

# GUIDELINES FOR INTELLECTUAL PROPERTY MANAGEMENT TO PATENT APPLICATIONS

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## Abstract:

This research aimed to study the approach of guidelines for intellectual property management to patent applications and then developed into a Structural Equation Modelling (SEM). Mixed-methodology research, quantitative and qualitative, is employed in this study. The quantitative data comes from a questionnaire of 500 large, small, and medium enterprises in Thailand who received patents, using statistical tests of descriptive, inferential, and multivariate analysis. The finding indicated that guidelines for intellectual property management to patent applications consisted of the four latent variables arranged in the order of the obtained means of importance as follows: organisation centric, knowledge management, research and development, and information management. In addition, the hypothesis test showed differences in business sizes revealed overall aspects that were significantly different at the 0.05 level. The analysis of the developed SEM showed that it was in accordance and harmony with empirical data and passed the evaluation criteria.

**Keywords:** structural equation modelling; SEM; intellectual property; patent application; innovation; research and development.

## 1 Introduction

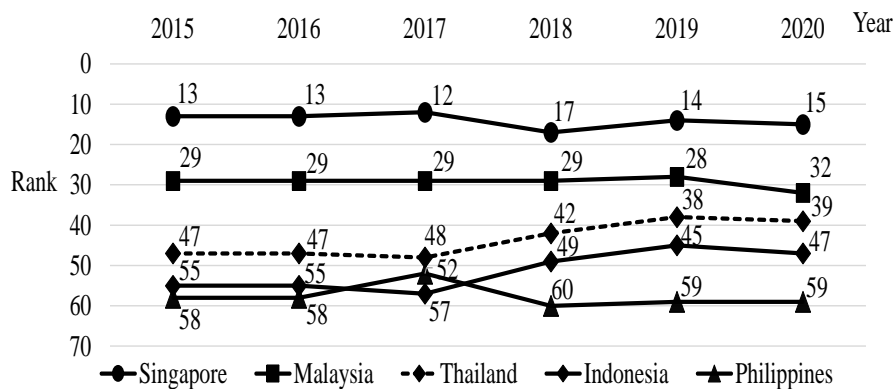
Due to the changing situation in the 4<sup>th</sup> Industrial Revolution, globalization and advances in science and technology have developed leaps and bounds that will result in revolutionary innovations. Government, education, and private sectors need to adjust the planning to ensure that able to support changes and develop competitiveness in innovation, technology, and intellectual property. These are the main factors supporting Thailand's economy to grow stronger amid the intense competition expected to increase productivity and create a variety of products and services that respond to new lifestyles.

The development of science, technology, research, and innovation; investment in research; and it is necessary to focus on the use of knowledge in science, technology, innovation, research results, and creativity in the business, government, and civil society sectors as well as giving importance to the development of the environment or fundamental factors that facilitate investment in research and development; research personnel development. It aims to integrate science, technology, research, and innovation management systems to improve science infrastructure's competitiveness rank, which is organized by the IMD World Competitiveness Ranking to be ranked not less than 30. The indicators with development

guidelines to accelerate investment in research and development drive towards commercial and social utilization (The National Economic and Social Development Plan, 2019).

Thailand's competitiveness ranking by IMD in science infrastructure from 2015-2020 has continued to improve from 47<sup>th</sup> place in 2015 to 39<sup>th</sup> place in 2020, within 6 years. However, when compared to ASEAN countries, it is found to be in 3<sup>rd</sup> place, after Singapore and Malaysia, respectively (National Research Council of Thailand: NRCT, 2021).

**Figure 1: Competitiveness ranking by IMD in science infrastructure; 5-country**



### 1.1 Problem statement

The competitive ranking by IMD in scientific infrastructure consists of 22 indicators. When considered in detail, classified by the 2015-2020 assessment criteria, it was found that Thailand was mostly ranked better, and improved by 12 indicators. Overall, it came from the country's research and development expenditure from both the public and private sectors. However, the declining ranking had five indicators that two of them showed a decrease in the number of patents filed and the number of patents granted to people in the country. (National Research Council of Thailand: NRCT, 2021).

In addition, the World Intellectual Property Organisation (WIPO) has recorded number of international patent applications under Patent Cooperation Testy (PCT) of the ASEAN region, comprising a total of 10 countries. Singapore has been the country with the highest number of PCT applications for 6 years continuously, and is followed by Malaysia and Thailand, respectively. Thailand has been ranked 3<sup>rd</sup> continuously for the past 6 years, which is close to the average ASEAN level as shown in Table 1 (WIPO, 2020).

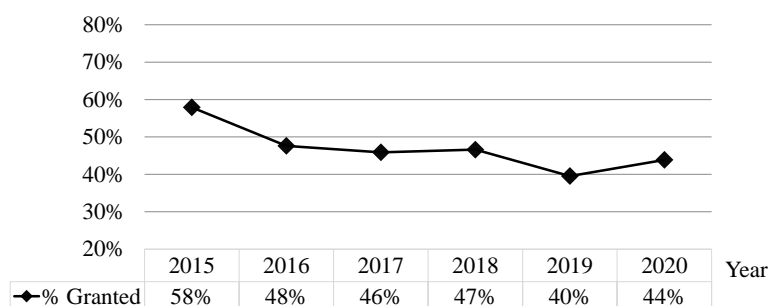
**Table 1 Number of PCT applications of top 3-country in ASEAN**

Country/ Year	2015	2016	2017	2018	2019	2020	Total
Singapore	907	864	871	935	1,112	1,278	6,907
Malaysia	267	189	141	144	202	255	1,511
Thailand	133	155	156	102	151	188	953
ASEAN	137	126	122	123	153	180	979

Note: ASEAN is the average number of 10 countries

Considering domestic patent records by the Department of Intellectual Property (DIP) that found the rate of entrepreneurs who have been granted patents and petty patents compared to those applying for patents and petty patents for the past 6 years, it was found that the statistics of people who have been granted patents and petty patents by Thai patent applicants have decreased continuously in 2015. It stood at 58%, down to 44% in 2020, and less than half the proportion approved per filing of patents and petty patents, shown in Figure 2 (DIP, 2020).

**Figure 2: Granted patents and petty patents in Thailand by DIP**



Therefore, researchers are interested in studying the management of intellectual property to patent applications. This is urgently important to support entrepreneurs of small, medium, and large enterprises who are capable of using intellectual property as collateral. Strengthen trade competitiveness and economic development in accordance with government policies supported by all sectors. Contributes to supporting achieving the goal of intellectual property management to be more effective in applying for a patent application. Received patent protection can be used for commercial production and further commercialization. Support the scientific infrastructure competitiveness index to achieve its next goals.

## 1.2 Research objective

From the issues mentioned above, therefore, the researcher has set the scope of research to study the factors affecting intellectual property management to patent applications as follows:

- To study the component of the intellectual property management to patent applications in the industrial business sector of Thailand.
- To develop the Structural Equation Modelling (SEM) of guidelines for intellectual property management to patent applications in the industrial business sector of Thailand.

### 1.3 Research expected benefits

The benefits that are expected to be obtained from the management application are as follows:

- Industrial businesses can apply this approach as an organisation's strategic plan to create a competitive advantage in business and sustainability.
- Government agencies can use the research outcome to manage the providing patent applications expeditiously, which will be aligned with the needs of the business sector as well as promote to achieve the target of the competitiveness ranking (IMD) in science infrastructure, ranked no less than 30.
- Educational institutions can be applied in teaching and learning by adding additional content in related courses or used as a case study on issues concerning intellectual property management to patent applications.

## 2 Literature review and development of hypothesis

Intellectual property is the result of the invention or creation of humans. This may be expressed in the form of tangible things such as goods, machines, or devices, or in the form of intangibles such as services or business ideas and industrial production processes. New innovations and information have become indicative of a nation's competence since the 21<sup>st</sup> century. Capital and resources in industrial societies are intangible assets such as information and technological innovations in knowledge-based societies.

The researcher has applied the main theory that is used to formulate a research conceptual framework; the guidelines for intellectual property management to patent applications support innovation management to drive further development in technology research to meet market demand, leading to intellectual property results, increasing the competitiveness of businesses to patent and the ability to convert the intellectual property for commercialization. Thus, the literature review is as follows.

### 2.1 Organisation centric

Onprasirt, T., et al. (2021) found that organisation is defined as proper organisational management to achieve competitive success and enable one to overcome the other competitors; can motivate the executives and employees to understand the importance of organisational success; and the work specialization of task division consists of providing tasks to each department, managing each, and delegating authority. Huihui, T. (2018) found that the organisational management theory with four classical theories: 1) scientific management 2) situational management contingency 3) behavioural management and 4) systems. Gonzaleza, RVD. and Melob, TM de. (2018) investigated the impact of organisational contexts on innovative knowledge management. According to a survey of 234 companies in the automotive industry. In conclusion, the results of the positive factors of the organisational context consisted of five factors: 1) human resource management 2) leadership support 3) learning culture 4) independence and 5) information technology systems. And

Donzé, P.Y. and Nishimura, S. (2022) studied the patent management of Siemens from 1890-1945. The organisations with knowledge management, including management of intellectual property, have positively impacted the performance of the organisation as well as the integration of research and development (R&D) on the law and utilization within the section of the company that leads to competitive advantages.

## **2.2 Knowledge management**

Srihabut, N., et al. (2021) found that Knowledge Management (KM) is one of the key factors that entrepreneurs were able to apply to enhance value-added creation and to increase sustainable competitive efficiency in the global market. Shujahat, M., et al. (2017) studied the effects of knowledge management on the innovation knowledge process: 1) knowledge generation, 2) knowledge sharing, and 3) knowledge application to innovative knowledge. Ode, E. and Ayavoo, R. (2020) research analyses data using Structural Equation Modelling (SEM) to discuss the relationship between knowledge management in innovative companies. The important factors are: 1) knowledge generation 2) knowledge storage 3) knowledge diffusion and 4) knowledge application. The results show that the creation of knowledge storage and knowledge application have significant positive effect on the company's innovation. Pereira, S. de A. and Quoniam, L. (2017) studied how information and knowledge are important drivers of innovation. Patent database management technologies such as the websites WIPO and Patent2Net provide information on patent registration. In addition, supporting organisations in the patent database leverage the details to bring future innovations. And Al-Emrana, M., et al. (2018) studied the impact of knowledge management on information management systems. It was found that 1) knowledge sharing was the most frequently studied KM process, followed by 2) knowledge acquisition and 3) knowledge application.

## **2.3 Information management**

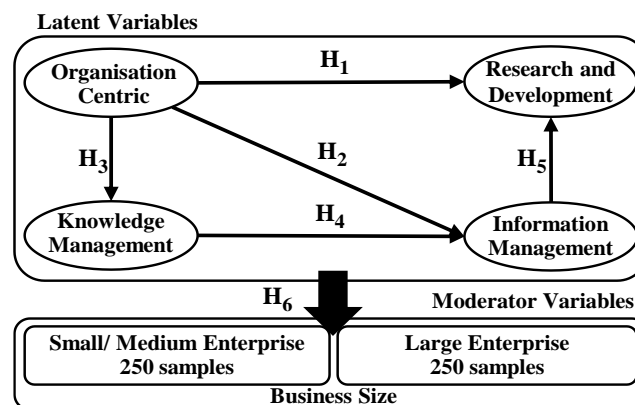
Information management consists of four main components: 1) humans 2) process 3) technology 4) content. Therefore, information management is not only related to technology but also related to humans (Robertson, R. J., 2005). Silpcharu, T. and Panthanapratez, T. (2021) found that current and up-to-date information is the most important. All operations now require the most updated data, which is effectively restored, such as product prices, customer behaviour, financial data, and domestic and international logistics expenditures. Trappey, A. J. C., et al. (2017) researched the patent search program called Thomson Innovation for dividing patents into subgroups to analyse industry technology trends and compare patent portfolios held by competitors, where the number of patent families and patent forward references were used as indicators of the patent significance. Kim, G. and Bae, J. (2017) researched a new approach to forecasting promising technologies through patent analysis. Forecasting promising technologies will be relevant opportunities for the company's intellectual property management. Additionally, research and development researchers have determined that the patent contains detailed information about the developed technology, in the analysis to assess whether the technology sector is promising or not in further research and development planning.

## 2.4 Research and development

Lai, PC. (2018) studied research and development, innovation, and strategic planning for intellectual property management. It can be concluded that the strategic direction of the organisation in strategic planning for technology transfer has 3 aspects: 1) funding 2) alliance cooperation and 3) trade strategy. These are areas for further research and development in support of intellectual property management. Kim, M., et al. (2017) researched the impact of research and development capabilities on patents and new product development on Small-Medium Enterprises (SMEs) in Korea. The study found that R&D's high focus on human resource management in the creation of open innovation is a key factor for building an organisation's performance. It is necessary to acquire and participate in research and development learning from external organisations instead of adding research and development personnel to the organisation itself. O'Reilly, C and Binns, A. J. M. (2019) studied the three-step process of innovation. The organisation's understanding of how to generate new ideas has advanced greatly over the past 20 years, and many large companies are considered exemplary in using the incubation method to deal with intermittent innovation. Thus, the three-step components are: 1) idea generation, 2) incubation, and 3) scaling with increased innovation. Success in continuous innovation requires more sophisticated leaders to manage these processes.

Based on the above literature review that can be formulated the conceptual framework for the guidelines for intellectual property management to patent applications under four components, namely, organisation centric, knowledge management, information management, and research and development, as shown in Figure 3.

**Figure 3: Conceptual framework of the guidelines for intellectual property management to patent applications**



## 2.5 Hypothesis

In accordance with the objective and related literature, the researcher determined six hypotheses based on the related theories as follows.

H1 Organisation centric variables directly influence research and development variable.

Micheli, P., et al. (2017) studied organisational modelling in strategy formulation in order to elevate the functions of the organisation from large multinational corporations as well as SMEs. The results of the study were summarized into 6 practical guidelines: 1) support from senior management 2) leadership 3) raising awareness of roles and participation 4) response and coordination, 5) assessment, and 6) formatting processes for product and service development. Hameed, W. Ul., et al. (2018) studied the factors influencing open innovation and the role of research and development. The study used SEM as a statistical tool and found that 1) external knowledge, 2) internal innovation, and 3) departmental R&D as the main factors in the company's open innovation operations are internal innovation and external knowledge have a significant positive impact on the R&D department. This will help promote the benefits of small-medium-sized enterprises to increase overall efficiency by accelerating open innovation systems, leading to stronger competition in intellectual property rights.

H2 Organisation centric variables directly influence information management variable.

For the conceptual framework of information strategy for organisations or business entities, Earl (1989) has proposed a five-point information strategy framework that consists of what, how, where, who, and why are the strategies of the information system to be used in the organisation. Gemünden, H. G., et al. (2017) conducted a research study on project-oriented organisations and innovation portfolios and found that three factors: 1) technology and innovation management, 2) system to support information management, and 3) human resource management and knowledge management.

H3 Organisation centric variables directly influence knowledge management variable.

Donzé, PY. and Nishimura, S. (2022) outlined the relationship between organisations and knowledge management, including management of intellectual property has affected the performance of the organisation. The integration of research and development on the law and utilization within the company and various links, working units lead to competitive advantages. Davis, G. F. and DeWitt, T. (2021) said that the Resource-Based View (RBV) is one of the most successful theoretical approaches to strategic management. The main goal is to apply knowledge and skills in resources within the organisation to produce goods and services that give the organisation a competitive advantage.

H4 Knowledge management variables directly influence information management variable.

Shujahat, M., et al. (2017) examined the impact of knowledge management processes on innovative knowledge. The importance of knowledge worker productivity during the knowledge management process is 1) Knowledge Generation 2) Knowledge Sharing and 3) Knowledge Application to innovative knowledge, while Pereira, S. de A. and Quoniam, L.

(2017) studied the information and knowledge are key drivers of innovation. Technological developments and changes that make organisations more competitive.

H5 Information management variables directly influence research and development variable.

Kim, G. and Bae, J. (2017) researched a new approach to forecasting promising technologies through patent analysis. Forecasting promising technologies will be relevant opportunities for the company's intellectual property management. Additionally, research and development researchers have determined that the patent contains detailed information about the developed technology. In the analysis to assess whether the technology sector is promising or not in further research and development planning.

H6 Importance levels of guidelines for intellectual property management to patent applications as overall, classified by business sizes was different.

The difference between a large enterprise that achieves innovation and gains competence is the advantage of a clear and coherent framework to support Intellectual Property (IP) operations. Most organisations have a direct IP management agency, such as the IP center, IP clinic, or IP law, to serve as a hub for educational, consulting, and asset aggregation activities. Shafi, M. (2021) studied efficiency through innovation as well as development within competence and found that the role of the organisation is determined to improve the innovation capability of the small enterprise; it requires both external resources and internal changes to continuously research and develop new products to compete and survive in the market.

### **3 Research methods**

This research aims to create new knowledge (inductive research) by using mixed-methodology research consisting of 3 parts: qualitative research with in-depth interview techniques; quantitative research using survey techniques; and qualitative research using focus group discussion techniques to confirm the validity of this research model.

#### **3.1 Qualitative research phase**

In the first qualitative research with an in-depth interview technique, the sample group consisted of nine experts in the business sector who have experience in innovation, technology, and intellectual management. They were selected through the purposive sampling method with the qualifications of experts undertaken by the Faculty of Business Administration at King Mongkut's University of Technology North Bangkok. The structured interview in open-end questions followed the concept of four latent variables reviewed from theory and literature. The four latent variables are: 1) organisation centric 2) knowledge management 3) information management, and 4) research and development, then the development of the questionnaire from the knowledge content; an in-depth, theory, and literature review.



### 3.2 Quantitative research phase

Quantitative research with surveying technique; the drafted questionnaire was content validated and reviewed by five experts in the academic. It was evaluated by using item objective congruence (IOC) analysis that showed a 0.80-1.00 value (accepted at >0.50). Finally, we obtained the suitable 100 observed variables in four latent variables for the try-out questionnaire that evaluated the reliability from Cronbach's alpha statistic showed at 0.99 (accepted at >0.80) and discrimination for both checklist and rating-scale question items (accepted at >0.30) using standard deviation (SD) analysis obtained at 0.47-3.06 and corrected item-total correlation analysis obtained at 0.33-0.83, respectively.

The population was determined from 2,430 industrial business sectors that have received patents (DIP, 2021). According to the Comrey and Lee criteria, the very good 500 samples were selected according to small-medium, and large businesses, with 250 samples in each group, using a multi-stage sampling method. The research tool was the questionnaire, including a checklist, a rating scale, and open-ended questions. Data analysis was conducted through descriptive statistics by SPSS, referred to as the five-Likert scale (Silcharu, 2020). Multivariate statistical analysis employed SEM by AMOS with evaluating the data-model fit in four criteria (Arbuckle, 2016).

**Table 2: Model-fit and acceptable criteria**

Evaluating the Data–Model Fit	Acceptable Criteria
Chi-square probability (CMIN- $\rho$ )	Value > 0.05
Relative chi-square (CMIN/DF)	Value < 2.00
Goodness of fit index (GFI)	Value > 0.90
Root mean square error of approximation (RMSEA)	Value < 0.08

### 3.3 Qualitative research phase

The second qualitative research with focus group discussion to review and confirm the SEM model; eleven experts in the related business sector, who are not the same as in the first qualitative research phase with an in-depth interview, were selected through the purposive sampling method.

## 4 Results

### 4.1 Importance level of guidelines

An analysis of the importance of the components of guidelines for intellectual property management to patent applications revealed that the overall importance was at a high level with a mean of 4.13, and when analyzing the level of importance for each component, it was found that all four component latent variables were of high importance. They are arranged in order of importance and can be sorted as follows: 1) a component of organisation centric was the mean of 4.15 2) a component of knowledge management was the mean of 4.14 3) a

component of information management with the mean of 4.12 and 4) a component of research and development with the mean of 4.10. When classified by item in each component variable with the highest level of importance in the first three, as below:

1 Organisation centric is 1) organise the work structure according to the clear function and linkage in support of intellectual property work with the mean of 4.29 2) manage the work by setting a clear innovation direction with the mean of 4.25) and 3) have a section to respond for intellectual property management i.e., IP Center or IP Clinic with the mean of 4.22, respectively.

2 Knowledge management is 1) to establish a knowledge management section to manage the information in a systematic manner which responds in fast and easy access with a mean of 4.28 2) to encourage staff to attend training courses for patent agents at DIP with a mean of 4.24 (SD = 0.78) and 3) to set up online training materials on innovation and intellectual property for easy access to information with a mean of 4.24 (SD = 0.84), respectively.

3 Information management is 1) seeking the patent information from websites such as WIPO, Patents Google, JPO, and USPTO for patent mapping analysis with a mean of 4.18 2) having software to support storing and linking to other databases within the organisation with a mean of 4.17 (SD = 0.830) and 3) having protection system for personal devices i.e. thumb drive / external hard disk to prevent copying to the outside organisation with a mean of 4.17 (SD = 0.834), respectively.

4 Research and development is 1) continuously reviewing short-term and long-term research and development plans i.e., every 3 years and 5 years, etc. with the mean of 4.25 2) collaborating research and development with the government institutions i.e., NIA, NSTDA, Science Park, Central Lab with the mean of 4.21 and 3) have a committee to focus on quantity and quality of research and development on intellectual property to enhance research capability continuously with the mean of 4.18, respectively.

#### **4.2 Comparison of business size**

The t-test analysis compares the mean of the two-independent populations and the H<sub>0</sub>-hypothesis, proposing to compare business size on the importance of guidelines for intellectual property management to patent applications. Testing results revealed that each of the overall latent variables was statistically significant at the level of 0.05 as shown in Table 3.

**Table 3: The mean and SD of guidelines for intellectual property management to patent applications**

Guidelines	Small-medium enterprise			Large enterprise			t-value	p-value
	$\bar{x}$	SD	Importance level	$\bar{x}$	SD	Importance level		
Overall	4.04	0.44	High	4.22	0.46	High	-4.47	0.00*
1. Organisation centric	4.04	0.47	High	4.26	0.47	High	-5.06	0.00*
2. Knowledge management	4.06	0.51	High	4.23	0.52	High	-3.54	0.00*
3. Information management	4.03	0.48	High	4.20	0.51	High	-3.89	0.00*
4. Research and development	4.01	0.44	High	4.18	0.50	High	-4.03	0.00*

In small-medium enterprises with results, the overall importance level of the guidelines for intellectual property management to patent applications was high, with a mean of 4.04. In addition, it was found that all four latent variables were of high importance. They are arranged in order of importance and can be sorted as follows: knowledge management with a mean of 4.06, organisation centric with a mean of 4.04, information management with a mean of 4.03, and research and development with a mean of 4.01, respectively.

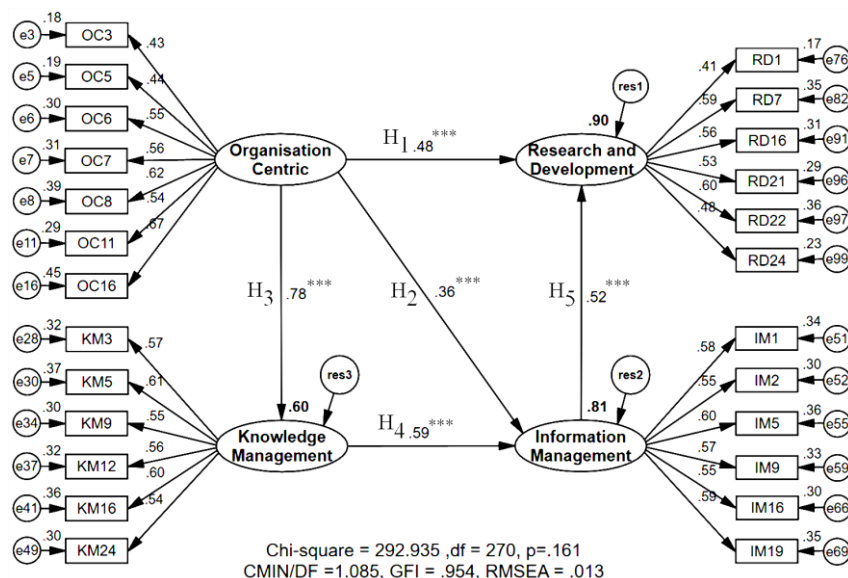
In large enterprises with results, the overall importance level of the guidelines for intellectual property management to patent applications was high with the mean of 4.22. In addition, it was found that all four latent variables were of high importance. They are arranged in order of importance that can be sorted as follows: organisation centric with the mean of 4.26, knowledge management with the mean of 4.23, information management with the mean of 4.20, and research and development with the mean of 4.18, respectively.

The comparison of the importance level of the guidelines for intellectual property management to patent applications between small-medium enterprises and large enterprises by using independent t-test analysis. The results revealed a statistically significant difference between the mean of an importance level for the two independent groups at the level of 0.05, which meant large enterprises were rated more important than small-medium enterprises.

### 4.3 Structural Equation Modeling (SEM)

The SEM of the guidelines for intellectual property management to patent applications after adjusting is comprised of four latent variables: one exogenous latent variable, namely Organisation Centric (OC), and three endogenous latent variables, namely Knowledge Management (KM), Information Management (IM), and Research and Development (RD), which associate twenty-six observed variables as shown in Figure 4.

**Figure 4: The SEM of guidelines for intellectual property management to patent applications in the standardized estimate mode after modification**



**Table 4: The results of four statistics criteria passed evaluating the data-model fit.**

Evaluating the Data-Model Fit	Acceptable Criteria	Results
Chi-square probability (CMIN-ρ)	Value > 0.050	0.161
Relative chi-square (CMIN/DF)	Value < 2.000	1.805
Goodness of fit index (GFI)	Value > 0.900	0.954
Root mean square error of approximation (RMSEA)	Value < 0.080	0.013

Therefore, it could be concluded that the four statistical criteria were met; the structural equation modelling of the guidelines for intellectual property management to patent applications was fit to the empirical information.

In Figure 4, the structural equation modelling of guidelines for intellectual property management to patent applications after the modification consisted of four latent variables can be described in the standardised regression weight of latent variables as follows.

H1: Organisation centric variable directly influenced the research and development variable with the standardized regression weight of 0.48 at the statistically significant level of 0.001, the squared multiple correlations ( $R^2$ ) of 0.90, and the variance of 0.01.

H2: Organisation centric variable directly influenced the information management variable with the standardized regression weight of 0.36 at the statistically significant level of 0.001, the squared multiple correlations ( $R^2$ ) of 0.81, and the variance of 0.05.

H3: Organisation centric variable directly influenced the knowledge management variable with the standardized regression weight of 0.78 at the statistically significant level of 0.001, the squared multiple correlations ( $R^2$ ) of 0.60, and the variance of 0.09.

H4: Knowledge management variable directly influenced the information management variable with a standardized regression weight of 0.59 at the statistically significant level of 0.001, the squared multiple correlations ( $R^2$ ) of 0.81, and a variance of 0.05.

H5: Information management variable directly influenced the research and development variable with the standardized regression weight of 0.52 at the statistically significant level of 0.001, the squared multiple correlations ( $R^2$ ) of 0.90, and the variance of 0.01.

Twenty-six observed variables were influenced by four latent variables. They can be described by the standardised regression weight of observed variables in order sorted as follows.

**Seven observed variables were influenced by the organisation centric variable.**

- 1 Clear strategic plan on intellectual property management (OC16) of 0.67.
- 2 Budget planning for research and development to patent (OC8) of 0.63.
- 3 Clear intellectual property performance indices i.e., patents, petty patents, copyrights, journals (OC7) of 0.56.
- 4 Clear role and responsibility for the research and development department (OC6) of 0.55.
- 5 Shared values of technology and innovation developing to intellectual property (OC11) of 0.54.
- 6 Have a section to respond for the innovative organisation to manage the ideas initiation (OC5) of 0.44.
- 7 Have a section to respond to intellectual property management, i.e., IP Center or IP Clinic (OC3) of 0.43.

**Six observed variables were influenced by the research and development variable.**

- 1 Patented through the PCT system to protect international property rights via the Thailand DIP (RD22) of 0.60.
- 2 Research and development of new projects undertaken by startup unit (Innovation-Based Enterprise) (RD7) of 0.59.
- 3 Use patent mapping data for further research and development (RD16) of 0.56.
- 4 Additional rewards to researchers and inventors who have outstanding results (RD21) of 0.53.

- 5 Organize academic forums/ exhibitions and continually presented an award in honor of an outstanding innovator (RD24) of 0.48.
- 6 Continuous reviewing for the research and development short and long-term planning (RD1) of 0.41.

**Six observed variables were influenced by the information management variable.**

- 1 Determine and verify the accuracy of intellectual property items before storage (IM5) of 0.60.
- 2 Purchase the patent database software that is used for patent mapping analysis (IM19) of 0.59.
- 3 Have a policy to support the acquisition of insights data searching on the intellectual property i.e., patents landscape (IM1) of 0.58.
- 4 Create the information reporting systems, i.e., a single-page summary in the dashboard (IM9) of 0.57.
- 5 Have a policy to support investment and development for software and hardware continuously (IM2) of 0.55.
- 6 Continuous improvement by up-to-date information management (IM16) of 0.55.

**Six observed variables were influenced by the knowledge management variable.**

- 1 Collect the suggestions and ideas for continuous improvement (KM5) of 0.61.
- 2 Create a manual based on the experience of the granted patent process (KM16) of 0.60.
- 3 Encourage the exchange of knowledge within the organisation, both formal and informal (KM3) of 0.57.
- 4 Get training on innovation and intellectual property management from external experts continuously (KM12) of 0.56.
- 5 Cultivate the organisational culture of technology and innovation learning (KM9) of 0.55.
- 6 Join the membership/confederation, i.e., the Thai Chamber of Commerce, National Innovation Agency (NIA), DIP (KM24) of 0.54.

In addition to other statistical results of observed variables, i.e., the statistically significant level, the squared multiple correlations ( $R^2$ ), and the variance can be obtained in table 5.

**Table 5: Statistically of structural equation model after modification**

Variables	Estimate		R <sup>2</sup>	Variance	C.R.	P
	Standard	Unstandard				
Organisation Centric				0.10		
Research and Development	0.48	0.49	0.90	0.01	3.89	***
Information Management	0.36	0.55	0.81	0.05	3.71	***
Knowledge Management	0.78	1.14	0.60	0.09	7.29	***
Knowledge Management			0.60	0.09		
Information Management	0.59	0.61	0.81	0.05	5.62	***
Information Management			0.81	0.05		
Research and Development	0.52	0.35	0.90	0.01	4.33	***
Organisation Centric				0.10		
OC3	0.43	1.00	0.18	0.47		
OC5	0.44	1.11	0.19	0.54	6.89	***
OC6	0.55	1.48	0.30	0.52	7.78	***
OC7	0.56	1.52	0.31	0.53	7.83	***
Organisation Centric				0.10		
OC8	0.63	1.72	0.39	0.48	8.22	***
OC11	0.54	1.51	0.29	0.58	7.71	***
OC16	0.67	1.85	0.45	0.43	8.45	***
Research and Development			0.90	0.01		
RD1	0.41	1.00	0.17	0.53		
RD7	0.59	1.62	0.35	0.53	7.95	***
RD21	0.53	1.41	0.29	0.54	7.60	***
RD22	0.60	1.52	0.36	0.44	8.00	***
RD24	0.48	1.36	0.23	0.69	7.18	***
Information Management			0.81	0.05		
IM1	0.58	1.00	0.34	0.47		
IM2	0.55	0.95	0.30	0.50	9.84	***
IM5	0.60	1.11	0.36	0.52	10.50	***
IM9	0.57	1.06	0.33	0.55	10.13	***
IM16	0.55	0.94	0.30	0.49	9.82	***
IM19	0.59	1.11	0.35	0.55	10.37	***
Knowledge Management			0.60	0.09		
KM3	0.57	1.00	0.32	0.47		
KM5	0.61	1.16	0.37	0.52	10.18	***
KM9	0.55	0.99	0.30	0.51	9.52	***
KM12	0.56	1.06	0.32	0.54	9.66	***
KM16	0.60	1.13	0.36	0.51	10.09	***
KM24	0.54	1.02	0.30	0.56	9.43	***

Note: \*\*\*significant level at 0.001

#### **4.4 Direct and overall influence statistics analysis**

The overall influence statistical analysis of SEM in standardised estimate mode after model modification; the highest overall influence was on the organisation centric variable; the highest overall influence was on the research and development variable, with a standardized regression weight of 0.91. In addition, the highest direct influence was on the organisation centric variable, with a direct influence on the knowledge management variable with a standardized regression weight of 0.82.

#### **4.5 Discussion**

Key issues found from research findings on intellectual property management to patent applications. It is an intellectual property management approach that focuses on factors in creating the ability to manage intellectual property more effectively. The principles and factors influencing the management to achieve success, leading to the adoption of patent applications in accordance with the goals of the organisation. Patents can create commercial value, prevention of infringement of intellectual property rights, and can be an indicator of innovation capability. Leverage the science and technology of Thailand to the innovation ecosystem to be strong in the country and connect to the international under the competitive environment of the industrial business sector in the era of industrial 4.0. The discussion leads to the conclusion of the solution with four different latent variables, including relevant papers cited as follows.

Organisation Centric latent variable has the highest mean of 4.15. The organisation-centered management model puts the main emphasis on laying the foundation for a systematic, interconnected operating structure, consistent with the core strategy, transmitted to the department, section, and individual employees in the form of a clear implementation plan with goals and Key Performance Index (KPI). Management is in accordance with the top-down and bottom-up policies to know the gaps in the operation and use them for analysis to improve the operating structure to be very effective. However, the organisation needs to look at the external factors (outside-in) that directly affect business operations to adapt to the rapidly changing situation in the present era. Patent intellectual property management is an integral part of leading enterprises that can generate enormous commercial value. Consistent with a study by Grimaldi, M., et al. (2018), strategic intellectual property measures can be applied to internal and external companies. The internal organisation management strategy considers various internal issues related to organizing the resources within the company that are necessary to assess costs. Acquisition of patents and other intellectual property information through publications and literature searches for analysis and planning for company decision-makers. Management pays special attention to the integration of the personnel, skills, and qualifications necessary for the strategic management of intellectual property (IP) management. Training of those involved in intellectual property management to improve awareness and protect the intellectual property interests of an organisation referred to (Gambardella, A., 2013). It is important to emphasize that senior management, managers, and seniors are needed to coordinate the overall strategic management of an organisation's intellectual property (Somaya D., 2002). In accordance with Dhawan (2016) who commented



that decisions about the strategic management of intellectual property should be given a high level of management and found that companies led by CEOs with legal backgrounds achieve good financial results more than any other company, because the value of the intellectual property is linked, intellectual property lawsuits are inevitable. Thus, it can be concluded that in an IP-rich industry, the need for specialists, legal and management knowledge is critical (Grzegorzczak T. and Robert Głowiński, R., 2020). And this is consistent with Holger Ernst (2016); the correlation between patent management and indicators of financial and patent performance from 158 technology companies from the US and Germany across various industries found 1) the importance of patent management, especially patent protection management, and 2) the handling of patent data is positively correlated with the level of a company's financial profitability and the strategic and financial impact of the patent portfolio. This means that patent protection and data management are the key management capabilities of a company that determines the level of value generated by patents.

The most important factor of the observed variable, it was found that the work structure was clearly structured according to the duties and that there was a link in supporting intellectual property work with a mean of 4.29 under of the organisation centric latent variable. The implementation with clear and comprehensive responsibilities under hierarchy and integrated matrix organisation that is linked to work from many departments within vision, mission, and value. Creation of an organisational culture in which high-level, middle-level executives and operational-level employees understand their roles and responsibilities. Build trust between departments to ensure smooth coordination. The important and support units that work for intellectual property management such as research and development, information technology, IP, financial, human development, and some organisations have specific departments such as innovation organisation, innovation-based incubators (IBI), a Start-up for direct support towards building an innovation ecosystem within the organisation and connecting to the outside of the organisation (Open Innovation) as well. Engaging in activities through process improvement to be more efficient and seeking new technology to replace working under old technology. Have a clear work plan (Framework) with clear goals, clear measurements, and assessments so that all departments are aware of and operate in the same direction. It has been shown that intellectual property management is important to build a technological innovation network using multiple external sources and optimise the ability to manage intellectual property to optimize technological innovation. Open innovation patent management, as Grzegorzczak T. and Robert Głowiński, R. (2020) said, companies should focus on patent management in line with their business model; organisational conditions, and a competitive environment that is important to researchers involved in intellectual property management (Somaya D., 2002). Proper patent management helps companies gain R&D feedback and achieve a sustainable competitive advantage, especially with increasing competition in technology, which requires greater skill and focus on patent management. Information management departments are tasked with acquiring information as important skills and techniques in data analysis for planning purposes. Determine the direction of research and development of products that must meet market demands and keep up with the times of innovation. Technology is rapidly advancing. Having big data, storage, and bringing

the data to analysis are all part of information management. The presence of insight, hindsight, and foresight information will be key factors that can create a competitive advantage in the industrial sector that needs to develop advanced technology (Deep Tech). Patent mapping insights analysis is very important in starting the process of making informed decisions at the beginning of research and development planning in accordance to Silpcharu, T. and Noongam, W. (2020) having a vision and creativity in leading an organisation to sustainable success is a strategy toward excellence, a strategic plan, and leadership are of the utmost importance; should have a long-term vision and definite goals; an important reason is that vision can shape attention and designate a focus of organisation management by combining various components in the organisation. Bencze, Z., et al. (2019) discusses patent mapping analysis by using patent data; patent applications are extracted from software called Orbit Intelligence, which contains information related to intellectual property, a tool used to identify trends in various fields of innovation, patents, and patent applications. The keyword search process is selected and grouped into categories. Search results will show legal status, patent family, priority year, priority country, and assignees. It will contribute to the decision-making and analysis of researchers and developers in determining the next direction.

## 5 Conclusion

Intellectual property management to patent applications is an approach that represents the principles of management within an industrial business organisation that is structured in intellectual property management. Organisations that place a high emphasis on this issue are role models for sharing experiences. Issues and improvements in the structure and operations for the successful acquisition of intellectual property management as an asset that leading enterprises value and regard as having commercial value. It is an index of performance indicators in innovation, science, and technology, creating a competitive advantage in commercialization. The researcher has suggested principles and the guidelines for intellectual property management to patent applications in the recommendation of observation during research for government-related sectors and industrial businesses as follows.

### 5.1: In government guidelines recommendation.

- Department of Intellectual Property (DIP) should consider improving the intellectual property protection system; facilitate the registration quickly and efficiently for entrepreneurs in the industrial business sector has entered the system of protection of intellectual property rights both domestically and internationally to meet international standards.
- National Innovation Agency (NIA) should accelerate the expansion of coverage of national innovation system development by creating awareness of national innovation identity among entrepreneurs, innovators, and start-up enterprises to enhance innovation capability in the global arena.
- National Science and Technology Development Agency (NSTDA) should expedite the transfer of knowledge in science, technology, and innovation to be used in the

commercial sector of the private sector by working with partners including government, private, and universities to provide comprehensive services in various forms.

- Office of National Higher Education Science Research and Innovation Policy Council (NXPO) should consider the framework of the measures tax deduction for research and technology development and innovation to be consistent and support concrete entrepreneurs in the small and medium-sized industrial sector.
- Thailand Development Research Institute (TDRI) should speed up the transformation of intellectual property into the capital to support Thai SMEs to be a reality by creating clarity of intellectual property valuation and accelerating the data linkage between the Department of Intellectual Property and the Department of Business Development. This will increase opportunities for SMEs to access funding sources.

## **5.2 In industrial business sector guidelines recommendation.**

- Industrial businesses should create an innovation ecosystem to be in line with the uncertain changing conditions in the era of globalization with a form of technological innovation that is cheaper to enter the market by looking for new opportunities from small and medium-sized entrepreneurs' start-up enterprises, which is the source of large-scale new ideas, creating cooperation to expand, expand the market, and enhance the country's innovation capability.
- Industrial businesses should create corporate innovations to bring knowledge and creativity combined with the talent management of entrepreneurs to gain a competitive advantage, which is an innovative business that is the foundation of the acquisition of intellectual property.
- Industrial businesses should have a process of incubating innovators. To set the quality target of personnel to create and apply the knowledge to work for research and product development that aligns to the direction of market demand that can be a spin-off to new businesses and lead to further international competition.
- Industrial businesses should have a patent search process for use in analysing, evaluating, and market planning for their business. This allows entrepreneurs to know the essence of the patents of their competitors in further research and development. Avoid infringing on someone else's patent and know-how to draft a patent application.
- Industrial businesses should have research and development with partners from both the government sector and educational institutions, which is a mechanism to help promote and support the business sector of the country and has the potential to do research and development to increase the ability of entrepreneurs to expand the product to the next level.
- Industrial businesses should use a patent agent or a patent attorney to represent the filing and review the procedures related to patent law for the patent application to be protected

effectively, quickly, and accurately in accordance with the criteria set by the Department of Intellectual Property.

The researcher expects that the guidelines recommendations gained from experience during the research period of more than one year should be more or less beneficial to stimulate the change in intellectual property management concepts regarding patents for better processes and to strengthen competitiveness in research, technology, and innovation systems that are important fundamentals of the acquisition of intellectual property in Thailand.

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