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The High Competency Dual Vocational Education System Management Model Linked to Vocational Education Innovation Areas

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ABSTRACT: Enhancing the quality of vocational graduates to ensure they possess academic and professional competencies suitable for employment and aligned with labour market demands. It is believed that establishing standards for enhancing the quality of teaching and learning that align with and are connected to the enterprises is a crucial way to create and train workers who meet the demands of the business sector. The study instrument was a questionnaire distributed to 423 administrators of vocational education colleges and enterprise representatives working with vocational education colleges under the Office of the Vocational Education Commission on the dual vocational education system. The research findings indicated that the management factors of the high competency vocational education dual system, associated with vocational education innovation areas, comprised of five components: 1) Strategic management and effective leadership 2) Sustainable management of collaboration and innovation networking 3) Development of curriculum and learning management connected with innovation areas 4) Cultivation of high quality, and competent personnel 5) Systematic management of resources and digital technology. The research findings were used to administer a high competency vocational dual education system. This method focused on helping students learn how to meet the demands of the labour market and to increase employment prospects.

Keywords: factor analysis, high competency, vocational education, innovation areas, dual system management.

I. INTRODUCTION

The national education policy for the management of vocational education and the vocational education act B.E. 2551 [1] aimed to create and improve vocational learners in line with the national economic and social development plan and the national education plan. It followed the National Qualifications Framework (NQF), the National Education requirements, the National Vocational Qualifications Framework (NVQF), and the vocational qualification requirements at each level. It is also connected to the occupational standard at both national and international levels. Hands-on learning is focused on providing students with the academic and job skills they need, as well as ethics, professional behavior, and good work habits that are in line with the demands of the job market, the community, and society. This will help them start their own professions. This is accomplished by enhancing the quality of teaching and learning in a manner that is aligned with and connected to the workplace. Managing dual vocational education is seen as a key way to create and develop a workforce relevant to the demands of the corporate world. This is an educational setup that is built on partnerships between vocational education colleges or institutes and the private sector, state

enterprises, or government organizations. This process involves curriculum development, teaching techniques, monitoring, and evaluation.

Students spend some of their time at the vocational education colleges or institute and the balance of their time getting real-world experience at a private corporation, state enterprise, or government agency. This type of educational administration is focused on working together. From the studied research on the efficacy of bilateral systems in Germany and Switzerland, which revealed that the effectiveness of dual vocational education was contingent not only upon the curriculum but also on the robust participation of the enterprises in both standard setting and practical training [2]. According to the Ministry of Education's 2020 guidelines for managing dual vocational education, the most important things for success were policy, students, instructors, schools, businesses, and parents [3]. According to the outcomes of subsequent assessment investigations, there were two main issues found: 1) The management system was not very efficient and lacked a clear structure; 2) There were insufficient vocational education workers to meet the demands of the employers [4-6]. This aligned with [7] study, which indicated that skills mismatch was a significant barrier to economic development in several nations globally, attributed to inadequate communication channels between educational institutions and companies; 3) The partnership between vocational education colleges and employers was not very strong yet; 4) The students, parents, and the community did not yet fully understand the advantages of dual vocational education; 5) It was not clear or consistent how to do public relations and spread the word about the benefits of dual vocational education; and 6) There were limited funding problems.

In light of the facts above, the researchers acknowledge the significance of administering a highly competent dual vocational education system that should integrate vocational innovation sectors to address the requirements of employment. The colleges need to strengthen a strong network of people from various areas, both inside and outside the college, and provide the required resources and understand the importance of dual vocational education management with a contemporary, quick, and up-to-date database management system that meets the needs of the economy and the country's requirement for highly qualified workers. This involves helping students realize the opportunity to earn income while learning, ensuring their competency meets national and international requirements. Also, it is used as a guideline to help vocational education colleges and employers in working together by setting rules, structures, and goals in order to improve the quality and broaden the administration of dual vocational education for future efficacy and sustainability.

The current situation in Thailand's dual vocational education system in innovation zones shows a rising number of students enrolling in vocational training programs. This growth is due to the increasing demand from businesses for interns, leading to a greater quantitative and qualitative demand from businesses for dual vocational trainees. However, Thai vocational schools lack the mechanisms to meet this demand due to shortages of teachers and trainers and outdated training equipment [8, 9]. The Office of the Vocational Education Commission is committed to improving the quality of dual vocational education to meet the demands of the modern labour market. This goal is achieved by promoting collaboration between the public and private sectors to develop student skills that match business needs, enhancing vocational education capabilities, and creating a new value system for vocational education to make it more attractive and aligned with long-term national development strategies. A gap in vocational education has been identified, requiring the development of a high-competency dual vocational education management system linked to vocational innovation zones. The effort involves tailoring education to the specific conditions of each area, granting curriculum and teaching autonomy, improving school management flexibility, and fostering collaborative educational management between the public and private sectors within innovation zones. This approach aims to elevate the national education system, a crucial foundation for developing high-quality Thai citizens.

Addressing these gaps is therefore essential. This research developed a high-competency vocational dual education management system linked to innovation zones. The results of this research will lead to regional innovation by integrating local agencies and businesses that require personnel with qualifications suitable for local occupations. This research applies the core concepts and strategies of UNESCO-UNEVOC to improve the quality of vocational education through a parallel approach. The research method involved

analyzing factors, gathering information from school administrators through a mix of interviews and surveys, using statistical methods like Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to ensure the reliability and validity of a combined model for the high-competency vocational dual education management system that is clearly connected to educational innovation zones, and improving digital management in dual education to make it more transparent and modern, while working with partner organizations in Thailand's innovation zones.

II. LITERATURE REVIEW

1. MANAGING THE DUAL VOCATIONAL EDUCATION

Dual vocational education is a type of vocational education that comes from a deal between enterprises, which include private enterprises, state enterprises, or government agencies, and a vocational education college or institute. This agreement is concerned with working together in curriculum planning, the teaching and learning process, and monitoring and evaluation. The students will spend their time both in the vocational education institutes and in work-based learning in enterprises. The dual education system is the main emphasis of the creation and growth of the vocational workforce through work-based learning. The Office of the Vocational Education Commission has set up five models and rules for all vocational education colleges to use when they start the dual vocational education system, as follows: [10]

- Model A: A completely integrated (100%) dual vocational education system in the area. This means that all students in all fields get vocational training at firms in the area.
- Model B: A dual vocational education system that is completely integrated (100%) and is used outside of vocational education colleges. This implies that there are no enterprises near the school, and all students in all disciplines of study get work-based learning at enterprises. There must be somewhere to stay near the training site, and teachers will be in charge of mentoring the learners.
- Model C: Management of dual vocational education in certain fields, contingent upon the preparation of the educational institution.
- Model D: Providing the opportunity for workers of enterprises that ask for its dual vocational training. The goal is to improve the skills and talents of the company's workers. This means offering customized dual vocational education courses or projects to certain categories of people.
- Model E: Running dual vocational education programs with enterprises in other countries. Students may select any model for the administration of dual vocational education, contingent upon the preparation of both the educational institution and the enterprise.

Successful management of dual vocational education systems follows these guidelines: examining the administration of dual vocational education by aiming at vocational education colleges achieving excellence within the Chachoengsao Provincial Vocational Education System to evaluate the management level of dual vocational education and compare its effectiveness in fostering excellence in vocational institutes. The study's findings determined that the quality of administration of dual vocational education in Chachoengsao Province's vocational education system aims for excellence in vocational education colleges. The quality of students and graduates, management, teaching and learning, and collaboration between enterprises and vocational education colleges were all very good [11]. The examination of the framework for establishing a famous dual vocational education management system within the industrial technology sector at the Office of the Vocational Education Commission.

The study found that the new model for developing a dual vocational education management system consists of components: Component Quality of educational management, which has four subcomponents: 1) Quality of students and graduates, 2) Administrators, teachers, and educational personnel, 3) Use of information technology and digital technology, and 4) Quality of the organization component [12] and component getting resources, which contains four parts: 1) the school's budget and fundraising, 2) the school's functions and duties, and 3) technology systems [13]. Examining the evolution of vocational education in China, utilizing the dual vocational education system as a case study. The study showed that China can make its vocational education system better in three important areas: policy execution, career

development, and social status. Improving technical and vocational education is a complicated process that needs resources from partners in the economy. Policymakers have a special duty to develop rules that help society get rid of bias and help young people realize the benefits of technical and vocational education better than ever before [14].

According to [15], the dual education system combines theoretical training in educational institutions with practical activities conducted at enterprises and institutions. It is becoming increasingly relevant for the modern vocational education system, which aims to train competitive specialists who are able to adapt to the needs of the labour market and effectively perform professional tasks. The vocational education programme in the transportation area. According to the logistics educational programme, students have to study the discipline of the organization of transportation. The students engage in practical work and develop three-dimensional graphic dependencies, which will contribute to the formation of the professional competencies they are studying [16]. It is also determined that the development of professional competences of future Bachelors of Vocational Education is the unity of their theoretical and practical training [17]. As Vocational Education and Training (VET) systems, which offer parallel learning environments in both work-based and vocational education colleges, are considered an international standard, it is important to examine the concepts and specific requirements of educational transfer. This focuses not only on specific projects concerning the parallel transfer of the VET system from Germany to Tunisia but also on examples of general factors for the transfer of such concepts. For example, key success factors include quality assurance and opportunities for graduates.

2. VOCATIONAL EDUCATION INNOVATION AREA

Quality education is important because excellence means anything that is better than the average. This promotes constructing competitiveness and flexibility to change transformation [18]. This area focuses on changes in the management and operation of schools to support the development of new ideas in education. This means that pilot schools can teach and learn in ways that are best for the area at the provincial level. This means that the government, local administrative bodies, the business sector, and civil society should all be allowed to collaborate in administering education, following only helpful and required rules. New ideas about education can test out in these designated educational regions. This gives schools more control over their operations and lets them tailor instruction to the requirements and circumstances of the community. The goal is to raise the standard of education and help students reach their educational goals. This may be done with the right resources and assistance from central government agencies for schools in the region. The Educational Innovation Zone Act B.E. 2562 was passed with the help of people in the community and other interested parties. The four keys are as follows: It is (1) to come up with and improve educational innovations and learning to raise educational achievement and spread their use to other schools, (2) to make education more equal, (3) to give pilot schools and educational agencies more power and freedom, and (4) to set up and improve ways for all sectors to work together to manage education [19, 20].

The establishment of area-based educational innovation zones tailored to the requirements of certain regions facilitates the creation and advancement of educational and learning innovations. This meant providing schools with freedom over their curriculum, teaching techniques, administration, and how they run their schools in a flexible way. The study sought to facilitate the development of educational innovations as a pilot initiative for decentralization and the empowerment of educational institutions and pilot schools, alongside the establishment and enhancement of collaborative mechanisms among the government, local administrative bodies, the private sector, and civil society within the region [21]. The education innovation in the Guangdong-Hong Kong-Macao Greater Bay Area was studied, and it was found that preunderstanding and implementing the national education right of the SAR, improving the standards and driving quality of talents, and strengthening innovation-driven development are important, and an education system with the characteristics of the Greater Bay Area should be built to give full play to the role of education in regional economic development and to cultivate talents in the new era [22].

The study was conducted within the Romanian R&D area. It highlights key interconnected aspects like research, national policies, public and private funding, human resources, key players in the field, R&D

output, and infrastructure. Some of the strong points in the area are generated by a handful of poles of excellence performing research entities based on highly qualified personnel and state-of-the-art infrastructure, stimulated by funding instruments under competitive conditions [23]. The weaknesses are due to a combination of shortcomings and malfunctions related to the system's funding and overall structure. These raise serious questions regarding the participation of the national R&D system in the sustainable development of Romania. Vocational education is working hard to make dual vocational education better so that it meets the needs of the present job market. The method stresses adjusting to the local situation and the skills of schools [24]. It also encourages collaboration between the public and private sectors to improve vocational education, teach students skills that enterprises need, and create a new value system that makes vocational education more appealing and in line with long-term national development goals.

3. CONCEPTUAL FRAMEWORKS

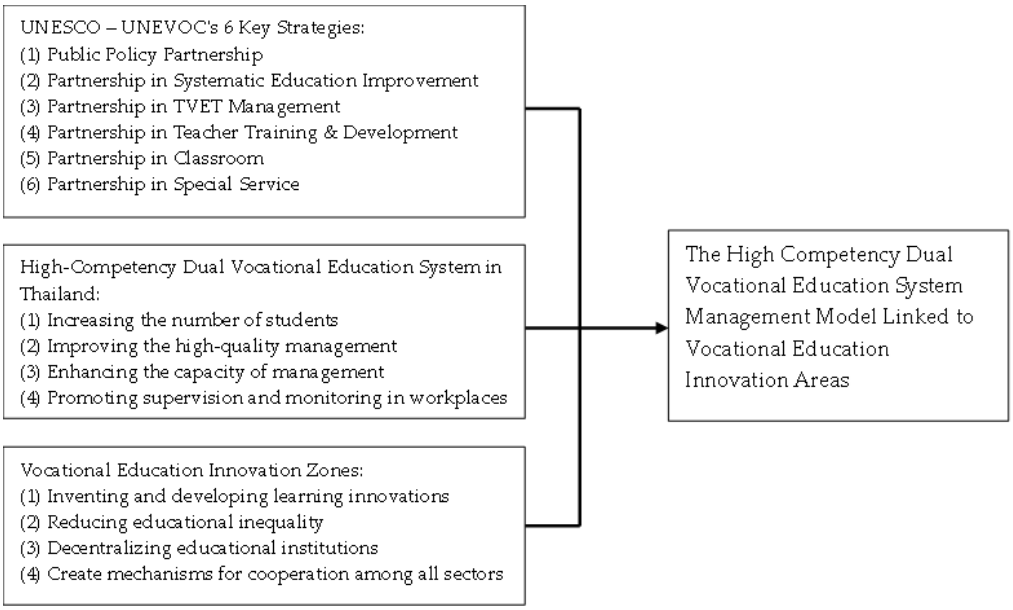

FIGURE 1. Conceptual framework.

III. MATERIAL AND METHOD

1. RESEARCH DESIGN

The research design employs a mixed-methods research methodology. Qualitative research entails the collection and analysis of content-driven data based on in-depth conversations with specialists who have worked with dual vocational education programmes for a long time. This includes both the public and private sectors, area-based education management, and the collaboration between educational institutions and enterprises. Quantitative research entails the collection and analysis of perspectives from vocational education college administrators, enterprise representatives, leaders of dual vocational education programmes, and scholars engaged in dual education administration. The surveys were made by using related processes, including management, managing the dual vocational education system, developing high-competency vocational education, and managing the vocational education innovation sector. This is in line with how the high-level dual vocational education system is run in connection with areas of vocational education innovation.

The qualitative findings were analyzed using thematic analysis, focusing on recurring managerial practices, challenges, and success factors. These themes were subsequently transformed into an initial pool

of questionnaire items, which were refined through expert validation before quantitative deployment. The item development process followed four steps: (1) synthesis of themes from qualitative interviews and relevant literature, (2) mapping themes to preliminary dimensions of dual VET management, (3) drafting and refining questionnaire items, and (4) expert validation

2. THE SAMPLE GROUP

The qualitative phase, semi-structured interviews were conducted with 10 experts who had more than ten years of experience in dual vocational education administration, enterprise-based training, and area-based education management. Quantitative data collection: The sample group comprised school administrators, department heads, leaders of dual vocational education units, and executives from firms engaged in the dual vocational education cooperation programme, representing 29 vocational education innovation zones. We took samples from 214 vocational education colleges in total. A standard sampling table was utilized at a 95% confidence level to get a sample size of 423 people [25].

3. RESEARCH TOOLS

This study analyses pertinent papers, textbooks, and scholarly publications about the administration of the high competency dual vocational education system associated with vocational education innovation areas. The results consist of a conceptual framework of components for system management and enquiries designed to facilitate in-depth interviews with experts via a semi-structured interview guide. The gathered data is from professionals experienced in overseeing dual vocational education programmes across both public and private sectors. The findings from this expert opinion study resulted in the formulation of comprehensive interview questions for the questionnaire [26].

This in-depth interview study examines the management components of a high-competency dual vocational education system linked to vocational innovation areas. The target group for the interviews consisted of 10 experts with at least 10 years of experience in managing dual vocational education systems in both the public and private sectors. The interviewees were selected using a purposive sampling method. The interview questions comprised three parts: 1) Five aspects of managing a high competency dual vocational education system linked to innovation areas: collaboration with businesses, personnel, curriculum, learning management, and assessment; 2) The management of high-competency vocational education linked to vocational innovation areas: planning, management, leadership, and control; and 3) Strategies for collaboration in managing a high-competency dual vocational education system linked to innovation areas: policy setting, school administration, personnel development, and teaching management.

Questionnaire Construction and Development: The outcomes from comprehensive interviews were examined and integrated with theories from pertinent publications, textbooks, and research. A 5-level Likert scale was used to make a draft of the questionnaire questions. The score levels were set up like this: Most Important (5 points), Very Important (4 points), Moderately Important (3 points), Less Important (2 points), and Least Important (1 point). The questionnaire was constructed by synthesizing data obtained from interviews with experts to create a set of 73 questions divided into three parts:

- Part 1: Factors in managing high competency dual vocational education systems linked to vocational education innovation areas. This part uses a 5-level rating scale and contains 30 questions.
- Part 2: Management of high competency dual vocational education institutions linked to vocational education innovation areas. This part uses a 5-level rating scale and contains 16 questions.
- Part 3: Strategies for managing high competency dual vocational education systems linked to vocational education innovation areas. This part uses a 5-level rating scale and contains 27 questions.

Improving the quality of the questionnaire: The draft questionnaire items were tested for instrument quality using the IOC value given by five experts, and the Index of Item Objective Congruence was also calculated. The IOC determined that all questions have values ranging from 0.60 to 1.00, signifying that they fulfilled the established requirements and were of enough quality for utilization without further enhancement [27].

4. DATA ANALYSIS

Data Analysis: The general information of respondents was examined utilizing frequency, percentage, mean, and standard deviation. EFA was used to look at component issues on how to run the high-competency vocational education dual system and how it relates to areas of vocational innovation. Investigation into whether it was right to use factor analysis methods like Kaiser-Meyer-Olkin (KMO) and Bartlett's Test [28]. Communalities were found by the correlation coefficients between one variable and all the other variables (values between 0 and 1). The total variance explained was calculated to see how the variables were grouped; principal component analysis and skew rotation were used to get the components by using the Promax approach. The requirement for consideration is that the element must possess an eigenvalue of 1.0 or above. Go up, and each variable in the component has to have a factor loading of 0.60 or higher [29].

To prevent over-extraction, Parallel Analysis (PA) and Velicer Minimum Mean (MAP) techniques were used. The analysis results showed that the model had higher structural accuracy when compared using the eigenvalue > 1 criterion. In addition to the eigenvalue-greater-than-one rule and scree plot inspection, factor retention was cross-checked conceptually against prior theoretical frameworks. The Promax oblique rotation was selected due to the theoretical expectation that management components of dual vocational education are interrelated rather than orthogonal. Promax rotation was selected as the factors were theoretically expected to be correlated rather than orthogonal. Factor retention was based on a combination of Eigenvalues greater than 1.00, scree plot analysis, and theoretical interpretability. Items with factor loadings below 0.50 or substantial cross-loadings were excluded to ensure construct clarity.

Confirmatory factor analysis uses goodness-of-fit indices [30] to assess how well a built measurement model fits with real-world data and compares these indices to set criteria. The following is a summary of the chi-square value: 1) The relative estimation error (df 2◎) [31] should be less than 2.00; 2) The value of the hypothesis test should be less than 0.05; 3) The Comparative Gradefit Index (GFI) [32] should be greater than 0.90; 4) The CFI should be greater than 0.90; 5) Tucker-Lewis Index (TLI) should be greater than 0.90; 6) Standardized Root Mean Square Residual (SRMR) should be greater than 0.90; and 7) The Root Mean Square Error Of Estimation (RMSEA) should be less than 0.05.

IV. RESULTS

Exploratory Factor Analysis Results: The mean values of all 73 variables were in the high range. Before doing exploratory factor analysis, correlation analysis techniques between variables using the KMO and Bartlett's Test were used. This is shown in Table 1.

Table 1. The relationship between variables can be examined by using the KMO value and Barthett's test.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.981
Bartlett's Test of Sphericity	Approx. Chi-Square	38742.500
	df	2628
	Sig.	0.000

Table 1: The results showed a KMO value of 0.981, which was higher than 0.50 and close to 1. This paper concluded that all 73 variables were suitable for using the internal factor analysis methodology to model the development of a high-capacity parallel vocational education management system related to the vocational innovation sector. The Bartlett's test had a chi-square distribution of around 38742.500 and a significance value of 0.000, which was less than 0.05. There was enough correlation between all the variables to do more factor analysis.

To observe how variables cluster, principal component analysis was organized with skew rotation using the Promax technique to determine the total variance explained. To be considered, each component must have an eigenvalue of 1.00 or higher, and each variable must have a factor loading of 0.50 or higher. Table 2 shows how the components can be arranged.

Tabel 2. Variance of variables by selecting and extracting components using principal component analysis combined with axis rotation.

Comp.	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings [a]
	Total	% Of Variance	Cumulative %	Total	% Of Variance	Cumulative %	Total
1	46.857	64.188	64.188	46.576	63.803	63.803	38.917
2	2.334	3.197	67.385	2.040	2.795	66.598	34.707
3	1.731	2.371	69.756	1.437	1.969	68.567	37.593
4	1.468	2.011	71.767	1.199	1.643	70.209	38.351
5	1.155	1.582	73.349	0.862	1.180	71.389	37.672
6	0.953	1.305	74.654				
.	.	.	.				
73	0.051	0.070	100,000				

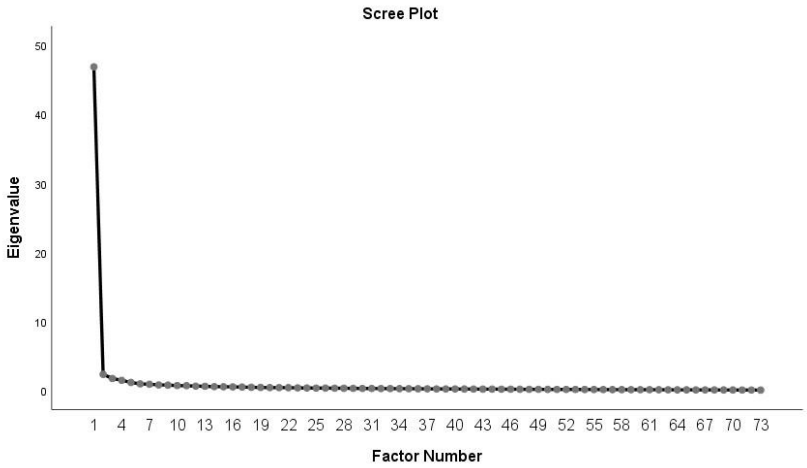

FIGURE 2. Scree plot.

Table 2: and Figure 2 indicate the numbers for extracting components by rotating the axis. The scree plot analysis revealed that the eigenvalue graph was starting to level out. The cumulative variance from factor No. 3 to factor No. 5 is 73.349%, which was the eigenvalue. The cumulative variance exceeded 1, indicating that it was within the acceptable range [33]. Eigenvalues that were less than 1 at factor number 6 were not part of the composition [34]. By rotating the axes, the five components can be separated. As shown in Table 3, each element had a variable, which included the variable itself, the variable's information, and the value of the element.

Table 3. The results of the component analysis of each variable.

Item	Mean	Standard deviation	Communalities	Factor loading	Eigenvalue	Cronbach's alpha
Element 1. Strategic management and effective leadership.						
P3no34	4.54	0.610	0.738	0.787		
P3no31	4.49	0.634	0.756	0.776		
P3no43	4.48	0.630	0.760	0.754		
P3no13	4.41	0.713	0.689	0.753		
P3no33	4.49	0.649	0.803	0.742		
P3no22	4.48	0.626	0.768	0.734		
P3no32	4.52	0.619	0.741	0.719		
P3no12	4.47	0.655	0.714	0.709	46.857	0.978
P3no41	4.46	0.648	0.748	0.689		
P3no42	4.43	0.653	0.764	0.680		
P3no14	4.47	0.659	0.779	0.678		
P3no21	4.47	0.637	0.758	0.664		
P3no44	4.46	0.655	0.785	0.663		
P3no23	4.47	0.648	0.753	0.612		
P3no11	4.46	0.666	0.678	0.585		
P3no24	4.45	0.700	0.737	0.510		
Element 2. Managing collaboration and networks in innovation zones sustainably.						
P1no15	4.41	0.716	0.757	0.875		
P1no11	4.40	0.701	0.649	0.796		
P1no12	4.34	0.739	0.599	0.781		
P1no13	4.30	0.759	0.686	0.714		
P1no14	4.39	0.730	0.562	0.662		
P1no26	4.48	0.681	0.746	0.656	2.334	0.960
P1no23	4.50	0.656	0.748	0.624		
P1no27	4.45	0.703	0.747	0.602		
P1no25	4.43	0.741	0.717	0.588		
P1no21	4.57	0.618	0.625	0.587		
P1no22	4.52	0.663	0.634	0.580		
P1no24	4.46	0.676	0.700	0.541		
Element 3. Curriculum development and learning management linked to innovation areas.						
P1no64	4.52	0.645	0.810	0.765		
P1no42	4.50	0.688	0.703	0.760		
P1no63	4.48	0.681	0.709	0.726		
P1no51	4.44	0.686	0.660	0.703		
P1no54	4.48	0.677	0.714	0.653		
P1no52	4.44	0.702	0.728	0.635		
P1no45	4.48	0.670	0.711	0.621	1.731	0.969
P1no43	4.48	0.684	0.747	0.619		
P1no44	4.45	0.696	0.672	0.600		
P1no62	4.50	0.656	0.744	0.587		
P1no41	4.52	0.667	0.690	0.572		
P1no61	4.51	0.649	0.648	0.563		
P1no53	4.52	0.674	0.744	0.509		
Element 4. Developing highly competent and quality human.						

Item	Mean	Standard deviation	Communalities	Factor loading	Eigenvalue	Cronbach's alpha
P2no45	4.43	0.737	0.686	0.738		
P2no42	4.52	0.626	0.766	0.707		
P2no62	4.41	0.710	0.712	0.671		
P2no43	4.51	0.627	0.681	0.641		
P2no51	4.49	0.677	0.699	0.619	1.468	0.951
P2no61	4.43	0.663	0.716	0.592		
P1no35	4.46	0.727	0.653	0.576		
P2no64	4.50	0.688	0.717	0.559		
P1no33	4.49	0.681	0.662	0.513		
Element 5. Systematic management of digital resources and technology.						
P2no24	4.46	0.694	0.826	0.787		
P2no31	4.44	0.672	0.791	0.704		
P2no33	4.47	0.698	0.731	0.680		
P2no21	4.43	0.674	0.756	0.630		
P2no23	4.48	0.667	0.782	0.606	1.155	0.967
P2no15	4.46	0.669	0.758	0.594		
P2no12	4.43	0.695	0.676	0.577		
P2no14	4.46	0.697	0.778	0.573		
P2no32	4.46	0.662	0.772	0.547		
P2no34	4.44	0.696	0.652	0.506		

From Table 3, total variance explained analysis was used to look at how variables were grouped. Principal component analysis and slant rotation using the Promax technique were employed to do factor analysis and find components. The rule for analysis was that each variable in a component had to have a factor loading of 0.50 or greater. The eigenvalue must also be at least 1.00. There are 60 variables [29]. These variables can be put into five groups: 1) strategic management and effective leadership, 2) managing collaboration and networks in innovation areas in a way that lasts, 3) creating curricula and learning management that are connected to innovation areas, and 4) hiring and training high-performing and qualified staff. and 5) managing digital resources and technology in a planned way.

Using Cronbach's alpha coefficient, a reliability test of the questionnaire showed that the average component reliability was 0.965, which was greater than the conventional threshold of 0.70 [35, 36]. Consequently, it can be inferred that the questionnaire exhibited a very high degree of consistency and was adequately dependable for data collection in this research. The strong reliability scores showed that the questions and parts were well connected, including the latent variable structure, which can be reliably evaluated based on the study framework, and the people who answered the questions understood what they were asking. This led to a high level of internal consistency in the questionnaire, and the results of confirmatory factor analysis indicated that the structural validity of a CFA model comprised of five components for the administration of a high-competency vocational education dual system associated with vocational innovation sectors is as follows: 1) Strategic management and effective leadership, 2) Sustainable management of collaboration and innovation area networks, 3) Curriculum development and learning management linked to innovation areas, 4) Development of high-quality, competent human resources, and 5) Systematic management of digital resources and technology. This was based on the indices used to see how well the model fits with real-world data from exploratory factor analysis. As seen in Figure 3 and Table 4.

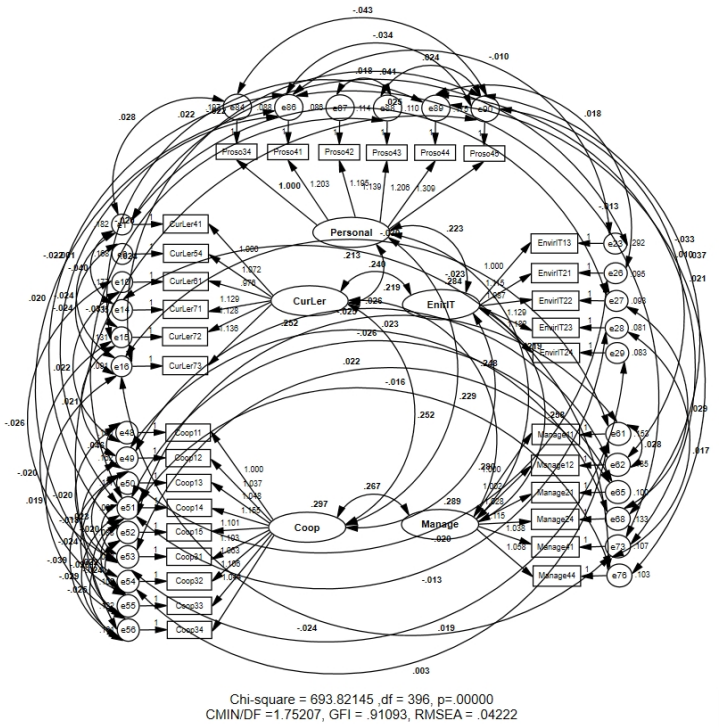

FIGURE 3. Confirmatory factor analysis.

Table 4. Indices used to assess the goodness of fit of the model with empirical data.

Consistency Index	Critirion	Test Results	Decision
1) Relative chi-square value (CMIN/DF)	Less than 2.00	1.745	pass
2) The value of the hypothesis test (p-value)	Less than 0.05	0.000	pass
3) Good Fit Index (GFI)	More than 0.90	0.910	pass
4) Comparative Fit Index (CFI)	More than 0.90	0.980	pass
5) Tucker-Lewis Index (TLI)	More than 0.90	0.975	pass
6) Normed Fit Index (NFI)	More than 0.90	0.955	pass
7) Incremental Fit Index (IFI)	More than 0.90	0.980	pass
8) Adjusted Goodness of Fit Index (AGFI)	More than 0.80	0.881	pass
9) Standardized Root Mean Square Residual (SRMR)	Less than 0.08	0.010	pass
10) Index value Root Mean Estimation Error (RMSEA)	Less than 0.05	0.042	pass

Table 4: The model fits the real-world data. The CMIN/DF = 1.745 was fine because the chi-square value was 698.237, the df was 400, and the p-value was 0.000. While other consistency indices, including GFI = 0.910, CFI = 0.980, TLI = 0.975, NFI = 0.955, and IFI = 0.980, were greater than 0.90, the RMSEA of 0.042 and the SRMR of 0.010 were less than 0.08, which is within acceptable limits. In conclusion, these results show that the developed measurement model is suitable and can be used to assess the validity and reliability of research instruments.

Table 5. Convergence validation.

Latent Variable	Average Variance Extracted (AVE)	Critirion of AVE	Composite Reliability (CR)	Critirion of CR	Convergent Validity
Curriculum and learning	0.664	0.50	0.922	0.70	pass
Digital and technology	0.742	0.50	0.934	0.70	pass
Collaboration and networks	0.740	0.50	0.962	0.70	pass
Strategic management	0.721	0.50	0.939	0.70	pass
Competent and human	0.700	0.50	0.933	0.70	pass

Convergence validity testing revealed that all indicators had standard factor weighting coefficients greater than 0.50. Furthermore, the Mean Extracted Variance (AVE) of the five latent components ranged from 0.742, exceeding the minimum criterion of 0.50. The Overall Reliability (CR) ranged from 0.922 to 0.962, exceeding the criterion of 0.70 for all components. These results reflect that the indicators can explain the latent components very well, and the research instrument is highly reliable. Therefore, it can be concluded that the measurement model has a very good level of convergence validity. Discriminant validity testing, using the Heterotrait–Monotrait Ratio (HTMT) index, which is a standard in modern research, showed that the HTMT values for all pairs of latent components were below the threshold of 0.90, meaning that each latent component is distinctly different. and can appropriately classify the conceptual structures being measured.

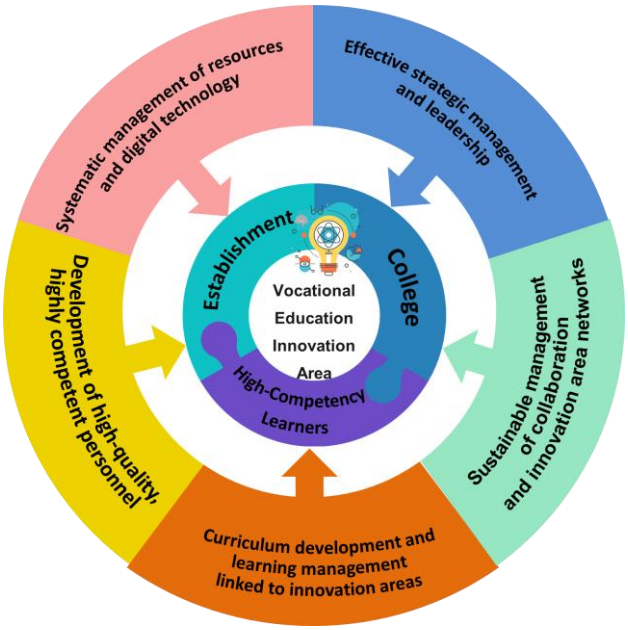

FIGURE 4. The high competency dual vocational education system management model linked to innovation areas.

In summary, convergent validity was supported by highly standardized factor loadings and strong composite reliability across all five components. Discriminant validity was established through clear factor separation and theoretically coherent component definitions. The refined CFA model demonstrated satisfactory fit indices, confirming the structural validity of the proposed management framework. Therefore, the five latent components can be used to develop a management model for a high-capacity parallel vocational education system that links vocational innovation areas. The development of a

management model for a high-competency dual vocational education system linking vocational innovation areas involved qualitative and quantitative data analysis. The findings revealed five components: 1) Effective strategic management and leadership; 2) Sustainable management of collaboration and innovation area networks; 3) Curriculum development and learning management linked to innovation areas; 4) Development of high-quality, highly competent personnel; and 5) Systematic management of resources and digital technology. These five aspects align with the success factors of dual vocational education and outcome-orientated school administration, as shown in Figure 4.

V. DISCUSSION

Research indicates that the management framework for a high-competency dual vocational education system, associated with vocational education innovation sectors, has five essential elements: 1) strategic management and effective leadership, and 2) administration of sustainable cooperation and innovation network domains. 3) Curriculum and learning management connected to areas of innovation; 4) Training of skilled, high-quality staff; and 5) Systematic management of resources and digital technologies to create highly skilled learners in line with worldwide vocational education reform trends. The organization is mostly driven by strategic management and good leadership. The modern vocational education executives need to be strategic in creating resilience and adjusting their organization's vision to meet the demands of the industrial sector as they change quickly [37, 38]. The success of dual vocational systems depends on effectively managing teamwork and connections, highlighting that both the public and private sectors must work together to share resources and support sustainable growth.

The recommended 6 partnership strategies for TVET quality improvement (2022-2029): 1) Public policy partnership, 2) Partnership in systematic education improvement, 3) Partnership in TVET management, 4) Partnership in teacher training & development, 5) Partnership in the classroom, 6) Partnership in special service [39]. Moreover, studies show that competency-based learning is crucial for creating curricula and managing learning. The effective implementation of a Dual Vocational Education and Training (VET) system depends on successfully integrating learning experiences in both locations [40]. Such an approach is consistent with UNESCO's policy that promoted school management based on worldwide job standards to help close the skills gap. In order to develop teachers and other educational staff as a process for passing on modern technology to students, this depends on training highly skilled people who are professional in both academic and practical abilities [41], which is called "Dual Professionalism" [42, 43]. Managing resources and digital technologies in a systematic guideline for using management as the tools need to be open and accountable. This requirement is in line with the Vocational Education 4.0 idea that provided a transformation guideline for digital tools to track and assess learning at work, which would improve the quality of the dual education system to its fullest potential [44]. Educational policies that emphasize the development of entrepreneurial skills in vocational schools improve the quality of students, preparing them to compete in the world of work [45]. According to the dual education and vocational training system, labour market accessibility and the quality of skills acquired through training are some of the strengths that characterize this model, with the best opportunities arising from demand in the business and manufacturing sectors [46].

The high-competency dual vocational education management model, which connects vocational innovation areas, demonstrates that area-based management, particularly strategic management and effective leadership, aligns with the notion of smart specialization [47]. When developing innovation areas, focus on what makes each area special or strong in order to have the best competitive edge, a strategic proposal to enhance innovation and entrepreneurship education in vocational education management. The goal is to improve the ability of vocational education to cultivate innovative talents and meet society's demand for innovative professionals [48]. According to the idea of the Triple Helix Model, this process needs strong collaborative management and networking within innovation areas. This means that educational institutions, industry, and the government need to work together to make the innovation ecosystem in the area work [49]. UNESCO-UNEVOC indicated that the curriculum development and learning management in vocational innovation sectors should be like a sandbox, where new ways of learning may be organized.

Innovation areas ought to exemplify educational management, prioritizing creativity and digital competencies, alongside the professional development of educators and staff to effectively execute their responsibilities as leader change agents who can use Industry 4.0 technology in the classroom and in learning [39], [50]. Finally, for data integration to work, digital technology needs to be managed in a systematic way in areas of vocational innovation. The result is quite similar to what was found: integrated data systems are needed for future administration of vocational innovation areas so that administrators may make decisions based on data. This will lead to effective and long-lasting management of areas for vocational innovation [51].

VI. CONCLUSION

Vocational education is realized as an important part of building the country's workforce. The administration of a highly competent dual vocational education system, which connects vocational education innovation areas through partnerships between enterprises and educational institutions, aims to cultivate highly skilled learners by enhancing the elements of the dual vocational education system. This study examined the elements involved in the administration of a high-competency dual vocational education system associated with vocational education innovation sectors. It starts by looking at how dual vocational education is organized in Thailand right now. Next, a literature review is conducted to establish the research framework. This effort resulted in the formulation of study questions and the development of a questionnaire to gather data from school administrators, department heads, heads of dual vocational education units, and managers at partner enterprises within the dual vocational education system. Exploratory and confirmatory factor analyses were used to look at the data. Method: Examine the components of the model to ensure its alignment with the obtained data.

The research produced a proficient vocational education dual system management model that integrates vocational education innovation sectors, comprising five components: 1) Strategic management and effective leadership, 2) Sustainable management of collaboration and innovation area networks, 3) Curriculum development and learning management associated with innovation areas. 4) Building a strong and skilled workforce, and 5) Managing resources and digital technologies systematically. These are the five things that were found, which can be adapted to the changes in technology and the economy, meet the demands of the 21st century, and raise the standard of dual vocational education to a high level of competency in areas of vocational education innovation. This is done by getting companies and schools to work together closely to make students who are very skilled and ready to join the current job market and society.

This study found that a modern approach to vocational education development that enhances student quality involves decentralization and regional collaboration. To successfully set up a strong vocational education system, it's important to create a curriculum that fits local needs, offer flexible learning options, work together with businesses, and manage regional networks. These measures contribute to efficient management in innovation zones, facilitating regional resource sharing, directly impacting student quality, generating employment income for students, improving work quality in businesses, and strengthening local communities. For practical use, the five parts of the model can be turned into measurable key performance indicators (KPIs), like student job rates, business participation, creation of training plans at work, joint curriculum development with businesses, joint skill development activities for instructors with on-site trainers, and the use of digital learning. These indicators can help vocational institutions and policymakers monitor and optimize the management of parallel vocational education within innovation zones.

VII. LIMITATIONS AND SUGGESTIONS

This research aims to develop guidelines for managing dual vocational education in innovation zones within industrial and service economic zones. It emphasizes collaboration with all sectors in the area, such as the Federation of Thai Industries, the Chamber of Commerce, the Department of Skills Development, and businesses. The goal is to set up a way to manage high-quality vocational education by adjusting the five parts of a strong dual vocational education system to fit vocational innovation zones. This adaptation will be

customised for each educational institution to enhance the quality of teaching and learning, ultimately facilitating graduates' employment in fields pertinent to their studies. The research identified several limitations, including a lack of understanding and confidence among parents in vocational education, who perceive it as solely for low-income workers, resulting in declining student enrolment. Furthermore, there is a limited number of qualified personnel in educational institutions and businesses, lacking the necessary resources for quality education and insufficient government funding for personnel development. So, future research should aim to create a strong management model for dual vocational education that connects with vocational innovation areas by working together and building networks and also focus on training skilled workers to make sure this effective dual vocational education system works well in the future.

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Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

The data analyzed in this study are available from the corresponding author upon reasonable request.

Institutional Review Board Statement

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