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Research and development center administration system for vocational education in Thailand: Technique of confirmatory factor analysis

Sistema de administración del centro de investigación y desarrollo para la educación profesional en Tailandia: técnica de análisis factorial confirmatorio

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Contents

ABSTRACT:
The objective of this research is to analyze the elements of the system of research and development center administration of vocational institutes in Thailand. The samples are 10 administrators of vocational institutes, 47 directors of academic institutes and 343 lecturers of the curricula, or 400 samples in total, selected with the stratified sampling technique. The tool used in this research is a questionnaire with the reliability value of 0.937. The primary assumption for the Confirmatory Factor Analysis has the value of Kaiser Meyer-Olkin of 0.83, and the value from Bartlett's test of 1774.30, with the statistical significance level of 0.01. The outcomes from the CFA on the system of vocational education research and development center administration of vocational institutes in Thailand show that the concurrence with the empirical data is as follows: $\chi 2 = 1.22$, p-value = 0.54, $\chi 2/df = 0.61$, GFI = 1.00, RMSEA = 0.00, AGFI = 0.98. The weights of the elements fall in the range of 0.51- 0.86, as follows: The weight of the element of policy, vision, mission and strategy is 0.51, the weight of the element of research quality management is 0.57, the weight of the element of budget management is 0.60, the weight of the element of publicity and public relations work is 0.66, the weight of the element of information system is 0.67, the weight of the element of monitoring and evaluation is 0.76, the weight of the element of intellectual property management is 0.80, the weight of the element of formation of organizational structure is 0.82, and the weight of the element of human resource management is 0.86.

RESUMEN:
El objetivo de esta investigación es analizar los elementos del sistema de administración de centros de investigación y desarrollo de institutos vocacionales en Tailandia. La muestra consiste en 10 administradores de institutos vocacionales, 47 directores de institutos académicos y 343 profesores de los planes de estudio, 400 muestras en total, seleccionadas según la técnica de muestreo estratificado. La herramienta utilizada en esta investigación es un cuestionario con un valor de confiabilidad de 0.937. El planteamiento principal para el análisis factorial confirmatorio tiene el valor de Kaiser Meyer-Olkin de 0.83, y el valor de la prueba de Bartlett de 1774.30, con un nivel de significación estadística de 0.01. Los resultados del CFA sobre el sistema de administración de centros de investigación y desarrollo de educación vocacional de los institutos vocacionales en Tailandia muestran que la concurrencia con los datos empíricos es la siguiente: $\chi 2 = 1.22$, valor p = 0.54, $\chi 2 / df = 0.61$, GFI = 1.00, RMSEA = 0.00, AGFI = 0.98. Los pesos de los elementos caen en el rango de 0,51 a 0,86, de la siguiente manera: el peso del elemento de política, visión, misión y estrategia es 0,51, el peso del elemento de gestión de la calidad de la investigación es 0,57, el peso del elemento la gestión presupuestaria es 0.60, el peso del elemento de publicidad y el trabajo de relaciones públicas es 0.66, el peso del elemento del sistema de información es 0.67, el peso del elemento de monitoreo y evaluación es 0.76, el peso del elemento intelectual la gestión de la propiedad es 0,80, el peso del elemento de formación de la estructura organizativa es 0,82 y el peso del elemento de gestión de

Keywords: Research and development center, Vocational institutes in Thailand, Confirmatory Factor Analysis

recursos humanos es 0,86.
Palabras clave: centro de investigación y desarrollo, institutos vocacionales en Tailandia, análisis factorial confirmatorio

1. Introduction

In accordance with the standard by Ministry of Higher Education, Science, Research and Innovation of Thailand, academic institutes that offer bachelor's courses must meet key criteria and have indicators set by Ministry of Higher Education, Science, Research and Innovation of Thailand, which are organization of teaching and learning of research with the emphasis on the development of experiments, research and studies in order to research on and develop innovations for the development of the country (Royal Thai Government Gazette, 2019) When academic institutes under the Office of Vocational Education Commission gather together and develop themselves as vocational institutes, the structure for the management and administration of all units must be adjusted to concur with regulations and standards set by Ministry of Higher Education, Science, Research and Innovation of Thailand.

Therefore, vocational institutes must develop systematic research management (Royal Thai Government Gazette, 2019) because research is the heart of problem solving and the foundation for innovations. Many academics such as Duangduean Phutayanan (2010), Samran Hongklang (2014), Bartol & Martin (2003), Feldman et al. (2002) and J. Lee & H.N. Win. (2004) have expressed their ideas that emphasize that research is important for the development of the country and is the invention of innovations through the systematic process of studies and experiments. Likewise, Royal Thai Government Gazette (2019) has explained that research and development will lead to the attainment of solutions and innovations for developing the country. Furthermore, Ministry of Higher Education, Science, Research and Innovation of Thailand (Royal Thai Government Gazette, 2019) has explained the importance of research that search is a process that build and develop bodies of knowledge. Research works that fit the fundamental economy can fill social gaps, enhance capacity of competition and develop the country.

Even though vocational institutes that are established in accordance with Vocational Education Act B.E. 2551 (A.D. 2008) have been giving bachelor's courses for a period of time, the findings from the surveys and assessments by the in-charge agency show that the quality of research management by lecturers of the curricula and students, as reflected through many indicators, is still lower than the standard (Royal Thai Government Gazette, 2019). especially those in the respect of research center administration and vocational education development of vocational institutes in Thailand, the elements of which are still vague and the concrete administration is still absent. Such problems lead to the limited quality of research works by vocational institutes. Thus, such problems are significant for vocational institutes in Thailand; and it is necessary to establish efficient systems of research center administration and development (Samran Hongklang, 2014).

Nevertheless, there have been certain researchers who have attempted to study on the directions for developing the systems of research and development (R&D) center administration. Examples of such researchers are Duangduean Phutayanan (2010) who has studied on the development of research work administration by universities, Samran Hongklang (2014) who has studied on patterns of administration of R&D centers in vocational institutes, Mark E. Welker Wake (2006) who has studied on the research works on the commitments of the institute, Philipp F.& Peter L. (2017) who has studied on the administration of the research center of Wageningen University, and Stephanie T. Nishimuraa et al., (2018) who has studied on the pattern of the academic assessment of research center: a case study of the center to prevent and solve problems of violence to the youths in Asia Pacific Region. However, all the works have not led to the clear identification of elements. Hence, the emphasis is put on the elements of R&D center administration of universities in Thailand in order to draw the conceptual framework for this research work. For instances, Khon Kaen University sets that the elements of the vocational education research and development center administration are 1) Research Work Promotion and Development Group, 2) Analysis and Evaluation Group, 3) Research Work Efficiency Development Group, and 4) Information and Research Work Publicity Group; Kasetsart University sets that the elements of the R&F center administration are 1) Research Work Publicity Department, 2) Information Department, 3) Coordination and Evaluation Department, and 4) Instruments and Scientific Experiment Department; and King Mongkut's Institute of Technology Ladkrabang puts that the elements of the R&D center administration are 1) Research Work Quality Administration, 2) Intellectual Properties, and 3) Academic Services.

From the studies on the structures of the administration of R&D centers of universities, related research works, and concepts suggested by academics, it is discovered that the explanations of elements of the administration of R&D centers are not much different from one another. However, it still cannot be conformed that such elements of R&D centers have efficiency that fit the contexts of vocational institutes in Thailand. In addition, there has never been any study on empirical information

conducted by people with direct involvements. Therefore, this research project on the elements of the administration of vocational education R&D centers of vocational institutes in Thailand is a study to verify theoretical information with empirical information in order to identify the key elements discovered from the synthesis of approaches and theories. Therefore, the objective of this research is to analyze the element of research and development center administration of vocational institutes in Thailand. The discovered elements will then be used for developing the pattern and direction for the administration of R&D centers of vocational institutes in Thailand and for determining the indicators for monitoring and evaluation, which will lead to further improvement of the quality of the administration of R&D centers of vocational institutes in Thailand.

2. Methodology

2.1. Population and Sample

Populations of this research project are administrators and directors of vocational institutes, and lecturers and teachers in vocational curricula from 23 vocational institutes that are under the control by the Office of Vocational Education Commission. The total number of populations is 1,570, and the sample size is 400 samples which has been set in accordance with the Confirmatory Factor Analysis (CFA) criteria by Tabachnick & Fidell (2012) who have stated that the sample size of 400 samples is considered as good sample size. The samples are chosen with the stratified sampling technique for 10 administrators of institutes, 47 directors of the institutes and 343 lecturers and teachers of the curricula.

2.2. Research Tool

The tool used in this research project is a 5-scale rating questionnaire to collect the

sample's opinions toward the elements of the development of the R&D center administration system by vocational institutes in Thailand. Such elements include human resource management, formation of organizational structure, intellectual property management, monitoring and evaluation, information system, publicity, budget management, research quality management, and establishment of policy, vision, mission and strategy. The questionnaire contains 52 questions that have been checked and verified for the accuracy of the contents by 5 experts; and each of all the items in the questionnaire attains the IOC in the rage of 0.60 – 1.00 (Rovinelli &Hambleton, 1997). Afterwards, after being refined in accordance with the suggestions by the experts, the questionnaire is tested with 30 non-sample populations in order to find Cronbach's Alpha Coefficient (α). The reliability value of the questionnaire is 0.937, which reflects the high level of reliability (Cronbach, 1951; Tavakol & Dennick, 2011). After that, 400 sets of questionnaires are distributed through mailing service for collecting information from the samples. The number of returned questionnaire sets is 400 or 100%.

2.3. Data Analysis

The technique used for analyzing the attained data is Confirmatory Factor Analysis (CFA) in order to test the structural concurrence by considering the concurrence between the model and empirical information. The analytical technique is CFA and the attained data are considered against the predetermined criteria and analyzed for statistical values with an instant computer program or LISREL 8.72.

3. Results

The results from CFA about elements of the system for the administration of vocational education R&D centers of vocational institutes in Thailand are shown in Tables 1-3 and Figure 1.

Table 1
Primary Test of Appropriateness
of Data (Kaiser-Meyer-Olkin)

Variables	KMO	Bartlett's Test of Sphericity	Sig
Elements of the Administration of R&D Centers of Vocational Institutes in Thailand	0.83	1774.30	0.00

From Table 1, the results from the test of primary assumption for the CFA on the elements of the system of administration of vocational education R&D centers of vocational institutes in Thailand, which is used for determining the appropriateness of data (Kaiser-Meyer-Olkin: KMO), and for studying on the interrelationship among questions. The findings from the research show that the KMO

is 0.83 and have high level of interrelationship. Thus, they are appropriate for the CFA. Furthermore, the interrelationship among variables is tested with the sphericity technique by Bartlett. Outcomes show that the interrelationship among variables or Bartlett's sphericity value is 1774.30; and the interrelationship is statistically significant (p-value = 0.00). Thus, it is confirmed that this set of data are appropriate and concurrent to the primary assumption for CFA.

Table 2
Significant results of the reported variables and their interrelationship

Variables	OS	PS	QM	BM	HR	IS	ME	PM	PU
Formation of Organizational Structure (OS)	1.000								
Establishment of Policy, Vision, Mission and Strategy (PS)	.479**	1.000							
Research Quality Management (QM)	.342**	.443**	1.000						
Budget Management (BM)	.329**	.364**	.352**	1.000					
HR Management (HR)	.700**	.464**	.337**	.371**	1.000				
Information System (IS)	.547**	.456**	.459**	.320**	.569**	1.000			
Monitoring and Evaluation (ME)	.651**	.549**	.372**	.421**	.635**	.600**	1.000		
Intellectual Property Management (PM)	.714**	.532**	.308**	.461**	.648**	.667**	.766**	1.000	
Publicity (PU)	.412**	.382**	.360**	.489**	.310**	.379**	.347**	.316**	1.000

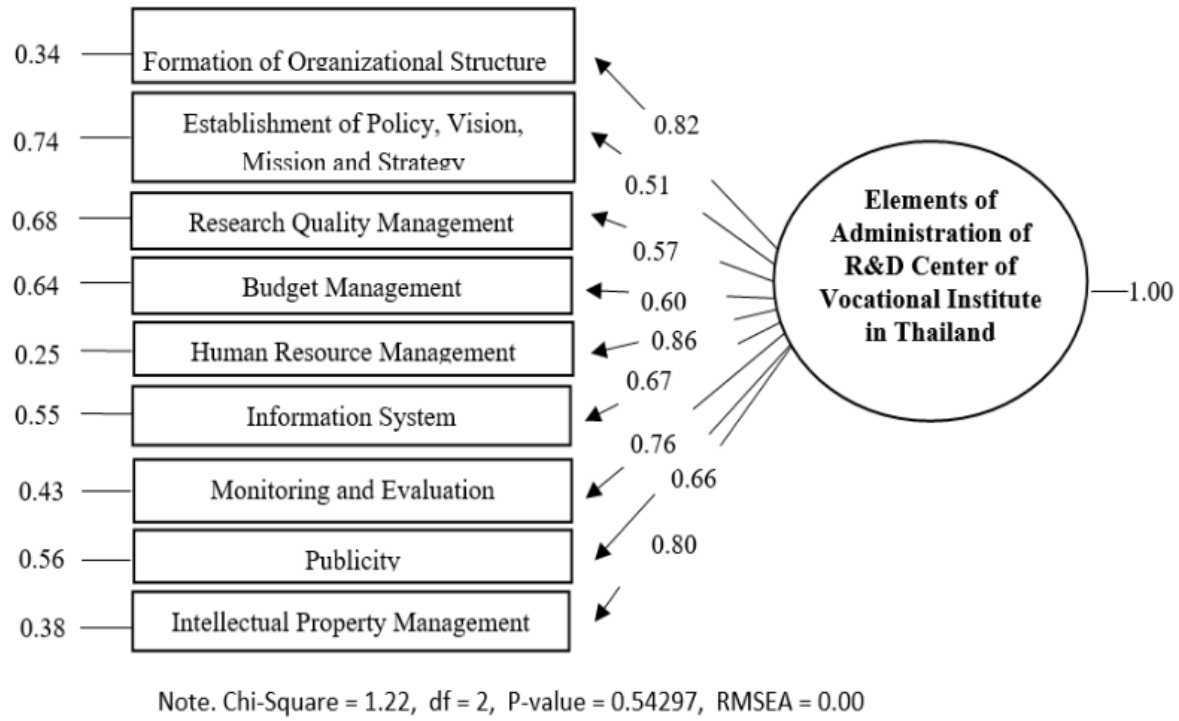
From Table 2, which shows the results from the test of interrelationship among variables, it is apparent that the studied variables are interrelated with one another with the statistical significance level of 0.01. The values of interrelationship among all variables are greater than 0.30, which have passed the predetermined criteria (Hair et al., 2010). It can be deemed that the interrelationship among variables is great enough for being used for identifying the confirmatory elements. The results from the test of the interrelationship among variables show that the greatest interrelationship is the one between the intellectual property management variable and the monitoring and evaluation variable, with the coefficient of 0.766, followed by the interrelationship between the intellectual property management variable and the formation of the structure of the organization variable (0.714). However, the lowest interrelationship is the one between the intellectual property management variable and the research work quality management variable (0.308).

Table 3
Criteria and theory of the study's Values of Goodness-of-Fit appraisal

Statistics Used for the Test	Criteria	Values	Results	Supporting Theory
$\chi 2$	> 0.05	1.22	Passed	Byrne (2001)
p-value	p> 0.05	0.54	Passed	Byrne (2001)
$\chi 2$ /df	<2.00	0.61	Passed	Hair et. al., (2010)
GFI	>0.90	1.00	Passed	Byrne (2001)
AGFI	≥ 0.90	0.98	Passed	Schumacker & Lomax (2010)
RMSEA	<0.05	0.00	Passed	Schumacker & Lomax (2010)

From Table 3, the results from the CFA show that the value of χ2 =1.22, p-value = 0.54 has met the criteria (Byrne, 2001), with the Goodness-of-Fix Index (GFI) = 1.00, and the adjusted GFI = 0.98. Both figures are appropriate because they are greater than 0.90 (Byrne, 2001; Schumacker & Lomax 2010). The root means square error of approximation (RMSEA) is 0.00 which meets the criterion that this value is not inferior to 0.08 (Schumacker & lomax, 2010). Thus, it can be concluded that the results from CFA are concurrent with the empirical information. The weights of elements considered, it can be said that the results from CFA are confirmed and all variables have the statistical significance level of 0.05.

Figure 1
Results from the Analysis of Element of the Administration of Vocational Education Research and Development Center of Vocational Institute in Thailand



Note. Chi-Square = 1.22, df = 2, P-value = 0.54297, RMSEA = 0.00

From Figure 1, it is apparent that the figures of all the variables are positive and the difference levels are 0.05. The weights of all variables are greater than 0.30 which means they meet the criteria for the CFA to identify the elements. Considered in the order from the greatest one to the smallest one, the variable of Human Resource Management has the greatest weight (Factor loading = 0.86), followed by the variable of Formation of Organizational Structure (Factor loading = 0.82). The variable in the third place is Intellectual Property Management (Factor loading = 0.80). The variable in the fourth place is Monitoring and Evaluation (Factor loading = 0.76). The variable in the fifth place is Information System (Factor loading = 0.67). The variable in the sixth place is Publicity (Factor loading = 0.66). The variable in the seventh place is Budget Management 7 (Factor loading = 0.60). The variable in the eighth place is Research Quality Management (Factor loading = 0.57). The variable with the lowest weight is Establishment of Policy, Vision, Mission and Strategy (Factor loading = 0.51).

4. Discussions

The results from the analysis of the elements of the administrative system for R&D centers of vocational institutes in Thailand with Confirmatory Factor Analysis (CFA) technique show that the HR management has the greatest weight of all because there have been plans to attract many researchers and assistants with knowledge and capabilities, many ways to enhance researchers' and assistants' efficiency so that they can will diversified knowledge and skills, and enhancement of researchers' and assistants' morale so that they will meet the goals. Such findings concur with the ideas of Sirot Phonphanthin (2004), Mohamad, M.M. et al., (2019), Barnes (1995) and Sern et al., (2019), who have mentioned that human resource management is the support and development of researchers by making a thorough plan to increase incentive in order to motivate lecturers to do more research works and to improve research related knowledge and capabilities of assistants in order to have desirable personnel to work to achieve the goals in the effective manner. The variable in the second rank is the formation of the structure of the organization because there are sub units with clearly assigned responsibilities and chain of commands, as well as the decentralization in terms of research works. This point has also been found out from the research works by Bartol & Martin (2003) Mustafa M.Z. et al., (2019) and Musid et al., (2019), the findings from which have pointed out that the formation of structure is an element for the development and alignment of organizations or units by

setting the tasks, power and responsibilities of each unit and by establishing chain of control and command, which will accelerate and ensure the efficiency of the operations of R&D centers. The variable in the third rank is intellectual property management because there has been encouragement for the implementation of research work to the making of commercial benefits, with the protection and utilization of intellectual properties for commercial benefits and the provision of intellectual property database service. Likewise, Feldman et al., (2002) and J.Lee & H.N. Win. (2004) have stated that universities nowadays are offering to researchers more profits as the remuneration for the intellectual properties. This is a strategy for managing intellectual properties and for registering patents so that universities can have commercial benefits. Thus, more research works are registered for patents. The variable in the fourth rank is monitoring and evaluation. It is essential to supervise and follow-up to track the progress of each research work. This also includes the evaluation of the research operation before, during and after each project. This point concurs with the findings from the research works by Stufflebeam (1990) and Jailani Mg.y et al.,(2019), who have discovered that the assessment before a research project focuses on environs and inputs whilst the evaluation during a research emphasizes on research process, and the evaluation after the project focuses on outputs. Thus, monitoring and evaluation enable researchers to active their research goals in the efficient manner. The variable in the fifth rank is the information. Data are gathered, stored, processed and analyzed with computer hardware and software, network systems and database all together in order to attain information that supports the research projects, decision making, planning and the operation of the organization. This concurs with the concept by Gwaltney Robert Alan (2005), which can be concluded that information system is the processing of the system development in terms of the organization of data with data collection computers and multimedia files in the systematic manner. At present, technologies have been advanced. Thus, data storage has become systematic and the retrieval is convenient. The variable in the sixth ranks is publicity. This variable is important because a research work must be presented in academic conferences and published in academic journals on Thailand and other countries, as well as the presentation in the form of a poster. This agrees to the findings from the study by Hall (1976) that publicity is a process whereby innovative research works are either accepted or rejected. The variable in the seventh rank is budget management that plays important roles because it incorporates the planning for finding the budget, identifying sources of funds, support for personnel's research projects and systematic evaluation of the expenditure of fund. In the light of this matter, Duangduean Phutayanon (2010) and Lau (2003) presented their perspectives that budget management is to efficiently find and provide funds and sources of funds for each research project by establishing research funding committee, setting the directions for the disbursement of research funds, for the monitoring of the results from the expense of funds, and for the personnel's participation in the management of research funds. The variable in the eighth order is research quality management with the research quality administration system that is transparent and participatory by setting research standards, encouraging the quality and creative research projects and supporting the publicity of research works in national and international scales. Similarly, Deming (1986) has explained that quality control and publicity are tools of administration and consist of 4 steps which are planning (Plan), implementing the plan (Do), checking the works that have been done (Check), and finding solutions to defects and defaults identified during the Check step (Action), which will improve the works and system, resulting in the quality of the research work that meets the predetermined criteria. The variable in the last rank is the establishment of policy, vision, commitment and strategy in accordance with the principles or procedure that have been set as the directions for the institute, groups or each individual to work towards the goal, and to set the directions for the organization to move towards in the future, in accordance with environs, with the consideration of external and internal factors. Such findings concur with the outputs from the works by Carl J. Friedrich (1963) and Sern et al., (2019), who have stated that there should be policy and plan for the development of personnel and suggested directions off personnel-related operations towards the predetermined goals so that the operations of the R&D center will be systematic and have a clear direction towards the predetermined goals.

5. Conclusions

The findings from this study confirm that the information of elements of the administration of vocational education research and development centers of vocational institutes in Thailand is concurrent with the empirical information. Such elements are 1) Human Resource Management, 2) Formation of Organizational Structure, 3) Intellectual Property Management, 4) Monitoring and Evaluation, 5) Information System, 6) Publicity, 7) Budget Management, 8) Research Quality Management, and 9) Establishment of Policy, Vision, Mission and Strategy, which will lead to the system of vocational education research and development center administration of vocational institutes under the Office of Vocational Education Commission, Ministry of Education of Thailand. The aforementioned elements play parts in the setting of policies, commitments, strategies and goals for the development of the system of vocational education research and development center administration of vocational institutes in Thailand. In addition, these elements can also be used for

making of strategic plans for the administration of vocational education R&D centers in vocational institutes in Thailand. Furthermore, administrators of institutes, directors of schools, teachers of the curricula and educational personnel can make operation plans on the bases of these elements or use these elements for making action plans and setting projects and activities within the frame of the administration of vocational education research and development centers of the vocational institutes that they work with.

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