Competency Framework to Cater for IR4.0 for the Financial Graduates in Banking Industry in China

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Abstract

The Fourth Industrial Revolution (IR4.0) has fundamentally transformed the banking industry through the widespread adoption of digital technologies such as artificial intelligence, big data analytics, blockchain, and cloud computing. These technological advancements have reshaped banking operations, service delivery models, and workforce competency requirements, creating new challenges for higher vocational education institutions in preparing industry-ready financial graduates. In China, the rapid digital transformation of the banking sector has intensified the mismatch between graduate competencies and industry expectations, thereby affecting graduate employability. This paper proposes a competency framework to support the development of financial graduates from higher vocational education (TVET) institutions in response to IR4.0-driven industry demands. Grounded in Innovation Diffusion Theory, the Resource-Based View, Human Capital Theory, the Iceberg Model of Competencies, Employability Theory, and Co-evolutionary Theory, the framework conceptualizes the dynamic relationships among IR4.0 technologies, industry requirements, TVET, graduate competencies, and graduate employability. The proposed framework offers theoretical insights and practical guidance for curriculum reform, competency development,

and industry–education integration in China's banking sector.

Keywords: Fourth Industrial Revolution (IR4.0), Higher Vocational Education (TVET), Graduate Competencies, Graduate Employability

1. Introduction

The Fourth Industrial Revolution (IR4.0) has emerged as a major driving force behind the transformation of the global financial service industry, particularly the banking sector. Technologies such as artificial intelligence, big data analytics, blockchain, and cloud computing have enabled banks to enhance operational efficiency, improve risk management, and deliver personalized financial services (Schwab, 2017; Gomber et al., 2017). In China, the banking industry has actively pursued digital transformation strategies, emphasizing scenario-based finance, intelligent operations, and data-driven decision-making to remain competitive in a rapidly evolving market (Sun, 2022; Xing, 2022).

While technological advancement has created new opportunities, it has also significantly raised workforce competency requirements. Modern banks increasingly demand employees who possess not only solid financial knowledge but also digital literacy, analytical thinking, innovation capability, and adaptability (Mention, 2019; Philippon, 2016). However, higher vocational education (TVET), which plays a critical role in cultivating applied financial talents in China, has struggled to keep pace with these changes. Existing finance programs in many vocational institutions remain focused on traditional banking operations, with limited integration of fintech content and insufficient emphasis on comprehensive competency development (Gong & Cong, 2024; Jiang, 2024).

As a result, a competency gap has emerged between the skills developed by TVET institutions and those required by the banking industry, leading to employment difficulties for graduates and talent shortages for employers (Du, 2021; Allen et al., 2012). Although prior studies have explored IR4.0 technologies, banking industry transformation, and graduate employability, these issues are often examined in isolation. There remains a lack of integrated frameworks that explain how technological and industry forces influence vocational education and graduate employability through competency development. This paper addresses this gap by proposing a theoretically grounded competency framework that links IR4.0 technologies, industry requirements, TVET, graduate competencies, and graduate employability within the context of China's banking industry.

2. Literature Review

The rapid advancement of the Fourth Industrial Revolution (IR4.0) has profoundly transformed the global financial service industry, particularly the banking sector (Schwab, 2017; Gomber et al., 2017). These transformations have altered operational models, service delivery mechanisms, and workforce competency requirements, leading to increased digitalization, automation, and data-driven decision-making (Mention, 2019). Consequently, higher vocational education institutions are under increasing pressure to align their talent training outcomes with evolving industry expectations (Allen et al., 2012). This chapter reviews relevant literature related to IR4.0 technologies, industry requirements, higher vocational education (TVET), graduate competencies, graduate employability, and underpinning theories. The review establishes a theoretical and empirical foundation for developing a competency framework for financial graduates to meet the needs of the banking industry in the IR4.0 era.

2.1 IR4.0 Technologies

The Fourth Industrial Revolution (IR4.0) represents a new phase of industrial development characterized by the convergence of digital, physical, and biological technologies (Schwab, 2017). Unlike previous industrial revolutions, IR4.0 emphasizes intelligent systems, automation, data-driven decision-making, and interconnected technologies (Kagermann et al., 2013). Core technologies associated with IR4.0 include artificial intelligence (AI), big data analytics, blockchain, cloud computing, the Internet of Things (IoT), and robotics.

In the financial service industry, particularly banking, IR4.0 technologies have significantly reshaped business models and operational processes (Gomber et al., 2017; Philippon, 2016). AI is widely applied in intelligent customer service systems, credit assessment, fraud detection, and investment decision-making. Big data analytics enables banks to analyse customer behaviour, manage risks, and offer personalized financial products (Bharadwaj et al., 2013). Blockchain technology enhances transaction transparency, security, and efficiency, especially in payment settlement and cross-border transactions (Tapscott & Tapscott, 2016). Cloud computing supports scalable financial services and reduces operational costs, while IoT facilitates real-time data collection and monitoring.

The integration of these technologies has led to the rapid development of financial technology (FinTech), which is regarded as a key driver of financial innovation and competitiveness (Mention, 2019). However, the widespread adoption of IR4.0 technologies has also raised the threshold for workforce competency, requiring financial graduates to possess not only traditional financial knowledge but also technological literacy, data analytical capability, and adaptability to digital environments (Sun, 2022). Therefore, IR4.0 technologies function as a critical independent variable influencing industry requirements and graduate competency development.

2.2 Industry Requirements

The transformation of the banking industry under IR4.0 has resulted in substantial changes in talent demand (Philippon, 2016). Modern banks require employees who are capable of integrating financial expertise with technological applications. Industry requirements have shifted from routine operational skills toward higher-level competencies such as digital literacy, analytical thinking, problem-solving, innovation capability, and compliance awareness (Mention, 2019).

Studies indicate that banks increasingly value employees who can operate intelligent systems, analyse large datasets, understand fintech applications, and adapt to rapidly evolving digital platforms (Gomber et al., 2017). In addition to technical skills, banks emphasize soft skills such as communication, teamwork, customer orientation, ethical awareness, and professional attitudes (Yorke, 2006). Risk management, regulatory compliance, and cybersecurity awareness have also become essential due to increased digitalization (Sun, 2022).

In China, the banking industry is actively advancing digital transformation strategies, focusing on scenario-based finance, intelligent front offices, cloud-based back offices, and data-driven decision-making (Xing, 2022). Consequently, the gap between traditional finance

education outcomes and actual industry requirements has become more evident (Du, 2021). The lack of alignment between graduate competencies and industry expectations has contributed to recruitment difficulties for banks and employment challenges for graduates, highlighting the necessity of clearly identifying industry-driven competency requirements as a foundation for curriculum design and talent development.

2.3 Higher Vocational Education (TVET)

Higher vocational education (TVET) in China plays a crucial role in cultivating applied and technical talents for frontline positions in production, management, and service industries (Ministry of Education of China, 2021). TVET emphasizes practice-oriented learning, industry relevance, and skill development, making it a key contributor to workforce preparation for the financial service industry (Gong & Cong, 2024).

In recent years, China's TVET system has actively promoted industry–education integration, school–enterprise cooperation, and competency-based education (Jiang, 2024). The introduction of competency-oriented training models has helped shift traditional discipline-based curricula toward application-focused learning. However, despite these efforts, several challenges remain within finance programs offered by higher vocational colleges.

Existing literature reveals that many finance programs lag behind the rapid development of fintech and IR4.0 technologies (Liu et al., 2023). Curriculum content often remains focused on traditional banking operations, with limited integration of AI, big data, blockchain, and digital finance. Teaching methods rely heavily on classroom lectures and simulation-based training, lacking immersive digital tools and real-world fintech scenarios. Furthermore, gaps in teachers' technological competence and limited access to advanced digital training platforms constrain effective talent cultivation (Du, 2021).

As a result, TVET institutions face increasing pressure to reform curriculum structures, teaching methods, and competency standards to better align with the evolving needs of the banking industry in the IR4.0 era.

2.4 Graduate Competencies

Graduate competency is widely defined as a combination of knowledge, skills, and personal attributes that enable individuals to perform effectively in specific occupational contexts (Spencer & Spencer, 1993). In this study, graduate competency is conceptualized as a multidimensional construct comprising knowledge, skills, and motives, based on the Iceberg Competency Model (McClelland, 1973).

In the context of financial graduates, knowledge includes both traditional financial theories and IR4.0-related technological knowledge, such as fintech applications, digital banking systems, and data analytics (Mention, 2019). Skills refer to the ability to apply knowledge in real work situations, including technological operation skills, problem-solving, communication, teamwork, and innovation. Motives represent deeper personal attributes such as professional attitudes, work ethics, adaptability, learning motivation, and customer service orientation (McClelland, 1973).

Literature indicates that while knowledge and skills are visible and trainable, motives are deeply embedded and significantly influence long-term job performance (Spencer & Spencer, 1993). Employers in the banking industry increasingly emphasize comprehensive competency profiles rather than isolated technical skills (Sun, 2022). However, empirical studies reveal that many financial graduates from higher vocational colleges lack balanced development across these competency dimensions, particularly in IR4.0-related skills and professional motivation (Du, 2021).

Thus, graduate competency serves as the key dependent variable in this research, influenced by IR4.0 technologies, industry requirements, and TVET training models.

2.5 Graduate Employability

Graduate employability refers to the ability of graduates to gain initial employment, maintain employment, and progress within their careers (Yorke, 2006). Employability is closely linked to competency alignment between education outcomes and labour market demands (Allen et al., 2012).

In the IR4.0 era, employability in the banking sector increasingly depends on graduates' digital competence, adaptability, continuous learning ability, and professional attitudes (Mention, 2019). Research shows that mismatches between graduate competencies and industry expectations are a major cause of declining employment rates among finance graduates in China, particularly those from higher vocational colleges (Du, 2021).

Insufficient exposure to fintech applications, outdated curricula, and limited practical training have weakened graduates' competitiveness in the labor market (Liu et al., 2023). Employers report dissatisfaction with graduates' readiness for digital banking roles, leading to higher training costs and longer adaptation periods (Sun, 2022). Consequently, enhancing graduate employability requires systematic identification of industry-required competencies and the development of targeted competency frameworks to guide education and training.

2.6 Related Theories

This study is underpinned by multiple theoretical perspectives that collectively explain the relationships among IR4.0 technologies, industry requirements, higher vocational education (TVET), graduate competencies, and graduate employability (Becker, 1964; Rogers, 2003; McClelland, 1973; Yorke, 2006). These theories provide a robust conceptual foundation for the proposed research framework and hypothesis development.

2.6.1 Innovation Diffusion Theory

Innovation Diffusion Theory, proposed by Rogers (2003), explains how new technologies and innovations are adopted and diffused within social systems over time. According to this theory, the emergence of advanced technologies acts as a catalyst for systemic change, compelling institutions to adjust their structures, processes, and practices (Rogers, 2003). In the context of IR4.0, the rapid diffusion of technologies such as artificial intelligence, big data, blockchain, and digital platforms has significantly altered workforce skill requirements and organizational practices (Schwab, 2017).

Within higher vocational education, Innovation Diffusion Theory suggests that TVET institutions must continuously adapt their curricula, pedagogical approaches, and training infrastructure to respond to technological advancements (Rogers, 2003). Failure to adopt and integrate emerging technologies may result in outdated training models and reduced relevance to industry needs. Therefore, this theory provides the theoretical justification that IR4.0 technologies positively influence the development and transformation of TVET systems.

2.6.2 Resource-Based View (RBV)

The Resource-Based View (RBV) of the firm emphasizes that sustainable competitive advantage is derived from valuable, rare, inimitable, and non-substitutable resources, particularly human capital (Barney, 1991). From an industry perspective, workforce competencies are strategic resources that determine organizational performance and competitiveness (Bharadwaj et al., 2013).

In this study, RBV explains how industry requirements shape expectations for graduate skills and competencies. The banking industry, facing digital transformation and intensified competition, defines specific competency needs aligned with fintech development and intelligent operations (Gomber et al., 2017). These industry-driven requirements are then transmitted to TVET institutions, which are responsible for embedding them into competency frameworks and training outcomes. Consequently, RBV provides the theoretical foundation supporting the proposition that industry requirements positively influence higher vocational education.

2.6.3 Human Capital Theory

Human Capital Theory, introduced by Becker (1964), posits that investment in education and training enhances individual productivity and economic value. Education functions as a key mechanism through which individuals acquire knowledge, skills, and abilities that improve work performance and employability (Becker, 1964).

In the context of this research, TVET serves as a mediating mechanism that transforms industry and technological demands into graduate competencies. By delivering structured learning experiences, practical training, and competency-based education, TVET institutions enhance both technical and soft skills required by the banking industry in the IR4.0 era (Allen et al., 2012). Human Capital Theory therefore supports the assertion that higher vocational education positively influences graduate competencies.

2.6.4 Iceberg Model of Competencies and Employability Theory

The Iceberg Model of Competencies, originally proposed by McClelland (1973), conceptualizes competency as comprising both visible and hidden elements. Visible competencies include knowledge and skills that are easily observed and trained, while hidden competencies encompass motives, attitudes, values, and personal traits that strongly influence long-term job performance (McClelland, 1973; Spencer & Spencer, 1993).

Complementing this model, Employability Theory emphasizes that graduate employability

extends beyond technical skills to include adaptability, lifelong learning ability, and personal attributes (Yorke, 2006). Together, these theories explain how comprehensive competency development directly affects employment outcomes (Allen et al., 2012).

In this study, the integration of the Iceberg Model of Competencies and Employability Theory provides the theoretical basis supporting the proposition that graduate competencies positively influence graduate employability. Graduates who possess a balanced combination of visible and hidden competencies are better positioned to secure employment, adapt to workplace changes, and sustain career development in a technology-driven banking environment (Yorke, 2006).

2.6.5 Co-evolutionary Theory

Co-evolutionary Theory emphasizes the dynamic and reciprocal relationship between technological advancement and industry development (Nelson & Winter, 1982). From this perspective, technologies and industries evolve together, influencing and shaping one another over time. Technological innovations drive changes in industry structures, processes, and skill requirements, while industry needs guide the adoption, refinement, and contextual application of technologies (Bharadwaj et al., 2013).

In the context of IR4.0 and the banking sector, emerging technologies redefine service models and workforce expectations, while industry demands accelerate the diffusion and customization of technological solutions (Schwab, 2017; Gomber et al., 2017). This bidirectional interaction provides the theoretical justification that IR4.0 technologies and industry requirements are mutually reinforcing.

3. Formulation of the Competency Framework

The conceptual framework illustrated in Figure 1 is designed to explore how vocational education can develop a competency framework that equips financial graduates in China's banking industry to meet the demands of the Fourth Industrial Revolution (IR4.0) (Schwab, 2017). The framework is structured around five core constructs: IR4.0 Technologies, Industry Requirements, Higher Vocational Education (TVET), Graduate Competencies, and Graduate Employability.

IR4.0 Technologies and Industry Requirements serve as the independent variables, representing external forces that drive transformation in the financial sector (Gomber et al., 2017; Mention, 2019). These constructs are linked through a bidirectional relationship, reflecting their co-evolution: technological advancements reshape industry practices, while industry demands guide the adoption and contextualization of these technologies (Bharadwaj et al., 2013). This interaction is grounded in Innovation Diffusion Theory (Rogers, 2003), which explains how new technologies spread and influence systems, and the Resource-Based View (RBV), which posits that industries define competitive advantage by specifying required skills and capabilities (Barney, 1991).

These external drivers exert influence on Higher Vocational Education (TVET), which acts as Mediator 1 in the framework. TVET is conceptualized as the educational response

mechanism that translates technological and industrial demands into structured learning environments. It encompasses curriculum design, pedagogical strategies, and institutional adaptation (Gong & Cong, 2024). This mediating role is supported by Human Capital Theory (Becker, 1964), which views education as a means of enhancing individual productivity and aligning graduate capabilities with labor market needs (Allen et al., 2012).

TVET, in turn, shapes Graduate Competencies, designated as Mediator 2. These competencies are categorized into visible attributes (technical, measurable skills) and hidden attributes (soft skills, adaptability, values), reflecting the dual dimensions of graduate preparedness (Spencer & Spencer, 1993). The logic of this interaction is informed by the Iceberg Model of Competencies (McClelland, 1973), which distinguishes between surface-level skills and deeper behavioural traits, and Competency-Based Education Theory, which emphasizes the alignment of learning outcomes with real-world performance standards (Mulder, 2014).

Finally, Graduate Employability is positioned as the dependent variable, representing the ultimate outcome of the competency framework. Employability is defined as the extent to which graduates possess the skills, knowledge, and attributes required to secure and sustain employment in the IR4.0-driven banking sector (Yorke, 2006; Allen et al., 2012). This construct is grounded in Employability Theory (Yorke, 2006), which highlights the importance of both technical and personal attributes in shaping career readiness.
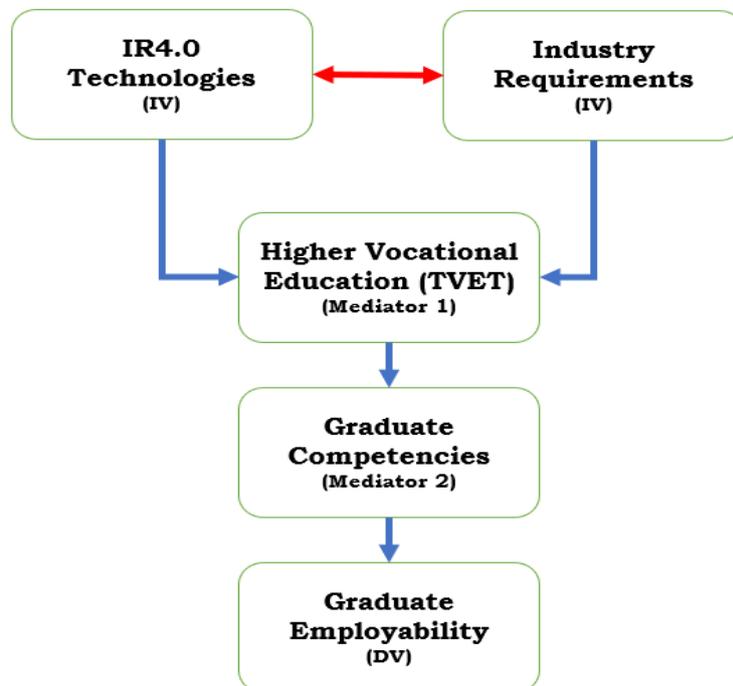

Figure 1. The proposed framework

The framework adopts a full mediation structure, whereby IR4.0 Technologies and Industry

Requirements influence Graduate Employability only through the sequential mediation of TVET and Graduate Competencies. This design ensures that vocational education remains central to the transformation process, aligning with the study's objective to develop a robust, education-driven competency framework for financial graduates in the IR4.0 era (Becker, 1964; Rogers, 2003). Based on the framework illustrated in Figure 1 and the theoretical rationale, the following hypotheses are proposed:

- **H1:** *IR4.0 Technologies positively influence Higher Vocational Education (TVET).* Rationale: Innovation Diffusion Theory (Rogers, 2003) suggests that emerging technologies drive systemic change, requiring educational institutions to adapt curricula, pedagogy, and training strategies to remain relevant.

- **H2:** *Industry Requirements positively influence Higher Vocational Education (TVET).* Rationale: The Resource-Based View (RBV) posits that industries define competitive advantage by specifying workforce skills, which TVET must integrate into its competency framework to meet labour market demands.

- **H3:** *Higher Vocational Education (TVET) positively influences Graduate Competencies.* Rationale: Human Capital Theory (Becker, 1964) emphasizes education as a mediator that enhances productivity by equipping learners with both technical and soft skills, thereby shaping competency development.

- **H4:** *Graduate Competencies positively influence Graduate Employability.* Rationale: The Iceberg Model of Competencies (McClelland, 1973) and Employability Theory (Yorke, 2006) explain that employability outcomes depend on the synergy of observable skills (visible competencies) and underlying attributes (hidden competencies).

- **H5:** *IR4.0 Technologies and Industry Requirements are mutually reinforcing through a bidirectional relationship.* Rationale: Co-evolutionary perspectives highlight that technological advancements reshape industry needs, while industry demands simultaneously guide the adoption and contextualization of technologies.

4. Empirical Validation Roadmap

To enhance the rigor and practical applicability of the proposed competency framework, this study outlines a structured empirical validation roadmap. Although the present paper is conceptual, the framework is designed to be empirically testable through quantitative analysis. Given the multiple latent constructs and mediating relationships proposed, Structural Equation Modelling (SEM) is recommended as an appropriate analytical approach. The validation process aims to operationalize and test the structural relationships among IR4.0 Technologies, Industry Requirements, Higher Vocational Education (TVET), Graduate Competencies, and Graduate Employability.

4.1 Research Design

A cross-sectional quantitative research design is proposed to examine the hypothesized relationships within the framework. This design aligns with prior employability and

competency studies that examine structural linkages between education, competencies, and employment outcomes (Allen et al., 2012; Yorke, 2006). Data may be collected from final-year finance students in higher vocational institutions, educators involved in curriculum delivery, and banking industry supervisors responsible for graduate recruitment. Including multiple stakeholder perspectives enhances the relevance of the findings to both education and industry contexts.

4.2 Measurement Development

Measurement items should be adapted from established theoretical and empirical foundations cited in this study. IR4.0 Technologies may be operationalized through perceived integration of artificial intelligence, big data analytics, blockchain, and digital banking systems within educational and industry contexts (Schwab, 2017; Gomber et al., 2017; Mention, 2019). Industry Requirements may be measured through competency expectations identified in digital banking transformation initiatives in China (Sun, 2022).

TVET can be assessed through indicators reflecting curriculum relevance, industry–education integration, and digital pedagogy reform (Gong & Cong, 2024; Jiang, 2024). Graduate Competencies should reflect the multidimensional structure of knowledge, skills, and motives grounded in the Iceberg Model of Competencies (McClelland, 1973; Spencer & Spencer, 1993). Graduate Employability may be measured using indicators related to job readiness, adaptability, and sustained career development, consistent with Employability Theory (Yorke, 2006; Allen et al., 2012). All constructs may be measured using a five-point Likert scale. Content validity may be ensured through expert review involving academics and banking practitioners to confirm alignment between measurement items and industry expectations.

4.3 Data Analysis Procedures

Empirical testing may proceed in two stages. First, measurement model evaluation should assess reliability and validity, including internal consistency, convergent validity, and discriminant validity. Second, the structural model should be examined to test the direct and indirect relationships specified in the hypotheses. Mediation analysis will evaluate whether TVET and Graduate Competencies function as sequential mediators between external drivers and employability outcomes, consistent with Human Capital Theory (Becker, 1964) and Employability Theory (Yorke, 2006).

Path coefficients, explanatory power, and effect sizes should be examined to determine the strength and significance of relationships. The proposed bidirectional relationship between IR4.0 Technologies and Industry Requirements may also be tested to reflect the co-evolutionary logic discussed earlier (Schwab, 2017; Gomber et al., 2017).

4.4 Expected Empirical Contribution

Empirical validation of the framework will provide quantitative evidence regarding the strength and direction of relationships among technological transformation, industry demands, vocational education reform, competency development, and employability outcomes. By translating theoretical constructs into measurable variables, the validation process will extend

existing discussions on IR4.0, fintech transformation, and TVET reform in China (Mention, 2019; Gong & Cong, 2024). Furthermore, validated findings can inform curriculum redesign, competency-based education strategies, and industry–education collaboration initiatives aimed at enhancing graduate employability in the digitally transformed banking sector.

5. Applicability of the Framework

The proposed competency framework has strong applicability for multiple stakeholders involved in vocational education and banking talent development. For higher vocational education institutions, the framework provides a structured reference for curriculum redesign and pedagogical reform. By aligning learning outcomes with IR4.0 technologies and banking industry requirements, TVET institutions can integrate fintech knowledge, digital tools, and competency-based training into finance programs, thereby enhancing their relevance and effectiveness (Gozman et al., 2018; Liu et al., 2023).

For educators, the framework emphasizes the balanced development of visible competencies, such as technical and analytical skills, and hidden competencies, including professional attitudes, adaptability, and motivation, as articulated in the Iceberg Model of Competencies (McClelland, 1973; Spencer & Spencer, 1993). This holistic approach supports the adoption of experiential learning methods, such as project-based learning, simulations, and industry collaboration, to strengthen students' practical and behavioural competencies.

From an industry perspective, the framework offers a clear competency reference for recruitment, training, and talent evaluation. Banks can utilize the framework to articulate workforce expectations, participate in curriculum co-development, and strengthen school–enterprise cooperation to reduce skill mismatches and training costs (Mention, 2019; Sun, 2022). Policymakers may also apply the framework to guide vocational education reform and promote industry–education integration in line with national digital transformation strategies.

6. Conclusion

The rapid advancement of IR4.0 technologies has profoundly reshaped the banking industry and redefined the competencies required of financial professionals. In China, higher vocational education institutions face increasing pressure to align finance education with the evolving demands of a digitally transformed banking sector. This paper responds to this challenge by proposing a competency framework that integrates technological, industrial, educational, and individual-level perspectives.

Grounded in established theories, including Innovation Diffusion Theory (Rogers, 2003), Human Capital Theory (Becker, 1964), and the Iceberg Model of Competencies (McClelland, 1973), the framework conceptualizes IR4.0 technologies and industry requirements as external drivers that influence graduate employability through the sequential mediation of TVET and graduate competencies. By emphasizing the central role of vocational education in translating industry and technological demands into comprehensive competency development, the framework contributes to the literature on TVET reform and graduate employability in the IR4.0 era.

The proposed framework offers both theoretical value and practical relevance, providing guidance for curriculum innovation, competency-based education, and industry–education collaboration. Future research may empirically test the framework using quantitative or mixed-method approaches and extend its application to other industries undergoing digital transformation.

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