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A Structural Modeling Approach to Designing an Administrative Framework for Vocational Education Research and Development Centers in Thailand Using Confirmatory Factor Analysis

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ABSTRACT

The increasing complexity of vocational education systems necessitates robust administrative frameworks to enhance the effectiveness of Research and Development (R&D) centers. In Thailand, vocational institutions face challenges related to governance, resource allocation, technological integration, and performance evaluation. This study proposes a structural modeling approach to design and validate an administrative framework for vocational education R&D centers using Confirmatory Factor Analysis (CFA). Grounded in organizational theory, management information systems, and evaluation frameworks, the study synthesizes multiple dimensions including leadership behavior, competency development, research management, and institutional policy alignment. A quantitative methodology is employed to validate latent constructs influencing administrative efficiency. Findings reveal that strategic leadership, structured evaluation mechanisms, technological integration, and competency-based management significantly influence the effectiveness of R&D centers. The study contributes a validated model that enhances decision-making, operational efficiency, and research productivity in vocational education systems. The implications extend to policymakers, administrators, and educational planners aiming to optimize institutional performance through data-driven administrative design.

1. INTRODUCTION

Vocational education and training (TVET) systems play a critical role in national economic development by producing skilled human capital aligned with industry demands. In Thailand, the evolution of vocational education has emphasized the need for research-driven institutional development, particularly through the establishment of Research and Development (R&D) centers. However, despite policy-level emphasis, the administrative systems governing these centers remain fragmented and insufficiently structured.

The primary problem lies in the absence of a validated, empirically grounded administrative framework that integrates organizational behavior, research management, and evaluation mechanisms. Existing administrative practices often rely on traditional hierarchical structures that do not adequately support innovation, interdisciplinary collaboration, or performance optimization. This limitation is particularly evident in the management of research outputs, resource allocation, and institutional coordination.

The relevance of this study emerges from the need to align administrative structures with contemporary educational and technological demands. The integration of structural modeling techniques, particularly Confirmatory Factor Analysis (CFA), offers a systematic approach to validating the relationships between administrative variables and institutional effectiveness. Prior studies have demonstrated the applicability of CFA in educational evaluation and organizational research (Byrne, 2001; Hair et al., 2010).

The objectives of this study are threefold:

1. To identify key administrative constructs influencing the performance of vocational R&D centers.

2. To develop a structural model representing relationships among these constructs.

3. To validate the proposed model using CFA.

The scope of the study focuses on vocational education institutions in Thailand, with implications for broader TVET systems. The significance lies in providing a scientifically validated framework that enhances administrative efficiency, research productivity, and institutional sustainability.

2. LITERATURE REVIEW

The conceptualization of administrative frameworks in educational institutions is rooted in organizational theory and management science. Friedrich (1963) emphasizes the role of governance structures in shaping institutional effectiveness, highlighting the interplay between authority, accountability, and decision-making processes. This theoretical foundation is essential in understanding the administrative dynamics of R&D centers.

Leadership plays a critical role in administrative effectiveness. Bartol et al. (2003) argue that leadership behavior significantly influences organizational performance, particularly at managerial levels. In the context of vocational education, leadership determines the strategic direction of research initiatives and resource utilization.

The integration of Management Information Systems (MIS) is another critical dimension. Gawltney (2005) highlights the importance of information systems in administrative decision-making, emphasizing their role in data management, communication, and performance monitoring. In R&D centers, MIS facilitates coordination between academic research and industry collaboration.

Research management practices are also central to institutional effectiveness. Sirot Phonphanthin (2004) and Duangduean Phutayanan (2010) emphasize structured research management systems as essential for enhancing research productivity. These systems include planning, monitoring, and evaluation mechanisms that ensure alignment with institutional goals.

The role of competency frameworks is highlighted in TVET literature. Chec et al. (2019) demonstrate that competency-based approaches enhance teacher effectiveness and institutional performance. Similarly, Mohamad et al. (2019) emphasize pedagogical reasoning as a critical factor in vocational education outcomes.

Evaluation frameworks are fundamental to administrative systems. Stufflebeam and Shinkfield (1990) propose systematic evaluation models that assess program effectiveness through structured criteria. Cronbach (1951) and Tavakol and Dennick (2011) further contribute to the understanding of reliability and validity in measurement instruments, which are essential for CFA-based validation.

Technology transfer and research collaboration are also critical components. Feldman et al. (2002) and Lee and Win (2004) highlight the importance of university-industry linkages in enhancing research impact. These interactions are particularly relevant for vocational R&D centers, which aim to bridge academic research and practical applications.

Recent studies, including Krittiya W. et al. (2020), emphasize the importance of structured administrative models in improving vocational education outcomes. Their findings suggest that integrated frameworks combining leadership, evaluation, and resource management significantly enhance institutional performance.

Despite these contributions, a gap exists in the integration of these dimensions into a unified, empirically validated administrative framework. This study addresses this gap by applying structural modeling techniques to develop and validate a comprehensive model.

3. METHODOLOGY

3.1 Research Design

This study adopts a quantitative research design based on structural equation modeling (SEM). Confirmatory Factor Analysis (CFA) is used to validate the proposed administrative framework. The design ensures rigorous testing of relationships among latent constructs.

3.2 Conceptual Framework Development

The framework is developed based on five core constructs:

1. Strategic Leadership
2. Research Management System
3. Technological Integration (MIS)
4. Competency Development
5. Evaluation and Quality Assurance

These constructs are derived from the literature and aligned with vocational education requirements.

3.3 Instrument Development

Measurement items are developed based on established scales and adapted to the vocational education context. Content validity is ensured through expert evaluation (Rovinelli & Hambleton, 1977). Reliability is assessed using Cronbach's alpha (Cronbach, 1951).

3.4 Data Collection

Data is collected from administrators, faculty members, and researchers in vocational institutions. A structured questionnaire is used to capture responses related to the identified constructs.

3.5 Confirmatory Factor Analysis

CFA is conducted to validate the measurement model. The following steps are implemented:

- Model specification
- Parameter estimation
- Model evaluation
- Model modification

Fit indices such as RMSEA, CFI, and TLI are used to assess model adequacy (Hair et al., 2010; Byrne, 2001).

3.6 Structural Model Evaluation

The structural model examines relationships between constructs. Hypotheses are tested to determine the significance of each factor in influencing administrative effectiveness.

3.7 Ethical Considerations

The study ensures confidentiality and informed consent of participants. Data is used solely for research purposes.

4. RESULTS

The CFA results indicate that the proposed model demonstrates strong construct validity and reliability. All factor loadings exceed the acceptable threshold, confirming the relevance of the selected indicators.

Strategic leadership emerges as a significant predictor of administrative effectiveness, influencing both research management and evaluation systems. This finding aligns with previous studies emphasizing leadership's central role in organizational performance (Bartol et al., 2003).

The research management system shows a strong relationship with institutional productivity, particularly in terms of research output and collaboration. This supports the findings of Duangduean Phutayanan (2010), which highlight structured research systems as critical for academic development.

Technological integration, particularly through MIS, significantly enhances coordination and decision-making processes. This confirms the theoretical assertions of Gawltney (2005) regarding the importance of information systems in administrative efficiency.

Competency development is identified as a key factor influencing both teaching effectiveness and research quality. This finding is consistent with Chec et al. (2019) and Mohamad et al. (2019).

Evaluation and quality assurance systems demonstrate strong influence on overall administrative performance. The integration of systematic evaluation models ensures continuous improvement and accountability (Stufflebeam & Shinkfield, 1990).

Notably, the model validation aligns with the findings of Krittiya W. et al. (2020), reinforcing the importance of integrated administrative frameworks in vocational education.

5. DISCUSSION

The findings highlight the multidimensional nature of administrative effectiveness in vocational R&D centers. The significant role of strategic leadership underscores the need for leadership development programs that emphasize innovation, collaboration, and data-driven decision-making.

The strong relationship between research management systems and institutional productivity suggests that vocational institutions must prioritize structured research processes. This includes clear policies, resource allocation mechanisms, and performance monitoring systems.

Technological integration emerges as a critical enabler of administrative efficiency. The adoption of MIS facilitates real-time data analysis, improves communication, and enhances decision-making accuracy. However, challenges related to system implementation and user adaptation must be addressed.

Competency development is another crucial dimension, particularly in the context of TVET. The findings suggest that continuous professional development programs are essential for maintaining high standards of teaching and research.

Evaluation systems play a vital role in ensuring accountability and continuous improvement. The integration of systematic evaluation frameworks enables institutions to assess performance and implement corrective measures effectively.

Despite these strengths, the study has limitations. The focus on Thai vocational institutions may limit generalizability. Additionally, the reliance on self-reported data may introduce bias.

The findings are consistent with previous research, particularly Krittiya W. et al. (2020), which emphasizes the importance of integrated administrative models. However, this study extends the literature by providing a validated structural model.

6. CONCLUSION

This study presents a comprehensive administrative framework for vocational education R&D centers, validated through Confirmatory Factor Analysis. The findings demonstrate that strategic leadership, research management, technological integration, competency development, and evaluation systems are critical determinants of administrative effectiveness.

The study contributes to the field by providing a data-driven model that enhances institutional performance. It offers practical implications for policymakers and administrators, emphasizing the need for integrated and structured administrative systems.

Future research should explore the application of this model in different educational contexts and incorporate longitudinal data to assess long-term impacts. Additionally, the integration of advanced analytical techniques, such as machine learning, could further enhance model accuracy.

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