INNOVATION CAPABILITY INDICATORS FOR ENTREPRENEURS DEVELOPED THE BUSINESS FROM THAI UNIVERSITY INCUBATOR

企業家的創新能力指標推動了泰國大學孵化器的發展

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Abstract

This research aimed to study and develop the innovation capability indicators for entrepreneurs who created their businesses from public universities' incubators in Thailand. This study applied the inductive research method using critical analysis; the sample included 202 entrepreneurs' variables related to Confirmatory Factor Analysis to find the model's concordance and empirical data. The entrepreneurs who developed their businesses from incubators of universities in Thailand had the innovation capability for business management through the following factors: the change and management development process at lower costs to achieve more efficient management, the novel/innovative product development process to the market, the perceived product enhancement process through new and modern channels, and the use of contemporary digital convergence for innovation capability construction to further take advantage of business competition. The research results and contributions revealed that the measurement model of innovation capability developed from the three main factors: process innovation capability, product innovation capability, and market innovation capability, leading to value synergistic business creation and directed innovation.

Keywords: Innovation Capability, Entrepreneurs, Incubator, Business Development, University, Thailand

摘要 這項研究旨在研究和開發針對在泰國公立大學的孵化器中創立企業的企業家的創新能力指標。本研究採用了臨界分析的歸納研究方法。該樣本包括 202 個與確認性因素分析有關的企業家變量，以找出模型與實證數據之間的一致性。通過泰國大學孵化器發展業務的企業家具有以下方面

的業務管理創新能力：變革和以較低的成本開發管理流程以實現更有效的管理，向市場推出新穎/創新的產品開發流程，通過新的和現代的渠道進行的產品改進過程，以及使用當代數字融合技術進行創新能力建設，以進一步利用業務競爭優勢。研究結果和貢獻表明，創新能力的度量模型是從流程創新能力，產品創新能力和市場創新能力這三個主要因素發展而來的，從而導致價值協同業務創造和定向創新。

关键词: 泰國大學創新能力，企業家，孵化器，業務發展

I. INTRODUCTION

Developing a country and lowering the number of individuals with intermediate level incomes requires economic drive-by technology and innovation, which will affect the country's ability to produce high-value products that significantly impact the overall economy and society. Constructing these drive-by technologies and innovations depends on the private sector, considered the essential economic system player. It can be done by building the technological and innovative capabilities of private entrepreneurs to develop the technologies and innovations that become truly commercial products. Building innovation in every organization and every level is possible. It may be necessary to increase the motivation of executives or operators for cooperation. However, many organizations still lack the factors and knowledge required to create these innovationswhich the management is missing several conducts.Thus, the organizations have to discover the toolsand methods to enhance the factors and knowledge for their use. Ultimately, innovation construction for the organization may become a heavy burden if there is no sufficient management and plan. Several research organizations can develop the technology for the marketplace in various forms; however, they may not apply those technologies or knowledge to achieve the utmost commercial benefits [1]. Hence, a shortcut to allow organizations the ability to innovate and originate unique products or to allow them enter into new markets or emerging markets and be accepted by consumers quickly is requesting information support from the research institutes of the educational entities [2],[3].

However, the private entrepreneurs that exist today still encounter problems and obstacles when developing the technologies and innovations that can be applied to commercial markets and sectors such as the access to resources supported by the government,the access to innovative product markets or industrial clusters, and the connection of knowledge resources and assets in the research institutes and universities. Regarding the university part and condition, the innovationand evolutionary development of public universities cannot immediately occur or replace. The readiness has to be built from several aspects, especially using the resources such as the universities' capital and researchers. These factors may not only originate from the organizations within the universities, but they may also rely on cooperation from external organizations. Furthermore,external organizations are a component that supports the innovation development of educational institutes simultaneously. This is concordant with the cooperative characteristics between the educational institutes and business sectors, and it has been found that today the private sectors and educational institutes cooperate and work more closely [4]. Moreover, there is a study found that the universities that mutually construct environments with private organizations in the form of science parks will more effectively transfer knowledge, technology, and innovation to private organizations [5], [6].

To provide the guidance of the innovation capability development for the entrepreneurs to generate advantages for competitive business which related to the research objectives of studying the innovation capability indicators of entrepreneurs developed from the business incubators of public universities in Thailand.

The main of this research also including to use and upgrade of these indicators to guide the construction of the model of innovation capability development of the entrepreneurs developed from the business incubators.The research results and contributions revealed that the measurement model of innovation capability developed from the three main factors in Section V and Section VI concludes with a brief summary and future recommendations.

II. LITERATURE REVIEW

A. University and Entrepreneurs' Development

The innovation development of universities cannot be achieved at once. Readiness has to be built from several aspects, especially the readiness in terms of various resources such as capital and

researchers within the university, including the cooperation from external organizations. It is concordant with the cooperative characteristics between the educational institutes and business organizations. Presently, research has revealed that private organizations and educational institutes cooperate and operate more closely [4]. Additionally, the universities that mutually construct the environments with private organizations in the form of science parks will transfer knowledge, technology, and innovation to private organizations more effectively [5]. Furthermore, the research [7] suggests that the trends of entrepreneurship education that have implications for knowledge include the probability of forming innovative practice models and programs developed by universities. The factor that enhances the successful transfer of innovation for a university is the construction of environments through industrial parks or incubator resources. These environments present and allow external entrepreneurs to have an opportunity to mutually and consistently learn innovation to improve their readiness by applying it to develop and extend the organizations further [8]. Hence, the Office of the Higher Education Commission established university business incubators to allow new business sectors to be able to mutually cooperate so that they can apply the existing research to develop and extend commercial products and services. The business development by a university business incubator will enhance the new businesses to improve their quality and potential to create value added from products and services, be sufficiently competent to be competitive with their rivals, and originate new businesses as startup companies. When such companies are stronger, they will be able to improve the future spinoff companies.

B. Innovation Capability

Using innovation is also considered the crucial factor to achieve competitive advantages in an organization [9] because it is one of the factors which that increase the efficiency of the overall organizational performance [10]. In addition, Maldonaso-Guzman, Garza-Reyes, Pinzon-Castro and Kumar's research [11] shows that innovation capabilities in products, processes, marketing, and management systems all have different levels of effectiveness for business and entrepreneurs. Among these different levels of effectiveness, one of the most important ones can be the increase in the level of innovative performance. However, there are no sufficiently clear theories on measuring innovation since the word innovation has been used with different purposes in each

organization worldwide depending on the meaning when using it [12]. The innovation capability likely has factors that differ for each studied issue. For example, innovation capability may consist of marketing capability and technology capability [13]; conversely, Lyon, Lumpkin and Dess [14] categorize innovation capability into two aspects: product innovation capability and process innovation capability. The study of North and Smallbone [15] classifies innovation capability into four parts, which include product innovation capability, market innovation capability, process innovation capability, and behavior innovation capability. Additionally, the research of Wang and Ahmed [16] divides innovation capability into five aspects: product innovation capability, market innovation capability, process innovation capability, behavior innovation capability, and strategic innovativeness capability [17].

Innovation can be measured using the innovative result that occurs from the research and development process and by comparing the result with the costs in the research and development process. The results can be in the form of material or process developments or they may be derived from adding some innovations to a product or process [13],[18],[19]. This is concordant with the findings of Castellacci and Natera [20] that the main three variables relevant to the innovation capability are the innovative factors input into the system, the resulting scientific inventions, and the resulting technologies.The organization only uses innovation as a partial factor. For example, Hareebin, Aujirapongpan, and Siengthai [21] state that innovative performance in the context of small and medium enterprises can be categorized into three parts: 1) the construction of value added and contributions/patents, 2) reduced capital and upgraded quality of a product and service, and 3) opening new markets. The definitions of innovation capability of several academics in various periods reveals that the definitions are different in numerous ways, depending on the purposes of research to study, and there has not been a clear conclusion on the definition of innovation capability [22],[23],[24]. However, the term of "innovation capability" has been used recurrently in the innovation management literature, but there is still considerable divergence about its meaning and implication to organizations [25]. Narcizo, Canen and Tammela [26] seeks that innovation is the property or property of an organization, and it is an organizational process, practice or high-level organizational routine. Nowadays, it is found that the university is an important agency in creating research and invention for forwarding to outside organizations

and being developed to be innovative in the market [27]. In addition, the university has a wide range of partnerships with external agencies, including building quality personnel that meet the needs of the department, or it can be a collaboration between the university and external agencies to create more sustainable businesses or innovations [28]. A university that creates an environment with private entities in the form of a science park will enable the transfer of knowledge, technology and innovation to the private sector more efficiently [29]. And also one thing that can be concluded regarding innovation capability is that it becomes the subinnovation capability determined by the researchers in the same orientation. Hence, the current researcher also organized the groups of innovation capability based on the same characteristics. However, the groups selected were appropriate to the business of entrepreneurs developed from the incubators of the universities in Thailand. Innovation capability consists of three groups as follows, as shown in Table 1: 1) process innovation capability, 2) product innovation capability, and 3) market innovation capability.

Table 1.
Innovation capability indicators

Indicators	Academics
1. Process Innovation Capability - The business accepts the change of new management occurring later. - Management develops to improve business performance to achieve lower investment. - Business management is adapted in new and more effective forms.	North & Smallbone [15], Rakthai, Aujirapongpan & Suanpong [17], Cohen & Levinthal [18], Dutse [19], Hareebin, Aujirapongpan & Siengthai [21], Aujirapongpan & Hareebin [23], Nystrom, Ramamurthy & Wilson [24],
2. Product Innovation Capability - The business can create new products/patents for the marketplace. -The business can build more value from existing materials by developing new forms for the products. - The business has sufficient instruments/machines for product manufacturing. -The business develops the product manufacturing process to achieve lower investments.	Duanxu & Shuai [13], Lyon, Lumpkin & Dess [14], Wang & Ahmed [16], Rakthai, Aujirapongpan & Suanpong [17], Cohen & Levinthal [18], Dutse [19], Hareebin, Aujirapongpan & Siengthai [21],
3. Market Innovation Capability - The business can create the process of the perceived products through new and modern channels. -There are channels to enable the customers to buy or use the services in various forms. - The capital of marketing activities decreases by using new styles of communication technologies.	Rajapathirana & Hui [9] Rakthai, Aujirapongpan & Suanpong [17] Hareebin, Aujirapongpan & Siengthai [21], Sulistyo & Siyamtinah [30]

III. METHODS/MATERIALS

This research studied and applied the inductive research method using critical analysis of the development of innovation capability indicators for entrepreneurs who developed their businesses from the incubators of public universities in Thailand using qualitative research.The research used the confirmatory factor analysis technique and the Structural Equation Modeling (SEM) technique to study the empirical data[6], thenexamined the model's concordance with the entrepreneur group developed by the business incubators of universities in Thailand using questionnaires to collect dataand finally corroborated the results.

A. Sample and Research Instrument

The population used in this research was the entrepreneurs developed from the business incubators of public universities in Thailand, which were taken from the lists of the business incubators of universities in Thailand on the website of the Office of the Higher Education Commission (OHEC).Today, there are a total of 56 centers (mua.go.th, retrieved on 25 January 2018); and the sample group was the entrepreneurs that met the population characteristics, which resulted in a total of 202 samples. The minimum conditions of the structural equation test concordant with the determination of the sufficiency for the sample size for the strength of the estimation of the structural equation model state that there should not be less than 200 sample units in the study [31]. The samples were selected using the purposeful sampling method.

The instrument used to collect the data for this research was a questionnaire. The researcher adapted the questionnaire by studying the information in the documents of the relevant conceptualized theories and research contributions.

The questionnaire was composed two parts: entrepreneurs' general information and the measurement of the factors of entrepreneurs' innovation capability.

B. Data Collection and Analysis Methods

The researcher collected all qualitative data using the online questionnaires by coordinating with the entrepreneurs via email and telephone. After the responders had finished responding to the questionnaires, the researcher examined the completeness of the information before analyzing the data at a further stage.

The researcher examined the concordance of the linear structural relationship model (LISREL) by analyzing the structural equation model developed by the researcher and compared with the empirical data derived from the data collected by the questionnaires. SPSS Statistics 17.0 was used to conduct the base statistical analysis, including analyzing the frequencies, percentages, means, standard deviations, t-tests, chi-squared, alpha coefficients, Pearson product moment correlations, KMOs, and Bartlett's test. The characteristics of the responders were used to develop and examine the research instruments and investigate the correlation of the variables. Furthermore, IBM SPSS Amos 21.0.0 was used to conduct confirmatory factor analysis to confirm that the components of each factor used for this study were valid and suitable, including their theoretic coverage. The absolute fit indexes included the goodness of fit (GFI) that used the root mean square error of approximation (RMSEA), which is the value indicating the discordance of the model constructed with the

covariance matrix of the population. The root means square residual (RMR), it is the index used for comparing the level of harmony with the empirical data of two models and the Comparative Fit Index (CFI) [31], [32].

IV. RESULTS AND DISCUSSION

The researcher received a total of 202 returned online questionnaires. This number was sufficient for the data analysis according to the determination of the sample size, which states that there should not be less than 200 sample units; therefore, these samples are sufficient for constructing a structural equation. The entrepreneurs and responders' general information is given in Table 2.

Table 2 shows the analysis of the 202 questionnaires that were completed. The table revealed that most of the respondents were female at 125 persons (60.91%), and 77 (39.09%) were male. Most of the respondents were from 31 to 40 years old at 98 persons (48.64%). Second was 67

persons (33.18%) were from 41 to 50 years old, and then 22 persons (10.91%) were from 21-30 years old. Regarding educational background, most of the respondent had a Master's degree at 105 persons (51.82%). The second was 93 persons (45.91%) had a Bachelor's degree, and 4 persons (2.27%) had higher than a Master's degree. Regarding work experience, most of the respondent had less than 5 years of work experience at 116 persons (56.82%). Second was 55 persons (27.27%) had from 6 to 10 years of experience, and 28 persons (14.09%) had from 11 to 15 years of experience. Regarding work position, most of the responders were presidents or entrepreneurs at 126 persons (62.27%). Second was 44 persons (20%) who were department managers or department chiefs, and 26 persons (12.73%) were deputy department managers or deputy department chiefs. Moreover, regarding type of business owner 128 persons (63.18%) were the single owner of the business, and 74 persons (36.82%) were part of a partnership that owned a company. Regarding the period of business operations, most of them had operated less than five years at 89 persons (44.09%). Second was 77 persons (38.18%) who had the business operations from 6 years to ten years, and then those who had operated from 11 to 15 years (14.55%). Most of the businesses had from 1 to 20 employees at 105 persons (52.27%). Second was 72 persons (35.45%) who had from 21 to 40 employees, and 19 persons (9.55%) who had from 41 to 60 employees. Furthermore, most of the businesses provided services at 122 persons (60.45%). Second was 52 persons (25.91%) who manufactured products using their inputs, and 28 persons (13.64%) who worked as employees to produce the products as purchase orders.

Table 2.
Frequency and percentage regarding the responders' general information (n=202)

General information	Status	Frequency	Percentage
Gender	Male	77	39.09
	Female	125	60.91
Age	21-30years old	22	10.91
	31-40 years old	98	48.64
	41-50years old	67	33.18
	51-60years old	15	7.27
Educational Background	Bachelor's degree	93	45.91
	Master's degree	105	51.82
	PhD's degree	4	2.27
Work Experience	Less than 5 years	116	56.82
	6-10years old	55	27.27
	11-15years old	28	14.09
	More than 15	3	1.82

General information	Status	Frequency	Percentage
	years old		
Position	President/entrepreneurs	126	62.27
	Managing director /General manager	6	2.73
	Manager Department/ Chief	40	20.00
	Department/Deputy- Manager Department /Deputy- Chief Department	26	12.73
	Operational employees	4	2.27
Characteristics of Business Ownership	Single owners	128	63.18
	Partnership/company	74	36.82
Period of Business Performance	Less than 5 years	89	44.09
	6-10years	77	38.18
	11-15years	29	14.55
	More than 15 years	7	3.18
Number of employees	1-20employees	105	52.27
	21-40employees	72	35.45
	41-60employees	19	9.55
	61employees up	6	2.73
Characteristics of Business Performance	Service	122	60.45
	Products produced using their own symbols	52	25.91
	Works as employees to produce the products as purchase order	28	13.64

According to the confirmatory factor analysis used to study the questionnaires of the entrepreneurs' innovation capability in Thailand, the researcher divided the groups of questions on innovation capability into three groups: process innovation capability, product innovation capability, and market innovation capability. The questions were listed under each subtopic, and an English symbol was determined and used for the processing with the packaged software. The symbols were as follows:

A. INRAII: Process Innovation Capability

INR1: The business accepts management changes in new forms happening later.

INR2: The business performance has developed a management model that lowered management capital.

INR3: The business has adjusted the management model to make it more novel and efficient.

B. INPAII: Product Innovation Capability

INP1: The business can produce new products/patents to sell in marketplaces.

INP2: The business can increasingly construct the values from existing materials by developing products in new forms.

INP3: The business has sufficient equipment/machines for the manufacturing of products.

Table 3.
Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) and Bartlett's test of sphericity of the innovation capability

	Kaiser-Meyer-Olkin measure of sampling adequacy (MSA)	P-value	Bartlett's test of sphericity	df
Innovation Capability	0. 821	0.000	1227.885	45

Table 4.
Reliability (ρC) of the latent variables and the average variance extracted (ρv) of innovation capability

Latent variable	Reliability (ρC)	Average variance extracted (ρv)
INRAII	0.6914	0.5591
INPAII	0.7216	0.4637
INMAII	0.7307	0.8188

INP4: The business developed product manufacturing processes to achieve lower capital.

C. INMAII: Market Innovation Capability

INM1: The business can construct the product perception process through up-to-date and new channels.

INM2: The business has the channels to enable the customers to purchase or use the services in various forms.

INM3: The marketing management capital was reduced by using novel communication technologies(contemporary digital convergence).

Primarily, the researcher examined whether the variables were correlated by calculating the partial correlation using SPSS to consider whether the data were suitable for analyses. The KMO value and Bartlett's test were used, and they were interpreted using the following two statistical test values: 1) the Kaiser-Meyer-Olkin measure of sampling adequacy (MSA), which had a value that was from 0 – 1, and the value would equal 1 when each variable could predict the other variables and there were no errors; and 2) Bartlett's test of sphericity, which was used to examine whether various variables were correlated. If Bartlett's test

of sphericity was significant, it indicated that the various variables were correlated. Therefore, it can analyze the factors [31]. The analysis results are shown in Table 3.

Table 3 revealed that the Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) of the innovation capability equaled 0.821, which was higher than 0.80. Hence, it supports the suitability for factor analysis at a very high level. Bartlett's test of sphericity equaled 1227.885, and the p-value was 0.000, which was statistically significant at the 0.01 level. The results show that all variables are correlated and can be used to analyze the factors [31],[32]. The research evaluated the efficiency of the measurement model by considering the validity, which is the indicators' capability to be used to measure the latent variables in the model; the significance of the factor loadings; and the reliability, which is the measurement consistency includes the construct reliability (ρC) and the average variance extracted (ρv), as shown in Table 4.

The analysis results of the validity in Table 4 indicate that the factor loading of the latent variable was significant for every factor (t-value >|1.96|), which supports the reliability of themeasurement. Furthermore, the validity of the latent variables from the minimum to maximum was from 0.6914 to 0.7307, respectively, which indicates high reliability ($\rho c > 0.60$). Moreover, the average variance extracted from the minimum to maximum was from 0.4637 to 0.8188, respectively. INM can describe the variance of the variables in the factors higher than other factors ($\rho v > 0.50$). When using IBM SPSS Amos to analyze the confirmatory factor analysis of innovation capability, which comprises ten indicators and three subfactors, the results reveal that the data analysis results from the first tests were not concordant with the empirical data. The researcher adjusted the model until it was concordant with the empirical data by considering the chi-squared, p-value, GFI, AGFI, RMSEA, and RMR, as shown in Table 5.

Figure 1 shows that the chi-squared equaled 27.591 at 16 degrees of freedom (df), which obtained a p-value that equaled 0.0000. The chi-squared divided by the degrees of freedom (df) equaled 1.724. The Goodness of Fit Index (GFI) equaled 0.973. The adjusted goodness of fit index was 0.908, the root mean square error of approximation (RMSEA) was 0.060, the root mean square residual (RMR) was 0.025, and the comparative fit index (CFI) was 0.989. Hence, the research model has an acceptable level of agreement with the empirical data and the results are corroborated.

Table 5.
Evaluation result of confirmatory factor analysis for innovation capability

Evaluation of Model Concordance	Criteria	Analysis Result	Concordance Level
Chi-square Probability Level	$P>0.05$	0.035	Moderate concordance
Relative Chi-square	<3	1.724	Concordant
GFI	>0.900	0.973	Concordant
AGFI	>0.900	0.908	Concordant
RMSEA	<0.080	0.060	Concordant
RMR	Almost 0	0.025	Concordant
CFI	>0.900	0.989	Concordant

V. RESULTS AND DISCUSSION

The results of the confirmatory factor analysis of innovation capability indicated that the model is concordant with the empirical data at a high level, and every value was statistically significant. These results suggest that the subfactors of the all their innovation capability, which included process innovation capability, products innovation capability, and market innovation capability, are considered crucial factors for innovation capability. These results are concordant with the studies of Rajapathirana and Hui [9], Duanxu and Shuai [13], Lyon, Lumpkin and Dess [14], North and Smallbone [15], Wang and Ahmed [16], Cohen and Levinthal [18], Dutse [19], Hareebin, Aujirapongpan and Siengthai [21], Aujirapongpan and Hareebin [23], and Nystrom, Ramamurthy and Wilson [24], Sulistyo and Siyamtinah [30]. The factor loading of each subfactor of the innovation capability indicators identified that the market innovation capability factor (INMAII) and the marketing activity capital factors were decreased by the use of novel communication technologies(contemporary digital convergence) (INM3), and the factor loading was the highest at 0.94. This result is concordant with the current situation since the current era is a digital marketing stagethat focuses on digital or online channel marketing to access consumers through various kinds of equipment for communication (such as smartphones). Second, process innovationcapability (INRAII) and the indicator that businesses accepted the novel management changes happening later (INR1) had factor loadings of 0.93 because the environments (for example, the economy, society, politics, and technology) for business performance today are changing all the time. Especially important is the economy, which has higher competition that affects the company discovering various strategies and guidelines to perform the business to achieve

competitive advantages and be able to survive and grow steadily in the long term due to the capability ofcoping with external risks, crises, and challenges. Novel and synergistic management are regarded as crucial for entrepreneurs to advance their business to securely and sustainably elevated achieve competitive advantages and challenges over their rivals or indication issues.
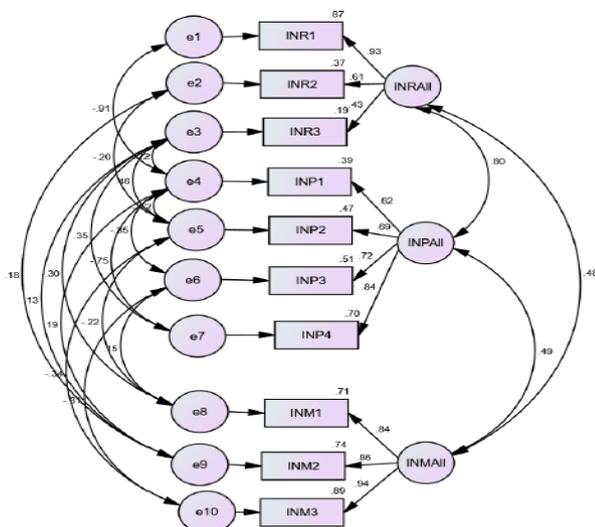

Figure 1. Confirmatory factor analysis model of innovation capability

VI. CONCLUSION

The confirmatory factor analysis analyzed the innovation capability variables from the 10 indicator items under three subfactors of observed variablesand the research results revealed that the measurement model of innovation capability developed from the three main factors consisting of: 1) process innovation capability, 2) product innovation capability, and 3) market innovation capability.The results show that this process can integrate synergetic effects and measure the innovation capability factors of entrepreneurs in Thailand efficiently because the analysis results of each issue of factors were concordant with the measurement modeland enhance adaptability in the workflow process for creative solutions. The results revealed that the entrepreneurs who developed their businesses from the business incubators of public universities in Thailand had innovation capability in their business management through the change and noveltyconstruction process and the development of lower investment management to enable the administration to be more efficient. Moreover, the entrepreneurs had novel/innovative product development processes that could bring products to markets to enhance the process of product perception through modern channels and incorporate up-to-datewith contemporary digital convergence and fundamental technologies to use in constructing innovation

capability to achieve competitive advantages in their performance and further their businesses.

In this study, the researcher used statistical instruments for overall data analysis without emphasizing the differences in the samples on some characteristics or variables such as gender, age, educational level, and position that represent demographic patternsand technological fusion. These samples likely have different parameters or models. Hence, these variables are likely affect the research conclusions or may cause the research conclusions to be different from the overall analysis. If researchers analyze the models of this research according to the values of some variables by applying multiple analysis methods to various groups of samples, the research results will be more thorough and profound, which will be concordant with the variables' value levels. Consequently, the contributions from this research will be able to more truly describe the current phenomena. Due to being surrounded by success, one of the most valuable variables can be the effect of the level of innovation capability. Furthermore, researchers should study other components that may impact the innovation capability of the entrepreneurs and directions in incubators in Thailand. For instance; innovative foresight, diversified marketing, and management innovation improve the pathway the organization is conducted. Moreover, the researchers may additionally emphasize the indicators of each relevant factor to further strengthen the innovative dimension models. All of these can lead to value synergistic business creation and directed innovation.

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