

Defining Technopreneurs' Commercialization Research Process in the Emerging Thai Economy: Research for Constructing Grounded Theory

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Abstract – This research aimed to 1) define sources of meaning in technopreneurs' commercialization research process, 2) establish the common features of technopreneurs' commercialization research process, and 3) construct a grounded theory of technopreneurs' sources of meaning and commercialization research process. The study employed a qualitative ground theory approach to explain the phenomena and develop theoretical conclusions. Data was gathered through in-depth interviews with 15 technopreneurs using theoretical sampling. The interviews used open-ended questions, and the resulting data were analysed via analytic induction to define concepts and construct the grounded theory. The results indicated that technopreneurs elicited sources of meaning through the commercialization research process, which were categorized into three features of idea development with passion, integrated business model development, and innovative and technological business networking.

The commercialization research process includes eight stages: 1) business opportunity assessment, 2) technopreneurial mindset and passion development, 3) technology assessment and exploitation, 4) co-research and application to new product development, 5) technopreneurship incubation and business networking, 6) business planning for innovation commercialization, 7) continuous product improvement, and 8) sustainable technopreneurship and development. Finally, this research constructed theoretical conclusions, discussing and suggesting approaches for improving technopreneurs' commercialization research process and future research directions.

Keywords – Commercialization research, technopreneurs, technopreneurial activities, grounded theory, Thai economy.

1. Introduction

The Internet can be applied and used in a wide variety of ways. It offers opportunities to create innovative technology-based businesses online, which, in turn, promote economic growth, political involvement, and new forms of cultural expression. Through the Internet, entrepreneurs are able to develop and promote their goods and services in the market without having to make a large investment, and consumers have easy access to those products and services at a lower cost. In addition to this, citizens can more easily access news and be exposed to new political concepts from various sources, exchange ideas in public platforms created on the Internet, or even create content on their own [1], [2], [3]. Numerous studies have reported that the Internet has helped create new opportunistic cultures in various dimensions. In the economic realm, the Internet fosters a culture of entrepreneurship and creates a culture of informed consumption.

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In the electoral arena, the Internet also increases public access to information to help voters make decisions and increase participation in the electoral process [4], [5], [6]. Politically, it can also lead to citizen-driven social movements [7]. The Internet facilitates more comprehensive access to media overall, which may inspire the public to create their own content [8]. Finally, in the educational arena, learners have more freedom to independently seek knowledge and manage their own learning [9]. The Organization for Economic Co-operation and Development (OECD) [10] has noted the significance of the Internet in boosting overall economic production in four domains of expansion: commercial and investment networks and skilled labor movement; experiments in new business and technological models by new companies and entrepreneurs; maximum use of limited resources, such as labor, investment, and skills; and investment in innovations for economies that maximize the use of technology. In addition, the Internet offers opportunities to access information, connect with other individuals and businesses, and open new markets. These are a major driving force for various domains of change in business, including trade channels, design, manufacturing, marketing, product distribution, and services, collectively known as e-commerce. The United Nations Conference on Trade and Development (UNCTAD) estimated that the net value of global e-commerce increased to \$26.7 trillion in 2019, accounting for 30% of the global gross domestic product (GDP), a 4% increase from 2018 (\$25.6 trillion), which was considered a tremendous economic increase [11]. As for Thailand, the net value of e-commerce has steadily increased. In 2021, the total value was equal to \$0.12 trillion, representing a 6.11% increase from the previous year [12]. This clearly reflects the opportunities available for new entrepreneurs and existing businesspersons to use technological tools and digital innovations to their advantage.

Entrepreneurs, referring to individuals or groups of individuals who seek opportunities to start new businesses, are essential for the socioeconomic development of a country [13], [14], [15]. Entrepreneurs tend to be risk-takers who have a passion to continuously develop new businesses or further develop existing businesses [16]. Groups of entrepreneurs often have the potential to combine various resources to achieve business success [17]. In Thailand, entrepreneurs tend to own small and medium-sized enterprises (SMEs), which play a significant role in the Thai socio-economy. As noted in the report on the situations of SMEs in Thailand in 2021, a total of 3,178,124 SMEs had a growth rate of 1.39%, which is equal to 99.57% of the total enterprises in the country, employing 12,601,726

people representing 71.86% of the total national employment. The GDP attributable to SMEs was 5,603,443 million Baht, or 34.60% of the national GDP, increasing from 34.20% in the previous year. Moreover, the national GDP in the first half of 2022 grew by 4.1% compared to the same period last year, accounting for 35.1% of total national GDP [18]. Entrepreneurs are clearly key players in the socioeconomic development of Thailand; particularly those with technological skills and sufficient investment and who are situated in an economic environment that facilitates business growth. This implies a transition to what is known as “technology entrepreneurship.” In brief, technology has a significant influence on business operations that are continuously and rapidly evolving [19].

The term “technopreneur” is a combination of the terms “technology” and “entrepreneur” [20] and refers to business operators that use multidisciplinary methods, including evaluation and use of new technology to operate businesses such as manufacturing, trade, transportation, and other forms of business to ensure that the products delivered to customers are unique, diverse, connected, and able to meet changing needs and technological capabilities. Technopreneurs also refer to those who initiate new business opportunities through the use of technology, which can result in the manufacturing of new products or services for commercial purposes [21]. Finally, technopreneurs can be defined as entrepreneurs who leverage the innovations of researchers working at educational institutions for profit [22], [23], [24], [25], [26], [27] by employing a systematic work process [28],[29]. This indicates that technopreneurs are businesspeople equipped with the potential to survive, grow, and prosper due to a higher level of technical knowledge and insight compared with average businesspeople.

Several previous types of research are studying technopreneurship. For example, Saludung and Pramezwary [30] conducted research and development in the laboratory and aimed to develop cassava products into noodles and tasteless bread with a technology touch (technopreneurship). Aqidawati et al. [31] and Habibie et al. [32] studied a technopreneurship model suitable for a technological basis using comparative research of innovation of battery technology products and electric motorcycle conversion products, respectively. Meanwhile, Al Hashimi et al. [33] examined the relationship between the success of tech startups and the educational backgrounds of their owners. Alkhoori et al. [34] developed a new leadership model for successful technopreneur. Moreover, Chen et al. [35] explored a tribally owned manufacturing enterprise’s efforts to implement new strategies for expansion and diversification.

Saludung et al. [36] presented a study that aims to develop technopreneurship and ecopreneurship of yellow pumpkins based on factory products. In addition, Polyakov [37] proposed the main lessons of the development of technopreneurship in a specific region and showed the path for creating regional growth hubs and their embedment in global networks. Esponilla et al. [38] demonstrated the issues and challenges hindering the development of effective technology business incubation. Furthermore, Wijaya and Saudi [39] conducted to determine the role of universities in the printing techno while creating a strategy that may be used as a reference for universities that want to set up a technopark as a science entrepreneur training. Meanwhile Nassar and Muhamad [40] examined how culture influences innovation among technology startups, explored factors associated with technology innovation, and assessed how innovation influences financing for technology startups. Finally, Khofiyah et al. [41] introduced a framework for developing technopreneurship and innovation systems in agricultural drone technology development.

However, research on technopreneurship commercialization is limited. A few studies included the complexities and difficulties of the startup process to achieve practical outcomes [42], the cycle of technopreneurship in university spinoffs of academic entrepreneurs [43], strategies that can be used for startup based technology to commercializing an e-motor cycle [44], and the effectiveness of the business incubator and its impact on commercialization strategies based on incubatees' aspirations in three business incubators [45]. However, only little research had pursued the definition and process of technopreneurship commercialization research. To the best of our knowledge, no studies had been conducted on the technopreneurship commercialization in the context of Thailand. The country has benefited from a decade of public investment in innovation infrastructure, such as science parks, from government agencies. Moreover, from 2018, Thailand embarked upon a strategy of transformation, moving to become an innovation-driven economy under the Thailand 4.0 policy, which highlighted opportunities and investment trends in ten targeted industries divided into two broad categories: the initial five being "S-Curve industries" and the further five being "S-Curve industries" [46].

To fill this gap, this study was conducted to define technopreneurs' commercialization research process. The research questions were:

- 1) What are the definitions and backgrounds related to the commercialization research process?
- 2) How does technopreneurs' commercialization research process operate?

Grounded theory methodology was employed to describe and define technopreneurs' commercialization research process and develop theoretical abstract and evidence-based conclusions. The findings of the present study were anticipated to lead to a more comprehensive understanding and awareness of technopreneurs' commercialization research process. These conclusions can be used by related agencies and organizations to devise plans for developing and assisting technopreneurs with regard to commercialization. It is also hoped that the study findings will motivate technopreneurs to use digital technology and innovations more effectively in management, strategic planning, and competitiveness based on the application of technological knowledge to improve existing business operations, thus enabling such advances to become important mechanisms for the development of SMEs' and the overall digital economy of the nation.

Research objectives

- 1) To investigate the definitions and backgrounds of technopreneurs' commercialization research process.
- 2) To explore technopreneurs' commercialization research process.
- 3) To apply a grounded theory methodology to the resulting definition and identified processes of technopreneurs' commercialization research.

2. Methodology

This study applied qualitative research based on the grounded theory methodology [47]. The researcher employed the concepts of interpretivism and constructivism to define a new theory based on the ideas of key informants, along with the use of theoretical sampling. This strategy is selected because it enabled us to be receptive to diverse points of view, set aside preconceived notions, and express the data while integrating literature, data, and experience [48]. A phenomenon was investigated to examine and elucidate the commercialization research process, which was then developed into a concept and theory based on social truth. A hypothesis was then formulated, and a theoretical explanation based on the data directly collected on the topic was formulated [47]. This methodology enabled the researcher to elaborate on a logical concept that was used as a temporary hypothesis for interview guidelines to enable interactions with the key informants of the study. Data was collected, and the hypothesis was alternately revised until both data saturation and theoretical saturation were achieved [49].

Data collection was discontinued when the researcher repeatedly collected the same data with no new themes emerging [50]. Following this process, theoretical generalization was employed to explain what had been studied, and the definitions, background, and technopreneurs' commercialization research process were developed.

The present research sought to investigate the definition, background, and technopreneurs' commercialization research process and propose a theoretical conclusion. A qualitative methodology was employed to construct the grounded theory [49]. After having studied related concepts and research, the conceptual framework of the study was designed based on the grounded theory building process of Rodon and Pastor [51], as presented in Figure 1.

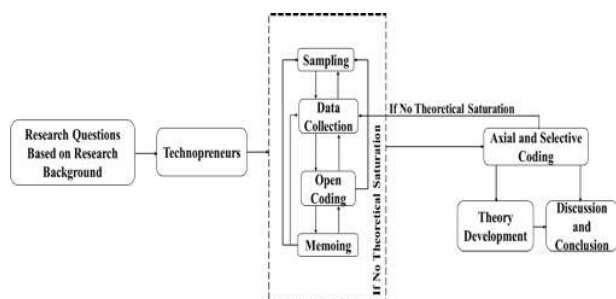


Figure 1. The conceptual framework of the study. Source: Adapted from Rodon and Pastor [51].

2.1. Major informants and sampling method

Theoretical sampling was employed to recruit the key informants of the study based on the premise that the key informants must be suitable and consistent with the research objective [52]. In this study, purposive sampling was employed using snowball sampling [53]. For this process, the researcher selected technopreneurs who possessed the following characteristics: 1) they had been certified as new technopreneurs, based on the criteria specified by the National Science and Technology Development Agency (NSTDA); 2) they were administrators who were chief innovation officers, CEOs, or founders of a technology business; and 3) they had at least 5 years of work experience. After selecting the key informants who met the inclusion criteria, the researcher conducted interviews. The key informants were also asked to recommend other technopreneurs who met the inclusion criteria for the researcher to interview. This process continued until the researcher was able to collect sufficient data to answer the research question. The informant information is presented in Table 1.

Table 1. Key Informant Details.

Pseudonyms	Business Type	Position	Experience (Years)
A	Food, Agriculture & Biotech	Chief Innovation Officer	16
B	Health, Wellness & Bio-Med	Founder	20
C	Digital & Internet of Things	Chief Innovation Officer	5
D	Electronic Commerce	Founder	12
E	Food, Agriculture & Biotech	Founder	15
F	Electronic Commerce	Chief Innovation Officer	10
G	Education Technology	Chief Innovation Officer	11
H	Health, Wellness & Bio-Med	Founder	8
I	Smart Devices	Founder	5
J	Food, Agriculture & Biotech	Chief Innovation Officer	11
K	Health, Wellness & Bio-Med	Founder	9
L	Digital & Internet of Things	Chief Innovation Officer	6
M	Food, Agriculture & Biotech	Founder	5
N	Food, Agriculture & Biotech	Founder	18
O	Electronic Commerce	Chief Innovation Officer	10

Source: Compiled by author based on in-depth interviews.

2.2. Research instruments

This study used four instruments of data procurement, as delineated below.

2.2.1. Key informant selection

The researcher selected key informants, collected data, and reported the data, as the most appropriate data collection/interview instrument. The researcher needed to have knowledge on the research topic, the ability to ask questions and understand the informants' replies, and to establish a rapport with the interviewees [47].

In addition, the researcher needed to have theoretical sensitivity, which was ensured by reviewing related documents, concepts, and theories on technopreneurs' commercialization research process prior to preparing the interview questions based on the conceptual framework of the study.

2.2.2. The interview questions

The interview questions were prepared for semi-structured in-depth interviews to ensure that the key informants were able to answer the questions as completely as possible. The questions used in the interview were related to the definition, background, and technopreneurs' commercialization research process, covering the research objective and related issues, and were divided into three parts: 1) questions on key informants' demographic characteristics, which require respondents to provide their business type, position, and experience; 2) questions on the definition and background of technopreneurs' commercialization research. This question was designed to collect respondents' opinions on the definition and source of technopreneurs' commercialization research, and 3) questions on key informants' perceptions regarding technopreneurs' commercialization research process. These were designed to gather the opinions of respondents on the steps of technopreneurs' commercialization research process.

2.2.3. Fieldnote observation tools

The fieldnote observation tools included notebooks, pencils, pens, and erasers to make notes of the data obtained during the interviews, including informants' demographic characteristics, details on the answers, perspectives, and emerging opinions. In addition, notes recorded observational data, including considerations such as informants' gestures, facial expressions, personalities, and body language, as well as the atmosphere of the interviews, to aid subsequent observational data analysis.

2.2.4. A voice recorder

A voice recorder was used to record informants' interview responses to ensure data completeness. The recorded data were used along with fieldnote data recorded to ensure that there are no inconsistencies in the data elicited from the informants.

2.3. Data collection

The present study applied qualitative research to examine a social phenomenon, with an emphasis on data regarding insiders' thoughts, perspectives, and opinions [54], [55].

Both primary and secondary data were collected using the techniques outlined below.

2.3.1. Primary data

Primary data were derived from semi-structured interviews and non-participation observations recorded as fieldnotes. Interviews and data analysis were conducted simultaneously. The researcher developed the initial concept based on the first key informant interview, explanations were sought following the interview, and a temporary hypothesis was formulated as an interview guideline for the next key informant. Data were collected from technopreneurs until data and theoretical saturation were achieved, at which time the data collection was completed.

2.3.2. Secondary data

Secondary data were retrieved from a review of documents, textbooks, academic reports, journal articles, and previous research through search platforms, such as the Scopus database. The world's well-known largest abstract and citation databases have thousands of documents and journals from various titles, fields, scopes and international publishers.

2.3.3. Field data observation

Observational field data began when the researcher contacted and made an appointment with key informants for an interview. The researcher explained the objective of the data collection and data use and ensured anonymity and confidentiality, so that the informants would be willing to cooperate in the data collection. Before the start of the interviews, the researcher asked for permission to audio-record, and data collection based on the interview guide commenced. After data regarding the informants' demographic characteristics were collected, the researcher asked questions about the definition of the technopreneur's commercialization research process prior to moving on to the commercialization research process itself. This process was continued until emerging issues were fully explored and data saturation was achieved. The researcher then ended the interviews. It is notable that during the interviews, the researcher ensured that a congenial atmosphere was created to establish the key informants' trust in the researcher and to ensure their honest and forthright cooperation in the process of data collection. The researcher took notes on prominent issues and observed the informants' behaviors, gestures, and facial expressions during interviews. The interviews lasted from 45 min to 3 h.

2.3.4. Protection of the rights of human subjects

This research was approved by the Institutional Review Board on Research Involving Human Subjects of Silpakorn University (approval code number: COE 63.0729-059). The researcher included an information sheet on the first page of the questionnaire, and data were collected only from those who signed an informed consent form indicating their willingness to participate in the study. The data collected in this study were then comprehensively analysed as anonymized group data, solely for academic purposes.

2.3.5. Data analysis and validation

Triangulation [56] was employed to reduce interpretation errors with regard to various perspectives to confirm clear and correct meaning. Triangulation included data triangulation, methodological triangulation, and theory triangulation.

1) Data triangulation was conducted by examining the three data sources: time, location, and person. As for time, the researcher examined data collected at different time points, comparing them to assess whether any change or inconsistency was evident. Regarding location, the researcher examined the credibility of the data elicited by means of interviews with different individuals in various places. Finally, the researcher considered the different demographic characteristics of key informants.

2) Methodological triangulation was executed through the process of supplementing interview data with non-participation observations and document analysis.

3) Theoretical triangulation was accomplished by examining the same data retrieved from various sources with different theoretical concepts prior to constructing negative cases until theoretical saturation was achieved.

Data were collected and analysed throughout the data collection stage and were recorded in detail to investigate the phenomenon under study; the recorded interviews were also transcribed verbatim. Typed transcriptions were then reviewed, coded, and interpreted. Preliminary data analysis was conducted throughout the data collection period, and categorization was employed to group similar data. In addition, only data that were directly related to the study objective were retained, analysed, and highly abstracted to elicit associated concepts and theories prior to categorization, adding details based on identified variables' quality and qualifications. Categories of concepts eventually became the conditions and theoretical conclusions that were presented as patterns called the grounded theory [52].

3. Results and Discussion

The study results and discussion about the defining technopreneurs' commercialization research process in the emerging Thai economy: research for constructing grounded theory can present by dividing into two points including 1) results, and 2) discussion, as delineated below.

3.1. Results

The study results about the defining technopreneurs' commercialization research process in the emerging Thai economy: research for constructing grounded theory can describe by dividing into two points including 1) definition, background, and technopreneurs' commercialization research process, and 2) technopreneurs' commercialization research process, as delineated below.

3.1.1. Definition, background, and technopreneurs' commercialization research process

Based on the study results, technopreneurs' commercialization research process was defined in diverse ways by different technopreneurs. Its definitions can be classified into three groups, as presented in Figure 2.

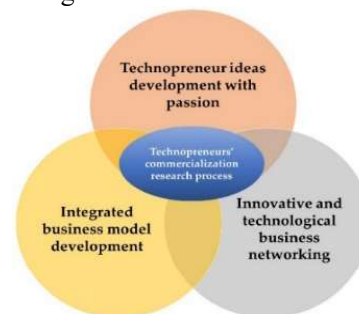


Figure 2. The definition of technopreneurs' commercialization research process.

3.1.1.1. Technopreneur idea development with passion

This concept refers to the transformation of ideas into actions initiated with determination, including the generation of different ideas and development of the ability to seek business opportunities with plans for new products or services based on research and development to create a product prototype to be launched in the commercial market. It also encompasses plans for appropriate economic ecosystems, focusing on the sustainable business growth from a national to an international level. This began with the entrepreneurs' drive to become successful business owners by starting new, challenging businesses.

These individuals were willing to invest their energy, ideas, and financial resources to seek new knowledge and experience and to develop new products and innovations while overcoming any obstacles or barriers that they may have faced, as one of them described:

It began with my interest in new inventions that eventually became patented. There was one customer who was a dentist who consulted me when his equipment became broken or defective and he was unable to get it fixed. It was very difficult to buy the spare parts needed. Thus, due to my personal interest, I began repairing the equipment for my customer myself. The customer said that if I was able to do this, I could become a freelance worker who could repair equipment all over the country. Then, I began to realize a business idea that was clear and could be done on a larger scale. I thought about the technology that could be my solution and a distinct innovation. I was able to solve problems in terms of price, service, and availability. I was able to consult the Office of Innovative Business Incubation Center to ask for information and advice on business startup. I then had a question in mind. I thought, why don't I quit my job and start my own company? In the end, I founded a company working on medical and health equipment with the internal driving force being that where there were problems, there would be money and opportunity. I also value making dreams come true—I want to expand my business from a national level to an international level for sustainability. (Pseudonym B)

3.1.1.2. Integrated business model development

This refers to technopreneurs' definition of the commercialization research process as a business operation pattern that is appropriate and able to induce customers' return for related products or services. The development of this type of business requires the interconnected of a body of multidisciplinary knowledge to create new knowledge for research and development of products to ensure functionality and suitability for actual industry with measurable outcomes. This led to new, launchable products or services to successfully achieve established goals. This process was considered both an art and a science of business operation, as noted by one interviewee below.

Innovation business requires the design of a business model that is suitable for present-day business operation. The emphasis is placed on the customers' demands because they are our patrons. We have to do something better than others, which makes the customers return to us for more purchases.

Only when this happens can we consider our business successful. In fact, technology and innovation business requires multidisciplinary knowledge from various fields and perspectives to attract more attention from the market. (Pseudonym D)

3.1.1.3. Innovative and technological business networking

This process was defined by technopreneurs as collaboration between entrepreneurs and related stakeholders in the industry, from the beginning to the middle and the end of the supply chain. It also involves coordination across fields, including both directly and indirectly related industries and government agencies working on research and development, investment promotion, production, management of intellectual property, and business incubation to establish new research and development. Traditional technological solutions require transformation to develop a new platform based on research and development of future technology. Business networking also encompasses the potential for marketing innovation, sales, and services, as well as the advancement of entrepreneurship skills, new product launches, protection of intellectual property, and the establishment of an innovative community based on appropriate and sustainable technology and an economic ecosystem.

In every business, there is always someone who takes control of the business. We are a new business, so we need to compete with others. We need to find partners who understand us, who are caring, and who are givers. This is very important. Nothing beats truly understanding people. Becoming part of the innovation incubation center has made me realize the scope of work as well as how to contact different agencies and organizations. This is because the world is beyond Thailand and ASEAN, so having a network and knowing people means we will be taken care of, our new products will be protected, and help will be offered. In Thailand there are many agencies and offices that offer support. It is our job as entrepreneurs to learn and make use of the mechanisms available. We need to realize our dreams. We are fortunate to have public mechanisms that drive us by creating a suitable ecosystem such as Startup Studio to create new startup businesses with an emphasis on research, innovation, and education, together with searching for sources of financial support and use of various IT platforms to distribute products, do marketing work, and offer aftersales services. This allows our passion to become reality, and we can launch our products in both local and global markets. (Pseudonym J)

3.1.2. *Technopreneurs' commercialization research process*

The analysis of the data collected from the key informants revealed eight steps of technopreneurs' commercialization research process, as delineated below.

3.1.2.1. *Business opportunity assessment*

This is an important first step in technopreneurs' commercialization research process. The key informants tended to start by seeking answers with regard to how their business could offer customer and the industry solutions. They investigated industrial problems and transformed them into innovations by consulting with public agencies that had publications issued through different media, such as the National Innovation Agency and the NSTDA. From the questions raised by the industrial sector, brainstorming was performed along with a search for research and development that could be used to solve problems. The gap in marketing and feasibility based on new technology was identified, with entrepreneurs closely and continually monitoring the work to ensure desirable outcomes, including access to investment, establishment of business networks, overseas product contests, product exhibitions, search for business partners, and registration of Thai innovation to create opportunities and ensure business success. To successfully take advantage business opportunities, entrepreneurs needed to establish readiness, including personnel development, knowledge, resources, and organizational culture.

We have to understand the problems and the difficulties we have. We have to constantly search for opportunities amidst the problems we have. For example, what we should do if the equipment is costly, where we can find spare parts for the repair, what we should do if we cannot have it fixed in time, etc. We have to look at business problems as opportunities for innovation and follow through on them with aftersales services that are innovative to pay back our users who have to invest a lot with us. We also need to assess the situations and think of a backup plan. We have to constantly follow up on information on the selection of persons who want to become entrepreneurs who can undergo training organized by the public sector because it helps us expand our network. We will also receive knowledge transfer and participate in the exchange of ideas and information. In addition, we need to follow up on whether there is an educational institution that is interested in business resulting from research and development with available costs and a company model, but without a clear business plan. (Pseudonym A)

3.1.2.2. *Technopreneurial mindset and passion development*

This is the second stage in technopreneurs' commercialization research process. The key informants in this study described their success in the establishment of a technology and innovation business that enabled them to conduct new research and development and transform it into new products and services that could be effectively used. They explained that they had to have innovation and to work harder, but the outcomes would also be more favorable. Thus, technopreneurs had strong determination, vision, and the ability to "think big." Technopreneurs' determination began with the first investment, which came from their own or their family's savings. They searched for business solutions by contacting experts or "gurus" in the field. From a small operation, the business gradually expanded until it became successful. The technopreneurs made the decision on the creation and development of an innovation, with a focus on forming the business.

I was looked down on by my friends, as just an employee with no savings and no success even though I was highly educated. They asked why I could not make it. Then I received advice from my customer who said that as a freelance worker I could work all over the Kingdom of Thailand. The customer asked why I didn't quit my job and start my own business. He said I knew how to do my job very well, so I should reap the benefits of my own work. I had to do it. I had to follow my dreams. Therefore, I decided to quit my job and follow my dreams of establishing a new business that will be remembered by the world. I needed to realize my longstanding dream. I also needed financial stability. I used my own savings and I received support from my family. (Pseudonyms K)

3.1.2.3. *Technology assessment and exploitation*

All key informants had the determination to develop new technology for commercial purposes; thus, the research that took place in a laboratory had to be revised and adjusted to suit actual use in the field. When the technopreneurs tested their innovations, if they came across challenges, they would consult experts until their innovation was usable and yielded the intended outcomes. When assessing the technology and its exploitation, technopreneurs chose the technology, innovation, techniques, and tools that suited the problems they were facing. Technology assessment and exploitation enabled them to appropriately determine business strategies and business models to assess field use and then expand to other fields, both domestically and abroad.

Technology assessment and exploitation also included the application and integration of the technology design, intellectual property, engineering techniques, and feasibility studies of startup business's innovations, as explained below:

The creation of quality innovation involved the selection and application of more than four technologies to solve problems related to medical equipment imported from overseas that became defective, but there was a lack of personnel who could fix such defects with expertise, or the medical equipment was broken due to a power shortage or flood. Before this, the technopreneur had brought up this problem, but nobody paid attention. They reasoned that it was not possible in the actual context of Thailand. Therefore, the technopreneur needed to have determination to continue developing the technology until it became stable and ready for use in all conditions. When a major flood occurred in Thailand, a lot of medical equipment was damaged and became unusable. However, the innovation of the technopreneur was still intact and could be implemented. This technological development helped increase sales volumes and business growth rates from 3% to 8%. More importantly, it created a new standard for Thai medical equipment as it was successfully registered as a Thai innovation. (Pseudonym H)

3.1.2.4. Co-research and application to new product development

One key informant explained:

We are lucky because the existing public mechanisms, particularly regarding research and development, have become an important force that drives business operation, thus enabling us to solve problems and making us determined to create new technology and innovation business. Thus, our work can be launched in both local and international markets, which means more revenue for the country. (Pseudonym G)

The projects supported by the government included research to solve entrepreneurs' challenges, joint research collaboration, and granting of rights for existing research, among other factors. The government supported collaboration between government personnel and private individuals to ensure the exchange of information and knowledge. Support from the government was also available in the form of a 300% tax deduction for the costs of research and development.

Joint research and development projects depended on entrepreneurs' readiness. For example, three technopreneurs, in particular, used research as a basis for the development of new products: a key business operation. Initially, other agencies' laboratories were used, prior to the construction of new laboratories.

Finally, the results of a collaborative project became intellectual property, and the commercial benefits increased the total net worth of the company.

3.1.2.5. Technopreneurship incubation and business networking

Key informants underwent a technopreneurship incubation process during the commercialization research process. The perspective was shared that although new inventions could create business opportunities for them, this was not sufficient to automatically generate income. Business administration skills to increase sales volumes, identification of target customers in the market, appropriate marketing strategies that suited the needs of the market and customers' behaviors, accurate accounting, smart fiscal management, and correct management of organizational resources, partners, customers, and taxation were also necessary.

Nobody knows everything. Even CEOs need to rely on advisors and consultants. In particular, technopreneurs need to be incubated by mentors who give advice and consultancy. If we survey how products move from shelf to store, we will see that the bottleneck is the entrepreneurs who lack the readiness to do marketing. If their weaknesses have not been dealt with, they can become business problems. At the incubation center, we received advice from the advisory team. We could prepare plans in advance and our potential could be maximized and our weaknesses taken care of. We were able to even solve problems in advance. (Pseudonym C)

In university incubation projects, technopreneurs who were determined and had already set up a company were recruited to work with professors and researchers to plan for business operation from the beginning to product launch in the market. The incubation center paid for business operation in accordance with the plan, with mentors supervising and giving advice to technopreneurs in all aspects to ensure that they were able to run the business appropriately and effectively, transforming their ideas into a technology and innovation business with marketing potential. The incubation of technopreneurs was considered to be a proactive effort and practical work, as opposed to just a theoretical seminar or training.

3.1.2.6. Business planning for innovation commercialization

When commercially launching innovative products and services based on science and technology, technopreneurs get to work closely with the market and their own customers.

Business planning mostly resulted from direct experience in addition to previous training and seminar participation, as demonstrated in the following key informant sentiments.

My experience working with a hotel enabled me to devise a business plan that focuses on the use of skills to look at business problems that could be addressed by a technology and innovation business that includes aftersales services that are also innovative. We need to create a niche and have to be able to solve problems in terms of cost effectiveness and services. I have applied the concepts of hotel business; that is, word of mouth advertising. I make sure that what the customers received was better than they'd had before. It is like we are paying them back. Therefore, we need a business plan that can serve the needs of the customers and create the highest level of customer satisfaction. This can be done by integrating information technology into business communication to emphasize customer satisfaction in service provision. (Pseudonym B).

3.1.2.7. Continuous product improvement

In this stage, the key informants summarized the significant factors leading to successful business operation based on the nature of ever-changing business. Interviewees noted that this can be achieved through continuous development and improvement, which constituted part of the establishment and expansion of future successes.

In order for a technology and innovation business to grow, entrepreneurs need to look into the future and realize the significance of continuous development and improvement of innovations, differentiating themselves from others. They have to be able to solve problems in terms of prices and services that vary in the market. That said, when customers, markets, and competitors are constantly changing, we always have opportunities. We have to continuously work to adapt ourselves to suit the current situation. Our work is never-ending; it continuously starts over and develops. (Pseudonym B)

3.1.2.8. Sustainable technopreneurship and development

In the final stage, key informants summarized the keys to success, with the significant factors being ethics, good governance, consideration, business partnership, sharing, determined team members, and shared goals. These were important for business operations to solve the problems of customers domestically and internationally. Technopreneurs first need to have expertise and acceptance from domestic customers.

After receiving support and cooperation from business partners, they can set up a "Team Thailand." Business operators must help one another, and they also need support from the government to create an economic ecological system that will be sustainably used. Furthermore, technopreneurs must work closely with their customers, recognizing them as the center of their business. This is because technopreneurs work to solve the problems of their customers, and their customers are the inspiration that led to new technological innovations for technopreneurs

Operators who run an innovation-driven business need to be ethical. They need to be givers rather than takers. They need good teamwork and partnership, and they have to rely on the establishment of a suitable ecosystem by the government to sustain their success. Furthermore, they need to work for the customers. Once the customers love us, they will support us. They will share their needs and problems with us because we are providers of solutions who have expertise in technology and innovation business. (Pseudonym F)

3.2. Discussion

The definition and background of technopreneurs' commercialization research process can be divided into three categories: technopreneur idea development with passion, integrated business model development, and innovative and technological business networking. Such categorization is in congruence with the definition of technopreneurs' commercialization research process as defined by Blanco [21], which refers to the commercialization research process as business operation resulting from individuals' determination to become entrepreneurs by assessing and utilizing modern technology, seeking technological business opportunity, and establishing business partners to develop new business and introduce new products or services in the commercial market. Likewise, Grimaldi et al. [24] explained that technopreneurs' commercialization research process is a new process and a pattern of business related to the use of technology and innovation to manufacture and successfully launch new products or services in the market. It also refers to a process of investment in a project that combines expert research and development in science and technology done as well as intellectual property from different educational institutions to launch a business with commercial value. This may be in the form of patenting, licensing, startup creation, and university–industry partnerships.

Technopreneurs' commercialization research process begins with seeking business opportunity, developing a conceptual framework with determination to become a technopreneur, evaluating the potential and use of technology, conducting joint research and developing research that result in new products, incubating technological business and establishing business networks, devising a business plan for the commercial launch of the product, continuously developing and improving products, and developing technological business for sustainability. Such findings are similar to the findings of Ismail et al. [28], who proposed a framework for successful product commercialization research to promote educational research results and transform them into new products or services under the operation of technopreneurs. It was reported that success in commercialization research results from the search for business opportunity; development of knowledge, skills, personality, and researchers' determination to become technopreneurs; creation of product concepts related to design and distribution; plans to commercially launch the products; development of packaging design and product promotion; marketing strategy planning for a competitive edge; establishment of business partners; maintenance of relationships with business partners; and facilitation and support for protection of intellectual property from related agencies. Furthermore, Suradi et al. [29] proposed eight major stages in the product commercialization process of technopreneurs: 1) analysis of business opportunity and feasibility, 2) awareness and development of entrepreneurship, 3) selection and assessment of technology utilization, 4) research into the development of product prototypes, 5) business incubation and establishment of business networks, 6) marketing plan for product launch in the market, 7) follow up and assessment of the commercial launch of the products in the market, and 8) establishment of business sustainability.

4. Conclusions

The analysis of the data elicited from key technopreneur informants was conducted to elucidate the definition, background, and technopreneurs' commercialization research process after the construction of a ground theory. Technopreneurs' commercialization research process could be divided into three categories: technopreneur ideas development with passion, integrated business model development, and innovative and technological business networking.

Eight stages of the commercialization research process were also revealed: 1) business opportunity assessment, 2) technopreneurial mindset and passion development, 3) technology assessment and exploitation, 4) co-research and application of new product development, 5) technopreneurship incubation and business networking, 6) business planning for innovation commercialization, 7) continuous product improvement, and 8) sustainable technopreneurship and development.

4.1. Research-based theoretical conclusion

This study of the definition, background, and technopreneurs' commercialization research process elicited the theoretical conclusion illustrated in Figure 3.



Figure 3. Theoretical conclusions

4.2. Recommendations

Two recommendations can be made based on the findings on the construction of a grounded theory to define technopreneurs' commercialization research process.

4.2.1. Theoretical recommendations

1) For technopreneurs' commercialization research process to be successful, technology and innovation must be the driving forces. To assist in this, a grounded theory of the commercialization research process was developed based on the data elicited from the key technopreneur informants. The grounded theory was derived using the inductive method, resulting in knowledge and facts obtained from the informants after careful consideration. Therefore, the key informants had practical understanding of technopreneurs' commercialization research process.

2) Technopreneurs' commercialization research process began with the development of a conceptual framework and determination to become technopreneurs, which was the result of individuals' thinking process, learning, and determination. These factors are complex and difficult to objectively measure; therefore, the researcher recommends guidelines to construct a theory with data-driven research to seek understanding of the phenomenon of interest. This will lead to the expansion of current knowledge and elicit new perspectives on the present-day trends of society. It is also considered a theory that was collaboratively constructed by the researcher and research participants.

4.2.2. Practical recommendations for technopreneurs

Based on the grounded theory of technopreneurs' commercialization research process, eight stages of the commercialization research process were identified, as noted above. Related agencies and organizations involved in the development of technology-based business are encouraged to develop guidelines for promoting and supporting new technopreneurs based on the eight stages in Figure 3. This can be accomplished by focusing on all eight stages of the process, such as making funding sources available, opening up space for business incubation, establishing collaborative networks, and organizing training on business planning for the commercial launch of products to ensure sustainable success.

4.2.3. The limitations of the study

Despite the contributions, several limitations in this research should be addressed in the future. In qualitative research, the size and sample used are often limited. The first limitation of this study was employing only 15 interviewees from 6 business types in Thailand in the qualitative analysis; thus, the conclusions drawn from these cases may be hard to generalize. Second, the researcher collected valuable insights from the founder and chief innovation officer about their perspectives on definitions, backgrounds, and technopreneurs of the commercialization research process. Notwithstanding, this study lacks the perspective of the other stakeholders in the technopreneurship business ecosystem.

4.2.4. Recommendations for further research

Despite this study's limitations, it offers literature groundwork for future studies in the areas of research commercialization of technopreneur for expanding the findings of this research can be made:

1) The present research aimed to construct a grounded theory. Further research using quantitative

methodologies can be conducted to examine and confirm the theory.

2) Future research could endeavor to use the grounded theory derived in this research to develop indicators that can then be extended into the formation of a prototype of technopreneurs' commercialization research process to successfully ensure the sustainability of technological and innovation business.

3) In addition, this study requires further validation across a wider population using a mixed-method: a combination of qualitative and quantitative methods. Therefore, further studies could collect and collate more data to allow a more in-depth generalization.

4) The comparative studies with countries will be precious contributions in the definitions, backgrounds, and technopreneurs' commercialization research process.

5) This study only collected valuable insights from the founder and chief innovation officer. Therefore, future studies might include more perspectives from the other stakeholders in the technopreneurship business ecosystem to broaden the perspective of the definitions and backgrounds related to the commercialization research process. They can also examine how do technopreneurs' commercialization research processes operate.

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