COLOMBO SCIENTIFIC PUBLISHING

INTERNATIONAL JOURNAL OF MULTIVARIATE DATA ANALYSIS THEORY & PRACTICE
E-ISSN: 2536-7935
P-ISSN: 2536-7927
PAGE NO: 01-07

A Conceptual Framework for Assessing TVET Lecturer Preparedness in Adapting to Industry 4.0 Intelligence-Driven Educational Environments

Minhaz Uddin
Chandpur Science and Technology University

Faruk Hossain
Cox's Bazar International University

ARTICLE INFO

Article history:
Published: March 01, 2022
VOLUME: Vol.07 Issue 01 2022

Keywords:
TVET, Industry 4.0Lecturer Readiness, Conceptual Framework, Structural Equation Modeling, Digital Competence, Educational Transformation, Professional Development, Intelligence-Driven Education

ABSTRACT

The rapid evolution of Industry 4.0 (IR4.0) has fundamentally transformed the landscape of technical and vocational education and training (TVET), requiring lecturers to adapt to intelligence-driven educational environments characterized by automation, digitalization, and data-centric pedagogies. This study proposes a comprehensive conceptual framework for assessing the preparedness of TVET lecturers in adapting to these emerging demands. Drawing upon established theories of professional competence, structural equation modeling (SEM), and educational transformation, the framework integrates multiple dimensions, including technological competence, pedagogical innovation, professional development, and institutional readiness. The research synthesizes empirical and theoretical insights from prior studies to identify key determinants influencing lecturer readiness and proposes measurable constructs for systematic evaluation. The framework emphasizes the interrelationship between individual competencies and organizational support systems, offering a structured approach for empirical validation using advanced statistical modeling techniques. The findings suggest that lecturer preparedness is a multidimensional construct influenced by both internal capabilities and external enablers, with significant implications for policy development, curriculum design, and institutional reform in TVET systems. This study contributes to the growing body of literature by providing a robust analytical model that aligns educational practices with the requirements of IR4.0, thereby enhancing the quality and relevance of vocational education in the intelligence age.

1. INTRODUCTION

The emergence of Industry 4.0 has introduced a paradigm shift in the nature of work, production systems, and educational requirements. Characterized by the integration of cyber-physical systems, artificial intelligence, and advanced data analytics, IR4.0 necessitates a workforce equipped with both technical expertise and adaptive competencies. In this context, TVET institutions play a critical role in preparing skilled human capital capable of meeting industry demands. However, the effectiveness of TVET systems largely depends on the readiness of lecturers to adopt and implement innovative teaching methodologies aligned with digital transformation.

The problem arises from the observable gap between traditional teaching practices and the dynamic requirements of IR4.0 environments. Many lecturers lack adequate exposure to emerging technologies and pedagogical strategies necessary for fostering digital literacy and problem-solving skills among students. This issue is compounded by insufficient institutional support and limited professional development opportunities, resulting in suboptimal educational outcomes.

The relevance of this study lies in addressing these challenges through a structured analytical framework that evaluates lecturer preparedness comprehensively. The primary objective is to develop a conceptual

model that identifies key factors influencing readiness and establishes measurable constructs for empirical assessment. The scope of this research is confined to TVET institutions operating within IR4.0 contexts, with a focus on integrating technological, pedagogical, and organizational dimensions.

The significance of this study extends to policymakers, educators, and institutional leaders by providing insights into enhancing teaching effectiveness and aligning educational practices with industry expectations. By establishing a systematic approach to evaluating readiness, this research contributes to the advancement of TVET systems in the intelligence-driven era.

2. LITERATURE REVIEW

The concept of lecturer preparedness in TVET has been extensively examined through various theoretical and empirical perspectives. One of the foundational studies by Abdullah et al. (2019) emphasizes the importance of professionalism and generic skills in shaping lecturer competence. Their structural model highlights the interdependence between professional attributes and teaching effectiveness, providing a basis for understanding readiness in contemporary educational settings.

The integration of IR4.0 into TVET curricula has been explored by Amiron et al. (2019), who identify critical skills such as digital literacy, problem-solving, and adaptability as essential components of vocational education. Their findings underscore the need for curriculum redesign to incorporate emerging technological competencies. Similarly, D'Souza and Mudin (2018) argue that universities must play a proactive role in facilitating technological adoption through strategic initiatives and resource allocation.

Theoretical frameworks such as structural equation modeling (SEM) have been widely used to analyze complex relationships among variables influencing educational outcomes. Awang (2012) and Byrne (2013) provide comprehensive methodologies for applying SEM in educational research, enabling the examination of latent constructs such as readiness and competence. Hair et al. (2010) further emphasize the importance of multivariate analysis in validating theoretical models, ensuring reliability and validity in research findings.

Studies focusing on lecturer readiness specifically highlight the role of institutional support and professional development. Ibrahim et al. (2018) demonstrate that continuous training and organizational commitment significantly enhance lecturer preparedness for educational transformation. Similarly, Hutkemri and Zamri (2017) identify infrastructure and technological facilities as critical mediators in the adoption of digital teaching practices.

Despite these contributions, several research gaps remain. Existing studies often focus on isolated dimensions of readiness without integrating them into a unified framework. Additionally, there is limited emphasis on the interaction between individual competencies and institutional factors. This study addresses these gaps by proposing a holistic conceptual framework that incorporates multiple dimensions and their interrelationships.

The theoretical positioning of this research is grounded in competency theory, organizational readiness theory, and technological adoption models. By synthesizing insights from these perspectives, the study establishes a comprehensive foundation for analyzing lecturer preparedness in IR4.0 contexts.

3. METHODOLOGY

This study adopts a conceptual research design aimed at developing a comprehensive framework for assessing TVET lecturer preparedness. The methodology is structured around the identification of key constructs, the development of theoretical relationships, and the formulation of a model suitable for empirical validation using SEM techniques.

3.1 Conceptual Framework Development

The proposed framework is based on four primary dimensions:

Technological Competence: This dimension refers to the ability of lecturers to utilize digital tools, platforms, and emerging technologies effectively. It includes skills such as data analysis, online teaching, and integration of smart technologies into instructional practices.

Pedagogical Innovation: This construct emphasizes the adoption of modern teaching methodologies, including experiential learning, problem-based learning, and digital pedagogy. It reflects the capacity to design and deliver instruction that aligns with IR4.0 requirements.

Professional Development: Continuous learning and skill enhancement are critical for maintaining relevance in rapidly evolving environments. This dimension encompasses training programs, workshops, and self-directed learning initiatives.

Institutional Readiness: Organizational support plays a vital role in facilitating lecturer preparedness. This includes infrastructure, policy frameworks, leadership commitment, and resource availability.

3.2 Model Specification

The framework hypothesizes that technological competence, pedagogical innovation, and professional development directly influence lecturer preparedness, while institutional readiness acts as both a direct and moderating factor. The relationships among these constructs are modeled using SEM, allowing for the analysis of both direct and indirect effects.

3.3 Measurement and Validation

The constructs are operationalized using validated scales derived from existing literature. Data collection is proposed through structured questionnaires administered to TVET lecturers. Statistical analysis involves confirmatory factor analysis (CFA) to assess construct validity and reliability, followed by SEM to test the hypothesized relationships (Awang, 2012; Byrne, 2012).

Bootstrapping techniques are employed to evaluate the significance of indirect effects, ensuring robust model estimation (Awang et al., 2015). The use of SEM enables a comprehensive examination of the complex interactions among variables, providing insights into the determinants of lecturer readiness.

3.4 Practical Implementation

The framework can be applied in institutional assessments to identify gaps in lecturer preparedness. For instance, a TVET institution implementing digital learning platforms may use the model to evaluate whether lecturers possess the necessary competencies and whether organizational support mechanisms are adequate.

4. RESULTS

The conceptual analysis reveals that lecturer preparedness in IR4.0 environments is a multidimensional construct influenced by both individual and organizational factors. Technological competence emerges as a critical determinant, as lecturers must adapt to digital tools and platforms to deliver effective instruction. Pedagogical innovation is equally significant, reflecting the need for dynamic teaching approaches that foster critical thinking and problem-solving skills.

Professional development is identified as a key enabler, facilitating the continuous enhancement of skills and knowledge. Institutions that invest in training programs and capacity-building initiatives demonstrate higher levels of lecturer readiness. Institutional readiness itself plays a dual role, directly influencing preparedness and moderating the relationship between individual competencies and overall performance.

The framework highlights the interconnected nature of these dimensions, suggesting that improvements in one area can positively impact others. For example, enhanced institutional support can lead to increased participation in professional development activities, thereby improving technological competence and pedagogical innovation.

5. DISCUSSION

The findings align with existing literature emphasizing the importance of professional competence and organizational support in shaping lecturer readiness (Abdullah et al., 2019). The integration of multiple dimensions into a unified framework addresses the limitations of previous studies that focused on isolated factors. This holistic approach provides a more accurate representation of the complexities involved in adapting to IR4.0 environments.

From a theoretical perspective, the study reinforces the applicability of competency and organizational readiness theories in educational contexts. The use of SEM as a methodological tool enables the analysis of intricate relationships, contributing to the advancement of research methodologies in TVET studies.

Practically, the framework offers valuable insights for policymakers and institutional leaders. By identifying key determinants of readiness, it enables targeted interventions aimed at enhancing lecturer performance. For instance, institutions may prioritize investments in digital infrastructure and training programs to address identified gaps.

However, the study has certain limitations. As a conceptual model, it requires empirical validation to confirm the proposed relationships. Additionally, the framework may need adaptation to account for contextual differences across regions and institutions.

6. CONCLUSION

This study presents a comprehensive conceptual framework for assessing TVET lecturer preparedness in adapting to Industry 4.0 intelligence-driven educational environments. By integrating technological competence, pedagogical innovation, professional development, and institutional readiness, the framework provides a holistic approach to understanding and evaluating readiness.

The research contributes to the field by addressing existing gaps and offering a structured model suitable for empirical validation. It underscores the importance of aligning educational practices with technological advancements, ensuring the relevance and effectiveness of TVET systems in the intelligence age.

Future research should focus on validating the framework through empirical studies and exploring its applicability across different educational contexts. Policymakers and educators are encouraged to utilize the framework as a tool for enhancing lecturer preparedness and improving educational outcomes.

REFERENCES

1. Abdullah, Z., Hoque, K.E., Ramlan, N.H., Shafee, S. (2019). Designing the structural model of TVET lecturers' professionalism and generic skills based on an empirical study in Malaysia. SAGE Open, 9, 3. 1–18.

2. Ahmad, F. (2017). 4.0 Industrial Challenge 21st Century Student. Retrieved 2017, April 12, from http://www.sinarharian.com.my/kampus/cabaran-industri-4-0-mahasiswa-abad-ke-21-1.658360.

3. Akhiar, Shamsuddin, P.S., & Jusoh, M.K. (2012). The Foundation of Professional Leadership and Professional Development. Kuala Lumpur: Freemind Horizons.

4. Amiron, E., Latib, A.A., & Subari, K. (2019). Industry revolution 4.0 skills and enablers in technical and vocational education and training curriculum. International Journal of Recent Technology and Engineering, 8, 1C2. 484–490.

5. Ariffin, A., Hamzah, N., Subramaniam, T.S., Rubani, S.N.K., & Zakaria, N. (2018, September). Student Acceptance of Massive Open Online Course Application (MOOC) at Tun Hussein Onn University of Malaysia. Paper presented ate the 8th National Conference in Education – Technical & Vocational Education and Training (CiE-TVET) 2018 (294–301).e-ISBN: 978-967-0823-41-6.

6. Awang, Z. (2012). A handbook on structural equation modeling (SEM) using AMOS. Bangi: MPWS Publication Sdn Bhd.

7. Awang, Z., Afthanorhan, A., & Asri, M.A.M (2015). Parametric and non-parametric approach in structural equation modeling (SEM): The application of bootstrapping. Modern Applied Science, 9, 9. 58–67.

8. Azman, Z., & Ibrahim, J. (2018, September). The Readiness of Nilai Polytechnic Graduates in Facing the Wave of Industrial Revolution 4.0 (IR 4.0). Paper presented at the 8th National Conference in Education - Technical & Vocational Education and Training (CiE-TVET) 2018. 523–532. e-ISBN: 978-967-0823-41-6.

9. Baba, A. (1997). Research statistic in education and social science. Bangi: National University of Malaysia Press.

10. Bok, D. (2006). Our underachieving colleges: A candid look at how much students learn and why they should be learning more. Princeton, NJ: Princeton University Press.

11. Buntoro, D.A. (2014). The Influence of Professional Ethics, Motivation, Competence and Job Satisfaction On Teacher Performance. Thesis. Faculty of Economics and Business, UIN Syarif Hidayatullah Jakarta.

12. Byrne, B.M. (2012). Structural Equation modeling with Mplus. Basic concepts, applications, and programming. New York: Routledge.

13. Byrne, B.M. (2013). Structural equation modeling with AMOS: Basic concepts, applications, and programming. Routledge.

14. D'Souza, U.J.A., & Mudin, D.K.D. (2018). Industrial revolution 4.0: role of universities. Borneo Journal of Medical Sciences, 12, 1. 1–2.

15. Guan, W. (2003). From the help desk: bootstrapped standard errors in H. J. Newton (Eds.),The stata journal (71–80). College Station, TX: Stata Press.

16. Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). Multivariate data analysis (7th Edition). Englewood Cliffs, NJ: Prentice Hall.

17. Harwell, M.R. (2011), Research Design: Qualitative, Quantitative, and Mix Methods. In Conrad, C. and Serlin, R. (Eds.), The SAGE Handbook for Research in Education: Pursuing ideas as the Keystoneof exemplary inquiry (2nd Edition). SAGE, Thousand Oaks, CA.

18. Hayes, A.F. (2009) Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. Communication Monographs, 76(4), 408–420. doi: 10.1080/03637750903310360

19. Hoyle, R.H. (1995). The structural equation modeling approach: Basic concepts and fundamental issues. In R. H. Hoyle (Ed.), Structural equation modeling: Concepts, issues, and applications (1–13). London: Sage Publication.

20. Hutkemri & Zamri, S.N.A.S. (2017). Mathematics teacher's readiness toward information and communication technology application: the mediating role of facilities. Advanced Science Letters, 22(8), 2027–2030.

21. Ibrahim, R., Baharuddin, S., & Baharom, H. (2018, September). Strengthening TVET: Readiness Level Polytechnic Lecturer in Education Transformation National 21st Century as the Industrial Revolution 4.0. Paper presented at the 8th National Conference in Education – Technical & Vocational Education and Training (CiE-TVET) 2018 (261–270).e-ISBN: 978-967-0823-41-6.

22. Ilias, K., & Ladin, C.A. (2018). Understanding and readiness of industrial revolution 4.0 among student's institute of teacher education, Ipoh. The Online Journal of Islamic Education, 6, 2. 18–26.

23. Juhan, R. (2012). Level of readiness for polytechnic engineering students on safety in the workshop. Department of Technical Education. University of Tun Hussein Onn Malaysia.

24. Kline, R.B. (2005). Principles and practice of structural equation modeling. New York: The Guilford Press.

25. Konting, M.M. (1997). Method of educational research. Kuala Lumpur: Dewan Bahasa dan Pustaka.

26. Makhbul. Z.K.M. (2018). 5 components handle industry challenge 4.0. Berita Harian. Downloaded from https://www.bharian.com.my/rencana/muka10/2018/01/370721/5-komponen-tangani-cabaran-industri-40

27. Ministry of International Trade and Industry (MITI). (2018). Industry 4WRD: National policy on industry 4.0. Perpustakaan Negara Malaysia.

28. Mohamad, M., Mohammad, M., Ali, N.A.M., & Awang, Z. (2018). The impact of life satisfaction on substance abuse: Delinquency as a mediator. International Journal of Adolescence and Youth, 23(1), 25–35, doi: 10.1080/02673843.2016.1267021

29. Nordin, N. (2011). The influence of emotional intelligence, leadership behaviour and organizational commitment on organizational readiness for change in higher learning institution. Procedia-Social and Behavioral Sciences, 129–138.

30. Pallant, J. (2013). SPSS survival manual: A step by step guide to data analysis using IBM SPSS (5th Special Edition). Buckingham, Philadelphia: Open University Press.

31. Paryono & Quito, B. G. (2010). Meta-analysis of ICT integration in vocational and technical education in Southeast Asia. An International Conference on VTET Research and Net-working. SEAVERN Research Report. SEAMO VOC-TECH Regional Centre, Brunei Darussalam.

32. Patton, M.Q. (1990). Qualitative evaluation and research method. Newbury Park: CA Sage.

33. Piaw, C.Y. (2006). Basic research statistics. Kuala Lumpur, Malaysia: McGraw-Hill.

34. Piaw, C.Y. (2014). Regression test, factor analysis, and SEM analysis. Shah Alam: McGraw Hill Education

35. Rahim, M.I., & Shamsudin, S. (2019). Categorisation of video lecture designs in MOOC for technical and vocational education and training educators. Journal of Technical Education and Training, 11, 4. 11–17.

36. Rase, R. (2013)The Readiness of Polytechnic Lecturers to Use the M-Learning Approach in Teaching and Learning in The State of Johor. Thesis, University of Tun Hussein Onn Malaysia.

37. Schwab, K. (2016). The fourth industrial revolution. Geneva: World Economic Forum. ISBN 1944835008.

38. Shafei, S., Haris, M.H.H., & Hamzah, Z. (2018, September). The Readiness of POLIMAS Lecturers in The Challenges of Industrial Revolution 4.0. Paper presented at the 8th National Conference in Education – Technical & Vocational Education and Training (CiE-TVET) 2018. (577–582). e-ISBN: 978-967-0823-41-6.

39. Sudman, S. (1976): Applied sampling. New York: Academic Press.

40. Xing, B., & Marwal, T. (2017). Implications of the fourth industrial age on higher education.Science and Technology, 73.10–15.

41. Yussof, M.R., Ahmad, M.R., & Aziz, R.A. (2018, September). SKR Student Perceptions on the Use of Automotive Equipment in Teaching and Learning at Rompin Community College. Paper presented at

the 8th National Conference in Education - Technical & Vocational Education and Training (CiE-TVET) 2018. (1–9). e-ISBN: 978-967-0823-41-6.

42. Yusuf, N.R., Ahmad, A.R., & Awang, M.M. (2018). Professionalism practice among lecturers in polytechnic in Malaysia. International Journal of Academic Research in Business and Social Sciences, 8, 2. 636–645.