production line are very costly to the food machinery company.

Pattern 5 of the Food-Machinery Flexibility Model. This pattern belongs to the NPDs in Group 5 that focuses on the development of a food company's new product with the food expert's recipe. Figure 4.8 reveals 34 NPDs within this pattern.

Out of the 34 NPDs, 32 were from SME A and 2 from SME B. The final recipe and the creation of a new product were completed by the food machinery company, but the original recipe was created by external co-development between food company and food experts. Nevertheless, the IPR of the new product belongs to the food company.

In NPD Pattern 5, there were no OI practices related to the laboratory scale of the food machinery company. Thus, there is no OI logic at the laboratory scale. On the other hand, the OI practices related to the industrial scale include:

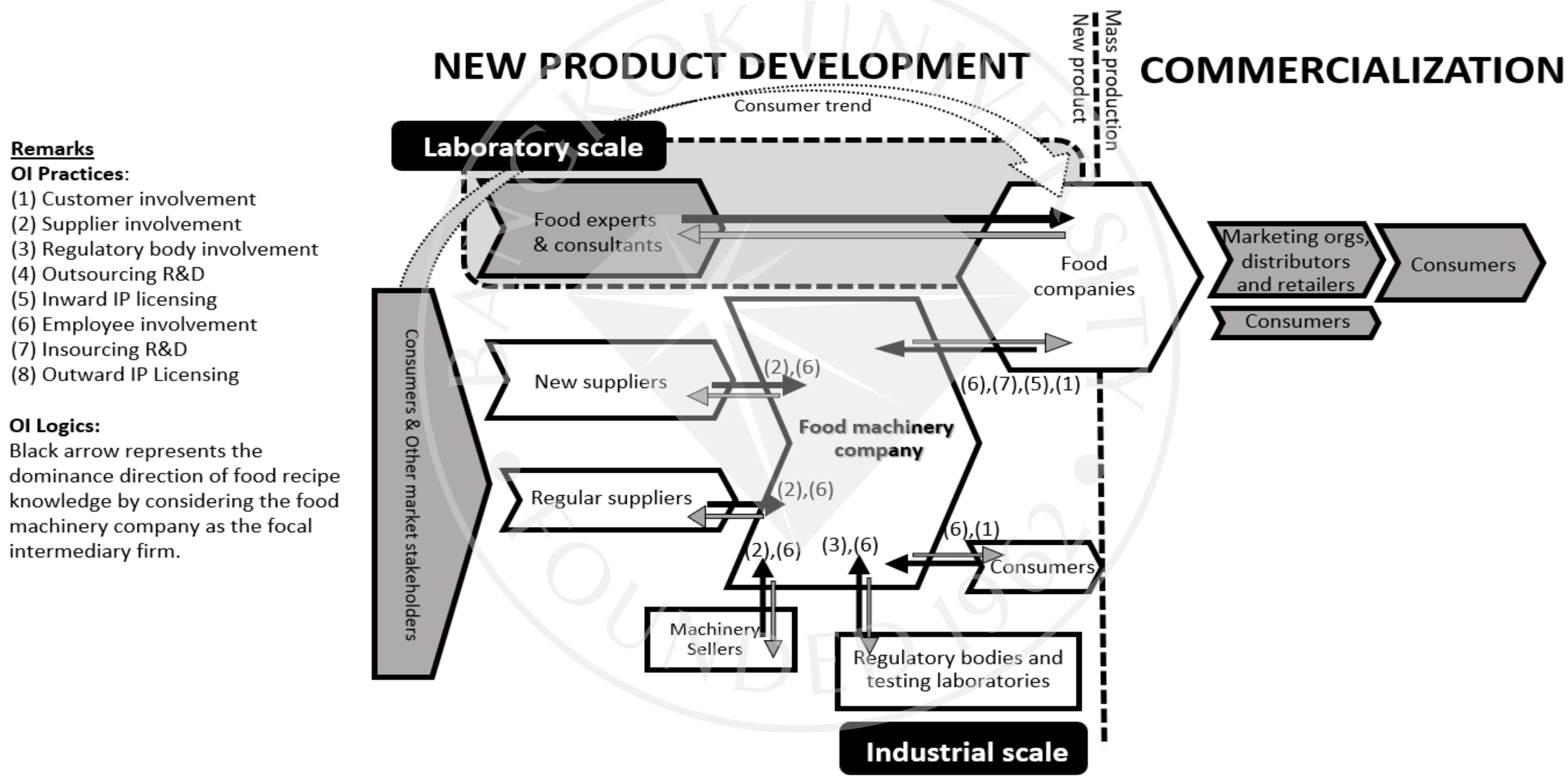
1) Employee involvement (by the manager, procurement team, and RA of the food machinery company)
2) Supplier involvement (with new suppliers and regular suppliers, but with the machinery sellers in some cases)
3) Insourcing R&D (with food company A17 to A24, and B04)
4) Inward IP licensing (with food company A17 to A24, and B04)
5) Customer involvement
6) Regulatory body involvement (with regulatory bodies & testing laboratories).

This pattern is suitable for food machinery companies who positioned themselves as superior OEMs for a variety of food companies. However, this does not include the laboratory scale. The laboratory scale will have been completed with R&D cooperation between the food company and the external food experts or the consultants. The critical task for the food machinery company is to obtain relevant food recipe knowledge at the laboratory scale, and adjust accordingly to suit their production facilities. They can then move to production and legal commercialization phase.

Pattern 5 suggests the food machinery company should consider handing the task of laboratory scale developments to experts in that field, and focus its expertise to developing their capability to implement an industrial scale for the NPDs. The greater number of new products that can be mass produced and legally commercialized, the more long-term benefit to the food machinery company. Most of the investigated cases concerned NPDs in which the food companies bought the new product IP from universities, food consultants, the owners of original food recipes, who already have laboratory scaling. This shortens the overall development process in terms of the preliminary market study, initial knowledge requirements, and the prototype development.

Figure 4.8

The Food-Machinery Flexibility Model: Pattern 5



Note. The arrows represent the flow of food recipe knowledge (OI logics). Modified from the Food-Machinery framework and the open food supply chain, by Bigliardi and Galati, 2013, p21.

However, the difficulty of this pattern is the food machinery company's ability to upscale the prototype. Since the food machinery company was not involved in the laboratory scaling, the prototype of the new product was created with lacking in the inputs of actual limitation factor from the production side. Any diversions between laboratory and industrial scaling could produce significant differences to the final merchandise when mass produced. These can range from different sources of the same ingredient from a different food supplier affecting the product taste, affecting the product quality, affecting as the percentage of yield loss at the actual production stage is always higher than the laboratory scale. These issues also affect the calculation for the new product costs and ingredient planning. The most common obstacle of Pattern 5 is that the production conditions of laboratory scaling provided by the food experts and consultants might not comply with current food laws and regulations. The new food product cannot be registered with the FDA to reach the legal commercialization stage.

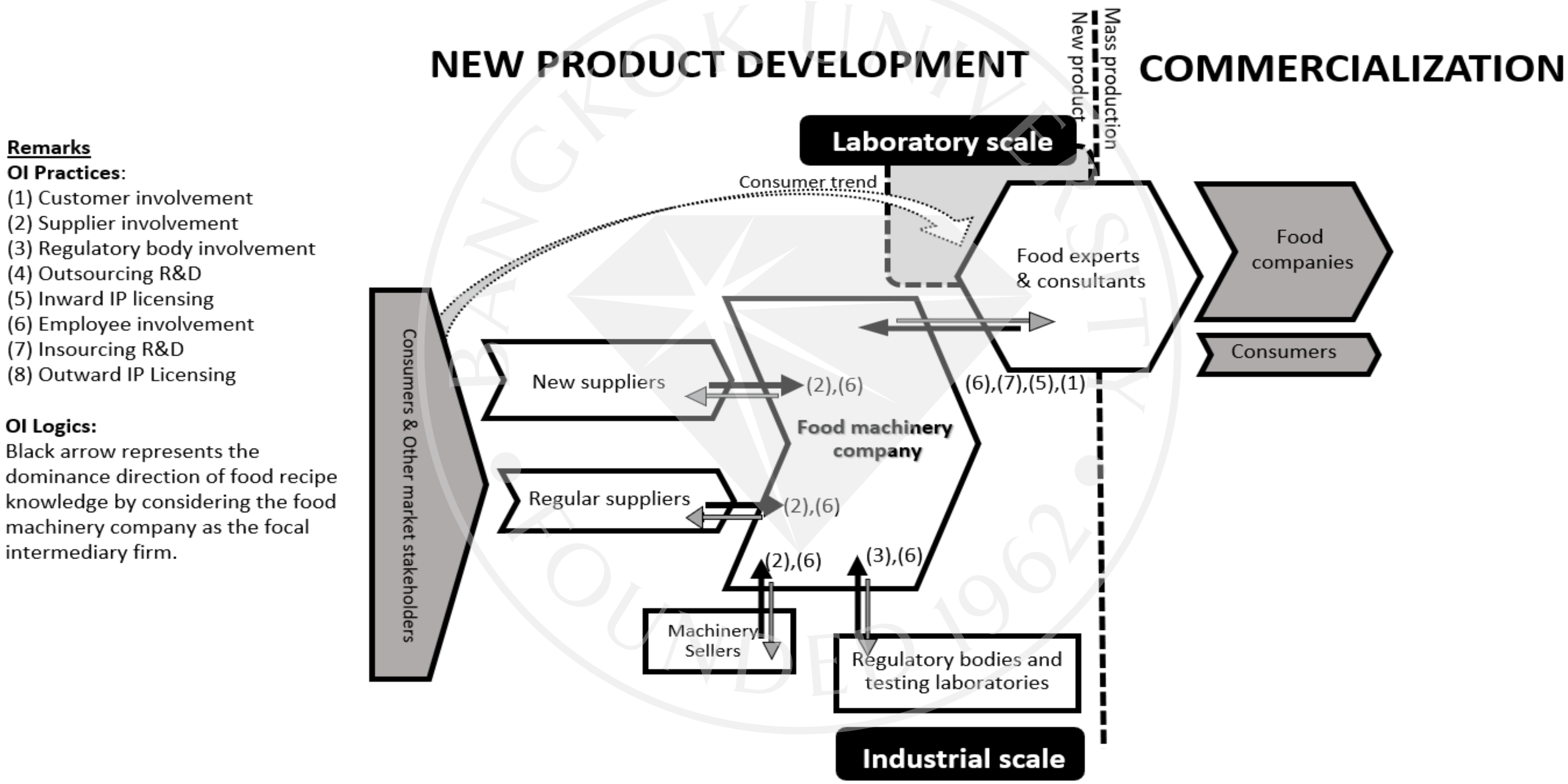
Pattern 6 of the Food-Machinery Flexibility Model. This pattern belongs to the NPDs in Group 6 that focuses on the development of a food expert's new product with the food expert's recipe. As shown in Figure 4.9, the findings reflected 5 NPDs within this pattern from SME A only. The idea of new product and the original recipe were created by the food experts & consultants. Hence, the IPR of the new product belongs to the food experts & consultants.

In this NPD pattern, no OI practices were related to the laboratory scale of the food machinery company. Hence, there was no OI logic applied at the laboratory scale. The OI practices related solely to the industrial scale were employee involvement (by the manager, procurement team, and RA of the food machinery company), supplier involvement (with new suppliers and regular suppliers), insourcing R&D, customer involvement and inward IP licensing (with hospital A01, national research laboratory A01, and university A03 and A04), and regulatory body involvement (with the regulatory bodies & testing laboratories).

This pattern is quite similar to pattern 5 as the food machinery company was only involved at the industrial scale. The laboratory scale was developed by the food experts and consultants. In the past, the ultimate aim of the academic food NPDs from academic researchers tended to focus only on the laboratory scale, but was quite difficult for the private sector to mass produce and legally commercialize at this scale. However, this finding showed some gradually changes to this matter. Some food experts and consultants have now extended their NPD / R&D / IP scope to cover the industrial scale including FDA registration.

Figure 4.9

The Food-Machinery Flexibility Model: Pattern 6



Note. The arrows represent the flow of food recipe knowledge (OI logics). Modified from the Food-Machinery framework and the open food supply chain, by Bigliardi and Galati, 2013, p.21.

Pattern 6 will assist the private sector food companies and/or food machinery companies to make commercialization easier to achieve. At the moment, Pattern 6 is rarely found in the Thai FI. However, one of the interviewees strongly believed that it will be grow in the future in respect of national policy change. The value of Pattern 6 is to obtain advanced knowledge at minimum cost. Some examples are the application of new food techniques and processes, the application of new food ingredients, and the modernized food trends. Even though each NPD always has an agreement on new product confidentiality, the food machinery company can apply some of this knowledge to the different NPDs, and still acts ethically. The difficulty with this pattern is the ability to upscale the prototype of new product, and to reduce the communication gap between the academics and practitioners.

4.4.5 Diachronic Overview of OI NPD

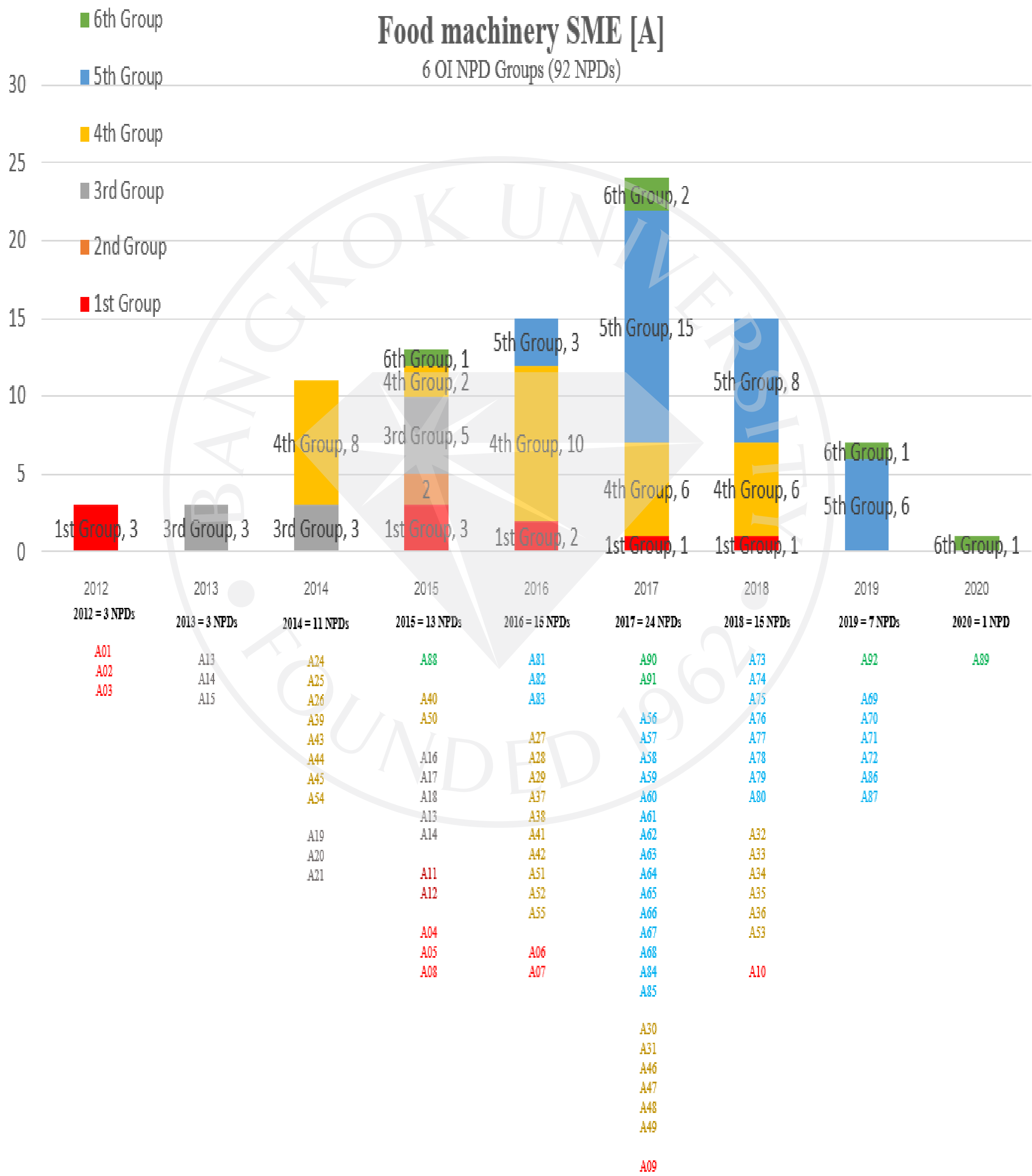
The Food-Machinery Flexibility Model and its 6 patterns, were agreed by validating the data analyzed and synthesized with the interviewees of SMEs A and SME B at the beginning of the third interview. Importantly, both interviewees were asked to explain the historical view of their OI NPDs again by using the Food-Machinery Flexibility Model and its 6 patterns.

The information gained based on their business strategies and economic situations in each operational period were added for the pattern analysis of each SME. This information helped the researcher to better understand the agility and flexibility towards OI NPD of each SME as reflected in the Figure 4.10 and Figure 4.11.

4.4.5.1 A Historical OI NPDs of SME A: Case A01-A92.

Figure 4.10

The OI NPD of food machinery SME A from 2012 to April 2020



SME A commenced on the trading situation in 2012 and commented that their initial goal was to produce its own brand products. However, due to external and internal factors, its business model became OEM dominant. At the end of 2019, the company's corporate income ratio between OEM and own brand were approximately 80:20, respectively. When they started commenced trading between 2012 and 2013, SME A had heavily invested in the manufacturing infrastructure and on factory standards. In contrast, the R&D investment was considered investing in a comparably low. Working with only a few NPDs at the first 2 years of its operation, the company's NPD projects sustained continuous growth and reached a peak in 2017 with 24 NPDs per year. It managed to produce 23 OEM NPDs and 1 NPD of its own brand. The highest performance was a result of many factors. Some of the reasons were that many of its clients (small size food companies) were supported with R&D funds through the government's OI policy, an increased awareness of the China market, and its internal strategy to increase production capacity through new machine installation.

However, the number of NPDs began to decline slightly during 2018-2019, due to the political uncertainties in the country. Furthermore, SME A chose to classify clients with valuable NPDs with the possibility of commercializing those products rather than contributing to a larger group of clients. This new mindset was revealed in an interview with Interviewee A who stated that "*...From 100 NPDs, 10% could reach FDA registration process, but only 1% that we can reap the long-term benefit. We cannot take care all NPDs efficiently. Besides, the income of R&D* (NPD) *service shows a really small amount compared with the mass-producing commercial* *products. Hence, we have to focus on what is really important and suitable for the company*".

In 2012, there were only 3 own brand NPDs in Group/Pattern 1 as presented in Case A01, A02 and A03. Since they were their first set of recipe developments, SME A imitated new product ideas from the marketplace and competitors. The company did so with the purpose to reduce cost of R&D.

In 2013, there were only 3 OEM brand NPDs in Group/Pattern 3 (as witnessed in Case A13, A14 and A15). Cases A13-A15 were the first attempt of SME A to introduce its existing recipe to food company A01 to maximize the company's production capacity. SME A could not suddenly increase its own product sales due to a lack of marketing capability.

However, it was a favorable option for SME A to achieve its goal with limited time, marketing and R&D resources, and budget restrictions. This observation was made based on the interview with Interviewee A who reported that "*In my opinion, bringing the existing product ideas is the most convenient way to earn more income and maximize production capacity, and recipes to the market. However, it seems to work for a short-term period. This kind of new product has none of the differentiable characteristic and selling point*".

After this successful approach by food company A01, SME A continued to introduce this OI NPD pattern to other food companies (such as food company A02, A03 and A04) in on-going projects. SME A applied 2 groups of OI NPD in 2014 (Group/Pattern 3 and 4), with 11 OEM brand NPDs conducted. Another 3 NPDs from the Group/Pattern 3 (Case A19 to A21) to food company A03 were practiced. SME A also developed a new pattern of NPD to support a new business model (OEM) with 8 other NPDs in Group/Pattern 4. Some of their clients (food companies) directly contacted SME A for the NPDs and the mass production for their brands at laboratory scale and industrial scale. This was the case for Case A24, A25 and A26 that belonged to the food company A05. Likewise, Case A39 that belonged to the food company A08, Cases A43, Case 44 and Case 45 belonging to food company A11 and case A54 belonged to the food company A15 were some instances of Pattern 4.

It was clearly stated in the interview with Interviewee A who cited that "*I met new OEM clients at the food event that we participated (*Thaifex 2014*), and some OEM clients directly contact me through my business connection*" and "*…the initial idea and the original food recipe of these new products (*the Group/Pattern 4*) were from our clients. They knew their end-consumers better than us. In some cases, they already had a market. In my opinion, these will reduce the failure risk during the stage of commercializing new products. For us, the main task of overall NPD is to apply our production technology to comply with the recipe and ingredients, such as, processing the pre-treat raw materials to match with the technology, transforming the specific ingredient ratio from the home cooking version into the industrial production version, identifying the proper production condition that abide by the regulations, and FDA registration. In my opinion, the clients were involved in the ideation process, such as, the new product preference, the selling point, and the ideal cost, and every sensory feedback in each step of the development".*

SME A applied 5 groups of OI NPD in 2015 (Group/Pattern 1, 2, 3, 4, and 6). For its own brand NPD, there were 3 NPDs in Group/Pattern 1 (Case A04, A05 and A08), 2 NPDs in Group/Pattern 2 (Cases A11 and A12 were outsourcing R&D to the university A01). For OEM brand, there were 5 NPDs in Group/Pattern 3 (Cases A16, A17 and A18) were OEMs for the food company A02, Case A22 and Case A23 were OEMs for the food company A04, 2 NPDs in Group/Pattern 4 (case A49 was OEM for the food company A13, and Case A50 was for the food company A04, and 1 NPD in the Group/Pattern 6 (Case A88 was OEM for the hospital A01).

In terms of outsouring R&D, Interviewee A stated that "*I'm not sure how many NPD patterns there were in 2015 but it had just happened. I outsourced R&D to the university A01 for my own brand NPD which needed the advance knowledge, while my internal R&D handled the NPD of the OEM brand which was less difficult. There were a lot of approaches evolved by new clients through many channels, such as, food exhibition, consortia, my organizational online platform, recommendation by the experts and business partners. My team and I had to be agile whilst flexible during many NPD & production routines for each client. That was tough for us but it made us survive till now.*"

Furthermore, the results also showed that SME A applied different OI NPD patterns with 1 client and at the same time (with the food company A04). At the beginning, SME A was directly contacted by food company A04 for the NPD Case A50 (Group/Pattern 4). During the initial stage of development, the manager of SME A found he could introduce his own recipe to the client. There was some similarity between these products. Food company A04 agreed to extend another 2 NPD projects (Cases A22-23 in Group 3). However, based on the fact received, the researcher found that interviewee A did not notice the difference in terms of OI NPD patterns in the first interview.

SME A applied 3 groups of OI NPD in 2016 (Group/Pattern 1, 4, and 5), with 15 NPDs conducted. For their own brand NPD, there were 2 NPDs in the

Group/Pattern 1 (Cases A06 and A07). For the OEM brand, there were 10 NPDs in the Group/Pattern 4, Case A27, A28 and A29 were OEM for the food company A05, Case A37and A38 were OEM for the food company A07, Case A41 was OEM for the food company A09, Case A42 was OEM for the food company A10, Case A51 to A52 were OEM for the food company A14, and Case A53 was OEM for the food company A03.

There were also 3 NPDs in the Group/Pattern 5. Cases A81 and Case 82 were OEM for the food company A20, and Case A83 was OEM for the food company A05. A new pattern of OI NPD (Group/Pattern 5) was coincidently applied in the same year. SME A was directly contacted by food companies A20 and A83 (at the food consortia and recommended by the expert) to develop industrial scale and mass production. These food companies had already outsourced laboratory scale R&D to the university A02 and A05 since the first meeting. Hence, SME A could shorten the overall NPD process and reach the commercialization stage for the OEM NPDs much faster. The experts from the universities provided the prototype of the new product, laboratory scale recipe and production condition guideline.

This practice was reflected in the interview of Interviewee A who reported that "*In order to achieve NPD Case A81 and Case 82 with continuous mass production processes, we had to invest new machine, which was needed some support of knowledge from the expertise and the machinery sellers to comply new machine with the NPD itself (recipe, process, and specific condition), and with our current manufacturing facilities. Without this machine, we have to do the production manually, this means we will fail the up-scaling of this new product*".

In 2017, SME has a total of 24 NPDs and these OI NDPs fell into the category of Group/Pattern 1, 2, 5 and 6. Among these NDPs, there was only 1 owned brand NPD as in Case A09 which came under the Group/Pattern 1. For OEM NPD, there were 6 NPDs in the Group/Pattern 4 (Case A30 and A31 were OEM for the food company A05, Case A46, A47 and A48 were OEM for the food company A12, and Case A49 was OEM for the food company A13), 15 NPDs in the Group/Pattern 5 (Case A56, A57 and A58 were OEM for the food company A17, Case A59 and Case A60 were OEM for the food company A18, Case A61 to A68, A84 and Case 85 were OEM for the food company A19, and Case A85 was OEM for the food company A22, and 2 NPDs in the Group/Pattern 6 (Cases A90 and A91 were OEM for the university A03 and A04).

On the following year, SME A applied 3 groups of patterns, namely Group/Pattern 1, 4, and 5 in its OI NPDs in 2018, with a total of 15 NPDs conducted. For own brand NPD, there was only 1 NPD that appealed in Group/Pattern 1 as seen in Case A10. For the OEM brand, there were 6 NPDs in the Group/Pattern 4 (Cases A32, A33 and A34 were OEM for the food company A05, Case A35 and A36 were OEM for the food company A06, and Case A53 was OEM for the food company A03).

The results revealed that SME A had applied different OI NPD patterns for food company A03 at different times. Initially, SME A had introduced its existing recipes to Food company A03 as reflected in Case A19 to A21 in Group/Pattern 3. Food company A03 then succeeded in commercializing these products resulting in the achievement of another NPD two year later as witnessed in Case A53 in Group/Pattern 4.

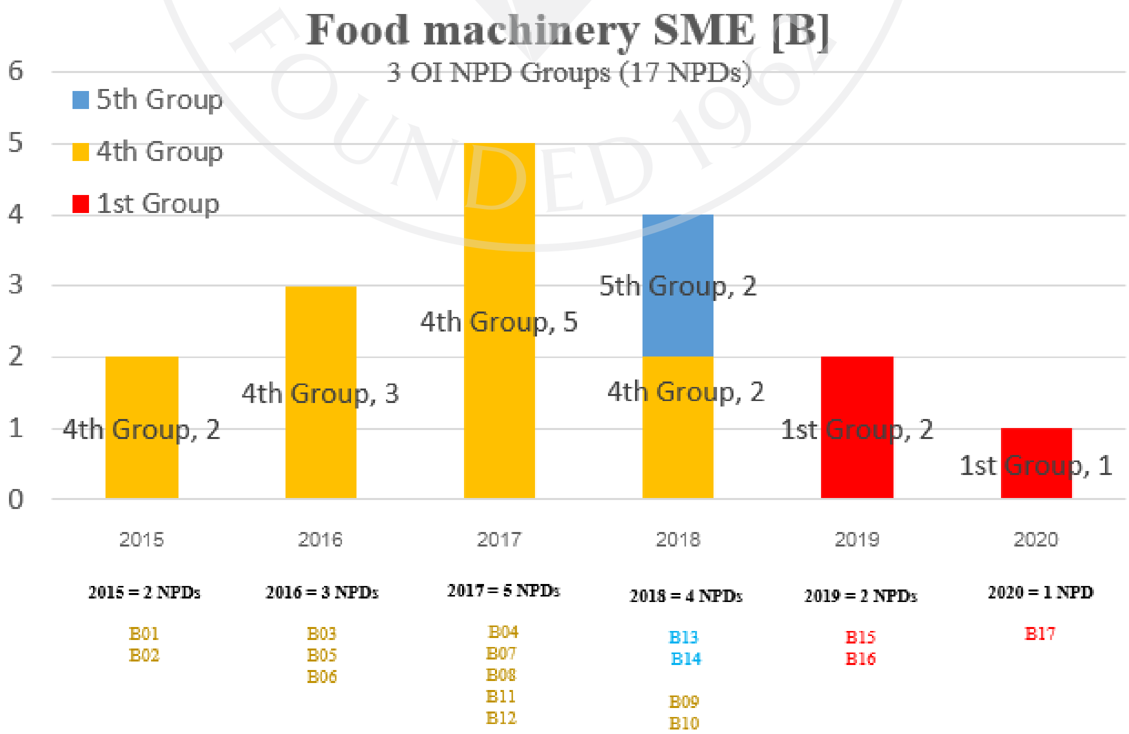
SME A applied 2 groups of OI NPD in 2019. These 2 groups belonged to Pattern 5 and Pattern 6. A total of 7 NPDs were conducted for the OEM brand. In addition, there were 6 NPDs in Group/Pattern 5. The cases involved Case A69, A70, A71 and A72 acting as OEM for the food company A19, Case A86 as OEM for the food company A23, and Case A87 as OEM for the food company A24. There were only 1 NPD in Group/Pattern 6. This was the case of A92 acting as OEM for the university A04.

In 2020, SME A found itself in a difficult situation due to the spread of coronavirus causing NPD activities to be significantly scaled back.

4.4.5.2 A Historical OI NPDs of SME B: Case B01-A17.

Figure 4.11

The OI NPD of food machinery SME B from 2015 to April 2020



SME B was established in 2015 with the aim to be an original equipment manufacturer (OEM). The business began its own brand production (and NPD) in 2019, by following the successes of NPDs from its clients. At the end of 2019, the company's corporate income ratio between OEM and own brand products were approximately 97:3. As SME B continued the business from the first generation of owners. It had few initial investments in the manufacturing infrastructure and the emphasis was on the investment of R&D equipment. Unfortunately, most of its new food products had no FDA number due to the nature of market. Resulting in small numbers of NPDs being included in this research study. Its NPD projects were considered to show a continuous growth, reaching a peak in 2017. There were on average 5 NPDs per year but these NPDs were the only OEM NPDs. This highest peak came from the R&D funds acquired from the government's OI policy at that time. Yet, the number of NPDs decreased slightly in the year from 2018 to 2019 due to the uncertaintyin the Thai politics.

In 2015, there were only 2 OEM brand NPDs in the Group/Pattern 4 as in the Case B01 and B02. In fact, SME B completed 6 OEM NPDs within the year but Case B01 and B02 were the only recipe developments which attained FDA registration recognition. Its client (food company B01) directly contacted SME B for the NPD to mass produce their brands at a laboratory scale and industrial scale. This recollection was noted via the interview of Interviewee B who stated that "*This is long term OEM clients since my father-in-law's generation. Likewise, he still continued the other NPDs in 2016 and 2017. We still continue mass-producing his products till now. Since he is a food trader, his products are fragile and variety, such as, RTE fruits, RTE local curries, and RTE local recipes. Some needed FDA number while some did not. Some* *products could generate a huge income especially the kinds of canned tropical fruit as I was able to source for the fruits from my land*".

By 2016, the number of OEM brand NPDs had increased to 3 in Group/Pattern 4 as seen in Case B03, B05, and B06. Case B03 was the OEM for the food company B01, and Case B05 and B06 were OEM for the food company B02. Interviewee B reported that "*This OEM client* (food company B02) *knew my factory from the address on packaging label of other OEM product in the market, what a surprise! He directly contacted me for the appointment*". Even though SME B still maintained their NPD pattern in the Group/Pattern 4 as in 2015, the uniqueness of this product went beyond the previous boundaries, from an add-on product to an existing product line and then into a new-to-the-firm product.

In 2017, more OEM brand NPDs were visible in the Group/Pattern 4. There were 5 NPDs as in Case B04, B07, B08, B11 and B12. Case B04 was an OEM for the food company B01. For Case B07 and B08, these were the OEM for the food company B02. As for Case B11 to B12, these were the OEM for the food company B03. Case B12 was noteworthy in that a new machine was added to the existing production line. This inward technology decision meant that SME B could provide a wider range of sterilized packaging such as retort pouches. This improvement was revealed by Interviewee B who commented that "*We positioned ourselves a full range of OEM RTE food products with variety type of sterilized packaging.*" and "*It was not just as a new machine installation. New production conditions strongly needed a new study to match with new packaging and new machine. We have been learning during the project implementation. We gained a lot of experiences through this NPD*".

In 2018, SME B applied 2 groups, namely Group/Pattern 4 and 5 of OI NPD. The company also had 4 NPDs conducted for OEM brand. There were 2 NPDs in Group/Pattern 4 as in Case B09 and B10, these were OEM for the food company B02. In addition, there were 2 NPDs in Group/Pattern 5. These two OEM NPDs were Case B13 and B14 for food company B04. A new pattern of OI NPD in Group/Pattern 5 was coincidently introduced this year where SME B was directly contacted by food company B04 (through its online platform which had been implemented in the same year) to develop into industrial scale and then for mass production. This food company had already outsourced laboratory scale R&D to the external expert at their first meeting. The prototype of the new product, laboratory scale recipe and production condition guidelines were fully provided. Hence, SME B could shorten the overall NPD process and fastened the commercialization stage for the OEM NPDs.

In 2019, only 2 own brand NPDs in the Group/Pattern 1 (Case B15 and B16) were conducted. Since they were the first set of own brand NPD, SME B copied new product ideas from the market and applied them to the creation of its OEM products. This change in strategy was caused by its clients with the OEM products not having a FDA number. Therefore, it could be easily switch to other food machinery companies.

In 2020, SME B found itself in a difficult situation related to the spread of coronavirus and NPD activities were significantly reduced.

4.4.5.3 Summary of Diachronic Overview of OI NPD. The analysis of the OI logics and practices observed enabled the establishment of OI patterns that will again be confronted with reality through new observation in each interview (Blom & Morén, 2011). The diachronic overview of SME A and SME B demonstrated the existence of a variety of food OI NPD patterns within the Food-Machinery Flexibility Model. It also reviewed the ability of these Thai SMEs to shift from one innovation logic to another and to adjust its innovation practices to the nature of the collaborative strategy associated with each new product development, at different levels of flexibility and agility.

Table 4.33

The OI NPD comparison between SME A and SME B

OI NPD Groups/Patterns within the Food-Machinery Flexibility Model	SME A	SME B	The similarity and difference between SME A and SME B
	Quantity of involved NPDs	Quantity of involved NPDs	
Group/Pattern 1	10	3	-SME A and SME B performed the same type of OI practices in both scales -SME A has an additional involved actor (the consumer) in the laboratory scale, in the NPD case A08 - A10
Group/Pattern 2	11	-	-SME B has no outsourcing R&D practice in the laboratory scale
Group/Pattern 3	2	-	-SME B has no outward IP licensing practice in the laboratory scale
Group/Pattern 4	32	2	-SME B has no insourcing R&D practice in the laboratory scale -SME A and SME B performed the same type of OI practices in the industrial scale
Group/Pattern 5	32	12	-SME A and SME B performed the same type of OI practices in the industrial scale
Group/Pattern 6	5	-	-SME B has no client as the food experts & consultants
	92	17	

As depicted in Table 4.33, SME A has more OI NPD groups/patterns as compared to SME B with 6 and 3 Groups/Patterns respectively. However, it must be noted that these data collected from SME A and SME B were covered in different periods. The data collected in SME B case covered a shorter period. Hence, the different amount of NPD groups/patterns could not be used for the comparison of historical innovation strategies evolution. However, the similar group/pattern remains a qualitative comparison.

In Group/Pattern 1, SME A and SME B performed the same type of OI practices in both scales. However, SME A collaborated with another additional involved actor, the consumer, in NPD Case A08, A09 and A10, to increase the validity of market demands through sensory testing at laboratory scale.

In Group/Pattern 4, SME B had no insourcing R&D practice at the laboratory scale, but the company had an inward IP licensing practice with no R&D fee to the food companies. SME A, on the other hand, applied their traditional inward IP licensing practices into the insourcing R&D. This practice started in 2014 and is still ongoing.

In Group/Pattern 5, SME A and B performed the same type of OI practices at the industrial scale. There was no significant difference between the two SMEs.

4.4.6 The OI NPD Generative Mechanism Identification

The OI generative mechanism (GM) is the causal power that contains all physical or social objects that act on other objects and phenomena to produce changes in the OI NPD. Hence, it could not be perceived by human sense as it is the mechanism underlying the NPD events of food machinery companies toward the OI NPD.

To answer **RQ3** (What generative mechanisms favor OI logics and practices implementation in the Thai Food machinery SMEs?), both SMEs A and SME B were also asked the same set of open-ended questions as in **RQ3.1** (What factors activate the ability of Thai food machinery SMEs to implement and sustain OI logics and practices?), and **RQ3.2 (**In what mechanisms are activated in Thai Food machinery SMEs OI NPDs?) to each group of OI NPD (Group/Pattern 1 to 6 for SME A and Group/Pattern 1, 4 and 5 for SME B).

The answers of RQ3.1 and RQ3.2 helped the researcher to identify the associated active factors for the GM sequences of recipe development from start to finish, and to answer the main research question concerning the generative mechanisms of Thai Food machinery SMEs OI NPDs.

4.4.6.1 The Identification of Active Factors Involved OI NPDs. The researcher identified the active involved factors from the 3rd interview, and confirmed these findings with the interviewees at the 4th round of interview.

During the third interview, the researcher found the interviewees gave abundance of answers that activate their ability to implement each group of OI NPD. All of them were connected and related to various types of capabilities, which link to the dynamic capabilities (DCs) (Refer to Table 4.34).

As seen in Table 4.34 on the following page, the researcher has identified the OI NPDs that have demonstrated active capabilities in the investigated food machinery companies that are consistent with DCs. This includes Sensing, Seizing, Transforming (Teece, 2020), Inventive capacity, Innovative capacity, Absorptive capacity, Desorptive capacity (Lichtenthaler & Lichtenthaler, 2009), and Entrepreneurial capabilities (Zhang, 2013).

Moreover, the researcher observed that that the legal compliance capacity was a prominent consideration to the OI NPD groups/patterns in accordance to the discussion with Interviewee A and Interviewee B. This capacity was not mentioned in the extanted DCs literature, but it is considered important to achieve the goal of legal commercialization of the new food product. Thus, the usable new innovative ingredient must be registered in the FDA database, and the testing results for the FDA registration process (nutrition fact, F_0, and microbial report) must be provided by accredited testing laboratories. This is because legal production of specific food products needs specific production licenses.

In addition, legal commercialization of food products requires an FDA number before it can be sold. Even though an organization may generate many technologies/innovations, it may lack the ability to commercialize legally (Chaochotechuang, 2016; Hongsaprabhas, 2017b; Tambunlertchai, 2015). This is the huge gap for most academic R&D in FI. This capacity is critical to the private sector for NPD legality in running their businesses. To achieve the status, this capacity needs to be developed by the organization through building strong relationships with involved actors such as the regulatory bodies and authorized testing laboratories, having sufficient financial resources, and staff experts skilled in the related laws and regulations.

Table 4.34

The OI NPD active factors and the Dynamic Capabilities codification

The Food-Machinery Flexible Model		**[RQ3.1]** OI NPD active factors	**[Coding]** Dynamic capabilities (DCs)
Group 1: 13 NPDs (Case A01-A10, B15-B17)	**Pattern 1** the food machinery company's NPD with its recipe.	●Capability to monitor competitors and consumer trends, convert in to tangible product ●Capability to manage its existing resources to response the rapid change of market ●Capability to transforms intangible idea and concepts into tangible new products ●Capability to propose new product to market	●Sensing, Seizing, Transforming ●Innovative capacity ●Transforming, Inventive capacity ●Innovative capacity
Group 2: 2 NPDs (Case A11-A12)	**Pattern 2** the food machinery company's NPD with the food expert's recipe.	●Capability to monitor and consumer trends, convert in to tangible product ●Capability to manage its existing resources to response the rapid change of market ●Capability to manage and drive the organization goes beyond its R&D limitation ●Capability to work with the academics ●Capability to obtains external knowledge and apply them with the organization ●Capability to transforms intangible idea and concepts into tangible new products ●Capability to propose new product to market	●Sensing, Seizing, Transforming ●Innovative capacity ●Entrepreneurial capabilities ●Absorptive capacity ●Absorptive capacity ●Transforming, Inventive capacity ●Innovative capacity
Group 3: 11 NPDs (Case A13-A23)	**Pattern 3** the food company's NPD with the food machinery company's recipe.	●Capability to command the whole organization to follow new strategy of the organization ●Capability to propose the existing product (and assets) to the external ●Capability to manage its existing resources to response the rapid change of market ●Capability to transforms intangible idea and concepts into tangible new products	●Entrepreneurial capabilities ●Desorptive capacity ●Innovative capacity ●Transforming, Inventive capacity
Group 4: 44 NPDs (Case A24-A55, B01-B12)	**Pattern 4** the food company's NPD with its recipe	●Capability to develop strong network platform ●Capability to create trust in the Network for long-term relationships development with private sector ●Capability to select the right NPD and/or client, and convert in to tangible product ●Capability to manage and drive the organization goes beyond its R&D limitation ●Capability to manage its existing resources to response the rapid change of market ●Capability to obtains external knowledge and apply them with the organization ●Capability to transforms intangible idea and concepts into tangible new products ●Capability to comply the laws and regulations	●Connective capacity ●Connective capacity ●Sensing, Seizing, Transforming ●Entrepreneurial capabilities ●Innovative capacity ●Absorptive capacity ●Transforming, Inventive capacity ●Legal compliance capacity*
Group 5: 34 NPDs (Case A56-A87, B13-B14)	**Pattern 5** the food company's NPD with the food expert's recipe.	●Capability to develop strong network platform ●Capability to create trust in the Network for long-term relationships development with private sector ●Capability to select the right NPD and/or client, and convert in to tangible product ●Capability to manage and drive the organization goes beyond its R&D limitation ●Capability to manage its existing resources to response the rapid change of market ●Capability to obtains external knowledge and apply them with the organization ●Capability to transforms intangible idea and concepts into tangible new products ●Capability to comply the laws and regulations	●Connective capacity ●Connective capacity ●Sensing, Seizing, Transforming ●Entrepreneurial capabilities ●Innovative capacity ●Absorptive capacity ●Transforming, Inventive capacity ●Legal compliance capacity*
Group 6: 5 NPDs (Case A88-A92)	**Pattern 6** the food expert's NPD with the food expert's recipe.	●Capability to create trust in the Network for long-term relationships development with public sector ●Capability to select the right NPD and/or client, and convert in to tangible product ●Capability to manage and drive the organization goes beyond its R&D limitation ●Capability to manage its existing resources to response the future market ●Capability to obtains external knowledge and apply them with the organization ●Capability to transforms intangible idea and concepts into tangible new products ●Capability to comply the laws and regulations	●Connective capacity ●Sensing, Seizing, Transforming ●Entrepreneurial capabilities ●Innovative capacity ●Absorptive capacity ●Transforming, Inventive capacity ●Legal compliance capacity*

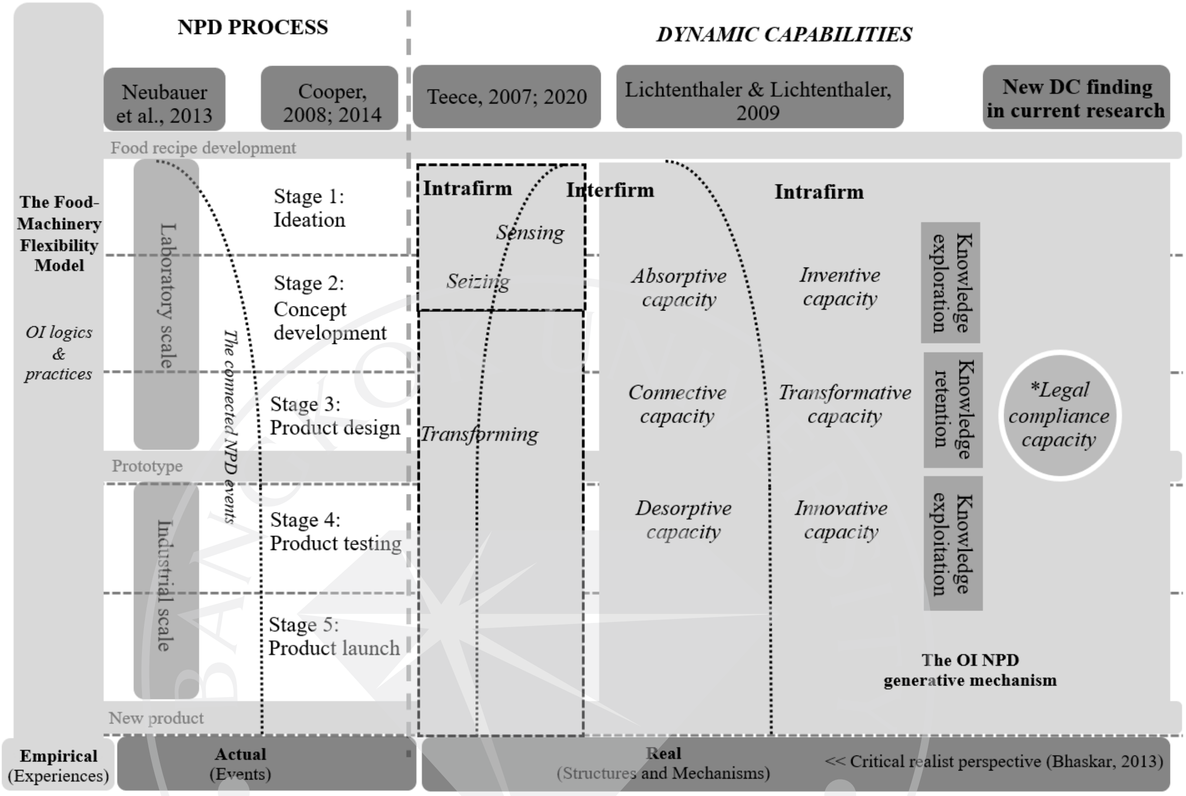
The food machinery companies' DCs associated with OI NPD are summarized in Figure 4.12.

As presented in Figure 4.12, the researcher did not include Entrepreneurial Capabilities (EC) as mentioned by Zhang (2013) with other DCs findings because it was naturally attached to the Sensing-Seizing-Transforming by definition (Teece, 2007; 2020). According to Zhang (2013) EC is the entrepreneur's ability to perceive, choose, shape and synchronize internal and external conditions for the organization's exploration and exploitation (p.7-8) and focuses on managerial decision making. After identifying the internal and/or external use of knowledge opportunities (based on the project feasibility, organization strategy, resource capability, core competency, and/or strategic motive for knowledge transfer), the organization's management team is responsible in making the decision for actual implementation.

The critical consideration around OI practices lead strategy decisions. Some of the examples are the decision to commercialize a given technology/innovation; the decision to apply inward new machinery facility; the decision to register for a new factory/production license, acquiring IP; or collaboration with strategic partners in the value chain and the decisions that arise in order to ensure predictable of organization development. Hence EC is needed to harmonize and continue the mobilization of the overall DCs of the organization.

Figure 4.12

The food machinery companies' DCs associated with OI NPD



Note. The integration of NPD process from Cooper, 2008; 2014; Neubauer et al., 2013, and the Dynamic capabilities from Lichtenthaler & Lichtenthaler, 2009; Teece 2007; 2020

In this research study, the researcher found the connection to each DCs. Teece's (2007; 2020) DCs are more applicable on the organization competitive development through the external acquiring, while Lichtenthaler & Lichtenthaler's (2009) defined DCs as are more applicable to the organizational routine and development through the exploitation and exploration of OI NPD. This is shown in Table 4.35. Corresponding to the research objective on OI logics, Lichtenthaler & Lichtenthaler's (2009) DCs is most appropriate to the current study as they introduce different OI logics and knowledge types which include knowledge exploration (inventive and absorptive capacities), knowledge retention (transformative and connective capacities), and knowledge exploitation (innovative and desorptive capacities).

However, the NPD always comprises of numerous events beyond the recipe development but their capabilities are still required. For instance, sensing (Teece, 2007; 2020) enables the access of enormous external opportunities such as new food trends, popular ingredients, potential clients, new production technologies and internal opportunities (changing of organizational strategy from own brand to OEM direction and vice versa). The ability to seizing (Teece, 2007; 2020) enables the selection of the best opportunity among others to the organization. The transforming capability (Teece, 2007; 2020), on the other hand, which is excluded in the study, enables the company to orchestra the whole process of OI NPD for new products which encompasses Lichtenthaler & Lichtenthaler's (2009) DCs.

Hence, as shown in Table 4.35, the researcher concludes that the active factor involving food OI NPDs is the dynamic capabilities of the company that include Sensing, and Seizing (Teece, 2007; 2020), Inventive capacity, Transformative capacity, Innovative capacity, Absorptive capacity, Connective capacity, Desorptive capacity (Lichtenthaler & Lichtenthaler, 2009), and legal compliance capacity (a new finding from the study). However, the connection of finding DCs to represent the OI NPD GMs needed further clarification at the 4th interview. To validate the resulting DCs, the researcher's supervisor was present in the interpretation of the results to enhance the credibility within a double-coding of the interview transcripts, and to reduce biases.

Table 4.35

The DCs associated with OI NPD of the food machinery companies

<table>
<tr><td>Teece's (2020) DCs</td><td colspan="4">"Sensing" is the capabilities that included the identification, development, calibration of technological/innovation opportunities, market/customer needs, and strategic challenges (Day & Schoemaker, 2008). The organization's top management is responsible for combining and analyzing data from various sources in the environment, then prioritize problems and identify new opportunities (p.11).

"Seizing" is the agility of the organization to respond to significant opportunities and threats once they have been identifying e.g., the investment in new technology commercialization; design and implementing new business models for various products/services (Teece, 2020, p.11).</td></tr>
<tr><td rowspan="5">Lichtenthaler & Lichtenthaler' s (2009) DCs</td><td rowspan="2">Innovation process</td><td colspan="3">Knowledge Management Type</td></tr>
<tr><td>Knowledge Exploration</td><td>Knowledge Retention</td><td>Knowledge Exploitation</td></tr>
<tr><td rowspan="2">Internal (Intrafirm)</td><td rowspan="2">"Inventive capacity" is the ability to internally explore new knowledge e.g., perceiving opportunities, generating internally new knowledge, integrating new knowledge into the organization knowledge base by establishing the knowledge linkage (p.1318-1319).</td><td>"Transformative capacity" is the ability to retain knowledge inside the organization over time, and reactivate it subsequently. It includes the activity of keeping the alive inside the organization (p.1320). To this current study, the researcher focuses only explicit transformative only e.g., food recipe in document form, microbial report etc.</td><td rowspan="2">"Innovative capacity" is the ability to internally exploit knowledge. This knowledge could be internally developed or acquired from external sources. The main idea is to match an organization's invention with the market context (p.1321).</td></tr>
<tr><td>"Legal compliance capacity" (*) is the ability to make all actives, inputs and outputs of the organization are complying with law and regulation, which is complementary to knowledge applications in the organization e.g., legally production of specific product always needs specific production license, and legal commercialization of food products need FDA number before selling etc.</td></tr>
<tr><td>External (Interfirm)</td><td>"Absorptive capacity" is the ability to explore external knowledge or knowledge acquisition e.g., exploratory learning, inward knowledge transfer (p.1319).</td><td>"Connective capacity" is the ability to retain knowledge outside its organization boundary, with interorganizational relationship e.g., alliance capability (Kale & Singh, 2007) and relational capability (Lorenzoni & Lipparini, 1999). This capacity is not inward/outward knowledge transfer. Instead, it focuses on externally maintaining knowledge through ensuring the privileged access to external sources (p.1320)</td><td>"Desorptive capacity" is the ability to externally exploit knowledge, which is complementary to internal knowledge application in an organization's product e.g., outward knowledge transfer (p.1321-1322).</td></tr>
</table>

Note. This model shows the integration of Dynamic capabilities from Lichtenthaler & Lichtenthaler (2009) and Teece (2020)

4.4.6.2 Identification of Mechanism/DC Sequence Underlying OI NPD Event.

The findings of RQ1 and RQ2 indicate the reality in the empirical domain. The connection between the involved actors in the OI logics and practices towards OI NPD were analyzed and synthesized into the Food-Machinery Flexibility Model, as one verion of realities among others. However, the OI generative mechanism (GM) may not be perceived by the human sense. This is because it is the mechanism underlying the activity of food machinery companies towards the OI NPD.

The findings from the third interviews revealed that DCs are the key abilities to activate the investigation of SME A and SME B to implement and sustain OI logics and practices. Hence, the OI GM is the mobilization of the DCs among actors in each NPD. However, the researcher found that only the empirical activities across the organizational boundaries (OI logics and practices) that followed the development of food recipe could not be connected and mobilized all DCs in the whole NPD process. This is due to the lack of some event identification. Take for instance the internal R&D, external development by the external party, and internal managerial decisions. Thus, all NPD events performed by the internal and external actors must be identified first and then followed by their underlying mechanisms (DC sequences). Finally, revealing the connected mechanisms underlying to the NPD events in each group/pattern of OI NPD are the generative mechanisms.

The resulting of the 13 NPD events performed by each actor from the first interview are presented on Table 4.18 to Table 4.27. The result of DCs shown in Table 4.35 are grouped into 14 DC sequences. The researcher reconfirmed these findings with the interviewees at the beginning of the fourth interview.

Table 4.36

The 13 main NPD events and their 14 underlying mechanisms in OI NPDs

(1) The event of acquiring the external/internal opportunities for the NPD * Including the scrutinization, identification, selection and seizure of the external and/or internal business opportunities	
External involved actor(s)	(1) No directed actor involvement: Consumers, Other market stake holders (2) Directed actor involvement: Food companies, Food experts & Consultants, The group of Marketing organizations, distributors, and retailers
Internal participation	Manager/Executive
OI practice(s)	(1) No directed actor involvement: Employee involvement (2) Directed actor involvement: Customer involvement, Employee involvement
Non-OI practice(s)	Marketing/business practice (prior practice before the recipe development), Managerial decision making
Occurring	M1.1: Group 1, 2 M1.2: Group 1, 2, 4, 5, 6
DC sequence(s) /Mechanism	**(M1.1)** No directed actor involvement: **“*Sensing* → *Seizing*”** **(M1.2)** Directed actor involvement: **“*Connective* → *Sensing* → *Seizing*”**
(2) The event of acquiring the ingredient knowledge to accomplish the NPD * Including the scrutinization, identification, and acquisition of the ingredient knowledge	
External involved actor(s)	New suppliers, Regular suppliers
Internal participation	Procurement team, R&D
OI practice(s)	Supplier involvement, Employee involvement
Non-OI practice(s)	Internal R&D (Identification of related ingredients with specification)
Occurring	All groups of OI NPD
DC sequence(s) /Mechanism	**(M2) *“Sensing → Connective → Seizing → Absorptive”***
(3) The event of the internal prototype invention and external sensory testing * Including the sensory feedback acquisition ** This step probably takes several rounds to complete the development at each NPD scale.	
External involved actor(s)	Consumer, Food companies, The group of Marketing organizations, distributors, and retailers
Internal participation	R&D, Production team (at the industrial scale), Manager (to connect the external parties)
OI practice(s)	Employee involvement (to connect the external parties for the sensory testing process)
Non-OI practice(s)	Internal R&D
Occurring	All groups of OI NPD.
DC sequence(s) /Mechanism	**(M3) “*Inventive* → *Connective* → *Desorptive* → *Connective* → *Absorptive*”**

(Continued)

Table 4.36 (Continued)

The 13 main NPD events and their 14 underlying mechanisms in OI NPDs

(4) The event of acquiring the related documents for the FDA registration * e.g., Nutrition fact, Thermal processing (F0), and Microbial report ** Including the step of transforming internal implicit knowledge into explicit knowledge (e.g., prototype samples, final recipe with ingredient list and ratio, production technology and process), delivering the related explicit knowledge to the accredited testing laboratories, receiving the documents for FDA registration and filing this explicit data.	
External involved actor(s)	Regulatory bodies & testing laboratories (Accredited testing laboratories)
Internal participation	RA
OI practice(s)	Regulatory body involvement, Employee involvement
Non-OI practice(s)	-
Occurring	All groups of OI NPD
DC sequence(s) /Mechanism	**(M4) "*Transformative → Innovative → Connective → Desorptive → Connective → Absorptive*"**
(5) The event of acquiring the FDA number *Including the step of adjustment of all related explicit documents to comply with the FDA format and requirements (beside the new product documents, other related documents still essential needed e.g., factory license, retort machine supervisor license), submitting and registering for the FDA number report, and filing this explicit data. ** This step probably takes several rounds to reach FDA requirement. In the case that FDA asked for an adjustment recipe to comply with regulation. RA has to translate this requirement to R&D and the mechanism sequence (C) has to be re-do again.	
External involved actor(s)	Regulatory bodies & testing laboratories (Thai FDA)
Internal participation	RA
OI practice(s)	Regulatory body involvement, Employee involvement
Non-OI practice(s)	-
Occurring	All groups of OI NPD
DC sequence(s) /Mechanism	**(M5) "*Legal compliance → Transformative → Connective → Desorptive → Connective → Absorptive → Legal compliance → Transformative*"**
(6) The event of acquiring new factory/production license to legally produce new product	
External involved actor(s)	Regulatory bodies & testing laboratories (Thai FDA)
Internal participation	RA
OI practice(s)	Regulatory body involvement, Employee involvement
Non-OI practice(s)	-
Occurring	Group 4, 5, 6
DC sequence(s) /Mechanism	**(M6) "*Sensing → Seizing → Legal compliance → Connective → Desorptive → Connective → Absorptive → Legal compliance → Transformative*"**

(Continued)

Table 4.36 (Continued)

The 13 main NPD events and their 14 underlying mechanisms in OI NPDs

(7) The event of the external prototype invention * Including the scrutinization, identification, and acquisition of the food experts	
External involved actor(s)	Food experts & consultants
Internal participation	Manager/Executive
OI practice(s)	Outsourcing R&D, Employee involvement, Inward IP licensing
Non-OI practice(s)	External development by the external party, Managerial decision making
Occurring	Group 2
DC sequence(s) /Mechanism	**(M7) "*Innovative* → *Sensing* → *Connective* → *Seizing* → *Desorptive* → *Connective* → *Absorptive*"**
(8) The event of providing sensory feedback for the external invention adjustment * This step probably takes several rounds to achieve external development.	
External involved actor(s)	Food experts & consultants
Internal participation	Manager/Executive, R&D
OI practice(s)	Outsourcing R&D, Employee involvement
Non-OI practice(s)	Internal R&D (for providing sensory feedback), External development by the external party
Occurring	Group 2
DC sequence(s) /Mechanism	**(M8) "*Connective* → *Absorptive* → *Innovative* → *Connective* → *Desorptive*"**
(9) The event of exploitation of the existing recipes to the external party	
External involved actor(s)	Food companies
Internal participation	Manager/Executive, R&D
OI practice(s)	Outward IP Licensing, Employee involvement, Customer involvement
Non-OI practice(s)	Internal R&D (for providing prototype sample and related information), Managerial decision making
Occurring	Group 3
DC sequence(s) /Mechanism	**(M9) "*Innovative* → *Sensing* → *Connective* → *Desorptive* → *Seizing* → *Connective* → *Absorptive*"**
(10) The event of being approached with the new product idea (and/or the original recipe) by external party	
External involved actor(s)	Food companies, Food experts & Consultants
Internal participation	Manager/Executive, R&D
OI practice(s)	Inward IP Licensing/Insourcing R&D, Customer involvement, Employee involvement
Non-OI practice(s)	Marketing/business practice (prior practice before the recipe development), Internal R&D (for providing related information e.g., production limitation), Managerial decision making
Occurring	Group 4 - 6
DC sequence(s) /Mechanism	**(M10) "*Connective* → *Absorptive* → *Connective* → *Desorptive*"**

(Continued)

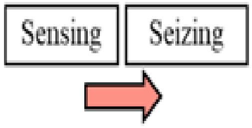
Table 4.36 (Continued)

The 13 main NPD events and their 14 underlying mechanisms in OI NPDs

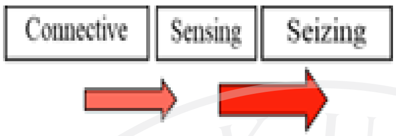
(11) The event of receiving the laboratory scale recipe from the external party *e.g., the laboratory scale recipe	
External involved actor(s)	Food companies, Food experts & Consultants
Internal participation	Manager/Executive, R&D
OI practice(s)	Employee involvement, Inward IP Licensing, Customer involvement, Insourcing R&D
Non-OI practice(s)	Internal R&D
Occurring	Group 3 - 6
DC sequence(s) /Mechanism	**(M11) "*Connective* → *Absorptive*"**
(12) The event of delivering the laboratory and/or industrial scale recipe to the external party	
External involved actor(s)	Food companies, Food experts & Consultants
Internal participation	Manager/Executive, R&D
OI practice(s)	Insourcing R&D, Employee involvement, Customer involvement
Non-OI practice(s)	Internal R&D
Occurring	Group 3 - 6 (Group 3 - 4: at the laboratory and industrial scale, Group 5 - 6: at the industrial scale only)
DC sequence(s) /Mechanism	**(M12) "*Transformative* → *Connective* → *Desorptive*"**
(13) The event of acquiring new machinery to achieve the NPD	
External involved actor(s)	Machinery sellers
Internal participation	R&D, Production team, Manager/Executive, Procurement team
OI practice(s)	Supplier involvement, Employee involvement
Non-OI practice(s)	Managerial decision making
Occurring	Group 2, 4, 5 and 6
DC sequence(s) /Mechanism	**(M13) "*Sensing* → *Connective* → *Seizing* → *Connective* → *Desorptive* → *Connective* → *Absorptive* → *Transformative*"**

(1) The Event of Acquiring the External/Internal Opportunities for the NPD

Based on Table 4.36, the underlying mechanisms / DC sequences of **M1.1** and **M1.2** are presented as below:

M1.1 

(in case of no direct actor)

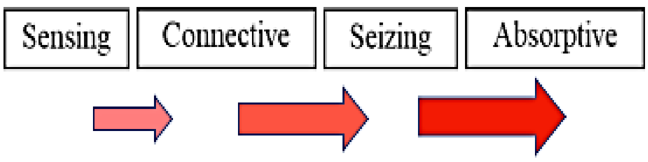
M1.2 

(in case of direct actor involvement)

From the mechanisms / DC sequences, it is found that the managers of the food machinery company had perceived the external market opportunities (e.g., trendy food materials) by sensing, and selecting the appropriate materials for the organization by Seizing through employee involvement practice. The connective capacity implemented from sourcing marketing opportunities was provided by the manager's privilege access to external sources; connections within marketing organizations, distributors and retailers and through customer involvement practices. These mechanisms / DC sequences were found in Groups 1, 2, 4, 5, 6 of OI NPD.

(2) The Event of Acquiring the Ingredient Knowledge to Accomplish the NPD

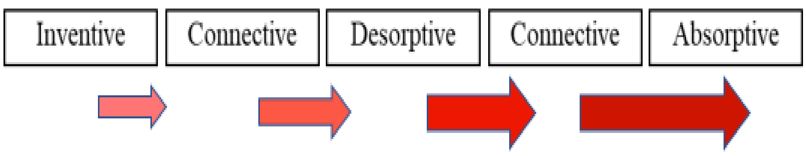
Based on Table 4.36, the underlying mechanism / DC sequence of **M2** is presented as follow:



This mechanism / DC sequence found that the procurement team acquired food ingredients / material knowledge from new suppliers and/or regular suppliers through employee involvement and supplier involvement practices, at both the laboratory and industrial scales. First, the procurement team sensed the pool of suppliers comcerning the required ingredients. The connective capacity was necessary due to the efficiency of supplier databases available. Most of the food machinery companies had developed their databases for accredited suppliers based on factory standards. The procurement team selected the appropriate one for their NPD [Seizing] through both the employee and supplier involvement. Lastly, absorptive capacity was implemented for the absorption of each ingredient knowledge, ingredient specification, minimum order quantity (MOQ) and unit price. For the ingredient's certificate of analysis (COA), the procurement received this document when the actual transaction occured at the industrial scale. In this case, absorption was developed at the individual level (the procurement team act as the knowledge gate) then to the organization level (R&D for the recipe development, and RA for the FDA registration). This mechanism / DC sequence was found in all groups of OI NPD.

(3) The Event of the Internal Prototype Invention and External Sensory Testing

Reflected on Table 4.36, the underlying mechanism / DC sequence of **M3** is illustrated as follow:

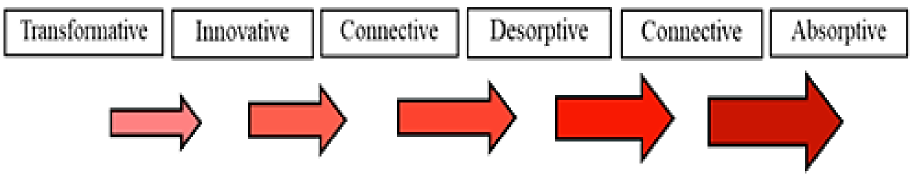


This mechanism / DC sequence found that the food machinery company started with the internal R&D at the laboratory and/or industrial scale [Inventive]. At this stage, the external feedback for the prototype is a critical contribution. The manager conducted and organized the sensory testing [Connective] through employee and customer involvement at both the laboratory and/or industrial scale. The product sample and some of the related knowledge were distributed to the external testers [Disorptive] (the indirect/direct consumers, and/or the group of marketing organizations, distributors and retailers, and/or the food companies). Some new products knowledge for examples, key selling ingredients, new product concepts and/or features needed to be exploited for the testers to understand the new product, allowing for precise feedback and adjustment in return.

The control of knowledge exploitation at this stage is important because the new product idea may leak to the market or competitors. Hence, the interorganizational relationship is considered important. Connective capacity was implemented again to collect feedback from the external testers. Lastly, the absorptive capacity is implemented from the individual level with the manager acting as the knowledge gatekeeper to the organizational level (R&D for the recipe adjustment). This mechanism / DC sequence was found in all groups of OI NPD.

(4) The Event of Acquiring the Related Documents for the FDA Registration

From Table 4.36, the mechanism / DC sequence of **M4** is presented as follow:

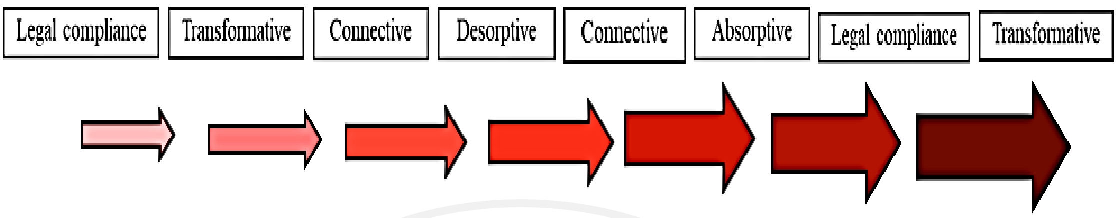


According to this mechanism / DC sequence, it was found that the regulatory affair team (RA) coordinated with the accredited testing laboratories (the regulatory bodies and testing laboratories) to acquire all the required documents for the FDA registration (Nutrition fact / F_0 / Microbial report) through employee involvement and regulatory body involvement practices.

Initially, the industrial scale food recipe was developed and explicitly transformed into a specific format [Transformative]. The new product sample (from the upscaling) and the industrial scale food recipe must be prepared [Innovative] and submitted to the accredited testing laboratories [Connective], for testing results needed for the registration with FDA. Hence, the innovative-Desorptive capacities are implemented together. Appearently, the food machinery companies internally exploited the knowledge to match their organization's invention with the market context (the requirement of FDA number), and this exploitation complemented the internal knowledge application (new product with the documents needed for FDA registration). The connective capacity is also essential to obtain and achieve this. By improving relationships with accredited testing laboratories enables faster testing results. In some occasions, the knowledge of specific testing requirements for new product categories are recommended by the accredited testing laboratories. Absorptive capacity is implemented when the relevant documents for FDA registration are received. This mechanism / DC sequence was found in all groups of OI NPD.

(5) The Event of Acquiring the FDA Number

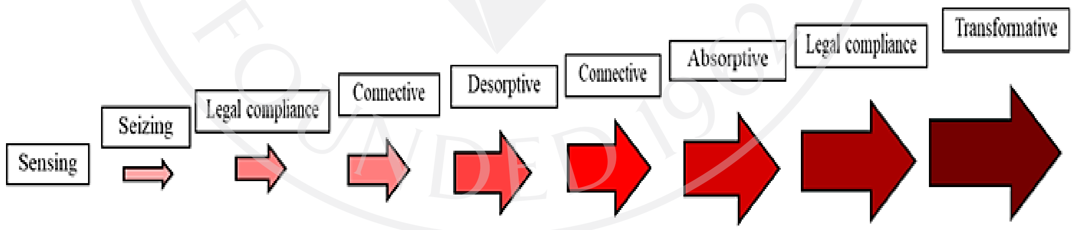
As depicted in Table 4.36, the mechanism / DC sequence of **M5** is presented as below:



This mechanism / DC sequence was found on the occasions when the RA coordinated with the FDA (the regulatory bodies and testing laboratories) regarding the FDA numbers of the company's new products. As FDA only accepted the accredited testing documents (Nutrition fact / F_0 / Microbial report) based on their official format (through both online and offline channels), internal legal compliance and explicit transformative capacities are needed for all inputs to comply with the law. The connective capacity is very important in this context. The better the relationships with FDA staffs become, the faster the company can be granted the FDA approval. This in turns results in less questioning for future new products in the registration process. On occasions the knowledge of specific requirements for new product categories are recommended by the FDA staff. The FDA consideration process usually takes 30-45 working days on average but the maximum period in this research study was advised by interviewee A as 1 year. In this case there were several discussion, Q&A sessions and additional supporting documentation required. Extra product samples and / or additional support documents can be requested by the FDA staffs at any time in the process [Desorptive and Connective]. In some cases, FDA staffs would ask for details of the recipe adjustment, for example concerning the adjusted ingredient ratio of innovative food ingredients or label adjustment to comply with updated laws and regulations. This situation causes the internal R&D team to adjust food recipes to meet legal compliance and transformative capacity. The DC sequence is repeated again until the FDA granted the approval. Acquiring an FDA number is the ultimate aim of this event for the legal commercialization of new products [Absorptive]. Lastly, the internal legal compliance capacity is implemented again by RA team to retain all legal elements documented and kept [Transformative] inside the organization for future audit by FDA. This mechanism / DC sequence was found in all groups of OI NPD.

(6) The Event of Acquiring New Factory/Production License to Legally Produce New Product.

As indicated in Table 4.36, the underlying mechanism / DC sequence of **M6** is presented as below:



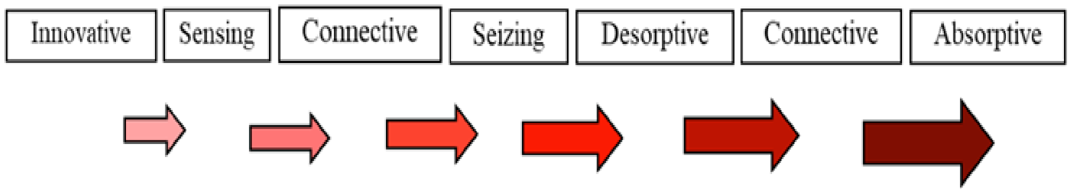
This mechanism / DC sequence emerged every time the food machinery company registered new factory/production licenses covering the scope of a new product. The RA team realized that its food machinery company could not register an FDA number for a new product because its current factory/production licenses did not cover the scope of the new product. In this case, the scope of supplement food for infants and young children aged 6 months to 3 years was beyond the ordinary food production license of SME A, thus internal sensing was applied. The RA, manager and other top management were all involved in selecting an appropriate new scope for the organization [Seizing] through employee involvement. Then the legal compliance capacity was implemented and all new product information and factory/production documents were prepared by RA, and submitted to the FDA [Connective and desorptive] to identify the correct process to make it is the new product compliant.

After receiving the advices from the FDA [Connective and Absorptive], the legal compliance capacity was repeated. All submitting documents were prepared in compliance with the regulations for a new factory / production license scope. Some factory production line adjustments were necessary [Transformative]. This DC sequence was repeated until the factory production line complied and gained approval of the FDA.

Lastly, the RA absorbed this knowledge at an individual level and expanded it to the organization level. This led the production team to adjust the production process to meet the requirements for a new scope. The RA re-submitted the documentation to the FDA, a process that involved several discussions between RA and FDA staffs. After achieving a production license corresponding to new product, the RA transformed the new license and its related documents inside the organization over time [Transformative]. This mechanism / DC sequence was found in Group 4, Group 5 and Group 6 of OI NPDs.

(7) The Event of External Prototype Invention

Illustrated in Table 4.36, the underlying mechanism / DC sequence of **M7** is shown as blow:



This mechanism / DC sequence had been identified when the food machinery company decided to outsource its R&D at the laboratory scale with an external party (food experts and consultant from the university A01). The employee involvement consisted of the manager and the support from internal R&D. The food machinery company had initiated new product idea but the internal R&D process failed because the initial recipe development lacked advanced knowledge. The innovative capacity was detected when the manager had an intention to share his new product idea to the external parties for external R&D. To overcome the company limitations as well as the new stringent product requirements, the manager sought the help from the pool of food experts and consultants [Sensing]. Through the manager's connection [connective], a group of food experts were recommended to the company. The manager was able to appropriately selected a food expert for the NPD [Seizing]. Desorptive- Absorptive capacities were revealed with the exchange of knowledge between food machinery company and the food experts, including the sharing of new product ideas, the organization's limitations, production constraints advised by food experts. The external recipe development was received through the outsourcing R&D practice and inward IP licensing practice. This GM sequence/mechanism was found in Group 2 of OI NPD.

(8) The Event of Providing Sensory Feedback for the External Invention Adjustment

Based on Table 4.36, the underlying mechanism / DC sequence of **M8** is presented as below:

Connective	Absorptive	Innovative	Connective	Desorptive

This mechanism / DC sequence had been witnessed at the sensory testing process of NPD group 2. The food machinery company outsourced its R&D at the laboratory scale with external parties; food experts and consultants, namely the university A01 in this research. This involved part of the outsourcing R&D practice, the employee involvement by the manager, and the support by the internal R&D team. The food expert took responsibility for creating the laboratory scale recipe, and the prototype sample for sensory testing. The food machinery team, on the other hand, tested and provided feedback for the next iteration. The connective capacity took place at the outset with the manager responsibility in organizing the sensory process to facilitate the communication between the external party (food expert) and the internal party (internal R&D as the tester). There was no direct interface between the other parties with the manager acting as the knowledge gate for this NPD event. In the sensory testing process, the prototype sample (together with food recipe, cost, selling point of new product, and new supplier contact) was delivered to the food machinery company for internal sensory testing. Hence, the absorptive capacity prevailed in this case. The innovative – desorptive capacities were implemented together as a result of the food machinery companies internally exploiting the feedback of the prototype, the market preference towards selling points, and the mass production process limitations. This mechanism / DC sequence was found in Group 2 of the OI NPDs.

(9) The Event of Exploitation of the Existing Recipes to the External Party

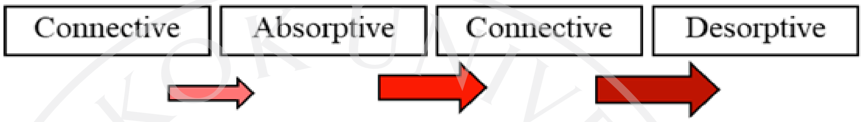
As indicated in Table 4.36, the underlying mechanism / DC sequence of **M9** is shown below:

This mechanism / DC sequence was observed when the food machinery company attempted to introduce its existing food recipe to the potential client (food company) and agreed to start the OEM NPD, through outward IP licensing and customer involvement practices. From the outset, the food machinery company had an organizational strategy for the existing food recipe exploitation [Innovative], as an OEM NPD. The manager did the external sensing for the target food companies and internal sensing for the appropriate existing food recipe. Matching took place and the food manager introduced the OEM NPD project to the food company [Connective]. During this OEM NPD approach, many streams of knowledge were proposed to the food company [Disorptive] including new product ideas, the recipes, selling points and business deals. If the OEM NPD project was accepted by the food company [seizing], the NPD would start. The absorptive capacity came in place with the absorption of each new product requirements including an acceptable unit price, and market preferences for taste and texture. This absorption capacity elevated from individual level (the manager acting as the knowledge gate) to organizational level

(R&D for the recipe development; in the mechanism M3). This mechanism / DC sequence was also present in Group 3 of OI NPD.

(10) In Event of Being Approached with the New Product Idea (and/or the Original Recipe) from the External Party

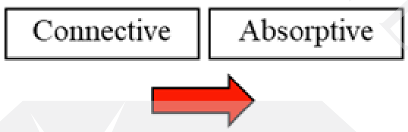
As illustrated in 4.36, the underlying mechanism / DC sequence of **M10** is presented as below:



This mechanism / DC sequence was observed when the OEM clients (the food companies in Group/Pattern 4-5, and as well as the food experts & consultants in Group/Pattern 6. The direct contact the food machinery company for the OEM NPD, came in the form of inward IP licensing and/or insourcing R&D, customer involvement, and employee involvement practices. The connective capacity was applied at the outset. The OEM clients acknowledged the existence of the food machinery company through many channels (for instance via the developed business platforms; the organization website, participation in food exhibitions, and through business connections based on recommendation by other food companies, food experts, and testing laboratories). When the food company was received telephone call and/or email from its networks or contactsindividual absorptive capacity was implemented by the manager by receiving new product ideas and related market trends. Subsequently a formal was conducted [connective capacity] with the food machinery sharing the general NPD protocol [desorptive capacity] including NPD expenditure, technology limitation, involved laws and regulations. Both the food machinery company and the food company then assessed the NPD feasibility and associated risks. The decision to adopt these OEM NPDs was made based on food machinery manager, to research the market demand the for these OEM NPDs by acquiring external and internal opportunities for the NPD. This is a typical mechanism of (M1.2) Connective→Sensing→Seizing. This mechanism / DC sequence was found in Groups 4 to 6 of OI NPD.

(11) The Activity of Receiving the Laboratory Scale Recipe from the External Party

Presented in Table 4.36, the underlying mechanism / DC sequence of **M11** is presented as below:

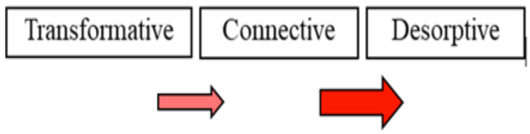


This mechanism / DC sequence was found when a laboratory scale recipe was developed and prepared by an external party as present in Group 5 and 6, and/or the case that the laboratory scale recipe was internally developed by the food machinery company as in Group 3 and Group 4, were delivered to the food company as its asset. Eventually, the food machinery company received the external laboratory scale recipe for the industrial scale NPD.

In this research study, the NPD event involves employee involvement, inward IP licensing, customer involvement, insourcing R&D practices and internal R&D. Connective capacity was implemented to develop the interorganizational relationship from the outset. Since the laboratory scale recipe had already been developed, it was absorbed and build up from individual level (the manager acting as the knowledge gate) to the organizational level (R&D) This mechanism / DC sequence was found in Groups 3, 4, 5 and 6 of the OI NPDs.

(12) The Event of Delivering the Laboratory and/or Industrial Scale Recipe to the External Party

Depicted in Table 4.36, the underlying mechanism / DC sequence of **M12** is illustrated as follow:

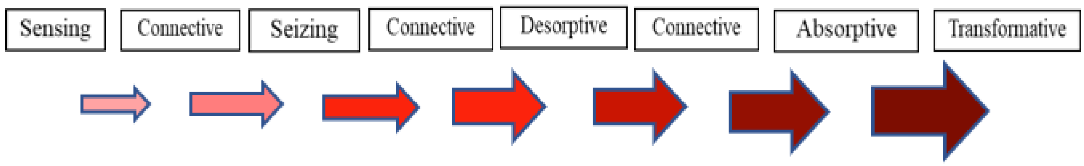


This mechanism / DC sequence occurred when the food machinery company delivered the laboratory/industrial scale recipe to the OEM clients. This occurance was evident in the food company in the Group/Pattern 3, 4 and 5, and/or the food experts & consultants in Group/Pattern 6. OEM clients received the laboratory and/or industrial scale recipe from the food machinery company at the final stage of the customer involvement and/or insourcing R&D practices that approved and received the prototype or new product.

Once, the laboratory/industrial scale recipe was completed in the NPD event of the internal prototype invention, with its underlying mechanism M3, the explicitly transformative capacity was needed to transform all implicit knowledge during the development into documented form and provided to the food company. Take for instance, the laboratory scale documents include the laboratory food recipe and the laboratory scale production conditions. The industrial scale documents include the final food recipe, actual production condition, FDA number report, testing report. Then, the company delivered this explicit knowledge through connective and desorptive capacities. Connective capacity was implemented for the development of customer-supplier relationships. The desorptive capacity was required to exploit all of the new product knowledge to the food company. This mechanism was found in Group 3, 4, 5 and 6 of OI NPDs.

(13) The Event of Acquiring New Machinery to Achieve the NPD

Table 4.36 shows the underlying mechanism / DC sequence of **M13** is presented as below:



When the internal R&D and/or production team discovered the need for new machinery to complete the NPD and mass production of the new product [internal sensing], the procurement team became involved when they started to source and seek the necessary equipment and machinery seller/supplier [External sensing], the team then worked on contacting [Connective] and selecting [Seizing] the machinery seller for the appropriate machine to satisfy new product requirements. They became aware of the limitations of the production facilities with the best cost and selling options. Once the decision to buy the new machine had been made through the supplier involvement practice, the new machinery installation facilitiated the actual production process for the new product [Desorptive]. Many experiments were made during this process. The absorptive capacity was implemented to acquire the related machinery knowledge and the production knowledge. Take for instance, the production process condition setting, safety protocol in the case of unexpected incidents, machinery damage, machinery maintenance and calibration processes. Lastly, transformative capacity was implemented to ensure everything complied with the factory standards, laws and regulations. This mechanism / DC sequence was found in Group/Pattern 2, 4, 5 and 6 of OI NPD.

4.4.6.3 The Generative Mechanism in Each OI NPD Group. As the OI generative mechanism (GM) is the DC mobilized in the OI NPD, the identification of OI GMs needs to be connected to the associated mechanisms / DC sequences that underly the NPD events of food machinery company's NPD favoring OI logics and practices.

The findings from Section 4.4.6.2 and presented in Table 4.36 revealed that 13 NPD events in the actual domain has 14 underlying mechanisms / DC sequences in OI NPDs. These mechanisms were connected and identified in each pattern of the Food-Machinery Flexibility Model in the empirical domain. Hence, the flexible connection of mechanisms / DC sequences underlying each OI NPD pattern revealed the identification of 6 GMs of food OI NPDs in the real domain. In simple terms, these 6 patterns of Food-Machinery Flexibility Model can present the reality of empirical domain (OI logics and practices), actual and real domains (NPD events and Mechanisms). The researcher recurrent data collection for the involved DCs (Section 4.4.6.1), and the NPD events with the underlying mechanisms /DC sequences (Section 4.4.6.2) were based on process repetition in the 4th and 5th interview. The involved DCs, NPD events and their underlying mechanisms / DC sequences that were not categorized serve to enrich previous observations. To do so, the researcher confirmed the existence of OI NPD GM underlying the Food-Machinery Flexibility Model as illustrated in Figures 4.13 to Figure 4.18. The GM of each pattern was confirmed by the validity of the data analyzed and synthesized by the interviewees of SME A and SME B in the fifth interview (SME A for GMs in Group/Pattern 1-6, and SME B for GMs in Group/Pattern 1, 4 and 5). All remarks, clarifications, and accuracy of the interviewees are explained in the summary sections.

Figure 4.13

The GM underlying the Food-Machinery Flexibility Model: Pattern 1

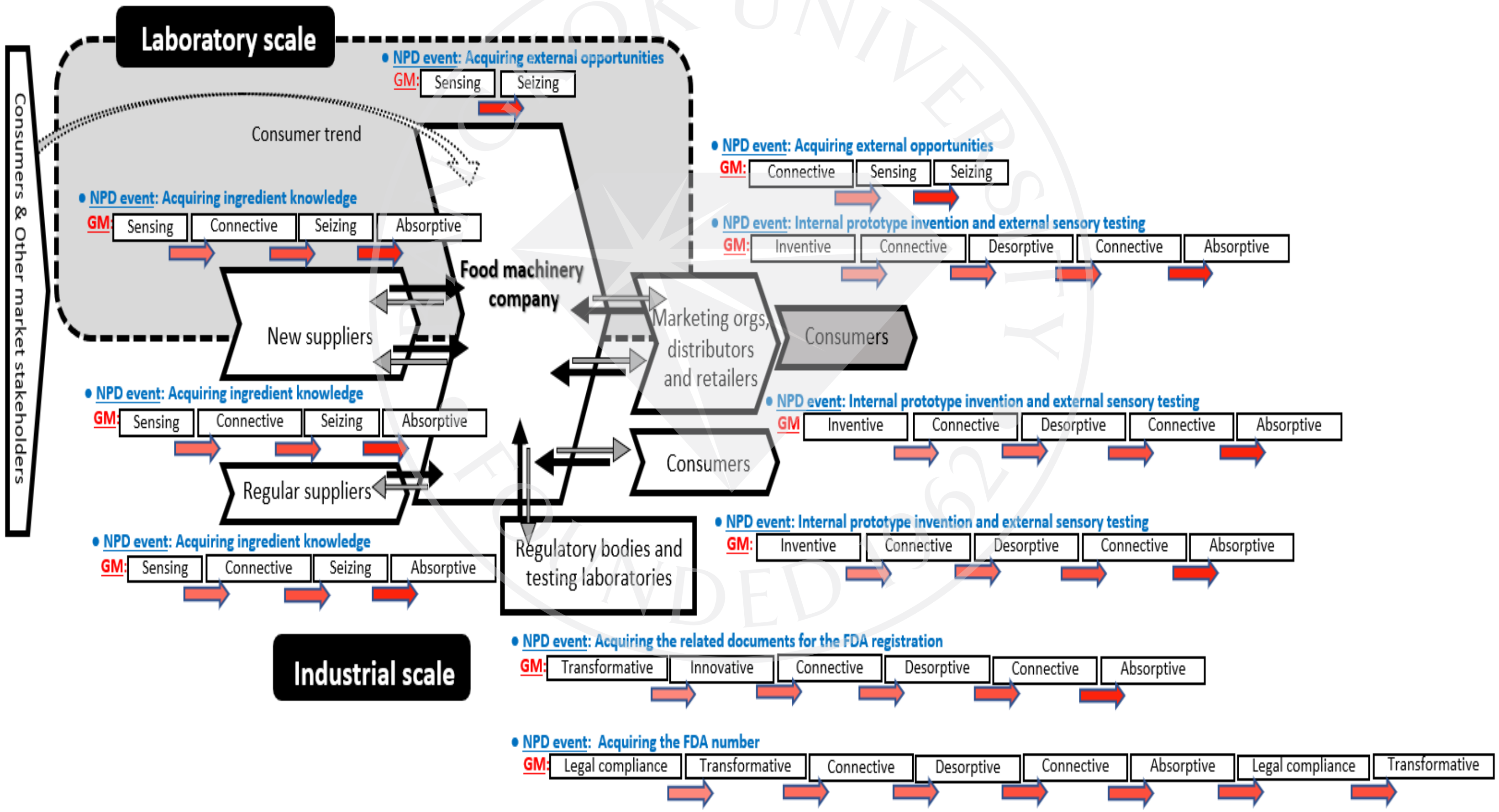


Figure 4.14

The GM underlying the Food-Machinery Flexibility Model: Pattern 2

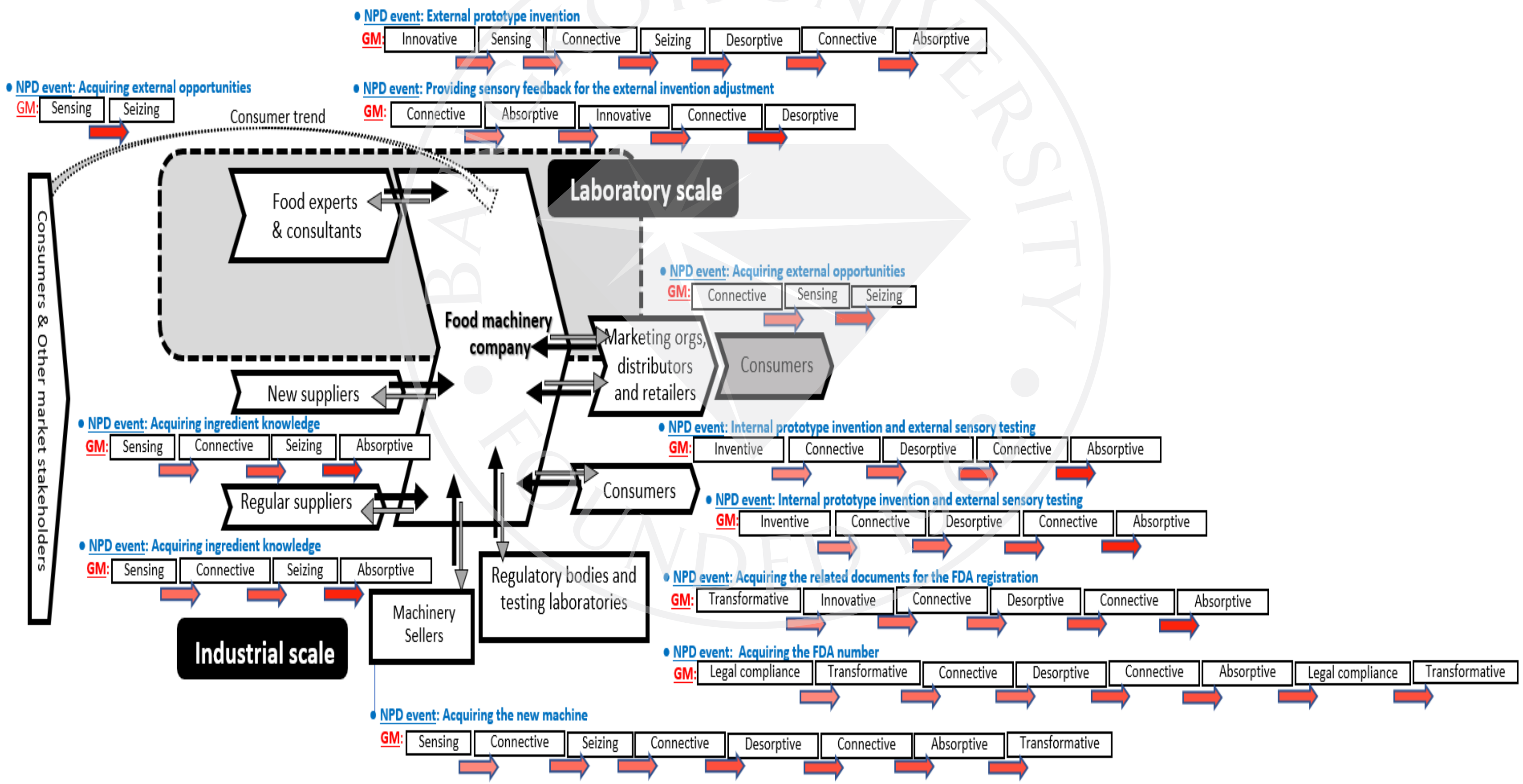


Figure 4.15

The GM underlying the Food-Machinery Flexibility Model: Pattern 3

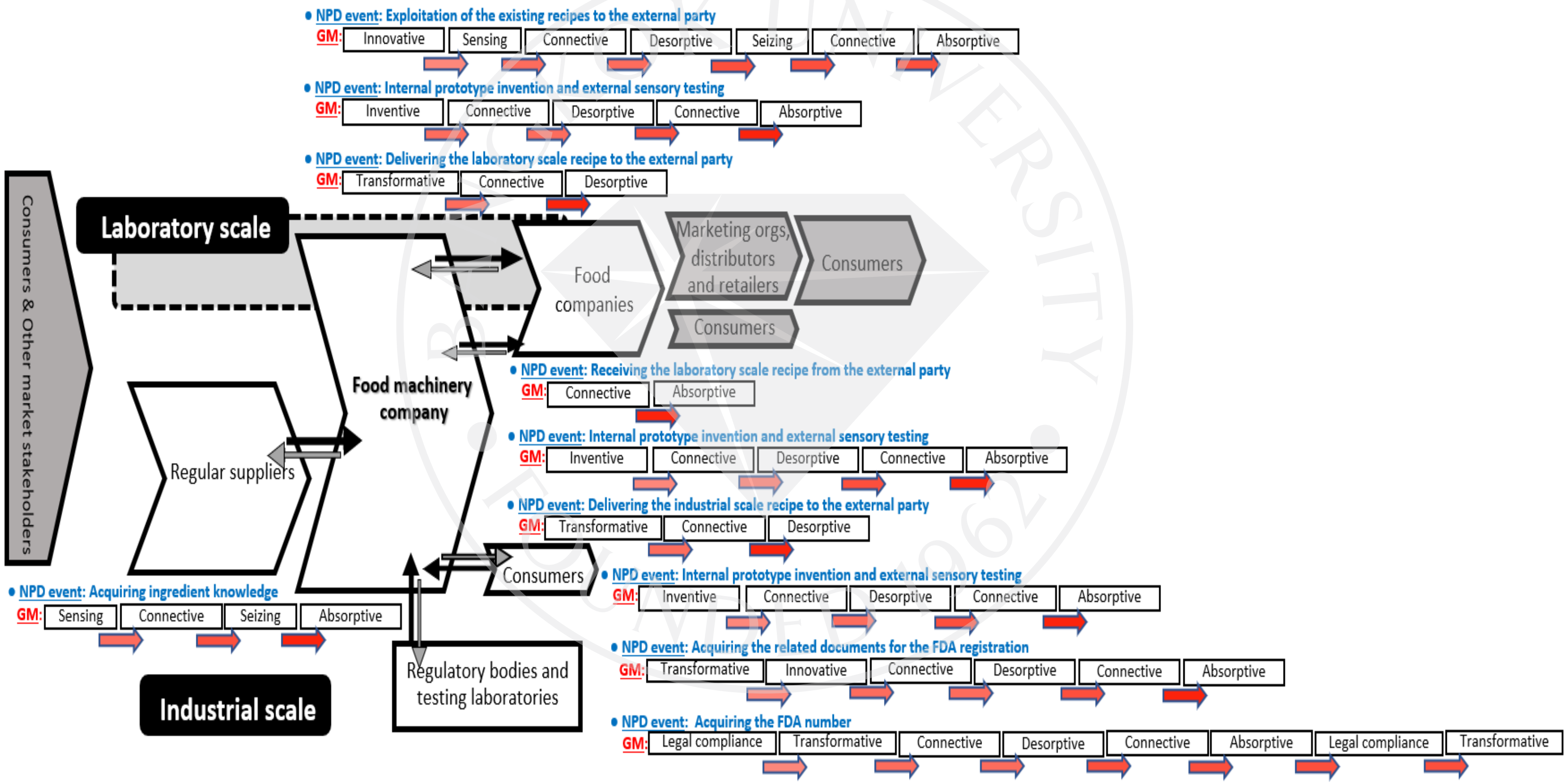


Figure 4.16

The GM underlying the Food-Machinery Flexibility Model: Pattern 4

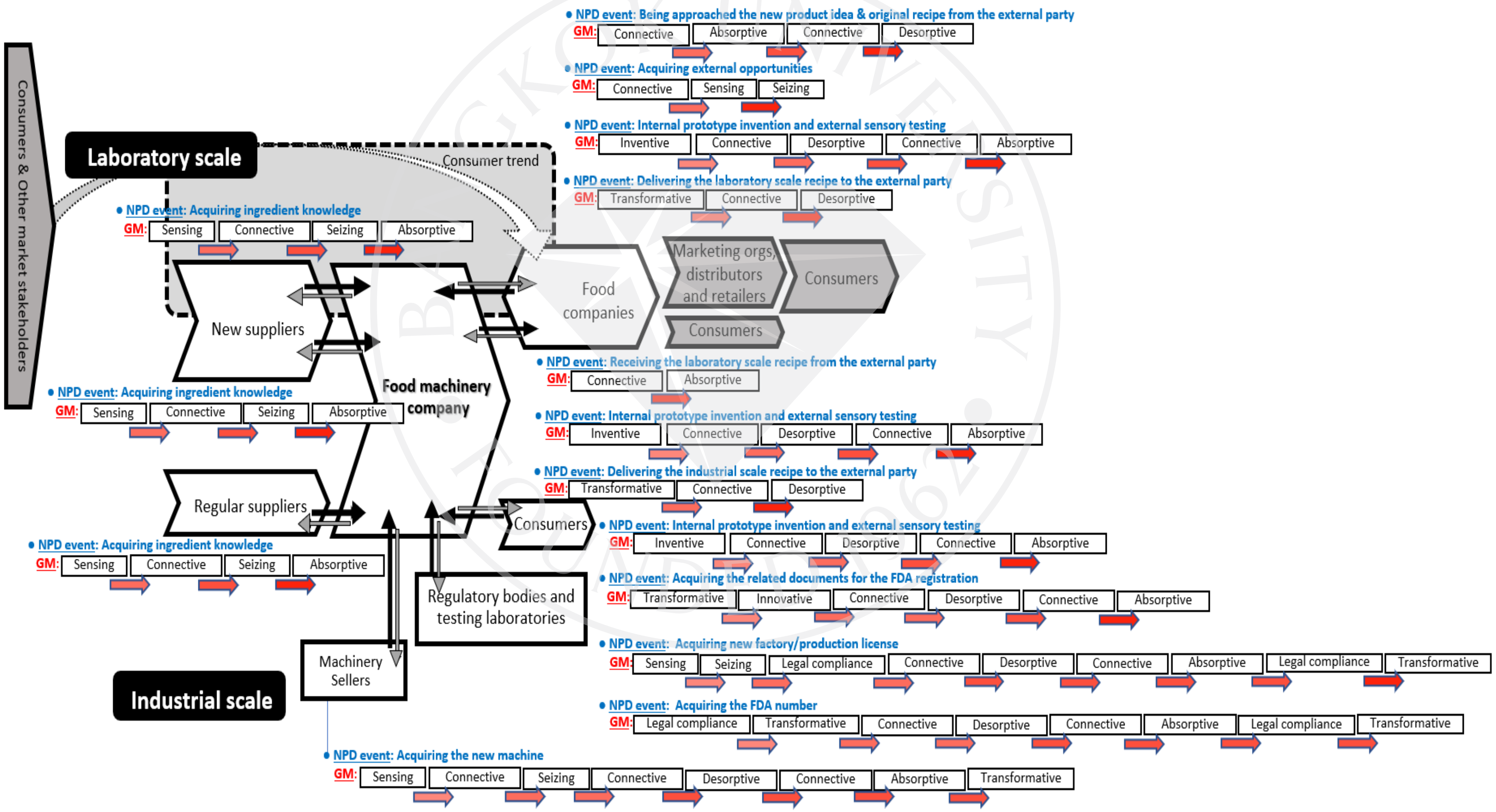


Figure 4.17

The GM underlying the Food-Machinery Flexibility Model: Pattern 5

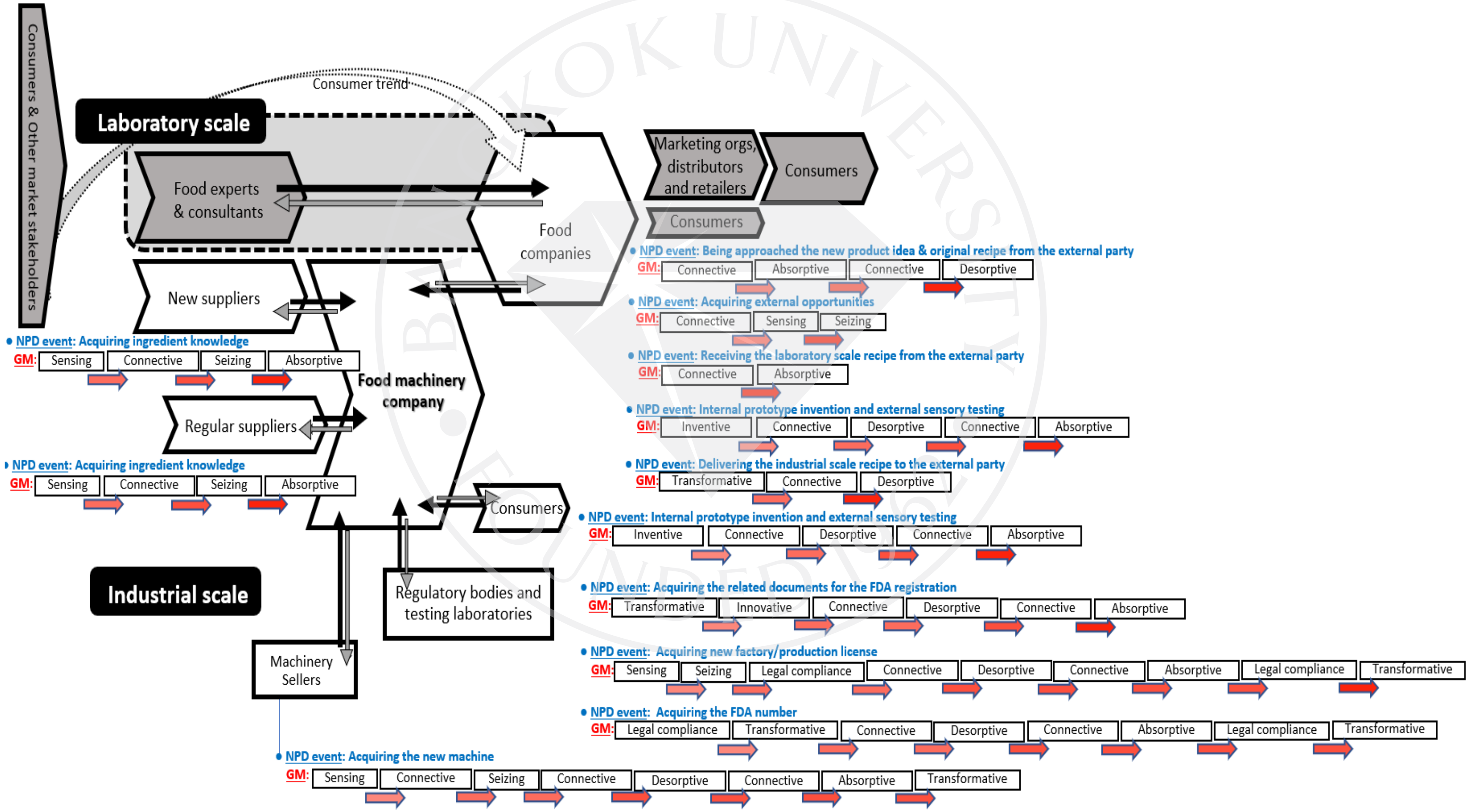
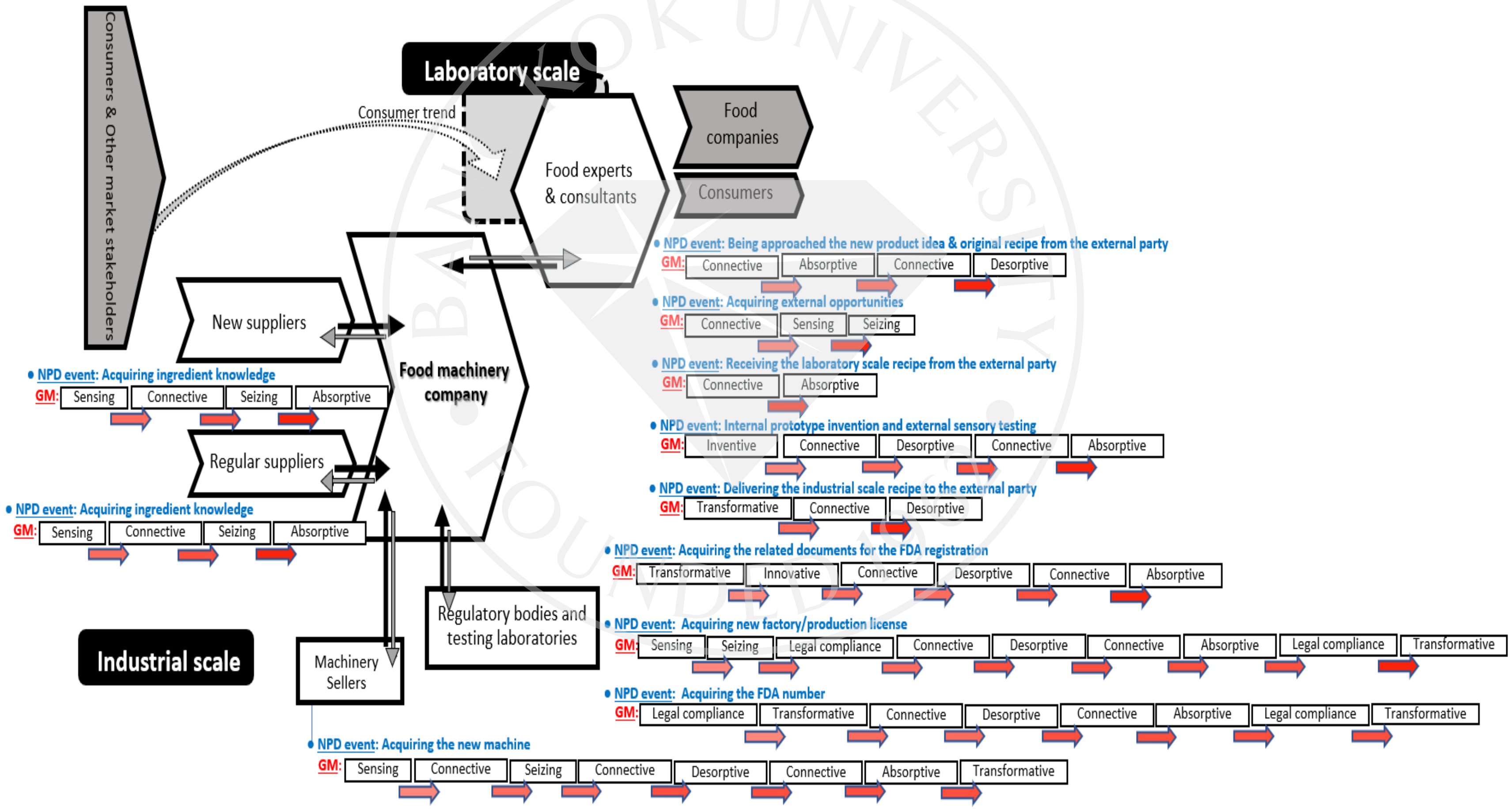


Figure 4.18

The GM underlying the Food-Machinery Flexibility Model: Pattern 6



4.4.6.4 The Summary of OI NPD Generative Mechanisms. Figures 4.12 - 4.18 reveal the GM of each OI NPD group/pattern through the identification of DCs mobilization from the first stage of NPD to the NPD completion at both the laboratory and industrial scale. In total, 6 GMs are underlying within the 6 groups/patterns of OI NPD. Each GM in each group/pattern comprised of vary mechanisms / DC sequences (Table 4.37).

Table 4.37

Six GMs of food OI NPD and their associated mechanisms

6 GMs underlying the 6 patterns of Food-Machinery Flexibility Model		Mechanisms / DC sequences														The initial DC that triggering GM (Trigger factor)
		M1.1	M1.2	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	
Group 1: 13 projects (Case A01-A10, B15-B17)	**GM1:** the food machinery company's NPD with its recipe.	✔	✔	✔	✔	✔	✔	-	-	-	-	-	-	-	-	Sensing
Group 2: 2 projects (Case A11-A12)	**GM2**: the food machinery company's NPD with the food expert's recipe.	✔	✔	✔	✔	✔	✔	-	✔	✔	-	-	-	-	✔	Sensing
Group 3: 11 projects (Case A13-A23)	**GM3:** the food company's NPD with the food machinery company's recipe.	-	-	✔	✔	✔	✔	-	-	-	✔	-	✔	✔	-	Innovative capacity
Group 4: 44 projects (Case A24-A55, B01-B12)	**GM4**: the food company's NPD with its recipe	-	✔	✔	✔	✔	✔	✔	-	-	-	✔	✔	✔	✔	Connective capacity
Group 5: 34 projects (Case A56-A87, B13-B14)	**GM5:** the food company's NPD with the food expert's recipe.	-	✔	✔	✔	✔	✔	✔	-	-	-	✔	✔	✔	✔	Connective capacity
Group 6: 5 projects (Case A88-A92)	**GM6:** the food expert's NPD with the food expert's recipe.	-	✔	✔	✔	✔	✔	✔	-	-	-	✔	✔	✔	✔	Connective capacity

As shown in Table 4.37, there are similarities and differences among GMs based on the nature of the implemented mechanisms that underly each OI NPD group.

1) The mechanisms/DC sequences M2, M3, M4, and M5 applied to all GMs (GM1-6), as they are the causal powers that operate general (necessary) NPD events. Take for instance, the event of acquiring the ingredient knowledge to accomplish the NPD, the event of the internal prototype invention and external sensory testing, the event of acquiring the related documents for the FDA registration, the event of acquiring the FDA number. This suggests the involvement of OI practices; supplier involvement (inward ingredient fitness), customer involvement, regulatory body involvement, and employee involvement are the main OI practices of all investigated food NPD GMs.

2) The mechanism / DC sequence M1.1 applies to own brand NPD only (GM1 and GM2), as it is the causal power that operates the event of acquiring the external opportunities from the marketplace without the direct involvement of external actors, while the OEM NPD does not have mechanism M1.1. This suggests the importance of the associated OI practice of employee involvement by the manager.

3) The mechanisms / DC sequences M7 and M8 apply to GM2 only, as they are the causal powers that operate the event of the external prototype invention, and the event of providing sensory feedback for the external invention adjustment. This suggests the importance of the associated OI practice of outsourcing R&D in GM2.

4) The mechanism / DC sequence M9 applies to GM3 only. It is the causal power that operates the event of exploitation of existing recipes to external parties. This highlights the significance of the associated OI practice of outward IP licensing and customer involvement in GM3.

5) The mechanism / DC sequence M1.2 applies to all GMs except GM3, as it is the causal power that operates the event of acquiring the external opportunities with direct involvement of external actor. This suggests the involvement of OI practices; customer involvement and employee involvement by the manager. However, the acquiring external opportunities in GM3 need more complex mechanism, namely M9, to complete this event.

6) The mechanism / DC sequence M10 applies to GM4, GM5, GM6 (mainly found in the OEM NPDs, except GM3). The mechanism represents the causal power that operates the event of being approached with a new product idea (and/or the original recipe) by the external party. This suggests the associated OI practice of inward IP licensing and customer involvement in GM4 to GM6.

7) The mechanisms / DC sequences M11 and M12 apply to OEM brand NPD only (GM 3 - GM6), as they are the causal powers that operate the event of receiving the laboratory scale recipe from the external party, and the event of delivering the laboratory and/or industrial scale recipe to the external party. This suggests that the associated OI practice of customer involvement is critical OI practice to GM3 to GM6

8) The mechanisms / DC sequences M6 and M13 apply to the specific NPD event; the event of acquiring new factory/production licenses to legally produce new products (Only case A24, A25 and A26 in GM4, case A87 in GM5, and case A92 in GM6), and the event of acquiring the new machine to accomplish the NPD (Case A11 and A12 in GM2, Case A30, A31, A39, A40, and B12 in GM4, Case A81 and A82 in GM5, and Case A88 in GM6). This suggests that the associated OI practices, the regulatory body involvement (new factory/production license registration) and

supplier involvement (inward machinery fitness) are critical OI practices to achieve some NPDs, but not to the general one. The study also illustrates that only SME A has mechanism M6 (the mechanism for acquiring new factory/production licenses to legally produce new products) while SME B has none. This outcome shows that DCs development of SME A over SME B becomes the core competency of SME A to legally produce more product categories than SME B.

In this research study, mechanisms (M6 and M13) were mainly found in the OEM NPD. This was due to the fact that the majority NPDs of SME A and SME B were OEM NPDs. The researcher strongly believes that it is possible to find these mechanisms in other OI NPD groups in other food machinery companies. However, further study on this matter is needed.

9) The initial DC of the first mechanism that mobilized the entire DC sequences is considered the triggering factor (TF) of the GM. Each GM has different TF depending on the nature of OI NPD. That is "*Sensing*" is the TF of GM1 and GM2 as the nature of own brand NPD is to sense the market opportunities, "*Innovative capacity*" is the TF of GM3 as the nature of exploitation NPD to internally exploit its existing knowledge, and "*Connective capacity*" is the TF of GM4 to GM6 as the nature of OEM brand NPD is to be approached and contacted by the external parties.

10) In respect of a GM comparison between the SME A and SME B, SME A applied more OI NPD groups than SME B. This results in SME A having more GMs than SME B (SME A: GM1-GM6, and SME B: GM1, GM4, and GM5). However, it does not conclude that SMEB has less flexibility of GMs execution in their OI NPD, compared with SME A. The researcher found the other factors that affected this comparison results were the organization strategy in that SME B just adopted the own

brand NPD strategy in 2019, while SME A adopted this strategy since they began trading in 2012. This caused 2 own brand NPD GMs for SME A, and 1 own brand NPD GM for SME B. Secondly the different periods of business operation meant SME B had less experience and orientation in the OI NPD pattern than SME A, and so GMs implementation.

For an improved comparison, only the OI NPD groups that both SMEs have applied (GM1, GM4, and GM5) are included. However, the objective of this research study is to reveal the GMs underlying the OI NPD only. Hence, this comparison should be explored in the future research.

4.5 Chapter Summary

This chapter discusses the data collection and analysis of the study. Following the introduction, the second section discusses data sampling. Purposive sampling (Campbell et al., 2020; Klar & Leeper, 2019) was adopted for the 2 investigated food machinery SMEs. SME A and SME B were selected from the Thai FI network. The Food & Beverage Manager of SME A and General Manager of SME B were choosen to represent their organizations and be interviewed on behalf of the company. A total of 109 NPDs (92 NPDs from SME A, 17 NPDs from SME B) were selected with the criteria that they must be commercialized NPD cases and achieved FDA approval, involved external actors, as well as having OI logics and practices.

The third section discusses the results of data collected from the 5 rounds of semi-structured individual interviews with the executives of the 2 Thai food machinery SMEs. Implicit and explicit information were collected from the 109 NPDs. The data were double-coded, and analyzed.

The fourth section presents the findings of the research study which comprises several sub-sections.

1) To categorize OI NPD, 6 groups of OI NPD were included following the creation of the original recipe and the IPR of new products as the criteria. 92 NPDs of SME A were categorized in Group 1 to Group 6, while 17 NPDs of SME B were categorized in Group 1, Group 4, and Group 5.
2) In the investigated OI NPDs 10 actors were identified through the study: 1) food machinery company, 2) food company, 3) food experts & consultants, 4) consumers, 5) other market stakeholders, 6) group of marketing organizations, distributors, and retailers, 7) new suppliers, 8) regular suppliers, 9) regulatory bodies & testing labs, and 10) machinery sellers.
3) For OI logics in the investigated OI NPDs, 3 types of OI logics (Enkel et al., 2009; Hongsaprabhas et al., 2018; Lichtenthaler, 2008) were identified through coupled OI logic with inbound dominance, coupled OI logic with outbound dominance, and no OI logics.
4) 8 OI practices were identified through the study. Of these practices, 5 were mentioned by Van de Vrande et al's (2009) typology. These 5 practices include employee involvement, outward IP licensing, customer involvement, outsourcing R&D, and inward IP licensing. While three of OI practices were absent from the Van de Vrade et al's (2009) typology; venturing, external networking, and external participation. Moreover, three of the new OI practices found in study were insourcing R&D, supplier involvement, and regulatory body involvement.

5) To synthesize the Food-Machinery Flexibility Model, the researcher used the data collected (10 involved actors, 3 OI logics and 8 OI practices) at the laboratory scale and industrial scale (which have not been mentioned in literature before), to enhance the findings of Bigliardi and Galati (2013). Six patterns within the same model were presented. The variety of patterns show the applicable OI NPD implementation of the investigated food machinery SMEs. These findings confirmed the existence of the food machinery company's role in the OI NPD as the innovation intermediary company. Furthermore, the flexibility of 6 OI NPD patterns utilization are presented in this study. This section demonstrated the OI NPD of the food machinery company in the empirical domain in the CR perspective (Bhaskar, 2013; Danermark et al., 2019).
6) For the OI NPD generative mechanism, 9 DCs were identified as active factors to sustain and maintain OI logics and practices of the investigated NPDs. Two Teece's (2007; 2020) DCs were present in this study, sensing and seizing. Six Lichtenthaler & Lichtenthaler's (2009) DCs were supported in this study; inventive capacity, transformative capacity, innovative capacity, absorptive capacity, connective capacity, and desorptive capacity. One of the new DCs found in this current research was legally compliance capacity. Hence, the GM of OI NPD was concluded as the mobilization of associated DCs in food OI NPD.
7) The specific sequences of DCs were used to identify the specific mechanism underlying the specific NPD events. The result showed 14 mechanisms (DC sequences) underlying 13 NPD events in this study.

8) Finally, these identified mechanisms were connected and proven within 6 patterns of the Food-Machinery Fleibility Model, to demonstrated the GM of food OI NPD. This section proved the OI NPD of the food machinery company in the actual and real domains from the perspective of Critical Realism (Bhaskar, 2013; Danermark et al., 2019).

CHAPTER 5

CONCLUSION AND DISCUSSION

5.1 Introduction

The extant literature revealed no academic research in explaining why some Thai FI SMEs have efficaciously adopted OI approaches. There has yet any studies in the identification of OI generative mechanism in this context. The results of this research study presented the existence of generative mechanisms favoring OI logics and practices implementation in the investigated Thai Food machinery SMEs, through revealing the involved actors, OI logics & practices in the empirical domain, and revealing the real domain by identificating connected DCs sequences / connected mechanisms that mobilized OI NPDs.

This chapter provides conclusive answers for each research question, discussions and recommendations to the food machinery company, along with the major theoretical and practical implications derived from the findings in the previous chapter. Following the research conclusions, the limitation of the study and the direction for future research will be discussed.

The structure of this chapter starts with the introduction to the chapter. the second section, presents the results of the findings to answer the research questions. In the following sections, the details of each finding are discussed based on main research questions. The next section discusses the implications for theories and practices perspective. Limitation of the study are also discussed in the next section, In the last section, the researcher provides directions for future research in the field.

5.2 Conclusion and Discussion from Results of Research Questions

5.2.1 Conclusions and Discussions from Results of Research Question 1

RQ1: Which types of actors are involved in Thai food machinery SMEs OI NPD processes? What relationships and roles actors have assumed in elaborating OI NPDs with the Thai food machinery SMEs?

Since the extant literature showed a lack in the specification for the nature of the actors involved in OI NPD studies, especially in a Thai FI context, this research focuses on the food machinery company as the focal actor of OI NPDs. The food machinery company plays an important actor in Thai FI, to transform the agricultural ingredients into food processing products. Importantly, the involvement in the food OI NPDs critically affect the economy of the Thai FI.

In this study, nine types of actors were identified involving the OI NPD of the food machinery company with the different roles and relationships. The list of 9 actors are as follows:

1) Food company
2) Food experts & consultants
3) Consumers
4) Other market stakeholders
5) The group of marketing organizations, distributors, and retailers
6) New suppliers
7) Regular suppliers
8) Regulatory bodies & testing laboratories
9) Machinery sellers

From a knowledge management perspective, their common role for the OI NPD is the sourcing of different knowledge needed for recipe development until the new product is completed. This include the sourcing of original recipe knowledge and developed recipe knowledge provided by the food companies (NPD Group 4 and Group 5), and food experts & consultants (in NPD Group 2 and Group 6); the source of new product idea provided by consumers, other market stakeholders, and the group of marketing organizations, distributors and retailers (NPD Group 1 and Group 2); the source of ingredient knowledge provided by the new suppliers and regular suppliers (in all groups); the source of law and regulation knowledge provided by the regulatory bodies & testing laboratories (in all groups); and the source of new machinery knowledge needed in the NPD which provided by the machinery seller (in Group 2, 4, and 5). Hence, the relationships between food machinery SMEs and each actor can be identified through the direction of knowledge flow (OI logic) and the activities that needed to operationalize OI logics (OI practice).

Beside the role of new knowledge creation (internal R&D at the laboratory scale and/or industrial scale), the food machinery company also takes responsibility to organize and orchestrate the whole knowledge flow of OI NPD to grow this new product offering, by combining the external knowledge with the internal knowledge. Hence, the innovation intermediary characteristic is detectible. Moreover, the conclusions from result for RQ1 show the initial information to structure the NPD model synthesis (in the empirical domain) and OI GM identification (in the real domain).

5.2.2 Conclusions and Discussions from Results of Research Question 2

RQ2: What OI logics and practices are implemented in the Thai FI machinery SMEs OI NPD processes?

The extant literature shows a lack of study of OI logics and practices in the Thai FI SMEs researched. Moreover, there is no specification for the nature of knowledge flowing in OI studies in this context. Hence, the flow of food recipe knowledge (Stewart-Knox & Mitchell, 2003) was chosen as the studied knowledge. Because it is the only knowledge flow that regularly exchanged among actors in the value chain, and has been transferred with the dynamic evolve among actors since the first step of NPD, laboratory scale and industrial scale, FDA registration, mass production, and delivery to end consumers on the packaging label (ingredient content). The origin of the food recipe (recipe creator) becomes the main strategic driver for the choice of OI logics and practices implemented. This research study demonstrates the importance of following the exchange knowledge flows associated with each recipe. To our knowledge, this type of approach has never been described before in OI studies.

As this research study follows only the development of one specific knowledge type (food recipe knowledge), it is a more practical observation that the direction of knowledge flow (OI logic) inbound or outbound is considered by the food machinery company as the focal firm. It is also much practical to identify only OI practice used for operationalization of the development of food recipe knowledge, and to compared with other OI studies in the literature.

For OI logics. Three types of OI logics have been identified involving the OI NPD of the investigated food machinery companies; coupled OI logic with outbound dominance, coupled OI logic with inbound dominance, and no OI logic.

The extant literature has shown only 3 types of OI logic which are inbound OI, outbound OI, and coupled OI logic (Chesbrough et al., 2006; Enkel et al., 2009; Lichtenthaler, 2008). However, there is no study that considered the dominance of the flow in coupled OI logic in the context of Thai FI SMEs. This current study found there is no absolute outbound and inbound OI, the coupled OI logic with the dominance characteristic of outbound and/or inbound is more accurate to the study context. To understand the reason behind this, the researcher looked for evidences from the interviews to observe the knowledge flow and discovered that the flow of knowledge is always a two-way flow of exchanges between the external actors and the food machinery company at varying degrees.

In addition, the extant literature shows none of OI logic study in the NPD context of laboratory scale and industrial scale in the Thai FI SMEs. The result of this current study has demonstrated the ability of the investigated food machinery companies to adjust their OI logic to the nature of each NPD and to switch from one logic to another. Most of the NPDs implied that they have adopted coupled OI logic with inbound dominance at both scale (NPD Group 1, 2, and 4). However, some NPDs implied the different OI logics between NPD scale. Take for instance, NPD Group 3 claimed coupled OI logic with outbound dominance in the laboratory scale but inbound dominance in the industrial scale. As for NPD Group 5 and Group 6, there were no implication of OI logic in the laboratory scale but coupled OI logic with inbound dominance in the industrial scale. To the researcher's knowledge, such a high level of agility in managing different types of knowledge have not been reported in the FI SME literature on OI.

For OI practices. Eight types of involvement were identified through the study. This involvement comprises of employee involvement, outward IP licensing, customer involvement, outsourcing R&D, inward IP licensing (Van de Vrande et al., 2009), insourcing R&D, supplier involvement, and regulatory body involvement.

The extant literature shows the lack of empirical characterization of OI practices which occur in FI SMEs context (Usman et al., 2018). Most of the OI studies in food SMEs adopted the typology of Van de Vrande et al (2009) that identified SMEs' OI practices being connected to the technology exploitation (exploitation practices / outbound practices) and technology exploration (exploration practices / inbound practices). However, no research studies were found for the empirical characterization of OI practices mobilized in the coupled OI logics in the Thai FI SME. This research study found that there is no absolute outbound and inbound logics. Subsequently, all the OI practices always operationalize the exchanging of 2 directions of food recipe knowledge between the involved actors.

Hence, the researcher concluded that coupled OI logic with outbound dominance connected to the exploitation practices (outbound practices), and coupled OI logic with inbound dominance connected to the exploration practices (inbound practices), are more accurate in the studied context. Moreover, the researcher found 2 of Van de Vrande et al's (2009) OI practices, namely customer involvement and employee involvement having an ambidexterity characteristic. They can be either develop exploitation practice or exploration practice depending on the nature of the involved NPDs. The original customer involvement from Van de Vrande et al (2009) identified as an exploration practice. However, the current study presented that the customer involvement in NPD Group 3 is considered exploitation practice while exploration practice in the rest of NPD groups. Contrary to the original employee involvement of Van de Vrande et al's (2009) typology, which identified as the exploitation practice at the intra-organization level, the majority of employee involvement in this study is considered as exploration practice at the inter-organizational level. Only the employee involvement in the NPD Group 3 is considered exploitation practice while considering exploration practice in the rest of the NPD groups. This explains why the ambidexterity characteristic comes from the nature of NPDs. If these practices involved in exploitation NPD (Group 3), they act as the exploitation practice, and vice versa.

This current study did not find the existence of the 3 OI practices cited by Van de Vrade et al's (2009). These 3 OI practices consist of venturing, external participation, and external networking. The researcher believed that these practices could be found in other Thai FI SMEs. This opinion is based on the perspective of interviewee A. However, venturing and external participation practices are more involved in the business co-operation and/or open business strategy rather than the recipe development in the food NPD process.

On the other hand, this current study argues that the external networking (Van de Vrande et al., 2009) has a broad definition, drawing on/or collaborating with the external network partners to support the innovation processes. By this definition, all other OI practices are external networking. So, the researcher did not include the external networking practice into this study.

However, three new practices have been added to Van de Vrande's et al. (2009) typology and defined according to recurrent observations; insourcing R&D, supplier involvement, and regulatory body involvement. Among the new findings for OI practices in this study, the regulatory body involvement deserves special attention as it seems to have potential effect on the enhancement in this particular area. Many academics and practitioners reckon that R&Ds has been neglected in the FDA related activity, resulting in their new food product not being able to be registered for an FDA number. The FDA registration process has been identified as a barrier to food NPDs for a long time (Chaochotechuang, 2016; Hongsaprabhas, 2017b; Saigosoom, 2012). As a matter of fact, little attention has been in theorizing these FDA-barriers, dynamic update laws and regulations, and related practices for the implementation and empirical investigations.

Furthermore, the extent literature has shown no OI practices study in the NPD context in laboratory and industrial scale in the Thai FI SMEs. The amount of OI practices attached to coupled OI logics at the industrial scale is always higher as compared with the laboratory scale. This situation is explained by the greater diversity of actors and activities required to achieve the optimization of a new food recipe mass production process. The results from this current study also demonstrated the ability of the investigated food machinery companies to constantly adapt their associated OI practices to the NPD requirements.

5.2.3 Conclusions and Discussions from Results of Research Question 3

RQ3: What generative mechanisms favor OI logics and practices implementation in the Thai Food machinery SMEs?

Since the extant literature shows no study has identified OI GMs in the NPDs of Thai FI SMEs, the ultimate objective of this study aims to identify the causal powers / generative mechanisms favoring OI logics and practices implementation in the Thai FI SMEs from a critical realistic perspective.

To achieve this goal, the researcher adopted CR epistemology (Bhaskar, 2013; Danermark et al., 2019) to reveal the reality in 3 domains. Through 5 rounds of semi-structured interviews with 2 executives in two Thai food machinery SMEs, and the analysis of 109 food NPDs observations enable the establishment of patterns that will again be confronted with reality through new observations in each round of interviews (Blom & Morén, 2011).

The knowledge of reality in the empirical domain. On the 3 domains of reality from a CR perspective (Bhaskar, 2013), the knowledge of reality in the empirical domain is based on observations, while the actual and real domain do not reveal themselves only through observation. Hence, the empirical phenomena of this current study were the involved actors, OI logics and practices of food machinery company's NPD. The researcher has revealed the empirical objects through the answer of RQ1 (the identification of OI NPD actors) and RQ2 (the identification of OI logics and practices).

Since the extant literature also shows no specific OI framework proposed in the Thai FI SMEs, the researcher therefore deployed 9 involved actors, 3 OI logics, and 8 OI practices of 109 collaborative NPDs to characterized by the Food-Machinery framework (Bigliardi & Galati, 2013a; Bigliardi et al., 2010). This model formed the basis of the study. All research findings were connected to synthesize the Food-Machinery Flexibility Model, and revealed six distinctive patterns within the same model. Each NPD patterns required the implementation of different involved actors, OI logics and practices.

This finding also confirmed the existence of an innovation intermediary role of the food machinery company in the food OI NPD. However, the specific OI practices associated with each OI logic became the initial element (in the empirical domain) that revealed some of the generative mechanisms required to efficaciously apply OI strategies in a Thai food SME.

The knowledge of reality in the actual domain. As this current research is based on a CR perspective (Bhaskar, 2013), the findings of RQ1 and RQ2 become a reality in the empirical domain. The connection of the involved actors, OI logics and practices toward OI NPDs were analyzed and synthesized in the Food-Machinery Flexibility Model as one version of realities among others. However, the OI GM could not be perceived by human sense, because it is the mechanism underlying the event of food machinery companies towards OI NPDs. Hence, the researcher had to explore the entire events in NPDs to reveal the actual domain. Thirteen NPD events were identified through the summarized answers of RQ1.2, are as follows:

1) in the event of acquiring the external/internal opportunities for the NPD
2) in the event of acquiring the ingredient knowledge to accomplish the NPD
3) in the event of the internal prototype invention and external sensory testing

4) in the event of acquiring the related documents for the FDA registration
5) in the event of acquiring the FDA number
6) in the event of acquiring a new factory/production license to legally produce a new product
7) in the event of the external prototype invention
8) in the event of providing sensory feedback for the external invention adjustment
9) in the event of exploitation of the existing recipes to the external parties
10) in the event of being approached the new product idea (and/or the original recipe) by the external party
11) in the event of receiving the laboratory scale recipe from the external party
12) in the event of delivering the laboratory and/or industrial scale recipe to the external party
13) in the event of acquiring new machinery to achieve the NPD

These 13 NPD events encompassed the relationship of both observable and unobservable factors for non-OI practices. Some of the examples are internal R&D practices, external development, marketing/business practices, and managerial decision making underlying the empirical OI practices and the involved actors. Each of these NPD events occur when its associated causal power / mechanism operates. This is the second domain that needed to identify the OI generative mechanism associated with NPDs.

The knowledge of reality in the real domain. The OI generative mechanism (GM) is the causal power that could not be perceived by human sense. This is because it is the mechanism underlying the NPD events of food machinery companies toward the OI NPD. To reveal the OI GM that produced changes in the OI NPDs, the factors that activated the ability of Thai food machinery SMEs to implement OI logics and practices must be explored (RQ 3.1). Nine DCs were identified as the active factors in this research study. These are sensing, seizing (Teece, 2007; 2020), inventive capacity, transformative capacity, innovative capacity, absorptive capacity, connective capacity, desorptive capacity (Lichtenthaler & Lichtenthaler, 2009), and legally compliance capacity.

Then specific sequences of DCs were used to identify the specific mechanism attached to the specific NPD event (RQ 3.2). The findings showed 14 DC sequences (mechanisms) attached to 13 NPD events in this study. These mechanisms are as follows:

1) Mechanism (M1.1) "Sensing→Seizing" attached to NPD event (1)
2) Mechanism (M1.2) "Connective → Sensing → Seizing" attached to NPD event (1)
3) Mechanism (M2) "Sensing → Connective → Seizing → Absorptive" attached to the NPD event (2)
4) Mechanism (M3) "Inventive → Connective → Desorptive → Connective → Absorptive" attached to the NPD event (3)
5) Mechanism (M4) "Transformative → Innovative → Connective → Desorptive → Connective → Absorptive" attached to the NPD event (4)
6) Mechanism (M5) "Legal compliance → Transformative → Connective → Desorptive → Connective → Absorptive → Legal compliance → Transformative" attached to the NPD event (5)

7) Mechanism (M6) "Sensing → Seizing → Legal compliance → Connective → Desorptive → Connective → Absorptive → Legal compliance → Transformative" attached to the NPD event (6)

8) Mechanism (M7) "Innovative → Sensing → Connective → Seizing → Desorptive → Connective → Absorptive" attached to the NPD event (7)

9) Mechanism (M8) "Connective → Absorptive → Innovative → Connective → Desorptive" attached to the NPD event (8)

10) Mechanism (M9) "Innovative → Sensing → Connective → Desorptive → Seizing → Connective → Absorptive" attached to the NPD event (9)

11) Mechanism (M10) "Connective → Absorptive → Connective → Desorptive" attached to the NPD event (10)

12) Mechanism (M11) "Connective → Absorptive" attached to the NPD event (11)

13) Mechanism (M12) "Transformative → Connective → Desorptive" attached to the NPD event (12)

14) Mechanism (M13) "Sensing → Connective → Seizing → Connective → Desorptive → Connective → Absorptive → Transformative" attached to the NPD event (13)

Finally, the identified mechanisms above were connected and demonstrated within the 6 patterns of the Food-Machinery Flexibility Model, to illustrated the GM of food OI NPD in the real domain. This result confirmed that the connected DCs sequences (the connected mechanisms) that mobilized in the OI NPD is OI GM of the investigated food machinery companies.

5.2.4 Conclusions and Discussions of Main Research Question

RQ: What are the generative mechanisms of Thai Food machinery SMEs OI NPDs?

The extant literature revealed no study identifies OI GMs in the NPD of Thai FI SMEs context. Only little attention has been paid to the GMs in food OI NPD, that is, the causal powers that explain how and why some of Thai food machinery SMEs efficaciously adopt OI in their NPD.

GMs are mostly possible to comprehend by analytical work (theory-building), only based on empirical observations (Blom & Morén, 2011). In order to achieve such an explanatory analysis, five rounds of interview are suggested and discussed through the retroduction (Archer, 2015) to find generative mechanisms by emphasizing knowledge from understanding the truth in each reality domain (Blaikie, 2007).

On the answers for the research questions (RQ1-RQ3), the knowledge of food OI NPDs in 3 domains of reality has been explored, analyzed, and connected as presented in Figure 5.1 on the following page. The origin of the food recipe is the main strategic driver for the choice of OI logics and practices. These results demonstrate the importance to track the exchange flows associated with the development of the food recipe to develop ambidexterity and organizational agility of each specific demand; client requirements, limitation of agricultural ingredients and technologies, business strategies for phase, food laws and regulations. The investigated food machinery companies developed a high level of flexibility to manage its operational routines. In adition, these companies developed a combinative dynamic capability (Lichtenthaler & Lichtenthaler, 2009) to optimize ingredient combinations, food processing, food laws and regulations, and business opportunities according to each specific NPD goal.

In summary, the OI GM of the food machinery company is the DCs mobilized in each OI NPD (Figure 5.1). These capabilities optimize OI logics and practices to each NPDs, demonstrated a business model shift in the investigated food machinery companies' business model during the operating time span. From an ordinary food machinery SME, it has become an innovation intermediary with a variety of OI NPD patterns (SME A has 6 patterns and SME B has 3 patterns).

Figure 5.1

The integration of Food-Machinery Flexibility Model with associated OI logics & practices, NPD events and GMs in CR perspective

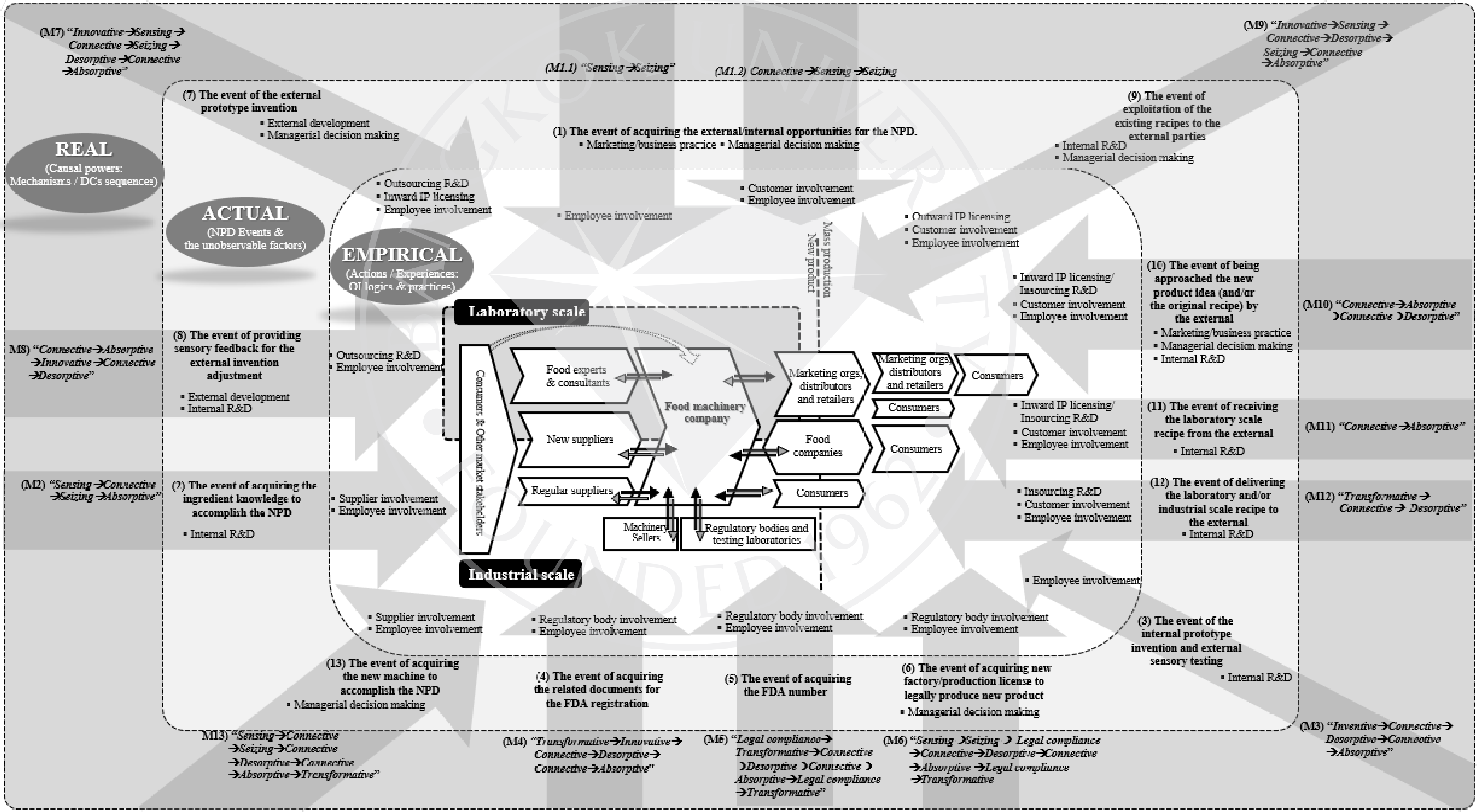


Figure 5.1 demonstrated the knowledge of food OI NPD in 3 domains of reality. In this research, each domain was connected by the development of food recipes during the NPD process.

1) Empirical domain is the data and facts that can be seized about phenomena. To this study, they are OI logics and practices, and actors involved.

The knowledge of reality in CR perspective is based on empirical domain. Actual and real domains do not review themselves only through the research observation. However, the analysis of these observations enables the establishment of patterns that will be confronted with reality through new observations in 5 rounds of semi-structured interview. Hence, it allows the researcher to reveal the causal powers of the OI NPD phenomena.

2) Actual domain is the realm of events that happens when causal power operates. It encompasses the relationship of the observable and unobservable factors underlying the empirical. To this study, they are the NPD events which encompass OI practices and non-OI practices respectively. The investigated SMEs demonstrated a high level of flexibility for managing their operational routines or various NPD events to achieve NPD cases in each group.

3) Real domain is the causal power underlying the event. To this study, it is OI GM or the associated DCs that mobilized in the NPD process. The investigated SMEs demonstrated a combinative DCs to optimize ingredient combinations, food processing, food laws, and business opportunities according to each specific NPD goal. These capabilities optimized OI logics and practices to each NPDs, demonstrated a business model shift to become food innovation intermediary.

Figure 5.1 would benefit the FI entrepreneurs, especially at the managerial level, who are looking for an efficient OI NPD strategic guideline. This figure helps the practitioners to implement OI in food NPD by following the academic explanation. For example, if the food SME would like to improve its organizational ability to achieve FDA registration process, it has to focus on the NPD event 5: the event of acquiring FDA number (Mechanism 5: “Legal compliance → Transformative → Connective → Desorptive → Connective → Absorptive → Legal compliance → Transformative”). Food SME has many choices to do so. It can select to strengthen its legal compliance capacity by investing in an experienced employee as SME A did. Apart from that, Food SME can select to strengthen its connective capacity by developing connections with FDA staff. These activities result in better regulatory involvement practices and employee involvement practice, and consequence to achieve more FDA new products. This example demonstrated that food SME could improve its DCs to capture and recombine external knowledge with its own. The DCs sequences to manage a set of OI practice for recipe knowledge exchange will be improved. However, the choice of improvement on specific DCs can be made by each food SMEs.

5.3 Implications for Theory and Practices

This research study explains how some Thai FI SMEs efficaciously adopt OI approach though the identification of involved actors, OI logics and practices, associated NPD events and the underlying GMs of each OI NPD patterns. These findings help both academics and practitioners to explore the “black box” of OI in the food NPD context as shown in Table 4.38.

Table 4.38

The academic and practical contributions of the study

Academic Research Gaps	Academic Contribution	Practical Contribution
Closured the OI in Thai FI SME gaps (Gap area 1)		
● No academic result explains how some Thai food machinery SMEs efficaciously adopt OI ● No study has identified OI GM in the NPD of Thai food machinery SMEs ● Lack of studies on OI logics and practices in the Thai food machinery SMEs ● Lack of specification in the nature of the actors involved in OI studies ● No specific OI framework proposed in the Thai food machinery SMEs	The proposal of the Food-Machinery Flexibility Model by identifying the GM of Thai food machinery SMEs' NPD, through understanding the relationship of OI logics, OI practices and associated DCs The GM of food OI NPD is the sequence of DCs mechanisms	6 OI NPD guidelines of food machinery SMEs were provided to effectively response the changes within organizational and external environment for innovation. The executive level of Thai food SMEs could develop efficacious strategic management on specific OI NPD pattern
Closured the OI logics gaps (Gap area 2)		
● Lack of precision regarding the dominance of the knowledge flow in coupled OI logics in the context of Thai food machinery SMEs ● Lack of specification of the nature of knowledge flowing in OI studies in Thai food machinery SMEs	The evidence of couple OI logics inbound and outbound dominance by following the exchanged knowledge of food recipe among associated actors in the NPD process	Understanding the development process of food recipe knowledge during the NPD, and how it is transferring among different actors. The IPR of a new product could be negotiated by the actor who owns the dominance control over the food recipe.
Closured the OI practices gaps (Gap area 3)		
● Lack of empirical characterization of OI practices that occur in Thai food machinery SMEs ● Lack of empirical characterization of OI practices that mobilize coupled OI logics in Thai food machinery SMEs	The evidence of empirical OI practices implementing in Thai food machinery SMEs, linking to coupled OI logics, and set of DCs mechanisms	Improving OI management through managing flexibility of OI practices and its associated DCs.
Closured the OI in NPD gap (Gap area 4)		
● No OI study in the NPD context at "laboratory scale" and "industrial scale" in the Thai food machinery SMEs	Reveals the importance of the up-scaling process to the food NPD, especially the FDA registration process to achieve legal commercialization of new products.	

5.3.1 Implications for Theory

This research contributes to the food OI literatures in 4 ways.

Firstly, the significant implementation of the Food-Machinery framework (Bigliardi et al., 2010; Bigliardi & Galati, 2013) for the increasing trends in the citation of academic literature (Bombaywala & Riandita, 2015; Galanakis, 2019; Grimsby & Kure, 2019; Parisot et al., 2019; Sadat & Nasrat, 2020). In the past, the focus actors in food OI studies were usually the food companies. However, the influence and importance of food machinery company (or the food manufacturer) has become more noticeable in the Thai FI SMEs context. This is due to the fact that food machinery companies are heavily involved in FI SME. However, none of the related researches for a Food-Machinery framework has deployed the OI logics, OI practices, and GM identification. Hence the originality of this study is the proposal of the Food-Machinery Flexibility Model and the discovery of the distinctive 6 patterns within this model.

Secondly, the findings point to a new perspective for food OI NPDs; the GM identification through the relationship of OI logics, OI practices, and DCs, which do not appear in the extant OI literature. There is a direct connection between involved actors, OI logics, OI practices, and DCs in the food NPD at different reality domains (Bhaskar, 2013). The coupled OI logic with a dominant direction according to the specific NPD project is more accurate to describe reality than the usual perspectives utilized in the extant literature. The dominant outbound practices and dominant inbound practices are connected to exploitation and exploration. This research study also reveals that there is no absolutely closed innovation existence in food NPDs.

Interestingly, the results were different at the laboratory scale and at the industrial scale.

However, the relationship of OI logics and practices are just one reality of the OI GM exploration in the empirical domain. The investigated food machinery companies' OI logics and practices became flexible when based on their ability to constantly re-combine routines, reconfigure their procedures, and adjust them to the specific goal of each NPD case. Hence, dynamic capabilities are the active factor for the implementation of OI NPDs in the food machinery company.

The empowerment of DCs explains at least partially its structural, managerial and strategic evolution from an ordinary food machinery company to a food innovation intermediary. This finding contributes to a better understanding on how internal and external learning practices affecting the evolution of the business model and the dominant logic. The researcher nevertheless concludes that the investigated food machinery companies developed their associated DCs to reach the optimum required OI logic and practice flexibility in each NPD. Hence, that is why the investigated food machinery companies efficaciously adopted an OI approach.

Thirdly, the food recipe knowledge flow is one of the appropriate knowledge to follow in the knowledge management field of FI NPD study. The OI logics and practices are evidently connected to the food recipe development in the NPD process (Hongsaprabhas et al., 2018). These research findings for OI logics and practices are enriching and expand the food OI literature (Chesbrough et al., 2006; Enkel et al., 2009; Lichtenthaler, 2008; Van de Vrande et al., 2009).

Moreover, various DCs are needed for the food recipe development. Each additional knowledge gained during the NPD process (technological knowledge, marketing & consumer knowledge, ingredient knowledge, production knowledge, law and regulation knowledge), affect the development of food recipe through "*absorptive capacity*". Thus, it is associated with each development step for a new food product from the very beginning of the NPD process until delivered to the end consumer including the legally required label content on the packaging. The researcher found that "*inventive capacity*" needed to be implemented in each internal development phase of the food recipe. As the food recipe changes during the NPD process are dynamic development and agility, the implicit transformative capacity is always implemented in each change to the food recipe. In this study, the researcher focused only on the "*explicit transformative capacity*" for which the development of food recipes was documented; the recipe at the end of laboratory scale, the industrial scale recipe before submission to the FDA, and the final recipe when FDA approval was granted. In addition, the "*innovative capacity*" and "*desorptive capacity*" usually implemented when a food machinery company attempts to internally exploit knowledge to an external party, which is complementary to its internal knowledge application in new product for example, proposing its food recipe to the food company for the OEM NPDs, sharing some of new product information to the tester in the sensory testing process, submitting the food recipe and its related documents to the FDA, and obtaining an FDA number for new products.

Finally, "*legal compliance capacity*" is unavoidable for the NPD to achieve legal commercialization regulations. Both active inputs and outputs of the new product must comply with the parameters set in law, which is complementary to knowledge retention in the organization, for example the strategic preparation of the food recipe and its related internal documents acquire a new factory license that covers the production scope of new product and/or acquiring FDA number for new products.

With regards to "*connective capacity*", it is always a part of every interaction to retain knowledge outside organizational boundaries. An inter-organizational relationship with other actors must be developed for better and privileged access to external sources.

These organizational abilities concern the nature of business interest, factory standards, and/or legal requirements.

A further level of capability was revealed in this research study, "*sensing*" and "*seizing*". These capabilities do not directly affect the food recipe development or NPD itself, but relate to the managerial capacity to select the best opportunities for the organization. In this current study and in common with Thai SMEs, the manager of SME A and SME B owned the business. They are responsible for the top and the middle management roles. They act as the knowledge gate to sense the options and variety of market opportunities and seize the best one to be a new product and/or client (food company and/or food experts and consultants) for the organization.

Fourthly, the findings demonstrate that DCs can strengthen OI within the organization. This is in agreement with Teece's (2020) argument concerning the existing relationship between OI and DCs. They are mutually reinforcing each other. In comparison between the 2 investigated food machinery SMEs, they performed almost the same NPD events, and the underlying mechanisms (Only NPD event (6); the event of acquiring new factory/production licenses to legally produce new product, and its underlying mechanism (M6), and NPD event (9); the event of exploitation of the existing recipes to the external party, and the underlying mechanism (M9), were not found in SME B. Regarding the same NPD event, for example NPD event (5); the event of acquiring the FDA number, SME A implemented this mechanism (5) with a higher level of legal compliance capacity compared to SME B. SME A had more experience in the FDA registration process through its NPD history, and investing in experienced RA employees. This resulted in SME A achieving more FDA new product than SME B. This observation demonstrates that strong dynamic capabilities increase the effectiveness of open innovation (Teece, 2020).

However, the individual DC cannot be represented by individual OI practice. The findings show that they are not a direct match. Since the NPD event encompasses the associated OI practices, involved managerial decision makings, internal R&D, (sometimes external development in NPD Group 5 and Group 6), there are too many elements to match each other. Hence, DCs sequences and group of involved OI practices underlying the same NPD event, is a more appropriate view for this relationship matching. It is more practical to identify the NPD event first (actual domain) and then mapping the empirical domain with the associated OI practices, and charting the real domain with sequence of DCs (mechanism). For example, NPD event (2); the event of acquiring the ingredient knowledge to accomplish the NPD, encompasses with supplier involvement and employee involvement (OI practices in the empirical domain), and its attached DCs sequence is (M2) *"Sensing → Connective → Seizing → Absorptive"*.

In summary, the research findings for the DCs mobilized in the commercialized food OI NPD enrich the extant OI and DCs literature (Lichtenthaler & Lichtenthaler, 2009; Teece, 2007; 2020).

5.3.2 Implications for Practices

The identification of GM in the OI NPD of Thai food machinery SMEs helps the food practitioners at management and operational level to improve their OI management through managing the flexibility of OI logics and practices, and its associated DCs. Thereby the organization can better perform NPD more viably through understanding its GMs and expanding OI NPD patterns. There are 3 implications for practical application.

Firstly, the findings indicate the important role of the industrial scale in food NPD as the FI NPD process from the practitioner's perspective is more diverse than the academic view. They increasingly reveal that due to NPD up-scaling, the results in the laboratory scale are always different to the results in the industrial scale. Reasons for this can be for example, the nature of agricultural ingredients. Frequently in food NPD, a different quantity of specific agricultural ingredients, used in the laboratory scale and industrial scale, may result in different product's taste, texture, and quality. Moreover, some of the newer agricultural ingredients are not suitable for a continuous mass production due to insufficient quantities from their seasonal harvest and/or low cultivation. Also, resource quality issues can be a with different sources of agricultural ingredient or different harvest timing affecting the nutrition content of products.

If we look at the NPD event (2), the event of acquiring the ingredient knowledge to accomplish the NPD, the supplier involvement practice (with the inward ingredient fitness) is present. To overcome this problem, the improvement / development of its underlying mechanism; (M2) "Sensing → Connective → Seizing → Absorptive", is needed. Moreover, the individual practitioner could investigate which DC improvement is needing for his specific case for example, SME B developed its connective capacity in this mechanism (M2) by networking with various fruit suppliers so as to enhance its privileged access in supplier involvement. Thus, SME B can access the consistent quality and quantity of fruit materials throughout the year. This is the core competence of SME B in achieving more NPDs and harmonizing its mass production of the new product.

Another reason that causes different results between laboratory scale and industrial scale is actual food processing and facilities. The use of different industrial machines and laboratory machines, or the machine's specification itself can give different results of the final product. Many academics and laboratory scale developers specifically focus on developing the new product itself, overlooking the actual production conditions. As seen in NPD event (11), the event of receiving the laboratory scale recipe from the external party, the involved OI practices are customer involvement, inward IP licensing, insourcing R&D and employee involvement. To overcome this problem, the improvement / development of its attached mechanism (M11) "Connective → Absorptive", needs to be developed. For example, SME A developed its connective capacity in this mechanism (M11) by providing its production facilities and limitations to its client network (the food companies in NPD Group 5 and the food experts & consultants in NPD Group 6), to make them aware of the industrial scale constraints at the beginning of their external laboratory scale development. In other words, enhancing SME A's OI ability by proactivity in its customer involvement.

Secondly, the findings indicate the important role of regulatory body involvement practices. Much of the extant literature shows that NPD encounter barrier arising from restrictive regulations from the FDA (Chaochotechuang, 2016; Porananond & Thawesaengskulthai, 2014; Rimpeekool et al., 2015). Reducing the NPD barrier from the FDA, can have positive impacts on lower cycle time of the NPD process, and avoid the possibility of having to adjust the product recipe in order to obtain FDA approval.

To achieve legal commercialization for a new food product, three NPD events are involved:

1) NPD event (4) the event of acquiring the related documents for the FDA registration
2) NPD event (5) the event of acquiring the FDA number
3) NPD event (6) the event of acquiring new factory/production licenses to legally produce new products.

To overcome FDA problems, the NPD events that are essential involve the improvement / development of their attached mechanisms is needed. These mechanisms consist of:

1) Mechanism 4 (M4): "Transformative → Innovative → Connective → Desorptive → Connective → Absorptive"
2) Mechanism 5 (M5): "Legal compliance → Transformative → Connective → Desorptive → Connective → Absorptive → Legal compliance → Transformative"
3) Mechanism 6 (M6) "Sensing → Seizing → Legal compliance → Connective → Desorptive → Connective → Absorptive → Legal compliance → Transformative"

This is in agreement with Chaochotechuang's (2016) argument that connective capacity is needed for the FDA registration process. The connection developed with the authority will reduce the barrier from restrictive regulations. In this case, for example, SME A had developed its legal compliance capacity to achieve more FDA numbers for its new products by hiring experienced RA (human resource investment for this specific function). Moreover, SME A had the mechanism (M6) while SME B did not have one. Hence, SME A can legally produce more new product categories compared with SME B with the ability to acquire new factory/production licenses. This shows the different level of the legal compliance capacity between the 2 SMEs.

Thirdly, this study provided an organized OI NPD model (the Food-Machinery Flexibility Model and its associated 6 patterns for the food managers to:

1) Become flexible in adopting different OI approaches within the organizations. This is in agreement with Sadat and Nasrat's (2020) argument that practicing different OI approached is important for food SMEs to survive in the current competitive business environment.
2) Develop associated DCs to improve their OI NPD performance.
3) Reduce failure NPD by predicting the associated NPD events and practices needed for each case.

This study provides an appropriate practical guideline for an effective OI implementation in the Thai food machinery SMEs by identifying OI GMs using the Food-Machinery Flexible Model. The model encompasses 6 distinctive patterns. The 6 different patterns of Food-Machinery Flexible Model are created based on the original recipe creator and IPR owner. The origin of the recipe is obviously the main strategic drivers for the choice of OI NPD pattern. Each pattern requires different guideline. The patterns are as follows:

Pattern 1: The development of a food machinery company's new product with its recipe. This pattern is appropriate to the food machinery company that possesses internal R&D capability to develop new products with their own brands. The main NPD tasks at laboratory scale is the internal R&D. Only some OI practices are involved such as supplier involvement practice for acquiring new ingredient information, and customer involvement practice for acquiring market demands. The various OI practices are heavily implemented with more external actors at the industrial scale such as supplier involvement, customer involvement, and regulatory body involvement. However, the employee involvement practice by the owner/manager seems to be the most important practice that detect various demands (sensing) and select the right market opportunity for its organizational NPD (seizing).

Pattern 2: The development of a food machinery company's new product with the food expert's recipe. This pattern is appropriate to the food machinery company with the ability to make its own brands, but lacks internal R&D capability to complete the NPD laboratory scale itself. Hence, outsourcing R&D practice with the external food experts is needed for problem solving. The external food experts should provide the prototype of a new product and the laboratory scale food recipe. For this pattern, the industrial scale is not complicated as the suggested production techniques for laboratory scale and up-scaling have already been prepared by the food experts. The critical factor to achieving this pattern is the ability to sense and seize the requirements of new products from market perspective, and desorptive capacity to communicate the precise new product idea and organizational limitation to the external food experts. However, working with the external experts are costly and relatively time consuming.

Pattern 3: The development of a food company's new product with the food machinery company’s recipe. The food recipe and the creation of a new product were completed by the food machinery company, but sold under the client’s brand. This pattern is appropriate to the food machinery company that wants to exploit its existing food recipes to other food companies by offering the NPD for OEM brand products. This pattern is convenient to implement at both scales because the new products are slightly adjusted compared to the original recipe. However, the new product tends to lack its unique characteristics. This pattern has the least number of involved actors in the OI NPD compared to other patterns, only the client (food company), regular suppliers, consumers for sensory testing, and regulatory bodies and testing laboratories were involved. The critical factors to achieving this pattern are the innovative capacity to internally exploit its organizational recipes and desorptive capacity to externally exploit the right NPD to the client.

Pattern 4: The development of the food company's new product with its recipe. The original recipe was finished by the food company, which resulted in the IPR of a new product belonging to the food company automically. This pattern is appropriate to the food machinery company aiming to position itself as a superior OEM for the various types of food company’s NPDs by increasing the S-curve of new product availability and reducing the risk within uncertain competitive business environments. The main idea of this pattern is to implement the food company’s recipe with available production technology on hand at the laboratory scale and industrial scale. This pattern also suggests the food machinery company to have a flexible NPD process and adjustable production line for the various requirements of different clients. To this pattern, customer involvement and inward IP licensing practices are very important. The absorptive capacity is strongly involved to acquire new external knowledge and the ability to recombine constantly its routines, reconfigure its procedures and adjust them to the specific aim of each NPD.

Pattern 5: The development of a food company's new product with the food expert's recipe. The original recipe was created by external co-development between food companies and food experts. The food machinery company has no involvement at the laboratory scale but the industrial scale only. Hence, the final recipe and the creation of a new product are completed by the food machinery company. However, the IPR of the new product still belongs to the food company. This pattern is appropriate to the food machinery companies who positioned themselves as superior OEMs for a variety of food companies with the shortened R&D period of each NPD. Without the laboratory scale, the main task for the food machinery company is to absorp all relevant recipe knowledge at the laboratory scale, and adjust accordingly to suit its current production facilities. The food machinery company can focus its expertise to developing their capability to implement an industrial scale for the NPDs. Since the prototype at the laboratory scale is created lacking in the inputs of actual limitation from the production side, the difficulty of this pattern is the food machinery company’s ability to transform the prototype into the mass production of new products.

Pattern 6: The development of a food expert's new product with the food expert's recipe. The idea of the new product and the original recipe were created by the food experts & consultants. Hence, the IPR of the new product belongs to the food experts. This pattern is quite similar to pattern 5 as the food machinery company has no involvement at the laboratory scale. The laboratory scale was developed by the food experts themselves such as the academic researchers from the university and/or national science center. With the assistant of food experts, the food machinery company can enhance its capability to achieve advanced NPDs. The difficulty with this pattern is the ability to transform the laboratory prototype into the actual new product, and to reduce the communication gap between the academics and practitioners.

The formal and systematic guideline to legally launch NPD processes at the laboratory scale and industrial scale have been provided through the 6 patterns of the Food-Machinery Flexibility Model. Each pattern of the suggested model has different characteristics. The chosen choice depends on the NPD purpose as mentioned above, as well as the business strategy and the capability of the food machinery company itself. Moreover, the suggested OI practices and involved mechanisms / DCs sequence have also been provided. For example, the food managers can use the Food-Machinery Flexibility Model with the Pattern 3 to Pattern 6, to check if their organizations have adopted appropriate practices for the OEM NPDs at each NPD scale. The model can also be used within the organizational R&D team to ensure all members from different work units are aligned and share common understanding of the key OI practices and DCs that need to be accomplished.

The food machinery SMEs who seek to become efficient innovation intermediary (Sawhney et al., 2003) could adopt the Food-Machinery Flexible Model and follow this provided guideline of its 6 patterns to leverage their OI NPD ecosystem. This guideline would enhance the organizations' ability to fill specific structural holes on its OI NPD strategy by identifying which opportunity to seize in the accessible social capital. The guideline could support the food machinery SMEs to develop solutions for their specific innovation needs, obtain advanced information on the subject for new product creation, and support organizational OI practices implementation. The different sets of OI practices and specific underlying mechanisms are required for each particular case of the food machinery SMEs. The guideline also helps the food SMEs to scrutinize their value chain partners and to identify innovation opportunities for the OI NPDs.

5.4 Limitations

There are a number of limitations in this research:

1) The low sample size due to the research conditions, resources and time constraints. As this current study set out to select only food machinery companies that act as the innovation intermediary in OI NPD, the purposive sampling with the criterion sampling type (Palys, 2008) was adopted. Under restrictive research conditions, only 2 food machinery companies were compatible. Thus, the research may not be representing the entire Thai FI SMEs. However, they were selected from the Thai FI networks through the National Innovation Agency (NIA), the Top executive SMEs consortia from the National Food Institute (NFI), ITAP (Innovation and technology assistance program), Food Innovation Network by Agricultural Research Development Agency (ARDA), all of which are reliable databases. This reduced any selection bias in the study (Berk, 1983).

2) Too few interviewees. Since this multiple case study was time-consuming, this is the prior-condition provided by the respondent organization themselves (Both SME A and SME B) that they offered only one representative as an interviewee for

the interview. It was fortunate that the researcher got a cooperation to conduct each interview and access their very classified data to complete this research.

To reduce the risk of inducing interviewees to what a researcher wants to achieve, the researcher adopted the semi-structured interview together with the document review method for the data collection. The associated documents were reviewed before and during each interview for cross-checking the collected data, such as food recipe at the laboratory and industrial scale, manufacturing processes at the laboratory and industrial scale, profile of associated suppliers, profile of associated clients, and FDA registration reports. The reviewing of these documents helped to ensure that the researcher still remains true to the original case with lower risk of participation bias. The researcher used the multiple data sources and database to eliminate bias followed the general trustworthiness guideline provided by Baxter and Jack (2008).

Even though this research was lacking in the triangulation within the same investigated SMEs, the triangulation was carried out to compare the findings of each interview between 2 interviewees from different investigated SMEs (interviewee A and Interviewee B). The researcher conducted every round of an interview with SME A first, and then followed by SME B. Because of single NPD project was considered as one unit of analysis (or one case) and then were categorized into 6 OI NPD groups, the triangulation of OI NPD groups were completed by interviewee A and interviewee B. This approach is in agreement with the cross-case analysis and synthesis provided by Yin (2003).

3) The validity of data comparison between 2 food machinery companies due to the data collected from SME A and SME B covered different periods of 8 years and

5 years respectively. The number of investigated NPDs were 92 NPDs and 17 NPDs for SME A and SME B. The substantial number of cases reduces the validity of the comparison in historical innovation strategies evolution. However, the NPD patterns and GMs remained comparable. Since the main analysis was qualitative and its goal was to identify GMs. If similar GMs were identified, comparison would be possible.

4) There may be possible bias on the part of the researcher in the data collection, analysis and interpretation of the findings through the lens of the researcher's own perspectives and background as a practitioner in the Thai FI for over 10 years. However, this biasness was minimized using double-coding the interview transcripts with a qualified researcher (a PhD candidate) and coding themes were compared to ensure reliability (Pilnick & Swift, 2011). Furthemore, all analyzed and synthesized information from each interview were validated by the interviewees in the following interviews. This included the presence of the researcher's supervisor in the interpretation of the results to make sure that the mentioned biases had been reduced.

5) The limited utilization of data collected from the investigated food machinery companies was only allowed to be used for this research purposed. The NPD information is considered a highly confidential asset for the SMEs, all interview records and transcripts required a non-disclosure agreement (NDA).

6) There was a limit to the generalization of the findings. As this current study adopted qualitative approach and based on the diachronic analysis (109 NPDs) of only 2 investigated Thai food machinery SMEs, this would require access to a larger sample size so that more reliable quantitative methods could be applied in future research. For example, a survey of existing Thai food machinery companies to obtain

more NPDs. However, the current study is exploratory research and just the first attempt in understanding the GM of food OI NPD favoring OI logics and practices.

7) Moreover, the generalizability of this study is limited to the food SMEs context and exclude the larger companies (LC) and multinational national enterprises (MNEs). Much of the literature pointed out that the OI study in LCs and MNEs context are not directly transferrable to the SMEs context (Van de Vrande et al., 2009). This is in agreement with the current study's findings. For example, the owners of SME A and SME B assumed top management roles and middle management roles at the same time. In other words, they are making strategic decisions as well as the routine tasks associated at manager level. This contrasts to LCs and MNEs in that top management was not involved in the middle management's decision making and routines. Hence, the involved mechanisms (DC sequences) and their OI NPD GMs could show different results.

8) Change in national economy, business trends, consumer trends, new food technologies, related laws and regulations in Thai FI may affect the results of the study including the global economic slowdown (2018 - 2019). Adding to these, the spread of COVID-19 (2020 – to date) has significantly affected the volume of NPDs and the types of NPDs implementation in both investigated food machinery companies, as well as their business and financial strategy. However, the aim of this research study was to explore the GM of commercialized food OI NPD. The acquired information gained through this research was enough for the analysis, and in achieving the research goals.

5.5 Direction for Future Research

This study contributed to the literature on OI NPD in the FI SMEs with a focus in the Thai context. However, some recommendations for further research can be acknowledged. The findings in this study have used 109 NPD cases from the Thai FI SMEs, while many other SMEs refused to participate in the study. To confirm the research findings, a further study can compare data findings with several other food machinery companies. The choice of the additional food machinery SME is of central importance as they can act as ordinary food suppliers in their value chain or as an innovation intermediary as seen in this study. A comparison of different types of OI strategies can help to re-define a typology combining strategy, OI logics and practices, and DCs.

Moreover, the results also showed that the investigated food machinery company (SME A) applied different NPD patterns with the same food company as its long-term strategic partner. Some of the examples are as follows:

1) Food company A03 implemented NPD Pattern 3 (Case A19 to A21) in 2014, and NPD Pattern 4 (Case A53) in 2018
2) Food company A04 implemented NPD Pattern 3 (Case A22 and A23) in 2015, and NPD Pattern 4 (Case A50) in 2017.

This information should be taken into account in subsequent analysis of FI SMEs in the element of co-adaptation NPD and co-evolution of NPD. For example, the changes in organizational routine during the years of co-operation. The diachronic relationship between specific food machinery company and these food companies should be further observed.

Beside the OI logics, OI practices, and DCs, the other concepts and constructs toward the Food-Machinery Flexibility Model should be investigated. Future research should develop much more detail into the investigation of the OI NPDs phenomena. Take for instance, the other DCs concepts that are provided by different researchers.

The triggering factor (TF) identification in this research is just the initial exploration for the bigger view of OI GM. In this research study, it is the first DC that trigger the other DCs to continuously mobilize in the entire NPD project. To understand the reason behind this, its functions and relationships would need to be explored in future study.

Finally, it is recommended that future research continuing this study utilizes a variety of data collection methods, data analysis, and an evaluation of research results from different points of view. The changes in research methods, size companies studied, corporate culture, any new laws and regulations in Thai FI can be important factors which could change results of the study. Academic and practical researchers must rely on their own knowledge when choosing information, research parameters, and the appropriate process of data analysis and evaluation.

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APPENDIX A

SEMI-STRUCTURED INTERVIEW GUIDE

(I) Interview Letter

Dear Sir/Madam,

Company name …………….

Re: Invitation to take part in a research study.

My name is Throngvid Hongsaprabhas, I am a Ph.D. student at the Institute for Knowledge and Innovation Southeast Asia (IKI-SEA), Bangkok university, currently writing my dissertation report to complete the requirements for the degree doctor of philosophy in knowledge management and innovation management.

You are being invited to take part in a research study which is to be conducted as part of a doctor of philosophy degree at Bangkok university. The attached document will assist you decide whether you want to take part in the study. Selection for interviews was based on your organisation's specific work, in relation to open innovation (OI) in the new product development (NPD) of food machinery SMEs. Main purpose of the study is to identify OI generative mechanisms (GMs) of the investigated NPDs. All 5 rounds of interview will be recorded to ensure accuracy. Permission will be asked before using direct quotes from the interviews. If location allows for a face-to-face interview, otherwise VDO or Zoom conference. Please let me know which channel is best for you. I hope we can arrange an interview appointment at your convenience.

The attached semi-structured interview guide is created to maintain a general theme of the study. All additional comments and suggestions are very welcome. Your contributions would be patronizing and I would like to thank you in advance for your cooperation.

Warm Regards,

Throngvid Hongsaprabhas.

pleumkarp@gmail.com

086 885 8683

(II) Consent Form

Research Participant Consent Form

Open Innovation Logics and Practices Generative Mechanisms in Thai Food Machinery SMEs NPDs: Multiple Case Studies

Name of Interviewer: Throngvid Hongsaprabhas

Please initial,

- I confirm that I have been given and understood the information sheet for the above study and received answers to any questions raised about the study.
- I understand that the researcher will hold all information and data collected securely and in confidence and that all efforts will be made to ensure that I and relevant information cannot be identified as a participant in the study. I give permission for the only researchers to hold relevant personal data.
  - I consent to being quoted “named and organization I represent” [ ] / or “anonymously” [ ]
  - Transcripts require a non-disclosure agreement (NDA) [ ]

- I confirm that I am aware that participation in this research involves my being interviewed and that this interview will be recorded, that this recording will be used by the researcher for research purposes.
  - I consent to being recorded [ ]
  - Interview records require a non-disclosure agreement (NDA) [ ]

I agree to take part in the above study.

Signature of participant: Signature of researcher:

______________________ ________________________

( ) (Throngvid Hongsaprabhas)

Date: _____________________ Date: __________________

*One copy for the subject; one copy for the researcher.

(III) Letter of Granting Approval from SME A

Research Participant Consent Form

Open Innovation Logics and Practices Generative Mechanisms in Thai Food Machinery SMEs NPDs: Multiple Case Studies

Name of Interviewer: Throngvid Hongsaprabhas

Please initial,

- I confirm that I have been given and understood the information sheet for the above study and received answers to any questions raised about the study.
- I understand that the researcher will hold all information and data collected securely and in confidence and that all efforts will be made to ensure that I and relevant information cannot be identified as a participant in the study. I give permission for the only researchers to hold relevant personal data.
  - I consent to being quoted "named and organization I represent" [✓] / or "anonymously" [ ]
  - Transcripts require a non-disclosure agreement (NDA) [✓]
- I confirm that I am aware that participation in this research involves my being interviewed and that this interview will be recorded, that this recording will be used by the researcher for research purposes.
  - I consent to being recorded [✓]
  - Interview records require a non-disclosure agreement (NDA) [✓]

I agree to take part in the above study.

[redacted]

Signature of researcher:

[redacted]

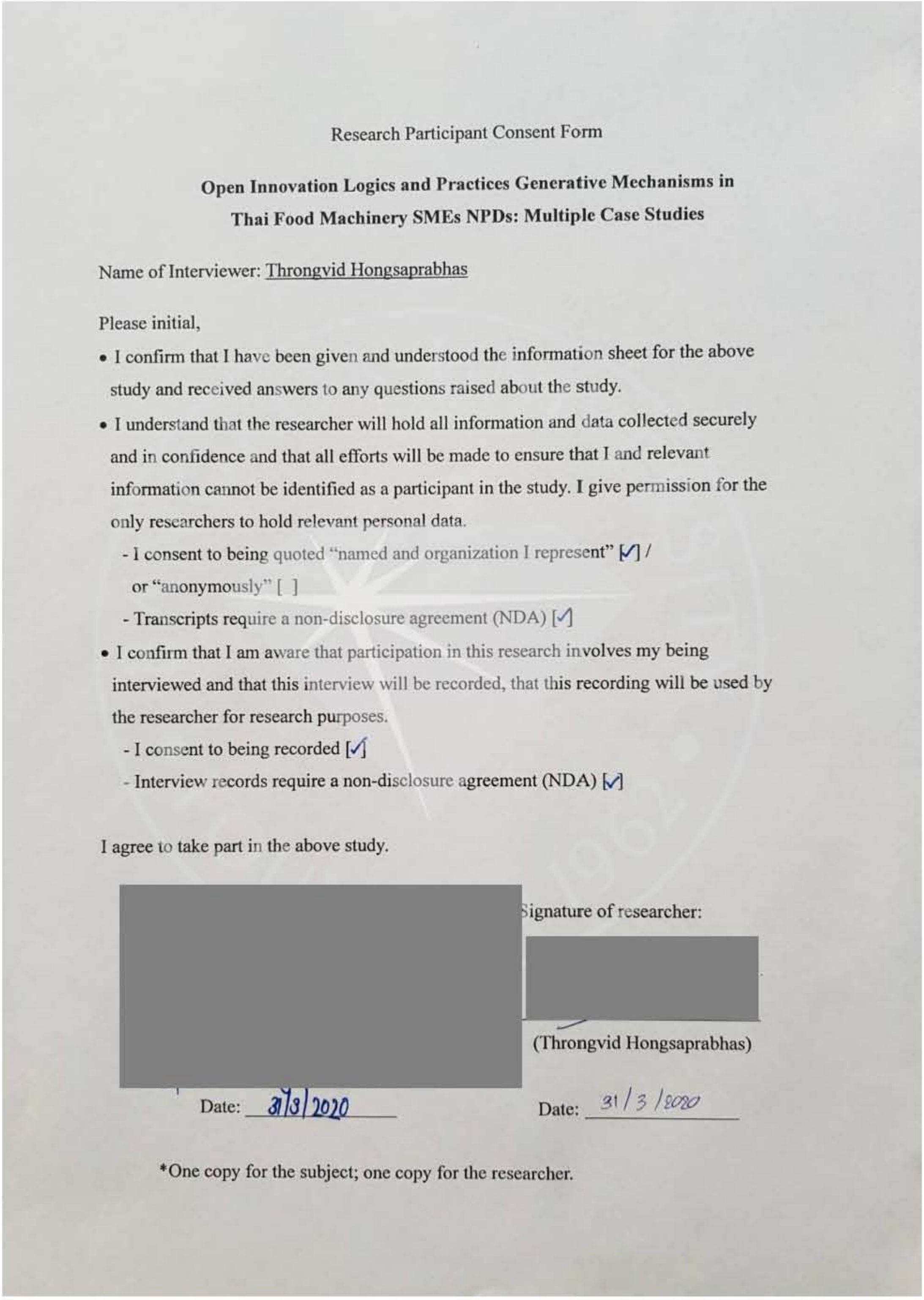
(Throngvid Hongsaprabhas)

Date: 21/3/2020

Date: 17/3/2020

*One copy for the subject; one copy for the researcher.

(IV) Letter of Granting Approval from SME B



Research Participant Consent Form

Open Innovation Logics and Practices Generative Mechanisms in Thai Food Machinery SMEs NPDs: Multiple Case Studies

Name of Interviewer: Throngvid Hongsaprabhas

Please initial,

- I confirm that I have been given and understood the information sheet for the above study and received answers to any questions raised about the study.
- I understand that the researcher will hold all information and data collected securely and in confidence and that all efforts will be made to ensure that I and relevant information cannot be identified as a participant in the study. I give permission for the only researchers to hold relevant personal data.
  - I consent to being quoted "named and organization I represent" [✓] / or "anonymously" [ ]
  - Transcripts require a non-disclosure agreement (NDA) [✓]
- I confirm that I am aware that participation in this research involves my being interviewed and that this interview will be recorded, that this recording will be used by the researcher for research purposes.
  - I consent to being recorded [✓]
  - Interview records require a non-disclosure agreement (NDA) [✓]

I agree to take part in the above study.

[redacted] Signature of researcher:

[redacted]

(Throngvid Hongsaprabhas)

Date: 31/3/2020 Date: 31/3/2020

*One copy for the subject; one copy for the researcher.

(V) Interview Protocol

- Name of research: Open Innovation Logics and Practices Generative Mechanisms in Thai Food Machinery SMEs NPDs: Multiple Case Studies

- Explain the purpose of the study: to identify OI generative mechanisms of OI logics and practices in the NPD process of Thai food machinery SMEs.

- Interview appointment (round/date/time)

    Interview 1/ Date: _________/ Time: ___________

    Interview 2/ Date: _________/ Time: ___________

    Interview 3/ Date: _________/ Time: ___________

    Interview 4/ Date: _________/ Time: ___________

    Interview 5/ Date: _________/ Time: ___________

- Explain ethics and confidentiality: 2 minutes

- Explain the purpose of interview round ______: 3 minutes

- Explain the interview process: 5 minutes

- Review the analysis from previous interview: 15 minutes (only interview 2 – 5)

- Interview length: 30 – 40 minutes/round

(VI) Semi-Structured Interview Guide for Each Round

Interview 1/ Date: _________/ Time: ___________

SME name: ________________________________

Objective of interview 1:

During interview 1, the interviewer would like to gather inputs on your successful NPDs that FDA granted approval; comprised of the involved partners, flow of food recipe knowledge among each involved partner, the development of food recipe knowledge during the NPD process, related NPD activities, NPD process at laboratory scale and industrial scale, and other possible information to identify the OI GMs of your successful NPDs.

Guideline for Interview 1

1) Demographic & Context:

-Interviewee's job title, department, level of involvement in NPD projects.

-Organization background e.g., organizational size, organizational structure, main customers, products, main technologies, SWOT, business environment, main partners.

2) OI NPD overview of each SME:

-Organizational attitudes toward OI NPD

-NPD background e.g., R&D team structure, R&D facility

-Who (internal organization) are involved in the selected NPD case___, what are their roles?

-What is your typical NPD process?

3) Who is the original food recipe creator of the selected NPD case___, what are their roles?

4) Who owns the IPR of a new product in NPD case___, what are their roles?

5) Who (external organization) are involved in the selected NPD case___, what are their roles in the NPD process?

6) All involved actors' roles are clearly identified to support research implementation?

<u>Guideline for Interview 1</u> (Continued)

7) What type of OI logics involved in the selected NPD case___, how it transferred and developed among each involved partner?

8) All associated OI logics are clearly identified to support research implementation?

9) What type of NPD activities are involved in the selected NPD case___, how it functions, with whom?

10). All associated NPD activities are clearly identified to support research implementation?

Interview 2/ Date: _________/ Time: ___________
SME name: ________________________________

Objective of interview 2:

During interview 2, the interviewer would like to confirm the findings and the analysis from interview 1, including: (i) NPD categorization; (ii) codification of OI practices and their attached OI logics; (iii) mapping of involved actors with associated OI logics and practices; (iv) every associated NPD activity; and (iii) the refined Food-Machinery model and its different patterns within the same model.

Moreover, the interviewer would gather inputs on the initiative of each NPD, managerial/strategic decision to notice NPD opportunities and choose to start each NPD.

Guideline for Interview 2

1) Presentation of the categorization of OI NPDs based on the origin of recipe and IPR for confirmation (using Table 4.7 for consideration).

- NPD cases ____ belong to Group 1
- NPD cases ____ belong to Group 2
- NPD cases ____ belong to Group 3
- NPD cases ____ belong to Group 4
- NPD cases ____ belong to Group 5
- NPD cases ____ belong to Group 6

2) Each considered OI NPD group to be emerged is explained clearly?

3) Present the codification of OI practices and their attached OI logics for confirmation (using Table 4.30 – 4.31 for consideration). In your opinion, how they implemented, sustained and maintained your OI NPD?

- Outward IP Licensing
- Insourcing R&D
- Employee involvement
- Customer involvement
- Outsourcing R&D
- Inward IP licensing
- Supplier involvement
- Regulatory body involvement

<u>Guideline for Interview 2</u> (Continued)

4) Each considered OI practices and their attached OI logics to be emerged are explained clearly?

5) Presentation of the mapping involved actors with associated NPD activities, OI practices and logics, for confirmation (using Table 4.18 – 4.27 for consideration).

- Confirmation on the mapping of food machinery company
- Confirmation on the mapping of food companies
- Confirmation on the mapping of food experts & consultants
- Confirmation on the mapping of marketing organizations, distributors and retailers
- Confirmation on the mapping of new suppliers
- Confirmation on the mapping of regular suppliers, their associated OI practices and logic
- Confirmation on the mapping of regulatory bodies and testing laboratories
- Confirmation on the mapping of consumers
- Confirmation on the mapping of machinery sellers
- Confirmation on the mapping of other market stakeholders

6) Each considered involved actors with associated NPD activities, OI practices and logics to be emerged are explained clearly?

7) Presentation of the refined Food-Machinery model, and different patterns for confirmation.

- The refined Food-Machinery model
- The refined Food-Machinery model: Pattern 1
- The refined Food-Machinery model: Pattern 2
- The refined Food-Machinery model: Pattern 3
- The refined Food-Machinery model: Pattern 4
- The refined Food-Machinery model: Pattern 5
- The refined Food-Machinery model: Pattern 6

8) What is the initiative of each NPD, managerial/strategic decision to notice and choose to start each NPD (using Table 4.18 – 4.27 for consideration).

Interview 3/ Date: _________/ Time: ___________

SME name: ________________________________

Objective of interview 3**:**

During interview 3, the interviewer would like to confirm the findings and the analysis from interview 2, including: (i) the Food-Machinery Flexible Model and its different patterns within the same model; and (ii) the initiative of each NPD, managerial/strategic decision to notice and choose to start each NPD.

Moreover, the interviewer would gather inputs on the historical view of OI NPD and business operation, the active factors involved in each group of your OI NPD, identification of main NPD events and their underlying mechanisms.

Guideline for Interview 3

1) Presentation of the food-machinery flexible model and its different patterns within the same model, for confirmation. The suggestion and preliminary insight of each OI NPD pattern are welcome.

- Food-Machinery Flexible Model
- Food-Machinery Flexible Model: Pattern 1
- Food-Machinery Flexible Model: Pattern 2
- Food-Machinery Flexible Model: Pattern 3
- Food-Machinery Flexible Model: Pattern 4
- Food-Machinery Flexible Model: Pattern 5
- Food-Machinery Flexible Model: Pattern 6

2) The combination of involved actors, OI logics and practices into a sequence of NPD steps is relevant to the integrated model under study?

3) The integrated model, Food-Machinery Flexible Model and its different pattern within the same model could contribute from the academic concept to implementation?

<u>Guideline for Interview 3</u> (Continued)

4) Please tell the historical view of your OI NPD and business operation since the beginning, as well as the initiative and managerial/strategic decision to notice and choose to start OI NPD.

5) What are the external and internal factors that affected the development of your OI NPD?

6) In your opinion, what are the active factors to implement, sustain and maintain your organizational OI NPD. Please identify by each OI NPD group.

7) All associated OI active factors are clearly identified to support research implementation?

8) Please identify main NPD events in each OI NPD group, as well as their underlying mechanism.

9) All main NPD events and their underlying mechanism are clearly identified to support research implementation?

Interview 4/ Date: _________/ Time: ___________ SME name: ________________________________
Objective of interview 4: During interview 4, the interviewer would like to confirm the findings and the analysis from interview 3, including: (i) confirmation of the codified active factors (DCs) to implement OI NPDs; (ii) confirmation of associated DCs and their definition; (iii) confirmation of the DC sequences underlying each main NPD event.
<u>Guideline for Interview 4</u> 1) Presentation of the codified DCs associated in each group of OI NPDs (using Table 4.34 for consideration). 2) All codified DCs associated in each group of OI NPDs are clearly identified to support research implementation? 3) In your opinion, how the associated DCs implemented, sustained and maintained your OI NPD? Regarding each DCs definition in Table 4.35, what is missing in these provided definitions? - Sensing - Seizing - Absorptive capacity - Connective capacity - Desorptive capacity - Inventive capacity - Transformative capacity - Innovative capacity 4) Each considered DCs to be emerged is explained clearly?

<u>Guideline for Interview 4</u> (Continued)

5) The combination of DCs into a sequence attached to each main NPD event is relevant to the OI GM model under study?

6) Please sequence the associated DCs (mechanisms) underlying 13 main NPD events.
- The event of acquiring the external/internal opportunities for the NPD
- The event of acquiring the ingredient knowledge to accomplish the NPD
- The event of the internal prototype invention and external sensory testing
- The event of acquiring the related documents for the FDA registration
- The event of acquiring the FDA number
- The event of acquiring new factory/production license to legally produce new product
- The event of the external prototype invention
- The event of providing sensory feedback for the external invention adjustment
- The event of exploitation of the existing recipes to the external party
- The event of being approached with the new product idea (and/or the original recipe) by the external party
- The event of receiving the laboratory scale recipe from the external party
- The event of delivering the laboratory and/or industrial scale recipe to the external party
- The event of acquiring new machinery to achieve the NPD

7) Each considered DCs sequence (mechanism) to be emerged is explained clearly?

8) All DCs sequences (mechanisms) are clearly identified to support research implementation?

Interview 5/ Date: _________/ Time: ___________ SME name: ________________________________
Objective of interview 5**:** During interview 5, the interviewer would like to confirm the findings and the analysis from interview 4, including: (i) confirmation of 14 DCs sequences underlying 13 main NPD events; (ii) the OI GMs attached to the Food-Machinery Flexible Model and its different patterns within the same model; and (iii) the integration of Food-Machinery Flexible Model with associated OI logics & practices, NPD events and GMs,
<u>Guideline for Interview 5</u> 1) Presentation of specific DCs sequence (mechanism) underlying 13 manin NPD events for confirmation (using Table 4.36 for consideration). 2) Presentation of the GMs that mobilized in each pattern of OI NPD, their linear sequences and their TFs for confirmation. - The GM underlying the Food-Machinery Flexible Model: Pattern 1 - The GM underlying the Food-Machinery Flexible Model: Pattern 2 - The GM underlying the Food-Machinery Flexible Model: Pattern 3 - The GM underlying the Food-Machinery Flexible Model: Pattern 4 - The GM underlying the Food-Machinery Flexible Model: Pattern 5 - The GM underlying the Food-Machinery Flexible Model: Pattern 6 3) Each considered OI GM pattern to be emerged is explained clearly? 4) The integrated model of OI GM underlying each pattern of the Food-Machinery Flexible Model could contribute from the academic concept to implementation?

<u>Guideline for Interview 5</u> (Continued)

5) Presentation of the integration of the Food-Machinery Flexible Model with associated OI logics & practices, NPD events and GMs, for confirmation.

6) The intended outcomes from the final integrated model are explained clearly?

7) The final integrated model can result in a number of OI NPD scenarios that might broaden the vision?

8) The final integrated model is comprehensive enough for many kinds of food machinery SMEs?

9) The use of the final integrated model is relevant to identify possible views for OI NPD in FI SMEs?

(VII) Example of Interview Transcript and Coding

According to the Cut-and-Paste approach (Myers, 2011), the researcher identified repeated keywords, sentences or phrases that are relevant to the research questions by separating color. In this study, yellow refers to the code that relevant to RQ1 (Involved actors), green refers to the code that relevant to RQ2 (dark green for OI logics and light green for OI practices), while blue is relevant to RQ3 (the factor that activate the ability of investigated SMEs to implement OI). Furthermore, pink refers to OI NPD categorization which needed for research analysis. Once the verbatim coding process was completed, the color-coded copies of the transcripts were cut and sorted. So that all parts within each transcript that related to a particular theme were placed together for further analysis. The summary coding result was shown in Table 4.6.

Verbatim transcripts	Coding	
"*…From 100 NPDs, 10% could reach FDA registration process, but only 1% that we can reap the long-term benefit. We cannot take care all NPDs efficiently. Moreover, the income of R&D service is really a smaller amount compared to mass producing commercial products. Hence, we have to focus on what is really important and suit the company. In my opinion, this approach is the most convenient way to earn more income and maximize production capacity by bringing the existing product ideas, and recipes to the market. However, it seems to work for a short-term period. This kind of new product has no differentiate characteristic and selling point*" (Interviewee A)	-Insourcing R&D	RQ2
"*There is no absolute close innovation in this NPD (Case A15). The knowledge exchanging was dominated by us because we approached our recipe to the client*" (Interviewee A1)	-Coupled OI logic: outbound dominance	RQ2
""*Since we are SMEs, the more of new products can be commercialized, the more chances for us to compete larger enterprises with limited resources*" (Interviewee A)	-Commercialized ability (*This code did not include in the further study as it was eliminated when compared with another coder)	RQ3

Verbatim transcripts	Coding	
"*OI allows us creating a stronger business relationship with the clients*" (Interviewee B)	-Connective capacity	RQ3
"*The main difference between NPD case A10 and case A12 is the internal R&D capability. In case A10, my R&D team can do lab-scale ourself but case A12 cannot. That is why we had to outsource R&D to the university A01 for NPD case A12. The expert from university A01 took care of all tasks in NPD lab-scale. For example, new ingredient sourcing, original recipe creation, recipe development with production technology, sensory test, and lab scale recipe providing. However, this NPD process consumes so much time. That is the main reason my team do not prefer this method*" (Interviewee A)	-Inventive capacity -Outsourcing R&D -Food experts & consultants (The university A01)	RQ3 RQ2 RQ1
"*…I think the case A13-A23 are much simpler compared to other OEM NPDs. I have just approached the previous recipe to the potential clients (food companies). Hence, these NPDs were not difficult in both scale (laboratory scale and industrial scale) and the FDA registration. They were the same menu (recipe) with minor adjustment in taste and texture, depending on client preference. This method also helped my production department to fulfill the available production capacity*" (Interviewee A)	-OI NPD groupping -Customer involvement -Regulatory body involvement -Food company -Production capacity (*This code did not include in the further study as it was eliminated when compared with another coder)	- RQ2 RQ2 RQ1 RQ3
"*NPD case A88-A90 are quite rare to find in the ordinary food machinery company's portfolio because most of the academic and government's NPD were ended with the IP registration at the lab scale. No further development, for example, industrial scale and FDA registration process*" (Interviewee A)	-IP licensing -Regulatory body involvement	RQ2 RQ2
However, the national policy towards food NPD seems to have slightly changed in recent years. In my opinion, many of their food NPDs reached the industrial scale more often than the past 5 years, probably due to the purpose of increasing the IP commercialized readiness. Hence, creditability & strong company profile, academic & government connection, and the flexibility for the various academic research purpose were important factors" (Interviewee A)	-Connective capacity -Absorptive capacity	RQ3 RQ3
"*I met new OEM clients at the food event that we participated (Thaifex 2014), and some OEM clients directly contact me through my business connection*" (Interviewee A)	-Sensing -Connective capacity	RQ3 RQ3
"*…NPD case B15-B16 (4th group), B13-B14 (5th group) are traditional OEM. All of these cases belong to the client's new product and the original recipe was provided by the client. The main difference between them is the collaboration at lab scale. My factory involved lab scale for the case B15-B16 while case B13-B14 did not.*" (Interviewee B)	-OI NPD groupping	-

Verbatim transcripts	Coding	
"…*the initial idea and the original food recipe of these new products (the 4th group) were from our clients. They knew their end consumer better than us. In some cases, they already had a market. In my opinion, these will reduce the failure risk in the stage of new product commercialization. For us, the main task of overall NPD is to apply our production technology to comply with the recipe and ingredients, for example, the process of pre-treat raw materials to match with technology, transforming the specific ingredient ratio from the home cooking version into the industrial production version, identifying the proper production condition that comply with the regulations, and FDA registration. In my opinion, the clients were involved in the ideation process, for example, new product preference, selling point, and ideal cost, and every sensory feedback in each step of development"* (Interviewee A)	-For OI NPD grouping -Absorptive capacity -Transformative capacity -Legal compliance capacity -Customer involvement	- RQ3 RQ3 RQ3 RQ2
"*I'm not sure how many NPD patterns there were in 2015 but it had just happened. I outsourced R&D to the university A01 for my own brand NPD which needs advanced knowledge, while my internal R&D handled the NPD of the OEM brand which had less difficulty. There were a lot of approaches by new clients through many channels, for example, food exhibition, consortia, my organizational online platform, recommendation by the experts and business partners. My team and I had to agile and flexible many NPD & production routines for each client. That was tough for us but it made us survive till now.*" (Interviewee A)	-Outsourcing R&D -Food experts & consultants (The university A01) -Seizing -Connective capacity -Absorptive capacity	RQ2 RQ1 RQ3 RQ3 RQ3
"*In order to achieve NPD case A81-82 with continuous mass production process, we had to invest new machine, which need supported knowledges from the expertise and the machinery seller to comply new machine with the NPD itself (recipe, process, and specific condition), and with our current manufacturing facilities. Without this machine, we had to do production manually which means we will fail up-scaling this new product"* (Interviewee A)	-Supplier involvement (Inward machinery fitness) -Absorptive capacity -Desorptive capacity	RQ2 RQ3 RQ3
"*This OEM client (food company B02) knew my factory from the address on packaging label of other OEM product in the market, what a surprise! He directly contacted me for the appointment*" (Interviewee B)	-Connective capacity -Seizing	RQ3 RQ3
"*The newness type of our NPDs is majority in the additional to existing product lines. Most of them were the application of different tropical fruits and/or vegetables in different sterilized packaging*" (Interviewee B)	-Inventive capacity	RQ3

Verbatim transcripts	Coding	
"*This is long term OEM clients since my father-in-law's generation. Moreover, he still continues the other NPDs in 2016 and 2017. We still mass produce his products till now. Since he is a food trader, his products are fragile in different categories. For example, RTE fruits, RTE local curries, and RTE local recipes. Some needs FDA number while some are not. Some products can generate huge income especially canned tropical fruit. I also can supply fruits from my land*" (Interviewee B)	-Connective capacity	RQ3
"*We normally do experiment on the industrial scale 2 times for 1 NPD, but to these NPDs (case A13-A23), only 1 time. We are the experts on these recipes*" (Interviewee A)	-Inventive capacity	RQ3
"*It is not just as a new machine installation. New production conditions were strongly need a new study to match with new packaging and new machine. It was learning by doing project. We gained a lot of experiences through this NPD*" (Interviewee B)	-Supplier involvement (Inward machinery fitness)	RQ2
"*I learnt from the previous experience that I shouldn't ignore the sound of actual customers, especially for the own brand NPD. Just a sales agent (Marketing organization) and new suppliers could provide us the idea and knowledge of a new product, but it still lacking the insight of consumer needs and behaviors. This is a necessary element to achieve the creation of unique product characteristic. The more efforts we put in the ideation process, the better implemented in new-to-the market products"* (Interviewee A)	-Consumers -Marketing organization, distributors, and retailers -New suppliers -Supplier involvement (Inward ingredients fitness) -Customer involvement	RQ1 RQ1 RQ1 RQ2 RQ2
"*I acknowledged the market opportunity of Thai desserts for the China market. I met many Chinese tourists here. The selected recipes were named by our sales agent (marketing organization). However, Thai desserts are difficult to apply with retort technology and transform into ready-to-eat form. Regarding many internal experiments, I noticed that the NPD case A11 and A12 could not complete with my own R&D capability. Hence, I lend the hand to external expertise instead (outsourcing R&D with university A01)*" (Interviewee A)	-Sensing -Seizing -Marketing organization, distributors, and retailers -Outsourcing R&D	RQ3 RQ3 RQ1 RQ2
"*The outsourcing R&D to the university A01 were conducted at lab scale only. This is a traditional practice for co-NPD with the universities and (or) government R&D agencies. Beside the NPD, the benefit of this outsourcing R&D is the guideline for industrial scale processes. I noticed that we need additional machines to complete these NPDs with mass production processes"* (Interviewee A)	-Outsourcing R&D -Supplier involvement (Inward machinery fitness)	RQ2 RQ2

Verbatim transcripts	Coding	
"*Even though I got a partial fund on these NPDs (case A11-A12), it's taken so much time on just a lab scale development. Time consuming is cost as well. Hence, after case A12, my strategy on NPD selection is not the market potential only, but the capability to complete NPD in proper time as well*" (Interviewee A)	-Seizing	RQ3
"*These NPDs were the easiest OEM NPD because we used our previous recipe as a basis, just minor recipe adjustment for each food company. For example, more spice 5%, increase thickness of curry 10%, and less chicken 15% from the original recipe*" (Interviewee A)	-Innovative capacity -Desorptive capacity	RQ3 RQ3
"*Normally, OEM projects always approach from the client side (food company), but in these cases, I'm the one who approached the client instead. I searched for potential food companies who could commercial my products, and directly contacted them to propose a project. All of them prefer to commercial these products with their brand, and I'm ok with the deal. Minor recipe adjustment helped me to shortcut the lab scale, and faster jump into industrial scale and FDA registration*" (Interviewee A)	-OI NPD groupping -Customer involvement -Sensing -Seizing	- RQ2 RQ3 RQ3
"*I got these clients from business channels (food company: case A24-A38, A41-A45, and A49-A54) and food expert recommendation (case A39-A40, A46-A48, and A55). To this OEM business model, I have to provide better services than the larger enterprises do. Co-developing a new product since lab scale is a good option for us. This was my strategy at that time to acquire the potential clients (food companies) as much as I could.*" (Interviewee A)	-Connective capacity	RQ3
"*…Only few OEM clients could develop into long term clients, especially SME clients. Hence, I had to carefully consider the inward new machinery to the company. Is it worth enough for the company investment? It is true that the requirement of a new machine is from the NPD itself, but it should benefit not only for one NPD. Hence, my procurement team and I worked so hard on sourcing new machinery sellers who could provide the specific machine that works well with the NPD and also has multifunction, applicable to other production improvements as well. As SME, we prefer local machinery sellers regarding the affordable price, on site installation and maintenance service are necessary*" (Interviewee A)	-Supplier involvement (Inward machinery fitness) -Employee involvement -Sensing -Seizing	RQ2 RQ2 RQ3 RQ3
"*These new products (case A56-A87) took a shorter time on the overall NPD process, compared with other NPDs. We involved only the industrial scale. Moreover, new suppliers of specific ingredients for the NPD, were introduced to us by the experts. Besides income from clients, we gain a lot of knowledge regarding NPD. For example, new food ingredient trends, guideline on production, qualified machinery seller and new supplier connection*" (Interviewee A)	-OI NPD grouping -New supplier	- RQ1

Verbatim transcripts	Coding	
"*These NPDs (case A88-A92) were rare cases to Thai FI that the IP of public sectors covered the industrial scale and FDA registration. Normally they did just the lab scale*" (Interviewee A)	-OI NPD Groupping	-
"*Only the client (Food company) who provides us a more precise new product concept and recipe, the more success in NPD that closely to their expectation*" (Interviewee A)	-Food company -Customer involvement -Absorptive capacity	RQ1 RQ2 RQ3
"*We have charged the lab scale fee but in some cases are not. It depends on the difficulty of NPD. These can develop into another business model, as R&D service. On the other hand, we have charged industrial scale fees to all cases because the upscaling takes huge expense. Moreover, I can approach and sell my existing recipe to others*" (Interviewee A)	-Insourcing R&D -Inward IP licensing -Innovative capability	RQ2 RQ2 RQ3
"*Most of the SMEs have limited marketing resources. We can't connect or reach the foreign consumers directly. Hence, we rely more on the trusted sales agents for the market side. We are sharing with each other regarding a new product*" (Interviewee A)	-Connective capacity -Marketing organizations, distributors, and retailers	RQ3 RQ1
"*About the Testing labs, we shared only food recipes and new product samples for the analysis. Then, we got full analysis reports and all necessary information back*" (Interviewee A)	-Coupled OI logics: inbound dominance	RQ2
"*Before the actual FDA registration, my RA team always contacted the FDA one stop service for prior evaluation of new products. She got a regulation guidelines and suggestion to make the new product comply with the law and guarantee achieving the FDA number*" (Interviewee A)	-Regulatory body involvement -Employee involvement -Legal compliance capacity	RQ2 RQ2 RQ3
"*Beside the new product's food recipe and related documents, my RA had to share a lot of internal information to achieve new factory license registration. For example, all machineries, production process, quality control, factory floor plan and layout etc. If the production scope in a factory license didn't cover a new product, we can't get an FDA number. Hence, no way for legal commercialization of new product*" (Interviewee A)	-Desorptive capacity -Legal compliance capacity -Regulatory body involvement	RQ3 RQ3 RQ2
"*During the machine installation, we gain a lot of knowledge. Not only the machinery setting for the new product itself but for the other product applications as well*", and "*Machinery sellers supported us on the machine installation with the basis on new product, process, and our existing production facilities. We shared new product materials for a trial production with new machine*" (Interviewee A)	-Supplier involvement (Inward machinery fitness) -Coupled OI logic: inbound dominance -Machinery seller	RQ2 RQ2 RQ1

Verbatim transcripts	Coding	
"*My factory has HALAL standard. All of my food products were certified by the central Islamic council of Thailand. That is why my new products can commercialize to Muslim market such as UAE. In my opinion, the new products could add more value through these certification*" (Interviewee A)	-Factory standards compliance (*This code did not include in the further study as it was not relevant to food recipe development)	RQ2
"*As we are SME, we don't have enough manpower to do variety tasks. Hence, in most of the NPD cases, we trust our sales agent on what kind of new products that they are able to sell. Even though their ideas are not new to the market, we can copy and develop the idea of trendy ingredients to ours*" (Interviewee B)	-Marketing organizations, distributors, and retailers -Connective capacity -Sensing -Seizing	RQ1 RQ3 RQ3 RQ3
"*…New supplier and regular supplier are needed for the development process, Indirect consumer is needed for sensory testing, while FDA and Testing labs are needed for FDA registration.*" (Interviewee B)	-New suppliers -Regular suppliers -Consumers -Regulatories and testing laboratories -Supplier involvement (inward ingredients fitness) -Customer involvement -Regulatory body involvement	RQ1 RQ1 RQ1 RQ1 RQ2 RQ2 RQ2
"*We had tried outsourcing R&D with the university once, but the outcome was not pleasure. That new product was just a prototype for the sensory testing, no FDA registration. Hence, it has not reached the commercialization stage yet. It's taken a year to complete one project, and the market has changed already*" (Interviewee B)	-Outsourcing R&D	RQ2
"*In the past, ordinary OEM clients always start business with us at the up-scaling stage or jumping to the mass production stage at the beginning. There's almost no OI and/or NPD involvement. However, these cases (case B01-B02) were a bit different. My client (food company B01-B03) asked us to do NPD since lab & industrial scale for them. We accepted these deals and helped them to develop new products because they're my friends*" (Interviewee B)	-Food company -Connective capacity -Seizing	RQ1 RQ3 RQ3
"*After we acquired new product ideas and concepts from our clients. We knew what kind of ingredients that we were looking for. Then the procurement team directly contacts the new supplier for the new ingredient information*" (Interviewee B)	-Seizing -Absorptive capacity -New supplier -Employee involvement -Supplier involvement (inward ingredients fitness)	RQ3 RQ3 RQ1 RQ2 RQ2

Verbatim transcripts	Coding	
"*I did free lab scale to all OEM cases because the clients are my friends. But I charged them at the industrial scale stage*". (Interviewee B)	-Insourcing R&D	RQ2
"*The client participates in OEM NPD at the sensory testing process*" (Interviewee B)	-Food company -Customer involvement	RQ1 RQ2
"*The contract R&D service encompassed many sub activities such as my procurement team acquired the ingredient knowledge from suppliers, internal R&D, sensory testing with client and indirect consumer, acquiring new product's testing result from accredited testing labs, and FDA registration*" (Interviewee B)	-Insourcing R&D -Employee involvement -Supplier involvement (inward ingredients fitness) -Customer involvement -Regulatory body involvement -Food company -Consumers -Regulatory bodies and testing laboratories	RQ2 RQ2 RQ2 RQ2 RQ2 RQ1 RQ1 RQ1
"*It seems that we are the only side that gain ingredient knowledge from the suppliers but we actually have to share the specific ingredient spec, preferable cost and order amount regarding the new product requirement and our existing production process as well such as the bone less black chicken material needs to half boiling and chill before delivery to us. It can't be freeze due to the different texture and smell after our production process*" (Interviewee B)	-New suppliers -Coupled OI logic: inbound dominance	RQ1 RQ2
"*I have very low involvement with the Certified organization. Most of my OEM clients are local entrepreneurs. Their new products sell at local markets which need no certification. Hence, my factory has only GMP standards as legal requirement*" (Interviewee B)	-Cerified organization (*This code did not include in the further study as it was not relevant to food recipe development)	RQ1
"*The joint business regarding the NPD* (external participation and /or venturing) *has not happened to our cases yet. However, I can tell you that some of my business friends (SMEs) survive through this kind of activity...The larger company has joint investment in the SMEs' new product that has opportunities*" (Interviewee A)	-External participation and /or venturing	RQ2
"*Some of the new products are developed beyond the current scope of the current factory license. Hence, we can't do FDA registration unless we got this new scope first*" (Interviewee A)	-Regulatory body involvement -Legal compliance capacity	RQ2 RQ3
"*Normally we consolidated many NPD projects to make sure that the new factory license investment is worthy*" (Interviewee A)	-Regulatory body involvement	RQ2

Verbatim transcripts	Coding	
"My procurement team and I worked so hard on sourcing new machinery sellers who could provide the specific machine that works well with the NPD and also has multifunction, applicable to other production improvements as well. As SME, we prefer local machinery sellers regarding the affordable price, on site installation and maintenance service are necessary" (Interviewee A)	-Employee involvement -Supplier involvement (Inward machinery fitness) -Sensing -Seizing -Machinery sellers	RQ2 RQ2 RQ3 RQ3 RQ1
"*Formal IP activities are considered time consuming. It's a more worthy investment to the larger enterprise or the academic or the government R&D sector, but not to the SMEs like us*" (Interviewee A)	-Inward IP licensing	RQ2
"*Now my business relies on OEM at 80% of production capacity. Of course, OI NPD is important to us"* (Interviewee A)	Production capacity (*This code did not include in the further study as it was eliminated when compared with another coder)	RQ3
"Many food machinery SMEs started their business with their own brand products, me too. However, they will find that it's not easy to manage the balance of sale volume and production capacity with only a few new products. OEM for other clients is one of the good solutions. Hence, it is unavoidable to do OI NPD with others" (Interviewee A)	Entrepreneurial capabilities (*This code did not include in the further study as it was eliminated when compared with another coder)	RQ3
"*The greater number of new products can be registered FDA number, the more chance of your products existing in the competitive market*" (Interviewee A)	-Regulatory body involvement -Legal compliance capacity	RQ2 RQ3
"*In my opinion. The flexible ability of my pre-process in the production line to absorp the various requirements of client's NPD, is a key dominant factor to achieve different types of new product productions. Most of the larger food machinery companies do not prefer to adjust their production line. Hence, their new product was limited to the production facility*" (Interviewee A)	-Inward IP licensing -Absorptive capacity -Transformative capacity	RQ2 RQ3 RQ3
"*Our factory is OEM based, so you can be sure that our NPDs adopted OI approach and the knowledge exchanging was dominantly transferred from clients"* (Interviewee B)	Coupled OI logic: inbound dominance	RQ2
"Many of our new products are local food menus for the specific local market, which most of the larger enterprises ignore this kind of market. We differentiate ourselves with the adaptability of food production technology for local clients, variety types of local food NPD" (Interviewee A)	-Adaptibility (*This code did not include in the further study as it was eliminated when compared with LR)	RQ3

(VIII) Example of Summary Data for the Development of the Food-Machinery Flexible Model: Pattern 1

Interview data from SME A: Case A01-A10 (OI NPD Group 1) were double-coded, organized and compounded in this section.

Case number:	Case A01 ☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement *Case A01 developed along with Case A02, Case A03
Product category:	RTE Thai food (Massaman curry with chicken – Intercook Brand)
The owner of recipe:	Food machinery SME A
The creator of recipe:	Food machinery SME A

CASE A01: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Sale agent (Local distributor - Retailers)	1.1) The source of information. They conveyed the information (product trends and preferences of target consumer, ideation cost) for the recipe development. 1.2) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Consumers	2) Provided initial sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
3) Food machinery company (Manager)	3.1) The company's knowledge gate. He proposed the company's original products to Sale agent, and received market request for the new product adjustment. Then translated this information to the company's team (Factory language). 3.2) Facilitated the communication regarding new product between R&D team and the Sale agent.	-
4) Food machinery company (R&D team)	4.1) Evaluated the possibility of NPD success rate at the beginning. 4.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 4.3) Estimated the idea cost of new product prototype.	-
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)
6) New supplier (x1 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)

CASE A01: NPD - Industrial scale

Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New supplier (x1 company)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)
3) Sale agent (Local distributor - Retailers)	3) Provided sensory feedback of the prototype in order to adjust the final recipe (Representative of direct target customer for product improvement)	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 4.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
5) Food machinery company (Production team)	5) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
6) Food machinery company (Procurement team)	6) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale.	Coupled logics (Inbound dominance)
7) Food machinery company (Manager)	7.1) Facilitated the communication regarding overall new product development between R&D team and the Sale agent. 7.2) Managed the new product commercialization and coordinated with Sale agent in order to deliver new product to target market.	Coupled logics (Inbound dominance)
8) Food machinery company (Regulatory affairs)	8.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 8.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose.	Coupled logics (Inbound dominance)
9) Testing labs (More than 1 Org.)	9) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
10) FDA	10.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 10.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A02

☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement

*Case A02 developed along with Case A01, Case A03

Product category: RTE Thai food (Panaeng curry with chicken – Intercook Brand)

The owner of recipe: Food machinery SME A

The creator of recipe: Food machinery SME A

CASE A02: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Sale agent (Local distributor - Retailers)	1.1) The source of information. They conveyed the information (product trends and preferences of target consumer, ideation cost) for the recipe development. 1.2) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Consumers	2) Provided initial sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
3) Food machinery company (Manager)	3.1) The company's knowledge gate. He proposed the company's original products to Sale agent, and received market request for the new product adjustment. Then translated this information to the company's team (Factory language). 3.2) Facilitated the communication regarding new product between R&D team and the Sale agent.	-
4) Food machinery company (R&D team)	4.1) Evaluated the possibility of NPD success rate at the beginning. 4.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 4.3) Estimated the idea cost of new product prototype.	-
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)
6) New supplier (x1 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)

CASE A02: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New supplier (x1 company)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)
3) Sale agent (Local distributor - Retailers)	3) Provided sensory feedback of the prototype in order to adjust the final recipe (Representative of direct target customer for product improvement)	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 4.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
5) Food machinery company (Production team)	5) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
6) Food machinery company (Procurement team)	6) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale.	Coupled logics (Inbound dominance)
7) Food machinery company (Manager)	7.1) Facilitated the communication regarding overall new product development between R&D team and the Sale agent. 7.2) Managed the new product commercialization and coordinated with Sale agent in order to deliver new product to target market.	Coupled logics (Inbound dominance)
8) Food machinery company (Regulatory affairs)	8.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 8.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose.	Coupled logics (Inbound dominance)
9) Testing labs (More than 1 Org.)	9) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
10) FDA	10.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 10.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A03
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
*Case A03 developed along with Case A01, Case A02
Product category: RTE Thai food (Green curry with chicken – Intercook Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A03: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Sale agent (Local distributor - Retailers)	1.1) The source of information. They conveyed the information (product trends and preferences of target consumer, ideation cost) for the recipe development. 1.2) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Consumers	2) Provided initial sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
3) Food machinery company (Manager)	3.1) The company's knowledge gate. He proposed the company's original products to Sale agent, and received market request for the new product adjustment. Then translated this information to the company's team (Factory language). 3.2) Facilitated the communication regarding new product between R&D team and the Sale agent.	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Evaluated the possibility of NPD success rate at the beginning. 4.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 4.3) Estimated the idea cost of new product prototype.	-
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)
6) New supplier (x1 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)

CASE A03: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New supplier (x1 company)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Chicken supplier with factory standard).	Coupled logics (Inbound dominance)
3) Sale agent (Local distributor - Retailers)	3) Provided sensory feedback of the prototype in order to adjust the final recipe (Representative of direct target customer for product improvement)	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 4.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
5) Food machinery company (Production team)	5) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
6) Food machinery company (Procurement team)	6) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale.	Coupled logics (Inbound dominance)
7) Food machinery company (Manager)	7.1) Facilitated the communication regarding overall new product development between R&D team and the Sale agent. 7.2) Managed the new product commercialization and coordinated with Sale agent in order to deliver new product to target market.	Coupled logics (Inbound dominance)
8) Food machinery company (Regulatory affairs)	8.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 8.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose.	Coupled logics (Inbound dominance)
9) Testing labs (More than 1 Org.)	9) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
10) FDA	10.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 10.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A04
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
*Case A04 developed along with Case A05
Product category: RTE Thai food (Green curry vegetarian – Intercook Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A04: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Sale agent (Exporter-Distributor)	1.1) The source of information. They conveyed the information (product trends and preferences of target consumer, ideation cost) for the recipe development. 1.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 1.3) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Food machinery company (Manager)	2.1) The company's knowledge gate. He proposed the company's original products to sale agent, and received market request for the new product adjustment. Then translated this information to the company's team (Factory language). 2.2) Facilitated the communication regarding new product between R&D team and the Sale agent.	Coupled logics (Inbound dominance)
3) Food machinery company (R&D team)	3.1) Evaluated the possibility of NPD success rate at the beginning. 3.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 3.3) Estimated the idea cost of new product prototype.	-
4) Food machinery company (Procurement team)	4) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Vegetarian meat and curry paste supplier).	Coupled logics (Inbound dominance)
5) New suppliers (x2 companies)	5) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Vegetarian meat and curry paste).	Coupled logics (Inbound dominance)

CASE A04: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New suppliers (x2 companies)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Vegetarian meat and curry paste).	Coupled logics (Inbound dominance)
3) Sale agent (Exporter-Distributor)	3.1) Provided sensory feedback of the prototype in order to adjust the final recipe (Representative of direct target customer for product improvement) 3.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 3.3) Checked the details on new product label (Packaging) and related documents regarding to extort new product.	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
5) Food machinery company (R&D team)	5.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 5.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
6) Food machinery company (Production team)	6) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
7) Food machinery company (Procurement team)	7) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale (Vegetarian meat and curry paste supplier).	Coupled logics (Inbound dominance)
8) Food machinery company (Manager)	8.1) Facilitated the communication regarding overall new product development between R&D team and the Sale agent. 8.2) Managed the new product commercialization and coordinated with Sale agent in order to deliver new product to target market.	Coupled logics (Inbound dominance)
9) Food machinery company (Regulatory affairs)	9.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 9.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose. 9.3) Coordinated with Thai FDA in order to get Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)
10) Testing labs (More than 1 Org.)	10) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
11) FDA	11.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 11.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A05
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
*Case A05 developed along with Case A04

Product category: RTE Thai food (Massaman curry vegetarian – Intercook Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A05: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Sale agent (Exporter-Distributor)	1.1) The source of information. They conveyed the information (product trends and preferences of target consumer, ideation cost) for the recipe development. 1.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 1.3) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Food machinery company (Manager)	2.1) The company's knowledge gate. He proposed the company's original products to Sale agent, and received market request for the new product adjustment. Then translated this information to the company's team (Factory language). 2.2) Facilitated the communication regarding new product between R&D team and the Sale agent.	Coupled logics (Inbound dominance)
3) Food machinery company (R&D team)	3.1) Evaluated the possibility of NPD success rate at the beginning. 3.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 3.3) Estimated the idea cost of new product prototype.	-
4) Food machinery company (Procurement team)	4) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Vegetarian meat and curry paste supplier).	Coupled logics (Inbound dominance)
5) New suppliers (x2 companies)	5) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Vegetarian meat and curry paste).	Coupled logics (Inbound dominance)

CASE A05: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New suppliers (x2 company)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Vegetarian meat and curry paste).	Coupled logics (Inbound dominance)
3) Sale agent (Exporter-Distributor)	3.1) Provided sensory feedback of the prototype in order to adjust the final recipe (Representative of direct target customer for product improvement) 3.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 3.3) Checked the details on new product label (Packaging) and related documents regarding to extort new product.	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory t test purpose).	Coupled logics (Inbound dominance)
5) Food machinery company (R&D team)	5.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 5.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
6) Food machinery company (Production team)	6) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
7) Food machinery company (Procurement team)	7) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale (Vegetarian meat and curry paste supplier).	Coupled logics (Inbound dominance)
8) Food machinery company (Manager)	8.1) Facilitated the communication regarding overall new product development between R&D team and the Sale agent. 8.2) Managed the new product commercialization and coordinated with Sale agent in order to deliver new product to target market.	Coupled logics (Inbound dominance)
9) Food machinery company (Regulatory affairs)	9.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 9.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose. 9.3) Coordinated with Thai FDA in order to get Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)
10) Testing labs (More than 1 Org.)	10) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
11) FDA	11.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 11.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A06
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
*Case A06 developed along with Case A07
Product category: RTE Healthy food (Konjac Spaghetti in Teriyaki sauce – Konjac Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A06: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Sale agent (Exporter-Distributor)	1.1) The source of information. They conveyed the information (product trends and preferences of target consumer, ideation cost) for the recipe development. 1.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 1.3) Provided sensory feedback to adjust the prototype recipe.	Inbound logic
2) Food machinery company (Manager)	2.1) The company's knowledge gate. He perceived the opportunity and market need of konjac ingredient. Then translated this information to the company's team (Factory language). 2.2) Facilitated the communication regarding new product between R&D team and the Sale agent.	Coupled logics (Inbound dominance)
3) Food machinery company (R&D team)	3.1) Evaluated the possibility of NPD success rate at the beginning. 3.2) Conducted initial experiment on Konjac ingredient could match with the factory's production technology or not. 3.3) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 3.4) Advance planned the actual production in the NPD - industrial scale stage due to new ingredient. She considered all of the factory's facility limits and designed the experiment based on these limits. 3.5) Estimated the idea cost of new product prototype.	-
4) Food machinery company (Regulatory affairs)	4) Checked the prerequisites of new material (Konjac) with Thai FDA. Evaluated the possibility of NPD legally FDA registration.	Coupled logics (Inbound dominance)
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Konjac ingredient supplier).	Coupled logics (Inbound dominance)
6) New suppliers (x1 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Konjac ingredient supplier).	Coupled logics (Inbound dominance)

CASE A06: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New suppliers (x1 company)	2.1) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Konjac ingredient). 2.2) Provided the Certificate of Analysis (COA) of new ingredients (Konjac) for complying the factory standard and FDA registration purpose.	Coupled logics (Inbound dominance)
3) Sale agent (Exporter-Distributor)	3.1) Provided sensory feedback of the prototype in order to adjust the final recipe (Representative of direct target customer for product improvement). 3.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 3.3) Checked the details on new product label (Packaging) and related documents regarding to extort new product.	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
5) Food machinery company (R&D team)	5.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 5.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
6) Food machinery company (Production team)	6.1) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities). 6.2) Adjusted the production line to match with the new product processing.	-
7) Food machinery company (Procurement team)	7.1) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale (Konjac supplier). 7.2) Asked for Certificate of Analysis (COA) of new ingredients (Konjac) from new supplier regarding to FDA request.	Coupled logics (Inbound dominance)
8) Food machinery company (Manager)	8.1) Facilitated the communication regarding overall new product development between R&D team and the Sale agent. 8.2) Managed the new product commercialization and coordinated with Sale agent to deliver new product to target market.	Coupled logics (Inbound dominance)
9) Food machinery company (Regulatory affairs)	9.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 9.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose. 9.3) Coordinated with Thai FDA in order to get Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)
10) Testing labs (More than 1 Org.)	10) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report	Coupled logics (Inbound dominance)
11) FDA	11.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 11.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A07
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
*Case A07 developed along with Case A06
Product category: RTE Healthy food (Konjac Spaghetti in Green curry sauce – Konjac Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A07: NPD – laboratory scale

Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Sale agent (Exporter-Distributor)	1.1) The source of information. They conveyed the information (product trends and preferences of target consumer, ideation cost) for the recipe development. 1.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 1.3) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Food machinery company (Manager)	2.1) The company's knowledge gate. He perceived the opportunity and market need of konjac ingredient. Then translated this information to the company's team (Factory language). 2.2) Facilitated the communication regarding new product between R&D team and the Sale agent.	Coupled logics (Inbound dominance)
3) Food machinery company (R&D team)	3.1) Evaluated the possibility of NPD success rate at the beginning. 3.2) Conducted initial experiment on Konjac ingredient could match with the factory's production technology or not. 3.3) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 3.4) Advance planned the actual production in the NPD - industrial scale stage due to new ingredient. She considered all of the factory's facility limits and designed the experiment based on these limits. 3.5) Estimated the idea cost of new product prototype.	-
4) Food machinery company (Regulatory affairs)	4) Checked the prerequisites of new material (Konjac) with Thai FDA. Evaluated the possibility of NPD legally FDA registration.	Coupled logics (Inbound dominance)
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Konjac ingredient supplier).	Coupled logics (Inbound dominance)
6) New suppliers (x1 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Konjac ingredient supplier).	Coupled logics (Inbound dominance)

CASE A07: NPD - Industrial scale

Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New suppliers (x1 company)	2.1) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Konjac ingredient). 2.2) Provided the Certificate of Analysis (COA) of new ingredients (Konjac) for complying the factory standard and FDA registration purpose.	Coupled logics (Inbound dominance)
3) Sale agent (Exporter-Distributor)	3.1) Provided sensory feedback of the prototype in order to adjust the final recipe (Representative of direct target customer for product improvement). 3.2) Provided the involved law and regulation for the exportation of new product. All new product additional requirements and prohibitions regarding to the foreign law and regulation also provided. 3.3) Checked the details on new product label (Packaging) and related documents regarding to extort new product.	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
5) Food machinery company (R&D team)	5.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 5.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
6) Food machinery company (Production team)	6.1) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities). 6.2) Adjusted the production line to match with the new product processing.	-
7) Food machinery company (Procurement team)	7.1) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale (Konjac supplier). 7.2) Asked for Certificate of Analysis (COA) of new ingredients (Konjac) from new supplier regarding to FDA request.	Coupled logics (Inbound dominance)
8) Food machinery company (Manager)	8.1) Facilitated the communication regarding overall new product development between R&D team and the Sale agent. 7.2) Managed the new product commercialization and coordinated with Sale agent to deliver new product to target market.	Coupled logics (Inbound dominance)
9) Food machinery company (Regulatory affairs)	9.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 9.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose. 9.3) Coordinated with Thai FDA in order to get Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)
10) Testing labs (More than 1 Org.)	10) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
11) FDA	11.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 11.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A08
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
Product category: RTE Healthy food (Rice pudding – Mahatarn Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A08: NPD – laboratory scale

Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Direct consumers	1.1) The origin source of information. They provided insight information (their needs of new product) for the recipe development. 1.2) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Consumers	2) Provided initial sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
3) Food machinery company (Manager)	3) The company's knowledge gate. He received market request for the new product initiative. He also conducted the concept of new product. Then translated this information to the company's team (Factory language).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Evaluated the possibility of NPD success rate at the beginning. 4.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 4.3) Estimated the idea cost of new product prototype.	-
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Many types of rice and grain, milk).	Coupled logics (Inbound dominance)
6) New suppliers (x2 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Many types of rice and grain, milk).	Coupled logics (Inbound dominance)

CASE A08: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New supplier (x2 company)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Many types of rice and grain, milk).	Coupled logics (Inbound dominance)
3) Direct consumers	3) Provided sensory feedback to adjust the final recipe.	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 4.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
5) Food machinery company (Production team)	5) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
6) Food machinery company (Procurement team)	6) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale.	Coupled logics (Inbound dominance)
7) Food machinery company (Manager)	7) Managed the new product commercialization and coordinated with the retailer in order to deliver new product to target market.	Coupled logics (Inbound dominance)
8) Food machinery company (Regulatory affairs)	8.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 8.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose.	Coupled logics (Inbound dominance)
9) Testing labs (More than 1 Org.)	9) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
10) FDA	10) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market.	Coupled logics (Inbound dominance)

Case number: Case A09
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
Product category: RTE Healthy food (Multigrain pudding – O'Rice Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A09: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Direct consumers	1.1) The origin source of information. They provided insight information (their needs of new product) for the recipe development. 1.2) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Consumers	2) Provided initial sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
3) Food machinery company (Manager)	3) The company's knowledge gate. He received market request for the new product initiative. He also conducted the concept of new product. Then translated this information to the company's team (Factory language).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Evaluated the possibility of NPD success rate at the beginning. 4.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 4.3) Estimated the idea cost of new product prototype.	-
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Many types of rice and grain, milk).	Coupled logics (Inbound dominance)
6) New suppliers (x2 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Many types of rice and grain, milk).	Coupled logics (Inbound dominance)

CASE A09: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New supplier (x2 company)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Many types of rice and grain, milk).	Coupled logics (Inbound dominance)
3) Direct consumers	3) Provided sensory feedback to adjust the final recipe.	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 4.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
5) Food machinery company (Production team)	5) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
6) Food machinery company (Procurement team)	6) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale.	Coupled logics (Inbound dominance)
7) Food machinery company (Manager)	7) Managed the new product commercialization and coordinated with the retailer in order to deliver new product to target market.	Coupled logics (Inbound dominance)
8) Food machinery company (Regulatory affairs)	8.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 8.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose.	Coupled logics (Inbound dominance)
9) Testing labs (More than 1 Org.)	9) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, F0 value, microbial testing report.	Coupled logics (Inbound dominance)
10) FDA	10.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 10.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

Case number: Case A10
☑ Reach legal commercialization stage ☑ OI involvement ☑ Food machinery involvement
Product category: RTE Healthy food (Multigrain pudding soy– O'Rice Brand)
The owner of recipe: Food machinery SME A
The creator of recipe: Food machinery SME A

CASE A10: NPD – laboratory scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Direct consumers	1.1) The origin source of information. They provided insight information (their needs of new product) for the recipe development. 1.2) Provided sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
2) Consumers	2) Provided initial sensory feedback to adjust the prototype recipe.	Coupled logics (Inbound dominance)
3) Food machinery company (Manager)	3) The company's knowledge gate. He received market request for the new product initiative. He also conducted the concept of new product. Then translated this information to the company's team (Factory language).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Evaluated the possibility of NPD success rate at the beginning. 4.2) Developed the recipe of prototype based on NPD requirements and created prototype of new product at laboratory scale. 4.3) Estimated the idea cost of new product prototype.	-
5) Food machinery company (Procurement team)	5) Sourcing new suppliers of food material/ingredient to match with NPD requirements (Many types of rice and grain, soy milk).	Coupled logics (Inbound dominance)
6) New suppliers (x2 companies)	6) Provided new food materials/ingredients to match with NPD requirements at laboratory scale (Many types of rice and grain, soy milk).	Coupled logics (Inbound dominance)

CASE A10: NPD - Industrial scale		
Involved actor(s)	Role(s), relationship(s) and NPD activities/practices	OI logic(s)
1) Regular suppliers (More than 1 company)	1) Provided ordinary materials/ingredients/packaging in order to match with NPD requirements at the industrial scale.	Coupled logics (Inbound dominance)
2) New supplier (x2 company)	2) Provided new food materials/ingredients to match with NPD requirements at industrial scale (Many types of rice and grain, soy milk).	Coupled logics (Inbound dominance)
3) Direct consumers	3) Provided sensory feedback to adjust the final recipe.	Coupled logics (Inbound dominance)
4) Consumers	4) Provided sensory feedback to adjust the final recipe (The local tester for general sensory test purpose).	Coupled logics (Inbound dominance)
4) Food machinery company (R&D team)	4.1) Developed final recipe and co-facilitated the experiment of new product at the NPD - industrial scale with production team. 4.2) Calculated the cost of new product (cost of raw materials, production, packaging etc.)	-
5) Food machinery company (Production team)	5) Experimented producing new product with actual production process regarding to NPD industrial scale (with actual food materials/ ingredients/ packaging and actual production facilities).	-
6) Food machinery company (Procurement team)	6) Coordinated with new suppliers of food material/ingredient to get specific specification, cost and minimum quantities to produce new product at NPD - industrial scale.	Coupled logics (Inbound dominance)
7) Food machinery company (Manager)	7) Managed the new product commercialization and coordinated with retailers in order to deliver new product to target market.	Coupled logics (Inbound dominance)
8) Food machinery company (Regulatory affairs)	8.1) Coordinated with the testing lab in order to get all related testing reports of new product for the FDA registration purpose. 8.2) Coordinated with Thai FDA in order to get FDA number of new products for legally commercial purpose.	Coupled logics (Inbound dominance)
9) Testing labs (More than 1 Org.)	9) Provided analytical services and conducted reports related to FDA registration e.g., nutrition fact, f0 value, microbial testing report.	Coupled logics (Inbound dominance)
10) FDA	10.1) Approved product quality (by reviewing testing reports) and provided specific FDA number of new products before legally-launch to the market. 10.2) Provided Certificate of Free Sales (CFS) for exporting new product to foreign market.	Coupled logics (Inbound dominance)

(IX) The Synthesis of the Food-Machinery Flexible Model: Pattern 1

For the model synthesis in the empirical domain, the researcher used the collected data (the involved actors, empirical OI logics and practices) to refine the Food-Machinery framework (Bigliardi & Galati, 2013a) with the purpose to better reflect OI NPD of the investigated Thai SMEs, and proposed the Food-Machinery Flexibility Model.

Step 1: Qualification of the nature of the actors involved in each NPD. The researcher adjusted the key chain actors to the Food-Machinery framework (Bigliardi & Galati, 2013a) by comparing with the concept of Quadruple Helix Innovation (Carayannis et al., 2009), and the various actors in FI studies proposed by Galanakis (2016), and Grimsby and Kure (2019).

Step 2: Qualification of the empirical OI practices in exploration and exploitation using Van de Vrande's (2009) typology. If the observed practice is not described in the typology, it has been added either as an explorative practice or as an exploitative one.

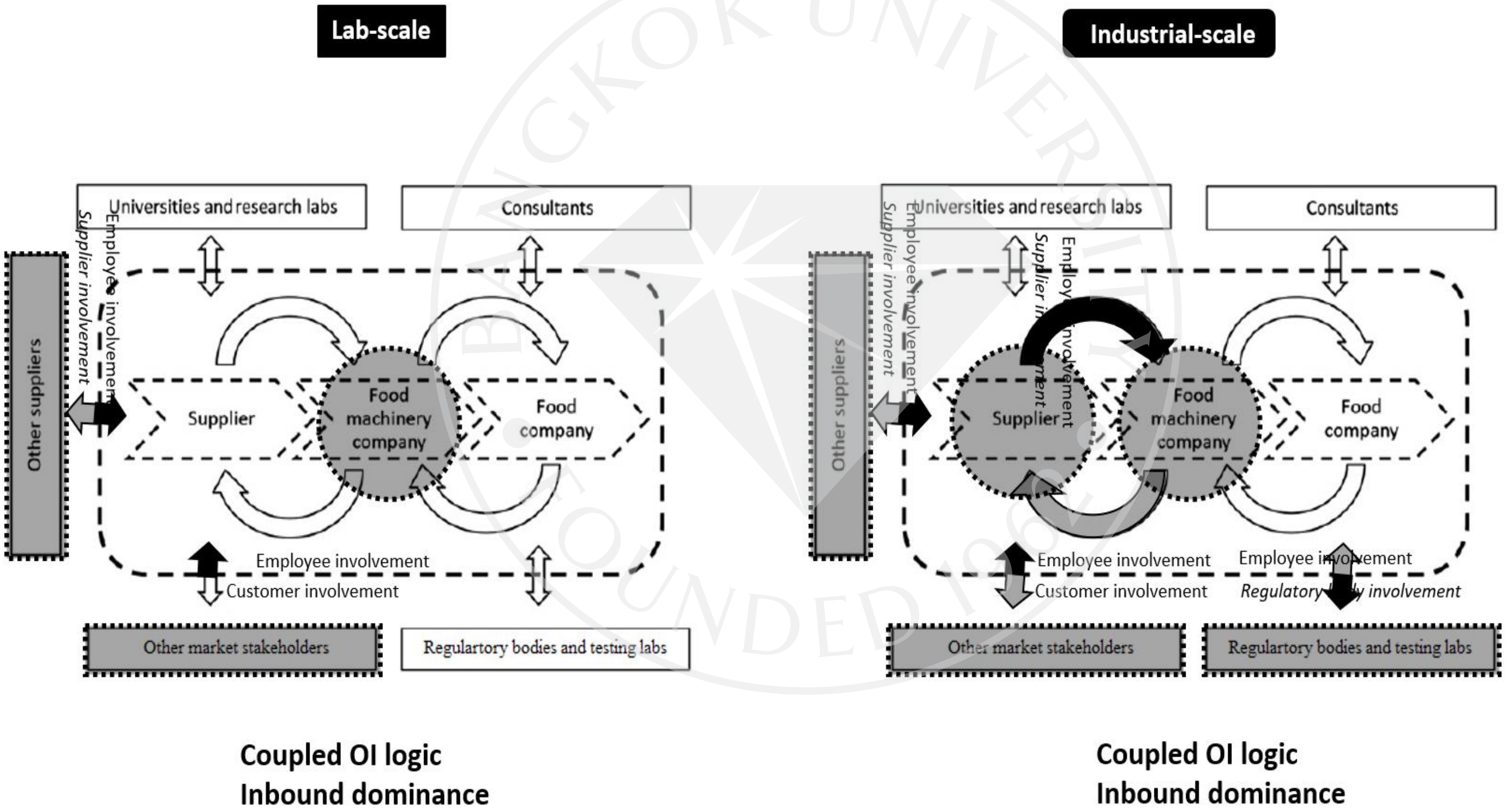
Step 3: Qualification of the OI logics using the flow of the recipe transferring among the partners within the Food-Machinery framework (Bigliardi & Galati, 2013a)

Step 4: Qualification of the NPD process sequence within the Food-Machinery framework (Bigliardi & Galati, 2013a) by seperating into 2 main stages which are laboratory scale and industrial scale (Neubauer et al., 2013).

Step 5: Qualification of the recurrent patterns of the food recipe creator, and the owner of the food recipe (IPR). Based on this information, 6 distinctive patterns of the Food-Machinery Flexible Model are created to separate them based on the inter-organizational recipe knowledge flow. According to the Food-Machinery Flexible Model: Pattern 1 (the development of a food machinery company's new product with its recipe), it was synthesized by the data collected from NPD Case A01 to Case A10 as shown in Figure 4.4. This finding was the initial stage for OI GM identification which determines the choice of specific NPD events.

The synthesis of Food-Machinery Flexibility Model: 1st pattern – the food machinery company's NPD with its recipe.
13 NPDs: **SME [A] = 10 NPDs (Case A01-A10),** SME [B] = 3 NPDs (B15-B17)

***Adapt from the Food-Machinery Framework (Bigliardi & Galati, 2013a)**



(X) The Identification of the Associated factors that Activate the Ability to Implement OI in NPD Group 1

In order to develop Table 4.34, the interview data related to the OI NPD active factors from SME A: Case A01-A10 (OI NPD Group 1) were double-coded, organized and compounded in this section. The repeated keywords /sentences related to ability in implementing OI NPD group 1 were revealed as the dynamic capabilities.

NPD case	Year of FDA registration	NPD initiatives & the associated factors that activate the ability to implement OI	Dynamic capabilities (DCs)
Case A01	2012	Manager did market survey which product match with their production technology. These is the first recipe set of company. Manager gathered ideas of new RTE products from the market. copy & development with cost reduction purpose. The factor that active OI implementation of this NPD case was the Capability to monitor competitors and consumer trends, convert in to tangible product.	Sensing, Seizing, Transforming
Case A02	2012	Manager did market survey which product match with their production technology. These is the first recipe set of company. Manager gathered ideas of new RTE products from the market. copy & development with cost reduction purpose. The factor that active OI implementation of this NPD case was the Capability to monitor competitors and consumer trends, convert in to tangible product.	Sensing, Seizing, Transforming
Case A03	2012	Manager did market survey which product match with their production technology. These is the first recipe set of company. Manager gathered ideas of new RTE products from the market. copy & development with cost reduction purpose. The factor that active OI implementation of this NPD case was the Capability to monitor competitors and consumer trends, convert in to tangible product.	Sensing, Seizing, Transforming
Case A04	2015	Manager noticed the vegetarian food trend through many channels e.g., internet, food event etc. Manager discussed with the marketing company + distributor regarding the vegetarian RTE products. He was suggested to launch new product as fast as possible to cath this trend. He also got the information about specific vegetarian materials which market familiar. Hence, adaptation their previous recipe with vegetarian material was good option. The factor that active OI implementation of this NPD case was the Capability to manage its existing resources to response the rapid change of market.	Innovative capacity

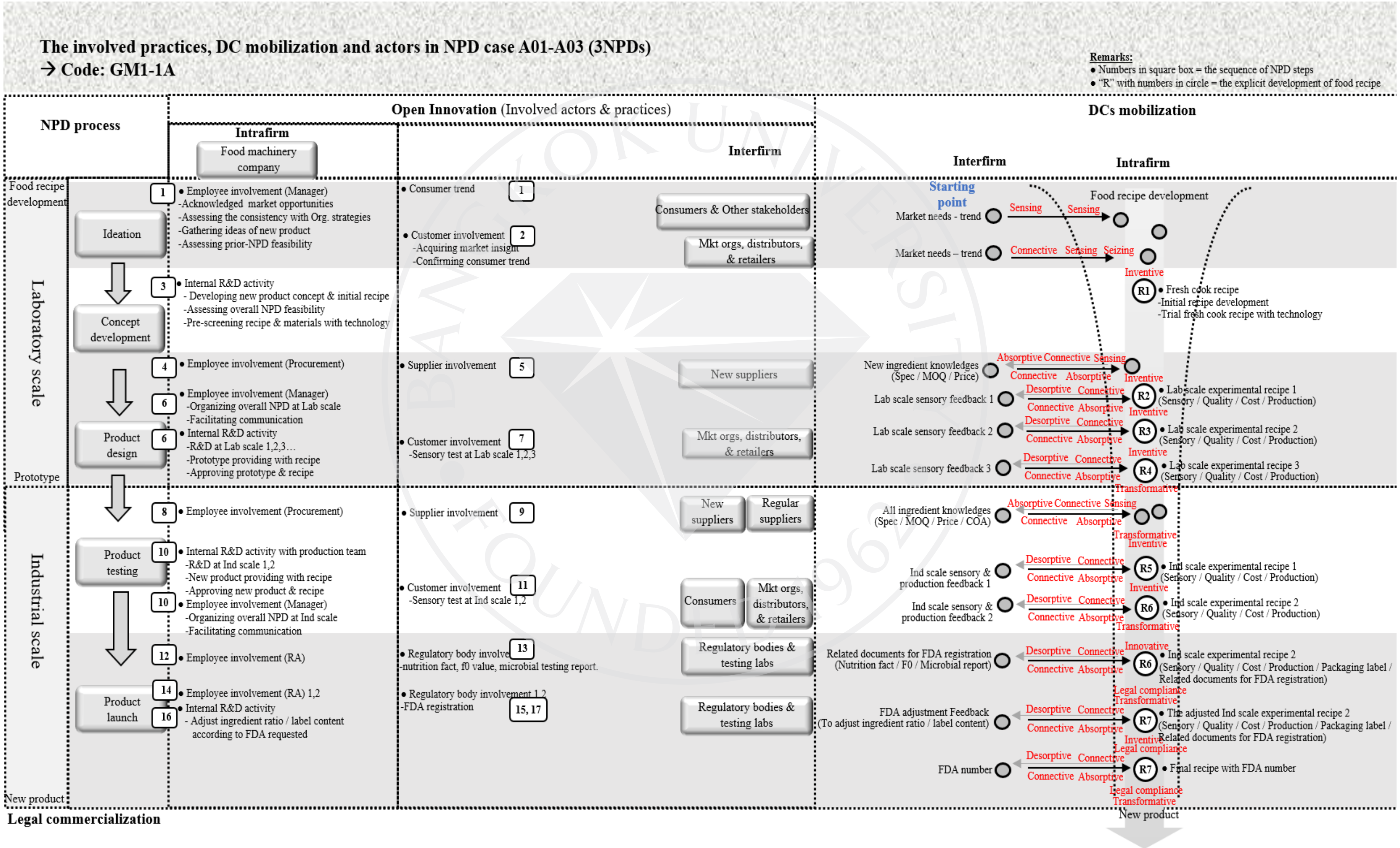
NPD case	Year of FDA registration	NPD initiatives & the associated factors that activate the ability to implement OI	Dynamic capabilities (DCs)
Case A05	2015	Manager noticed the vegetarian food trend through many channels e.g., internet, food event etc. Manager discussed with the marketing company + distributor regarding the vegetarian RTE products. He was suggested to launch new product as fast as possible to cath this trend. He also got the information about specific vegetarian materials which market familiar. Hence, adaptation their previous recipe with vegetarian material was good option. The factor that active OI implementation of this NPD case was the Capability to manage its existing resources to response the rapid change of market.	Innovative capacity
Case A06	2016	Manager noticed the vegetarian food trend through many channels e.g., internet, business meeting etc. Manager discussed with the marketing company + distributor regarding the vegetarian RTE products, got additional feedbcak on healthy trend and the suggestion of local recipes that could match targeted consumers. The factor that active OI implementation of this NPD case was the Capability to transforms intangible idea and concepts into tangible new products. Moreover, the capability to propose new product to market is needed as well.	Transforming, Inventive capacity, Innovative capacity
Case A07	2016	Manager noticed the vegetarian food trend through many channels e.g., internet, business meeting etc. Manager discussed with the marketing company + distributor regarding the vegetarian RTE products, got additional feedbcak on healthy trend and the suggestion of local recipes that could match targeted consumers. The factor that active OI implementation of this NPD case was the Capability to transforms intangible idea and concepts into tangible new products. Moreover, the capability to propose new product to market is needed as well.	Transforming, Inventive capacity, Innovative capacity
Case A08	2015	Manager noticed the Healthy food trend through many channels e.g., internet, consortia etc. Manager discussed with the retailer regarding the Healthy RTE products, and got suggestions of Thai traditional recipes that differentiae from others. The factor that active OI implementation of this NPD case was the Capability to transforms intangible idea and concepts into tangible new products. Moreover, the capability to propose new product to market is needed as well.	Transforming, Inventive capacity, Innovative capacity
Case A09	2017	Manager noticed the Healthy food trend through many channels e.g., internet, consortia etc. Manager discussed with the retailer regarding the Healthy RTE products, and got suggestions of Thai traditional recipes that differentiae from others. The factor that active OI implementation of this NPD case was the Capability to transforms intangible idea and concepts into tangible new products. Moreover, the capability to propose new product to market is needed as well.	Transforming, Inventive capacity, Innovative capacity
Case A10	2018	Manager noticed the Healthy food trend through many channels e.g., internet, consortia etc. Manager discussed with the retailer regarding the Healthy RTE products, and got suggestions of Thai traditional recipes that differentiae from others. The factor that active OI implementation of this NPD case was the Capability to transforms intangible idea and concepts into tangible new products. Moreover, the capability to propose new product to market is needed as well.	Transforming, Inventive capacity, Innovative capacity

(XI) The Synthesis of GMs in the OI NPD Group 1

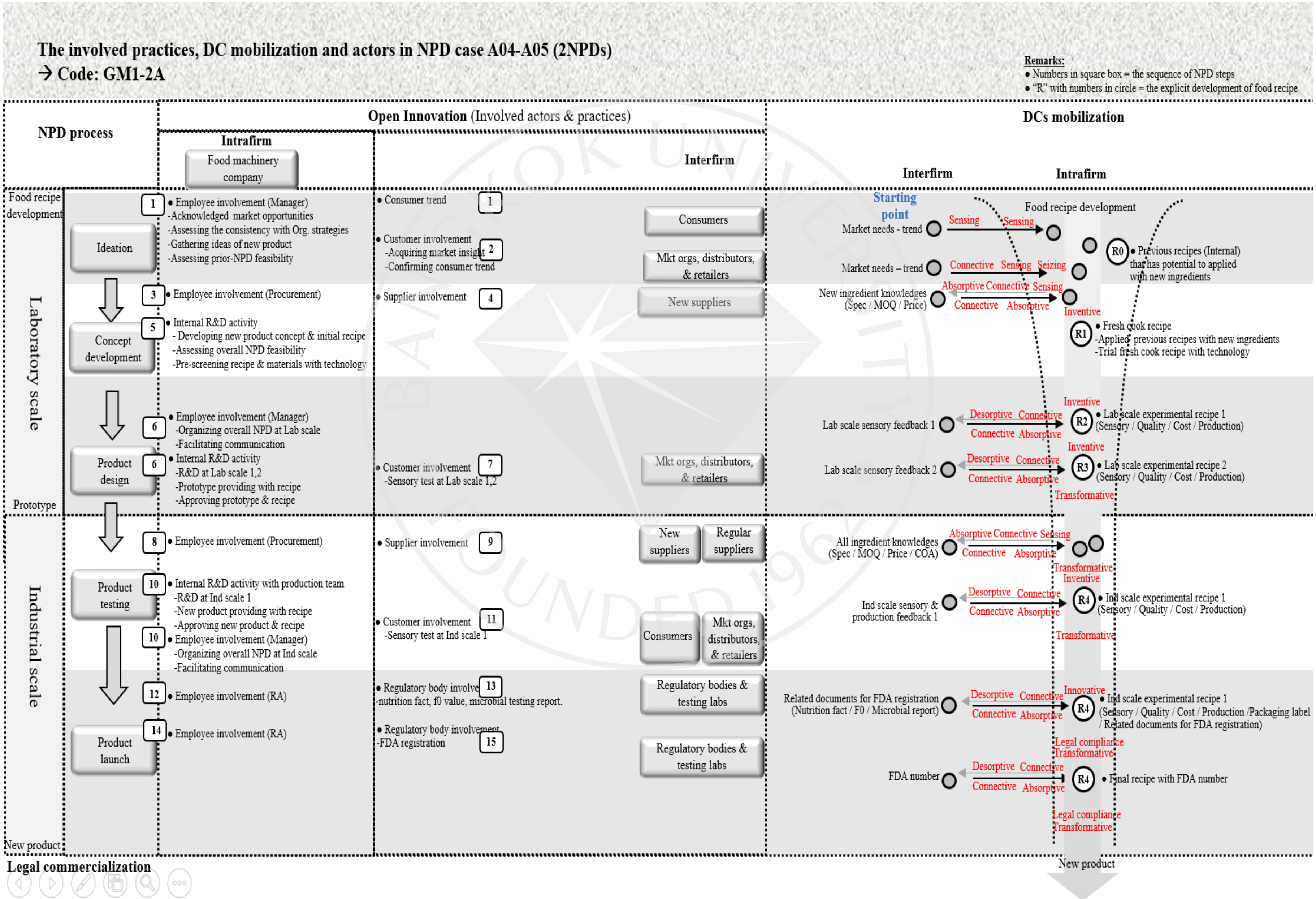
The DCs associated with OI NPDs, namely sensing, seizing (Teece, 2020), absorptive capacity, inventive capacity, connective capacity, transformative capacity, desorptive capacity, innovative capacity (Lichtenthaler & Lichtenthaler, 2009), and legal compliance capacity, were double-coded in Table 4.35.

Therefore, all the related coding themes, namely the involved actors (intrafirm and interfirm), the direction of knowledge flow (OI logics), OI practices, NPD activities, and the associated DCs, were organized and compounded in this section. The DCs mobilization in each NPD event were identified and connected in the entire NPD process. These DCs mechanisms were used for the development of Table 4.36.

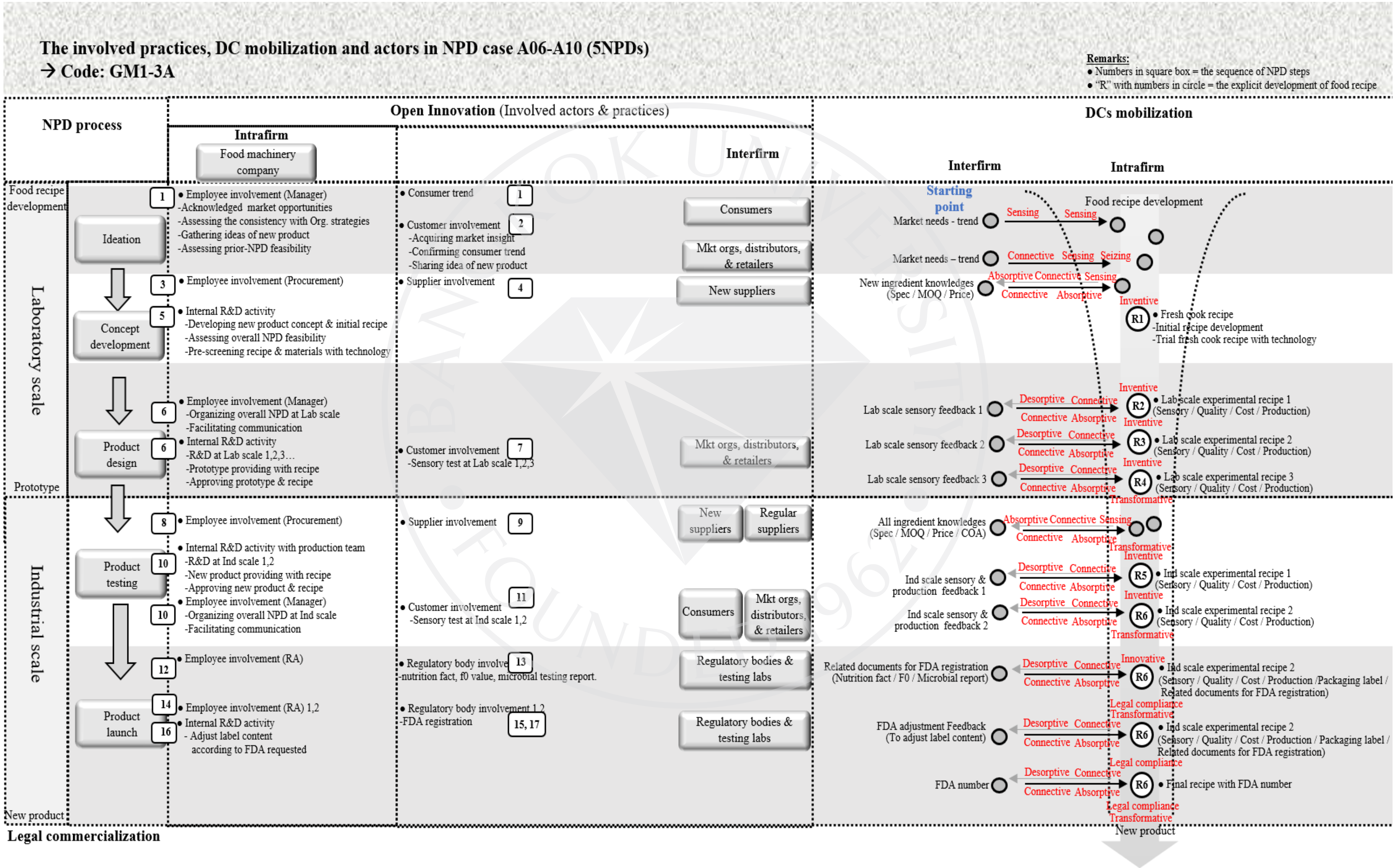
The associated codes from SME A: Case A01-A10 (OI NPD Group 1) were organized and compounded in this section. The OI GM in the first group had 3 different sequences of the same generative mechanism, namely GM1-1A (Case A01-A03), GM1-2A (Case A04-A05), and GM1-3A (Case A06-A10). The researcher adjusted these generative mechanisms into the first pattern of the Food-Machinery Flexible Model as shown in Figure 4.13.



The involved practices, DC mobilization and actors in NPD case A01-A03 (3NPDs)
→ Code: GM1-1A
Remarks:
• Numbers in square box = the sequence of NPD steps
• "R" with numbers in circle = the explicit development of food recipe
NPD process
Open Innovation (Involved actors & practices)
DCs mobilization
Intrafirm
Food machinery company
Interfirm
Interfirm
Intrafirm
Food recipe development
Laboratory scale
Prototype
Industrial scale
New product
Legal commercialization
Ideation
Concept development
Product design
Product testing
Product launch
• Employee involvement (Manager)
-Acknowledged market opportunities
-Assessing the consistency with Org. strategies
-Gathering ideas of new product
-Assessing prior-NPD feasibility
• Internal R&D activity
- Developing new product concept & initial recipe
-Assessing overall NPD feasibility
-Pre-screening recipe & materials with technology
• Employee involvement (Procurement)
• Employee involvement (Manager)
-Organizing overall NPD at Lab scale
-Facilitating communication
• Internal R&D activity
-R&D at Lab scale 1,2,3…
-Prototype providing with recipe
-Approving prototype & recipe
• Employee involvement (Procurement)
• Internal R&D activity with production team
-R&D at Ind scale 1,2
-New product providing with recipe
-Approving new product & recipe
• Employee involvement (Manager)
-Organizing overall NPD at Ind scale
-Facilitating communication
• Employee involvement (RA)
• Employee involvement (RA) 1,2
• Internal R&D activity
- Adjust ingredient ratio / label content according to FDA requested
• Consumer trend
• Customer involvement
-Acquiring market insight
-Confirming consumer trend
• Supplier involvement
• Customer involvement
-Sensory test at Lab scale 1,2,3
• Supplier involvement
• Customer involvement
-Sensory test at Ind scale 1,2
• Regulatory body involve
-nutrition fact, f0 value, microbial testing report.
• Regulatory body involvement 1,2
-FDA registration
Consumers & Other stakeholders
Mkt orgs, distributors, & retailers
New suppliers
Mkt orgs, distributors, & retailers
New suppliers
Regular suppliers
Consumers
Mkt orgs, distributors, & retailers
Regulatory bodies & testing labs
Regulatory bodies & testing labs
Starting point
Market needs - trend
Market needs – trend
Sensing
Connective Sensing Seizing
Inventive
R1 • Fresh cook recipe
-Initial recipe development
-Trial fresh cook recipe with technology
New ingredient knowledges (Spec / MOQ / Price)
Absorptive Connective Sensing
Connective Absorptive
Lab scale sensory feedback 1
R2 • Lab scale experimental recipe 1 (Sensory / Quality / Cost / Production)
Lab scale sensory feedback 2
R3 • Lab scale experimental recipe 2 (Sensory / Quality / Cost / Production)
Lab scale sensory feedback 3
R4 • Lab scale experimental recipe 3 (Sensory / Quality / Cost / Production)
Desorptive Connective
Connective Absorptive
Transformative
All ingredient knowledges (Spec / MOQ / Price / COA)
Ind scale sensory & production feedback 1
R5 • Ind scale experimental recipe 1 (Sensory / Quality / Cost / Production)
Ind scale sensory & production feedback 2
R6 • Ind scale experimental recipe 2 (Sensory / Quality / Cost / Production)
Innovative
Related documents for FDA registration (Nutrition fact / F0 / Microbial report)
R6 • Ind scale experimental recipe 2 (Sensory / Quality / Cost / Production / Packaging label / Related documents for FDA registration)
Legal compliance
FDA adjustment Feedback (To adjust ingredient ratio / label content)
R7 • The adjusted Ind scale experimental recipe 2 (Sensory / Quality / Cost / Production / Packaging label / Related documents for FDA registration)
FDA number
R7 • Final recipe with FDA number
New product



The involved practices, DC mobilization and actors in NPD case A04-A05 (2NPDs)
→ Code: GM1-2A
Remarks:
• Numbers in square box = the sequence of NPD steps
• "R" with numbers in circle = the explicit development of food recipe
NPD process
Open Innovation (Involved actors & practices)
Intrafirm
Food machinery company
Interfirm
DCs mobilization
Interfirm
Intrafirm
Food recipe development
Laboratory scale
Prototype
Industrial scale
New product
Legal commercialization
Ideation
Concept development
Product design
Product testing
Product launch
• Employee involvement (Manager)
-Acknowledged market opportunities
-Assessing the consistency with Org. strategies
-Gathering ideas of new product
-Assessing prior-NPD feasibility
• Employee involvement (Procurement)
• Internal R&D activity
- Developing new product concept & initial recipe
-Assessing overall NPD feasibility
-Pre-screening recipe & materials with technology
• Employee involvement (Manager)
-Organizing overall NPD at Lab scale
-Facilitating communication
• Internal R&D activity
-R&D at Lab scale 1,2
-Prototype providing with recipe
-Approving prototype & recipe
• Employee involvement (Procurement)
• Internal R&D activity with production team
-R&D at Ind scale 1
-New product providing with recipe
-Approving new product & recipe
• Employee involvement (Manager)
-Organizing overall NPD at Ind scale
-Facilitating communication
• Employee involvement (RA)
• Employee involvement (RA)
• Consumer trend
• Customer involvement
-Acquiring market insight
-Confirming consumer trend
• Supplier involvement
• Customer involvement
-Sensory test at Lab scale 1,2
• Supplier involvement
• Customer involvement
-Sensory test at Ind scale 1
• Regulatory body involve
-nutrition fact, f0 value, microbial testing report.
• Regulatory body involvement
-FDA registration
Consumers
Mkt orgs, distributors, & retailers
New suppliers
Mkt orgs, distributors, & retailers
New suppliers
Regular suppliers
Consumers
Mkt orgs, distributors, & retailers
Regulatory bodies & testing labs
Regulatory bodies & testing labs
Starting point
Market needs - trend
Market needs – trend
New ingredient knowledges (Spec / MOQ / Price)
Lab scale sensory feedback 1
Lab scale sensory feedback 2
All ingredient knowledges (Spec / MOQ / Price / COA)
Ind scale sensory & production feedback 1
Related documents for FDA registration (Nutrition fact / F0 / Microbial report)
FDA number
Sensing
Connective
Seizing
Absorptive
Desorptive
Inventive
Transformative
Innovative
Legal compliance
• Previous recipes (Internal) that has potential to applied with new ingredients
• Fresh cook recipe
-Applied previous recipes with new ingredients
-Trial fresh cook recipe with technology
• Lab scale experimental recipe 1 (Sensory / Quality / Cost / Production)
• Lab scale experimental recipe 2 (Sensory / Quality / Cost / Production)
• Ind scale experimental recipe 1 (Sensory / Quality / Cost / Production)
• Ind scale experimental recipe 1 (Sensory / Quality / Cost / Production /Packaging label / Related documents for FDA registration)
• Final recipe with FDA number
New product


The involved practices, DC mobilization and actors in NPD case A06-A10 (5NPDs)
→ Code: GM1-3A
Remarks:
• Numbers in square box = the sequence of NPD steps
• "R" with numbers in circle = the explicit development of food recipe
NPD process
Open Innovation (Involved actors & practices)
DCs mobilization
Intrafirm
Food machinery company
Interfirm
Interfirm
Intrafirm
Food recipe development
Laboratory scale
Prototype
Industrial scale
New product
Legal commercialization
Ideation
Concept development
Product design
Product testing
Product launch
• Employee involvement (Manager)
-Acknowledged market opportunities
-Assessing the consistency with Org. strategies
-Gathering ideas of new product
-Assessing prior-NPD feasibility
• Employee involvement (Procurement)
• Internal R&D activity
-Developing new product concept & initial recipe
-Assessing overall NPD feasibility
-Pre-screening recipe & materials with technology
• Employee involvement (Manager)
-Organizing overall NPD at Lab scale
-Facilitating communication
• Internal R&D activity
-R&D at Lab scale 1,2,3…
-Prototype providing with recipe
-Approving prototype & recipe
• Employee involvement (Procurement)
• Internal R&D activity with production team
-R&D at Ind scale 1,2
-New product providing with recipe
-Approving new product & recipe
• Employee involvement (Manager)
-Organizing overall NPD at Ind scale
-Facilitating communication
• Employee involvement (RA)
• Employee involvement (RA) 1,2
• Internal R&D activity
- Adjust label content according to FDA requested
• Consumer trend
• Customer involvement
-Acquiring market insight
-Confirming consumer trend
-Sharing idea of new product
• Supplier involvement
• Customer involvement
-Sensory test at Lab scale 1,2,3
• Supplier involvement
• Customer involvement
-Sensory test at Ind scale 1,2
• Regulatory body involve
-nutrition fact, f0 value, microbial testing report.
• Regulatory body involvement 1,2
-FDA registration
15, 17
Consumers
Mkt orgs, distributors, & retailers
New suppliers
Mkt orgs, distributors, & retailers
New suppliers
Regular suppliers
Consumers
Mkt orgs, distributors, & retailers
Regulatory bodies & testing labs
Regulatory bodies & testing labs
Starting point
Market needs - trend
Sensing
Sensing
Market needs – trend
Connective
Sensing
Seizing
New ingredient knowledges (Spec / MOQ / Price)
Absorptive Connective Sensing
Connective Absorptive
Inventive
R1
• Fresh cook recipe
-Initial recipe development
-Trial fresh cook recipe with technology
Lab scale sensory feedback 1
Lab scale sensory feedback 2
Lab scale sensory feedback 3
Desorptive Connective
Connective Absorptive
Inventive
Transformative
R2
• Lab scale experimental recipe 1 (Sensory / Quality / Cost / Production)
R3
• Lab scale experimental recipe 2 (Sensory / Quality / Cost / Production)
R4
• Lab scale experimental recipe 3 (Sensory / Quality / Cost / Production)
All ingredient knowledges (Spec / MOQ / Price / COA)
Ind scale sensory & production feedback 1
Ind scale sensory & production feedback 2
R5
• Ind scale experimental recipe 1 (Sensory / Quality / Cost / Production)
R6
• Ind scale experimental recipe 2 (Sensory / Quality / Cost / Production)
Related documents for FDA registration (Nutrition fact / F0 / Microbial report)
• Ind scale experimental recipe 2 (Sensory / Quality / Cost / Production /Packaging label / Related documents for FDA registration)
Legal compliance
FDA adjustment Feedback (To adjust label content)
• Ind scale experimental recipe 2 (Sensory / Quality / Cost / Production / Packaging label / Related documents for FDA registration)
FDA number
• Final recipe with FDA number
New product

(XII) The Summarized OI GMs of Food Machinery SME A and SME B

All various OI GMs from SME A and SME B were organized and compounded in this section. The researcher adjusted these associated generative mechanisms into each pattern of the Food-Machinery Flexibility Model to represent the actual and real domains. Hence, the flexible connection of mechanisms / DC sequences underlying each OI NPD pattern revealed the identification of 6 GMs of food OI NPDs in the real domain as illustrated in Figures 4.13 to Figure 4.18.

NPD group	SME A				SME B			
	OI generative mechanism	NPD amount (case)	Case number	Number of recipe development in each NPD (time)	OI generative mechanism	NPD amount (case)	Case number	Number of recipe development in each NPD (time)
1st group	GM1-1A	3	Case A01-A03	7	GM1-1B	3	Case B15-B17	3
	GM1-2A	2	Case A04-A05	4				
	GM1-3A	5	Case A06-A10	6				
	Total 3 GMs	**10**	**NPDs**	Average 6 times	**Total 1 GM**	3	**NPDs**	3 times
2nd group	GM2	2	Case A11-A12	5				
	Total 1 GM	2	**NPDs**	5 times				
3rd group	GM3-1A	9	Case A13-A21	3				
	GM3-2A	2	Case A22-A23	3				
	Total 2 GMs	11	**NPDs**	Average 3 times				
4th group	GM4-1A	3	Case A24-A26	7	GM4-1B	5	Case B01-B02, B05-B06, B10	6
	GM4-2A	6	Case A27-A29, A32-A34	7	GM4-2B	6	Case B03-B04, B07-B09, B11	5
	GM4-3A	2	Case A30-A31	7	GM4-3B	1	Case B12	5
	GM4-4A	10	Case A35-A36, A42, A46-A49, A51-A52,A55	7				
	GM4-5A	6	Case A37-A38, A41, A50, A53-A54	7				
	GM4-6A	2	Case A39-A40	7				
	GM4-7A	3	Case A43-A45	6				
	Total 7 GMs	32	**NPDs**	Average 7 times	**Total 3 GMs**	12	**NPDs**	Average 6 times
5th group	GM5-1A	3	Case A61, A65-A66	4	GM5-1B	2	Case B13-B14	2
	GM5-2A	9	Case A56-A58, A62-A64, A83-A84, A86	4				
	GM5-3A	14	Case A67-A80	3				
	GM5-4A	2	Case A59-A60	2				
	GM5-5A	1	Case A87	4				
	GM5-6A	2	Case A81-A82	3				
	GM5-7A	1	Case A85	5				
	Total 7 GMs	32	**NPDs**	Average 4 times	**Total 1 GM**	2	**NPDs**	2 times
6th group	GM6-1A	3	Case A89-A91	4				
	GM6-2A	1	Case A88	4				
	GM6-3A	1	Case A92	4				
	Total 3 GMs	5	**NPDs**	Average 4 times				
Total GMS of SME A = 23 GMs		92	NPDs		Total GMS of SME B = 5 GMs	17	NPDs	

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