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Research and Development Center Administration System for Vocational Education in Thailand: Technique of Confirmatory Factor Analysis

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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 Exploratory 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.

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

1. Introduction

Since the extension of missions for vocational colleges under the Office of Vocational Education Commission in Thailand, one of the novel missions is that those vocational colleges in each region are to form 'Institutes of Vocational Education' to provide not only vocational education certificates and diplomas but also a bachelor of technology. In order to achieve such the mission, all Institutes of Vocational Education have to follow the standards and regulations set by Ministry of Higher Education, Science, Research and Innovation of Thailand in managing curriculum of bachelor degrees, particularly, the focus on learning by research and development as this is believed that it leads to the growth and development of innovative society nationwide (Royal Thai Government Gazette, 2019). As a result, all Institutes of Vocational Education have to either rearrange their structures for inclusive management or adapt their administrative systems to cover all functions especially research and development as one focal task for the management of bachelor degrees.

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To be able to organize the function of research and development in those Institutes of Vocational Education, the research and development center should be well planned and established systematically. However, none of the studies addressed directly of the case studies how to effectively manage such the Researh & Development (R&D) center in vocational institutions in Thailand. The majority of the research often reported on the benefits of conducting research such as Bartol & Martin (2003), Feldman et al., (2002) and Lee & Win (2004) have expressed that research is essential for the development of the country and is the invention of innovations through the systematic process of studies and experiments. Likewise, the Royal Thai Government Gazette (2019) explained that research and development would 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) pointed out the impact of the research on the society as it helps contribute a huge amount of bodies of knowledge as well as. Enhances the capacity of competition and develop the country in all areas. Although without the studies mentioned earlier, one of the results from the quality assurance process after the operation of those Institutes of Vocational Education for a while represented the fact that the quality of managing the research domain was lower than the criteria set and it reflected the problem of management of the research and development centers as there were not clear components to fit in administrative system for managing such the centers. As a result, the quality of the research products emerged in the Institutes of Vocational Education was considered in a poor level as well as in a limited area. This issue has become a critical one for those Institutes of Vocational Education in Thailand and it leads to finding decent components or elements of the efficient administrative system for managing the research and development centers in the institutions (Hongklang, 2014).

Therefore, it is of our interest to investigate the proper elements of the administrative system for managing the R&D centers in the context of vocational education with the integration of higher education. There have been some researchers who have attempted to study on the directions for developing the systems of research and development (R&D) center administration. Phutayanan (2010) studied on the development of research work administration by universities., Hongklang (2014) studied on patterns of administration of R&D centers in vocational institutes., Philipp & Peter (2017) studied on the administration of the research center of Wageningen University., Nishimura et al., (2018) 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 mentioned have not led to the clear identification of those elements. Apparently, a variety of elements but different ones were selected in Thai higher education institutions such as Khon Kaen University sets that the elements of the vocational education research and development center administration include 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 the elements of the R&D center administration including 1) Research Work Publicity Department, 2) Information Department, 3) Coordination and Evaluation Department, and 4) Instruments and Scientific Experiment Department., King Mongkut's Institute of Technology Ladkrabang puts 3 elements of the R&D center administration including 1) Research Work Quality Administration, 2) Intellectual Properties, and 3) Academic Services. Hence, it is challenging for the Institutes of Vocational Education to figure out what components suit the need to manage their R&D centers successfully and effectively.

In addition, there have never been any studies on empirical information conducted with direct involvements. Therefore, this research on the elements of the administration of vocational education R&D centers of vocational institutes in Thailand was conducted to identify the main elements discovered from the synthesis of approaches and theories ant to verify those elements with the confirmatory analysis technique. The objective of this research was to statistically analyze the elements of research and development center administration of vocational institutes in Thailand. The discovered elements could 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 would 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 institute, and lecturers and teachers in vocational curricula from 23 vocational institutes that are under control by the Office of Vocational Education Commission. The total number of populations is 1,570, and the sample size is 400 samples. According to, Tabachnick & Fidell (2012), the sample size of 400 samples is considered as an appropriate 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, the 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 approved for their accuracy by 5 experts; and all items in the questionnaire attains the IOC in the range of 0.60 – 1.00 (Rovinelli &Hambleton, 1997). It has already been used as a pilot test. The reliability value of the questionnaire is 0.937, which reflects a high level of reliability (Cronbach, 1951; Tavakol & Dennick, 2011). Then 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 data. 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 EFA 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 EFA 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 a high level of interrelationship. Thus, they are appropriate for the EFA. Furthermore, the interrelationship among variables is tested with the sphericity technique by Bartlett. The results 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 is appropriate and concurrent to the primary assumption for EFA.

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

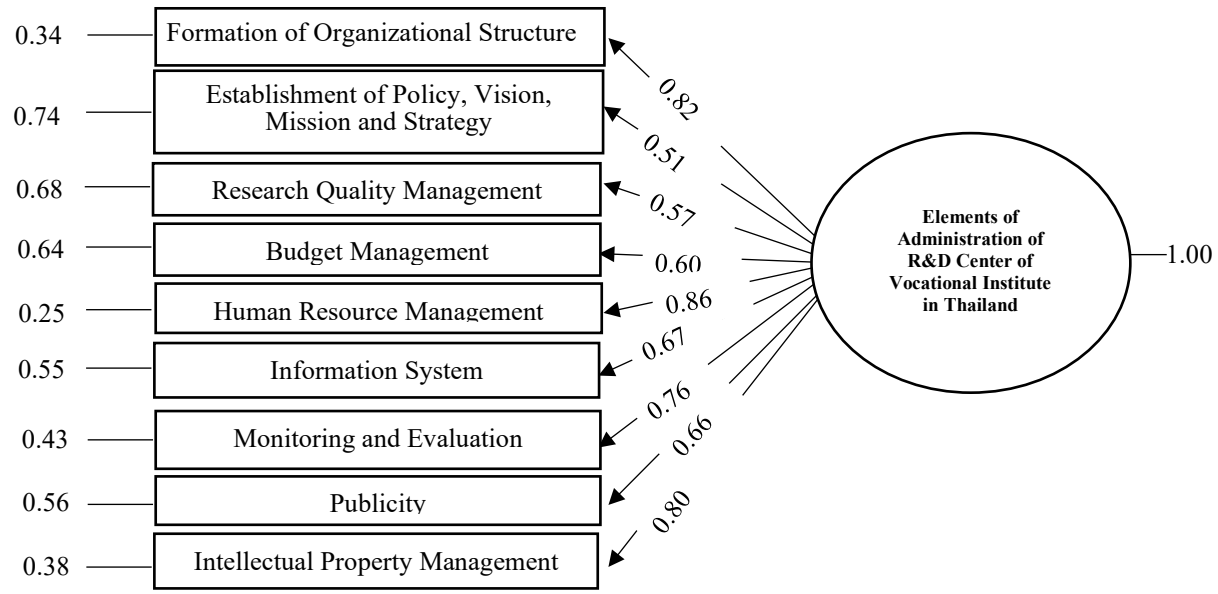
From Table 2, which shows the results from the test of the interrelationship among variables, it is apparent that the studied variables are interrelated with one another with the statistical significance level of 0.01. The values of the interrelationship among all variables are greater than 0.30, which 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 Organizational Structure variable (0.714). However, the lowest interrelationship is the one between the variable of Intellectual Property Management and the variable of Research Quality Management (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 $\chi 2$ =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 a 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 data. The weights of elements considered, it can be said that the results from CFA are confirmed and all variables have a statistical significance level of 0.05.



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

Fig. 1 - Results from the analysis of element of the administration of vocational education research and development center of vocational institute in Thailand.

From Figure 1, the figures of all 9 variables are positive and the different 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 were ranged as followed ; of Human Resource Management (Factor loading = 0.86), Formation of Organizational Structure (Factor loading = 0.82), Intellectual Property Management (Factor loading = 0.80), Monitoring and Evaluation (Factor loading = 0.76), Information System (Factor loading = 0.67), Publicity (Factor loading = 0.66), Budget Management (Factor loading = 0.60), Research Quality Management (Factor loading = 0.57), and Establishment of Policy, Vision, Mission and Strategy (Factor loading = 0.51).

4. Discussions

With the CFA technique, those elements were proven to be appropriate elements in the administrative system for managing R&D centers in the Institutes of Vocation Education. Regarding the different weight of each element, Human Resource Management with its greatest weight is considered as the first priority to be discussed since managing human resources to be fitted in the organization of R&D Centers can be a demanding job. As the Human Resource Management strategy should be planned to attract qualified researchers and assistants to work with their highest capacity and efficiency, HR management team's responsibility must also include retention strategy; that is to say HR management should have a well plan in supporting staff in order to enable everyone to achieve their goals so that the R&D centers would contain quality staff with high performance. This concurs with the studies of Phonphanthin (2004), Mohamad et al., (2019), Barnes (1995) and Sern et al., (2019), which agreed that human resource management is the main support and can help enhance the capacity of the Research and Development center as well as increase the capacity of the researchers by making a thorough plan to increase incentive in order to motivate those lecturers as researchers to do more research works. The next element discussed here is the Formation of the Structure of the Organization. This component is considered significant as Bartol & Martin (2003), Mustafa et al., (2019), and Musid et al., (2019), found 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 a chain of control and command, which will accelerate and ensure the efficiency of the operations of R&D centers.

In addition, the component of Intellectual Property Management has become crucial as it reflects the benefits to the higher education institutions especially the ones which have strong foundation on research and innovation. Therefore, this component supports 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 Lee & Win (2004) have stated that universities nowadays are offering the researchers more profits as the remuneration for intellectual properties and this offer becomes. A strategy for managing intellectual properties and for registering patents so that universities can have commercial benefits. As a result, more research works are registered for patents. The next element mentioned here is monitoring and evaluation. It is essential to supervise and follow-up to track the progress of each research work. To monitor and evaluate covers the evaluation of the research operation before, during and after for each project as. Stufflebeam (1990) and Jailani et al., (2019) have discovered that the assessment before a research project focuses on environs and inputs while the evaluation during research emphasizes on the research process, The evaluation after the project focuses on outputs. Thus, monitoring and evaluation enable researchers to achieve their research goals in an efficient manner.

When it comes to the component of the Information System, it can be regarded as a must for managing any organizations in the 21st century including the Research and Development centers. Alan (2005), concluded that the information system is the processing of the system development in terms of the organization of data with data collection computers and multimedia files in a systematic manner. Furthermore, the component of budget management plays an important roles because it incorporates the planning for finding the budget, identifying sources of funds, support for personnel research projects and systematic evaluation of the expenditure of funds. In the light of this matter, Phutayanon (2010) and Lau (2003) presented 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 the personnel participation in the management of research funds. The next element, Research Quality Management plays a vital role in managing an effective research and development centers as Deming (1986) explained that quality control and publicity are tools of administration which helps improve the works and system, resulting in the quality of the research work that meets the predetermined criteria. The last but not least component to be discussed is the establishment of policy, vision, commitment and strategy. Several studies posit that the success of the organizations was the results from the clear and practical directions in which the effective policy, vision and missions have been created and implemented (Friedrich, 1963 and Sern et al., 2019). Undeniably, the Research and Development Centers must be established with the proper policy, vision and mission. However, without the commitment from the staff in the organization and the tactical strategies, the achievement may not be reached.

5. Conclusion

The findings from this study confirm that there are nine elements to constitute the administrative system for managing the research and Development Centers under the Institutes of Vocational Education in Thailand. These elements are as follows: 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., In respect with different weights of each components, it represents that each component may be given different priority in managing the centers as discussed above. In other words, the study of these elements should enable the educators to bring this into practice which will lead to effective management in the future.

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