Human Resource Quality at Commercial Banks in the Context of Digital Transformation

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Abstract

The Fourth Industrial Revolution has significantly impacted various sectors, including the economy, politics, and education. In particular, it has transformed the way businesses operate. To succeed in the digital transformation era, one of the most critical strategies is to focus on enhancing the quality of human resources in the banking sector, ensuring sustainable development and aligning the growth of the banking industry with broader economic trends in the digital age. This study aims to analyze how commercial banks can improve the quality of their human resources in the face of the digital revolution. The research employs both qualitative and quantitative methods. The findings reveal that, in the context of digital transformation, the quality of human resources in commercial banks is perceived to be lower than that of managerial staff in previous settings, despite meeting stated job requirements. Factors such as "recruitment," "employee placement," "salary and benefits," "performance appraisal," and "training and development" were found to have a positive influence on human resource quality. In contrast, the "workplace environment" factor showed no statistically significant effect. Based on these findings, the research team proposed six strategic recommendations to enhance human resource quality in the banking sector.

1- Introduction

Industry 4.0 has brought about substantial changes in the economic, political, and social spheres, with finance and banking emerging as prominent sectors esteemed for their innovative technological implementations. The development of digital banking is one of Industry 4.0's most noticeable effects. Developing digital banking is no longer an option, but an inevitable requirement, forcing banks to increase their technological applications in financial transactions and transactions using multi-channel and multi-platform applications. Vietnamese banks are clearly redirecting their transformation to the contemporary technology model, working on a digital platform, in order to enhance competitiveness, reduce costs, increase profits, and improve operational efficiency with banks around the world and in the region. Focusing on the development of high-quality human resources for the banking sector to ensure sustainable development, and linking the development of the banking sector with the development trend of the economy in the digital era is one of the most crucial solutions for the process of digital transformation to be successful.

While in the past, bankers were often just required to be competent in one profession and pursue a certain advancement route, bankers today need to be more adaptable. Instead of emphasizing quantity, banks now prioritize employee quality. Human resources in the financial and banking industries must not only possess professional expertise and the capacity to analyze data but also be skilled in operating digital technology to meet the transformation and upgrade investment in technology infrastructure. In July 2019, the State Bank of Vietnam issued Decision No. 1537/QD-NHNN, which

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approved and launched a plan for the strategic development of human resources in the banking sector until 2025, with a vision extending to 2030 [1]. This decision demonstrates that the State Bank has promptly understood the evolving human resource needs in the banking industry and has taken appropriate measures to address the demands of the digital transformation process within the sector.

Human resources play a vital role in an organization. Human resource quality is a certain state of human resources, showing the relationship between factors constituting the inner nature of human resources. To ensure that banks have staff that can adapt to changing roles in the context of digital transformation, it is essential to improve the quality of human resources.

Numerous studies—both domestic and international—have explored the quality of human resources in general, as well as specifically within the banking industry. These studies can be grouped into the following thematic areas: (1) Research on the capacity of human resources to meet the demands of banking system development plans [2–4]; (2) The quality of human resources in the context of digital transformation, including studies on the future outlook of banking-sector human resources amid the Fourth Industrial Revolution [5], the role of high-quality human capital in enhancing the competitiveness of digital banks [6], and perspectives on developing high-quality human resources in banking and finance under Industry 4.0 [6]; (3) Criteria for evaluating human resource quality [7–11]; and (4) Factors influencing the quality of human resources [8, 12, 13].

However, most of these studies are brief and general in nature, focusing only on basic identification and analysis. There remains a lack of research grounded in the theoretical foundations of the banking system, as well as a shortage of comprehensive solutions aimed at improving the quality of human resources in Vietnam's banking industry in the future. For these reasons, the research team selected the topic: "Human Resource Quality at Commercial Banks in the Context of Digital Transformation" in Vietnam. This study seeks to provide an in-depth understanding of human resource quality in the banking sector, identify the factors that influence it during the transition to digital banking, and offer practical solutions to enhance the quality of human resources in this transformation process.

2- Literature Review and Hypothesis

2-1- Literature Review

2-1-1- Digital Transformation in Banking Sectors

The concept of digital transformation is the process of switching from a traditional system to a digital business model by applying new technologies like Big Data, IoT (Internet of Things), Cloud Computing in order to change operating procedures, leadership, work processes, and company culture [14]. Digital transformation in the banking industry involves a change in culture, organization, and business practices. Technological change includes providing client services via the Internet. Through this transformation, the bank supplies digital services to minimize face-to-face interaction, introducing platform banking to customers. The collaboration between the marketing and IT departments will create opportunities for the bank's digital product offering [15].

Digital transformation (DT) is a crucial strategic initiative for organizations to rectify output, adapt, and keep up with the digital economy [16]. Banking companies can improve the efficiency of their work, reduce costs, and improve interaction with their customers, thereby gaining competitive advantages in the market [17], improved security, operational efficiency, and financial inclusion [18].

Digital transformation in banking is not simply the application of new technologies such as artificial intelligence (AI) and Blockchain, it is the entire transformation process of the bank's business model, strategy, and culture on a digital technology platform. It can be seen that the digital transformation of the banking industry is considered a change in digital technology, digitizing all aspects and operations of the bank. This transformation makes it possible to create or modify operational procedures, business models, cultural norms, and customer experiences in order to adapt to shifting market demands and satisfy consumer expectations [14].

The study by Meena & Parimalarani (2020) [19], examined the effects of digital transformation on banking jobs and changes in the banking industry's employment structure as a result of the use of digital technology; the study also demonstrates how officials and employees of the banking sector's perceptions and ways of thinking have changed as a result of the use of digital technology; Lack of highly skilled workers, etc. Wang et al. (2024) [20] investigated the challenges banks have maintaining data privacy and cybersecurity while implementing new technologies, how they perceive these challenges, and what steps they take to reduce the risks involved.

Studies reveal that the issue places significant demands on bank restructuring and human resource restructuring; Bigtechs, Fintechs, or consulting companies, frequently offer a desirable work environment, and salaries are frequently more competitive than those of banks in the recruiting market. Because of the labor scarcity and fierce competition for qualified applicants, the banking sector's human resources need to increase their quality in order to adapt to the environment of digital transformation.

2-1-2- The Quality of Human Resources in Commercial Banks in the Context of Digital Transformation

Boxall et al. (2008) [21] defined human resources as "the knowledge, skills, networks, and energies of people and, underpinning them, their physical and emotional health, intellectual capabilities, personalities, and motivations." According to Dave (1975) [22], skills are typically categorized into four levels: imitation, application, technological leverage, and creative application. The quality of human resources is assessed based on their ability to meet the development needs of the banking industry and the strategic goals of the banking system. Vu (2015) [4] provided an overview of the current state of human resources in the banking sector, highlighting both quantitative and qualitative aspects. These include issues related to development strategies, risk management, international transactions and investments, economics, supplementary knowledge (such as information technology and foreign languages), economic and banking knowledge, communication skills, professional qualifications, project planning, strategic vision (especially among management teams), restructuring, banking operations, monetary policy, and inspection and supervision. Vu also identified the root causes of existing limitations and proposed solutions to improve human resource quality in the banking industry.

Le & Nguyen (2019) [23] emphasized the desire to enhance the attitude and working style, risk management, internal audit and control; appraisal assessment, loan classification, and provision making. Vo (2019) [5] examined how the Industrial Revolution 4.0 has affected the banking sector's resources and offered some policy recommendations to raise the quality of the banking workforce in Vietnam over the next few years. The human resources sector within Vietnam's banking industry encounters numerous challenges, notably a scarcity of personnel proficient in data analysis, adept in utilizing digital technologies, and possessing professional expertise. Thanh (2021) [24] affirms the importance of increasing competitiveness for digital banks with qualified workers and experienced human resources from Tien Phong Bank. Tran (2020) [6] analyzed some perspectives on the development of high-quality human resources in the banking and finance industry in Industry 4.0. The common view is that human resources are the quality of the resources that reside in each person and are used by them in the labor process. António Porfírio et al. (2024) [25] emphasized the vital role of employees' skills and stakeholders' digital experiences in overcoming limitations to its potential, while also supporting the enhancement of management and human resource policies to address digital transformation in the banking sector.

About the digital competence: Ala-Mutka (2011) [26] identify the key components of Digital Competence (DC) in terms of the knowledge, skills and attitudes needed to be digitally competent; Spires et al. (2018) [27] discuss the cognitive, social, and affective dimensions of digital literacy as it is a key requirement in contemporary K-12 education. Riina et al. (2022) [28] provides more than 250 new examples of knowledge, skills and attitudes that help citizens engage confidently, critically and safely with digital technologies, and new and emerging ones such as systems driven by artificial intelligence (AI).

2-1-3- Determinants and Criteria for Assessing the Quality of Human Resources

Nguyen (2017) [29] investigated the determinants of human resource quality, categorizing them into internal and external factors. External factors include recruitment policies, training and development, compensation, and working conditions, while internal factors consist of personal traits and attitudes, skills, knowledge, and physical health. Nguyen (2015) [30] analyzed factors affecting human resource development in the garment sector, identifying variables such as the economic environment, human resource quality, education and training, government policies, recruitment, job analysis, working environment, employee relations, and compensation. Several other studies have applied similar determinants, though within different contexts [31–34].

As noted by Hill and Stewart (2000) [35], various factors influence human resources in small-scale enterprises. These include business growth, innovation, business owners' perspectives, alignment with business outcomes, organizational culture, industry-specific characteristics, technological adoption, recruitment challenges, training efforts, change management, employee expectations, external support, and the practicality of training programs.

Lake (2008) [36], in a study on the lighting industry in Indonesia, identified three broad categories of factors affecting human resources: external factors (such as labor laws, labor market conditions, and labor supply characteristics), business environment factors (including company policies, recruitment, training, effective work management, and timely information management), and workplace environment factors (such as physical conditions, job characteristics, raw material sources, and factory location).

Bui (2012) [37] highlighted several variables that influence the quality of human resources. The study defines human resource quality for labor export as a state reflecting the interaction of internal factors, including: (i) physical strength deficiencies, (ii) education and training, and (iii) social consciousness. However, the study did not extensively explore the measurement system or the impact of these variables on the quality of labor-export-oriented human resources. The perspectives outlined in the aforementioned studies align with the British school's theory of the competency model (KSA model), which conceptualizes capability as a combination of the knowledge, skills, and attitudes required to effectively perform a job or function.

Sayyadi et al. (2017) [13] analyzed three categories of factors affecting human resource quality: economic factors, social factors, and environmental factors. Similarly, Nguyen et al. (2019) [8] examined macro-environmental factors influencing human resource quality in Dong Nai Industrial Park, including central agencies, the local regulatory environment, and the broader socio-economic context. Their study also identified several micro-level factors, such as leadership support, training and development policies, job performance, work capability, and the working environment. Pham & Mach (2014) [9] focused on clarifying the concept of human resource quality through three main groups of criteria: physical condition indicators, educational and technical qualifications, and ethical standards. These categories are commonly used for human resource assessment in commercial banks globally. Based on these three sets of criteria, the authors analyzed the current state of human resource quality in 18 foreign-invested banks in Vietnam.

Nguyen (2015) [7] argued that physical strength, mental capacity, attitude, and working style together constitute the overall capacity of the workforce. These elements are closely interrelated: physical strength serves as the foundation and means to apply knowledge; intelligence is the core determinant of human resource quality; and working style governs the transformation of physical and intellectual abilities into practical performance. Vu (2019) [11] evaluated human resource quality through the lens of intellectual, mental, and physical factors, emphasizing their improvement in areas such as recruitment, placement, promotion, training and retraining, policy implementation, and motivation strategies.

Tran (2020) [10] categorized the criteria influencing human resource quality in Ho Chi Minh City's industrial zones into three indicator groups: physical fitness (e.g., height, weight, health); mental strength (e.g., discipline, commitment, adaptability, work psychology, stress tolerance); and intelligence (e.g., education level, technical skills, experience). These groups of indicators are considered critical in assessing workforce quality. Nguyen et al. (2019) [8] also assessed human resource quality using four distinct criteria: workforce structure, qualifications and skills, physical health, and attitude and working style.

2-1-4- Research Gaps and Prioritized Research Issues in This Paper

Based on a review of previous studies related to the topic, the research team found that most research on human resource quality in the context of digital transformation has primarily focused on professional knowledge and skills. These include areas such as risk management, international transactions, international investment, economics, complementary competencies (e.g., information technology, foreign languages), knowledge in economics, banking, communication, professional qualifications, project planning, strategic vision (particularly among management teams), restructuring, banking operations, monetary policy, inspection, and supervision.

From a theoretical perspective on human resources, key indicators such as physical health, knowledge, skills, working style, and attitude are fundamental for measuring human resource quality. These elements have a direct influence on individual creativity, productivity in the workplace, and overall labor efficiency. It is widely acknowledged that the development of high-quality human resources significantly impacts the success or failure of a nation, industry, locality, or organization.

Furthermore, both internal and external factors affect human resource quality. These include recruitment policies, training and development, effective work management, timely information management, working conditions, compensation, and job characteristics. Therefore, adopting a comprehensive research approach—one that encompasses physical strength, mental capacity, attitude, working style, and the various factors influencing human resource quality in commercial banks—is essential in the context of digital transformation. Conducting such research through a survey of commercial banks is both relevant and necessary.

2-2- Hypothesis

In this section, we propose the following hypotheses along with their corresponding justifications:

The quality of human resources in the context of digital transformation can be assessed through indicators such as physical health, knowledge, a positive attitude toward adapting to new tasks, the ability to meet required qualifications, and the capacity to complete new responsibilities in a timely and competent manner [3].

Human resource training and development encompasses the identification of training needs [12], the design and implementation of training programs, professional development, training and development planning [38], and digital skill enhancement. According to Campbell & Kuncel (2001) [39], training is one of the most prevalent and challenging interventions in the field of human resources. Holton & Baldwin (2003) [40] further argue that improving workforce performance requires that skills and attitude training be applied directly in the workplace, sustained over time, and

adapted to diverse organizational contexts. Additional studies have also confirmed that training has a positive impact on the quality of human resources [35–37].

Hypothesis H1: *Human resource training and development has a positive impact on human resource quality in the context of digital transformation.*

Pham (2018) [33] found that several factors within the domain of employee placement contribute to improving human resource quality. These include labor allocation based on professional qualifications, workforce distribution according to individual capabilities, a well-structured human resource system, and the optimal utilization of competent employees. Additionally, providing clear job descriptions and designing roles that align with employees' personalities and preferences are also essential [41]. When employee placement is managed effectively, the overall quality of human resources is significantly enhanced [11, 29].

Hypothesis H2: *Employee placement has a positive impact on the quality of human resources in the context of digital transformation.*

A clear, public, and transparent salary and bonus policy can significantly enhance human resource quality in the context of digital transformation. Salary and benefits should reflect employee performance, be aligned with the company's financial outcomes, encourage improved performance, and offer a diversified compensation structure [41]. Otoo & Mishra (2018) [42] emphasized that salary is not merely a financial component but also a strategic instrument for promoting human resource development. Similarly, Nguyen (2015) [30] and Nguyen (2017) [29] highlighted compensation as a critical factor influencing human resource quality.

Hypothesis H3: *Salary and benefits have a positive impact on human resource quality in the context of digital transformation.*

The working environment is evaluated based on several factors: flexibility in time and workspace arrangements, a comfortable physical environment, availability of extracurricular activities and employee clubs [18], fair division of workload and working hours, limited overtime expectations [32], and provisions such as a dedicated space for meals and rest during lunch breaks. Nguyen (2017) [29], Nguyen (2015) [30], Lake (2008) [36], and Sayyadi et al. (2017) [13] concluded that the working environment has a direct impact on the quality of human resources.

Hypothesis H4: *The working environment has a positive impact on the quality of human resources in the context of digital transformation.*

Performance appraisal is assessed based on the presence of updated job descriptions, clearly defined roles and responsibilities, alignment between authority and accountability, well-established performance evaluation criteria [32], objective assessments by supervisors, and the extent to which employees feel satisfied and motivated by the evaluation outcomes [3]. Le & Nguyen (2022) [3], along with Otoo & Mishra (2018) [42], analyzed the connection between performance appraisal and human resource development, emphasizing its role as a key tool for enhancing both individual and organizational effectiveness. Similar conclusions have been drawn in other studies as well [31, 32].

Hypothesis H5: *Performance appraisal has a positive impact on human resource quality in the context of digital transformation.*

The recruitment variable is measured through the effectiveness of the recruitment system, clearly and objectively defined selection criteria, and the selection of candidates who possess the appropriate qualifications and personal attributes [30]. It also includes a public and transparent recruitment process and a strategic approach to attracting talent [33]. Several scholars have emphasized that recruitment and selection are closely interrelated and have a positive influence on human resource development [43, 44]. Zia-ur-Rehman et al. (2015) [45] argue that recruitment and selection represent one of the most effective human resource practices, enabling organizational managers to identify and attract potential candidates, thereby contributing to human resource development and enhancing overall organizational performance.

Hypothesis H6: *Recruitment has a positive impact on human resource quality in the context of digital transformation.*

Welfare is defined by the availability of support for employees' spiritual well-being, assistance during times of personal difficulty, a safe and healthy work environment, and the timely and effective implementation of reward and disciplinary policies [33].

Hypothesis H7: Welfare has a positive impact on human resource quality in the context of digital transformation.
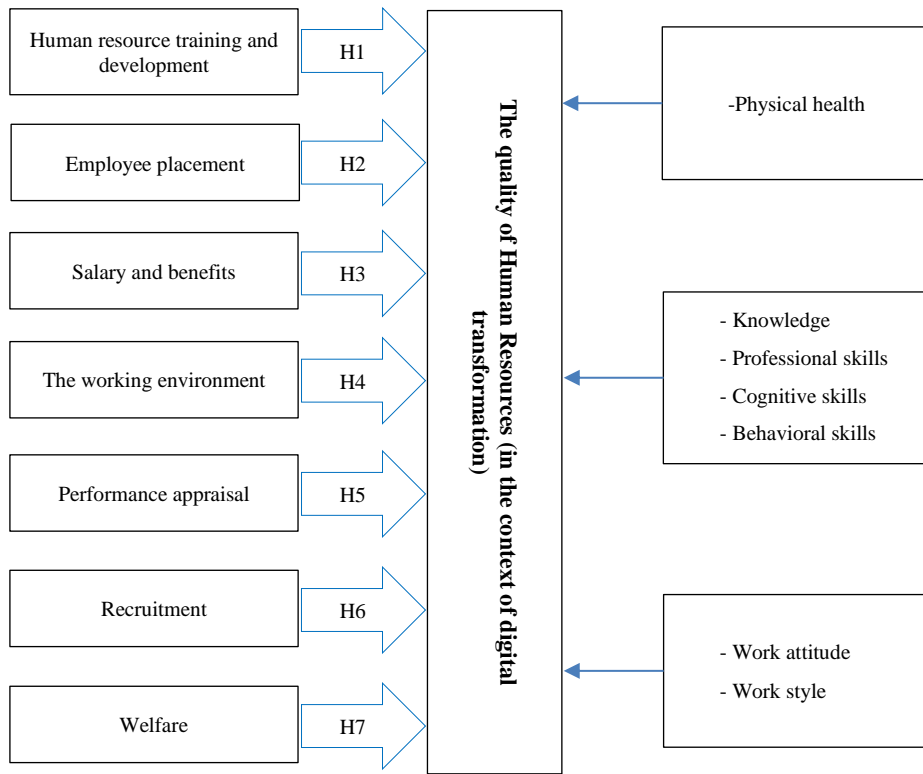
Figure 1 illustrates the research model.

Figure 1. Research model

3- Research Methodology

3-1- Research Process

The following method was used to conduct the study, which is shown in Figure 2.
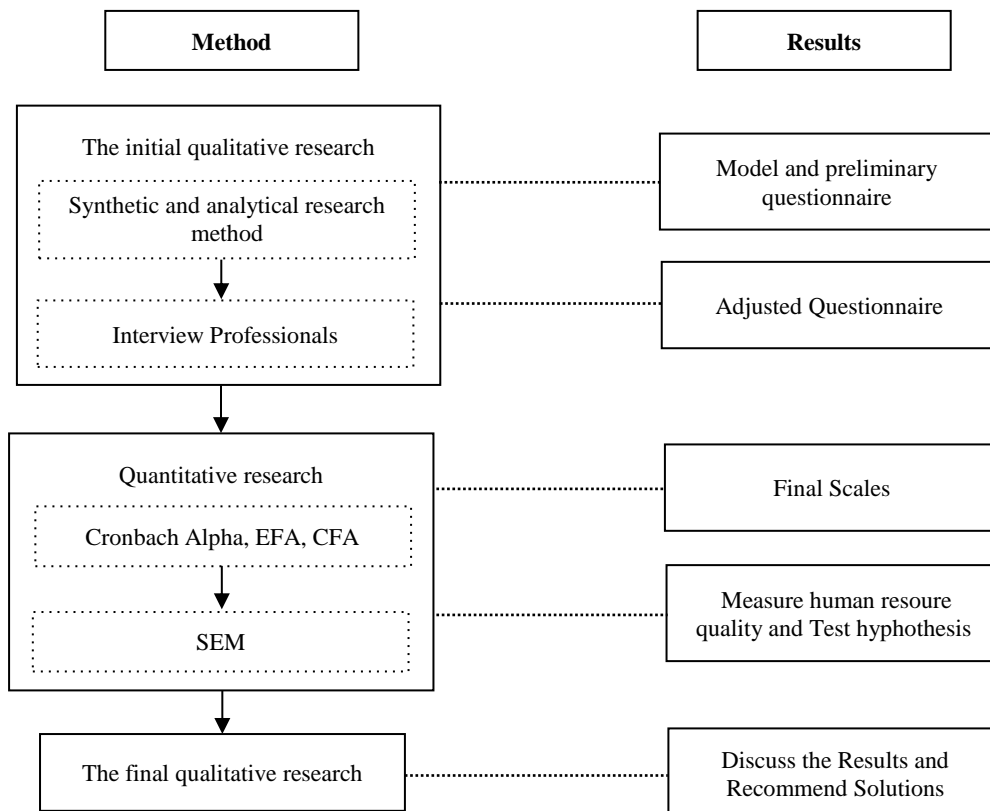

Figure 2. Research process

3-2- Qualitative Methods

The research team combines the approach of synthesis analysis of the received documents with discussion to develop a preliminary scale for measuring the quality of human resources of commercial banks in the context of digital transformation in order to achieve the qualitative research aim, including mixed methods and semi-structured interviews with experts holding management as well as staff positions within 30-60 minutes.

3-3- Quantitative Methods

3-3-1- Sampling Methods

The authors employed a multi-stage sampling method, which is a semi-random sampling technique, by selecting several representative banks based on specific characteristics such as charter capital, number of employees, and typical market share. For population segments within commercial banks, this method provides nearly the same level of accuracy as random sampling, while offering the advantages of reduced cost and a smaller sample size. The research team selected 13 banks with varying levels of charter capital and employee numbers for the investigation. At each bank, several transaction offices from different branches and head offices were randomly chosen. Questionnaires were distributed to all employees within the selected transaction offices or specific departments at the head offices. This multi-stage sampling approach ensures that every employee within the chosen offices or departments had an equal probability of being selected. Descriptive statistics for the study sample are presented in Table 1.

Table 1. Descriptive statistics of the study sample

No.	Bank's name	Samples	Rate (%)
1	Vietnam Bank for Agriculture and Rural Development - Agribank	48	11.91%
2	Joint Stock Commercial Bank For Foreign Trade Of Vietnam - Vietcombank	41	10.17%
3	Joint Stock Commercial Bank for Investment and Development of Vietnam - BIDV	40	9.93%
4	Vietnam Joint Stock Commercial Bank for Industry and Trade - Vietinbank	38	9.43%
5	An Binh Commercial Join Stock Bank - ABB	34	8.44%
6	Southeast Asia Commercial Joint Stock Bank	34	8.44%
7	Military Commercial Joint Stock Bank - MB	34	8.44%
8	ASIA Commercial Joint Stock Bank - ACB	30	7.44%
9	Vietnam Technological and Commercial Joint – Stock Bank - Techcombank	28	6.95%
10	Vietnam Prosperity Joint Stock Commercial Bank -VP bank	26	6.45%
11	Vietnam International Commercial Joint Stock Bank - VIB	19	4.71%
12	TienPhong Commercial Joint Stock Bank - TPB	16	3.97%
13	National Citizen Bank - NCB	15	3.72%
	Total	**403**	**100**

3-3-2- Sample Size

The authors use the SPSS program to analyze the data. We used two methods to identify the minimum required sample size:

Method 1: For exploratory factor analysis (EFA): According to Hair et al. (1998) [46] and Comrey (1973) [47], the sample size should be at least 5 times the total number of observed variables. This study included 48 questions; therefore, the minimum sample size needed is $84 \times 5 = 240$ observations.

Method 2: For multivariate regression analysis, the minimum sample size is calculated by $n = 50 + 8 \times m$, where m is the number of independent variables [48]. In this study, there are 7 independent variables; thus, the minimum sample size is $50 + 8 \times 7 = 106$ observations.

Based on the above two methods, for the research results to be scientifically valid, the sample size from 106 to 240 is representative of the population. In the study, the author distributed 500 survey questionnaires in 13 different banks and obtained 403 responses, ensuring the reliability of the sample size.

3-3-3- Survey Methods

The research team employed a survey method using questionnaires, which were distributed through multiple channels: directly to respondents, via staff members at branches and transaction offices, in graduate classes at the Banking Academy, and through online platforms. As a result, 311 valid responses were collected through direct distribution, and 92 valid responses were obtained from the online survey. In total, 403 valid responses were gathered for data analysis.

3-3-4- Data Analysis

The reliability of the scale is tested by the reliability coefficient Cronbach Alpha. In addition, we used EFA, which is used to evaluate convergent and discriminant validity, by examining factor loading and extracted variances. Furthermore, we used Confirmatory Factor Analysis (CFA) to test the suitability of the theoretical model. CFA is appropriate to use when the researcher has some knowledge about the underlying latent variable structure, in which the relationship or hypothesis (obtained from theory or experiment) between the observed variable and the underlying factor.

After qualitative research, the research team proposed a research model, conducting a confirmatory factor analysis to confirm once again the proposed hypotheses and consider whether the factors are correlated or not in the research model.

4- Findings

4-1- Results of in-Depth Interviews with Experts

According to the experts interviewed, the majority of commercial banks are currently progressing through the first and second stages of digital transformation. These banks are actively collaborating with public institutions and financial technology companies (such as BigTech and FinTech) to digitize products, automate services, and establish digital distribution channels for customers. However, banks face numerous challenges from the outset, including the need for rapid institutional restructuring, substantial capital investment, and enhanced digital capabilities in areas such as management, operations, and risk mitigation—particularly to safeguard consumer interests in the context of the "new normal" brought about by the COVID-19 pandemic.

In addition to significant investments in technological infrastructure, one of the major challenges commercial banks face in digital transformation is the recruitment of skilled technology professionals. Experts emphasize that digital innovation must become embedded in the corporate culture. Furthermore, the working environment should prioritize flexibility, creativity, and dynamism to effectively support digitalization efforts within banks. Moreover, digital transformation places greater demands on human resources. According to expert opinions, banking personnel during this transition must not only possess strong professional expertise but also demonstrate digital literacy and information technology competence. They are expected to be quick learners, adaptable, and responsive to technological advancements, with the ability to use and optimize tools such as the Internet, blockchain, and fintech platforms.

4-2- Quantitative Research Results

4-2-1- Check the Reliability of the Scale through Cronbach Alpha (CA)

All of the observed variables have the confidence coefficient CA, which is used to test the scale's reliability. If a particular variable's type is smaller than the scale's overall reliability coefficient, the total correlation coefficient is higher than 0.5, requiring the research team to re-examine all of the observed variables, and all nine scales are accepted as having high reliability.

The results of the scale reliability coefficient, total variable correlation coefficient, and reliability coefficient are presented in Table 2.

Table 2. Check the reliability of the scales

Observed variables	Total variable correlation	CA if variable type	Reliability coefficients (CA)
Labor recruitment			
TD1	0.654	0.873	
TD2	0.725	0.857	
TD3	0.718	0.859	0.883
TD4	0.777	0.845	
TD5	0.727	0.856	
Using labor			
SD1	0.767	0.918	
SD2	0.812	0.915	
SD3	0.801	0.915	
SD4	0.768	0.918	0.929
SD5	0.721	0.923	
SD6	0.771	0.918	
SD7	0.784	0.917	

Salary			
TL1	0.344	0.893	
TL2	0.757	0.773	
TL3	0.804	0.757	0.837
TL4	0.765	0.768	
TL5	0.607	0.813	
Welfare			
PL1	0.862	0.921	
PL2	0.840	0.925	
PL3	0.854	0.923	0.940
PL4	0.815	0.930	
PL5	0.818	0.930	
Training and developing			
DT1	0.846	0.935	
DT2	0.835	0.936	
DT3	0.784	0.940	
DT4	0.829	0.936	0.946
DT5	0.840	0.935	
DT6	0.805	0.939	
DT7	0.793	0.940	
Environment			
MT1	0.718	0.869	
MT2	0.757	0.860	
MT3	0.814	0.848	0.889
MT4	0.727	0.868	
MT5	0.655	0.883	
Work assessment			
DG1	0.708	0.937	
DG2	0.819	0.927	
DG3	0.794	0.929	
DG4	0.828	0.927	
DG5	0.785	0.930	0.938
DG6	0.735	0.933	
DG7	0.815	0.928	
DG8	0.789	0.930	
The quality of human resources			
CLS1	0.874	0.958	
CLS2	0.879	0.958	
CLS3	0.891	0.957	
CLS4	0.902	0.955	0.964
CLS5	0.868	0.959	
CLS6	0.893	0.956	

4-2-2- Check the Scale through EFA Analysis

We use the Principal Axis Factoring extraction method with Promax rotation in EFA analysis to discover latent structures.

The KMO test results for the 48 observed variables yielded a KMO coefficient of 0.968, which is greater than the threshold of 0.5. The Bartlett's test produced a significance level of 0 (Sig < 0.05), indicating that the observed variables are sufficiently correlated to justify the application of factor analysis. These results confirm that the exploratory factor analysis (EFA) is appropriate and that the survey data meet the requirements for conducting EFA.

According to the total variance explained table, 48 observed variables were reduced to 8 factor groups with Eigenvalues greater than 1. The total variance explained reached 75.224%, which exceeds the 50% threshold, indicating high statistical significance.

Upon reviewing the rotated component matrix, some variables—specifically TL1 and DG1—had factor loadings below 0.5 or cross-loadings with differences less than 0.3 across two factor groups. Therefore, the research team removed variables TL1 and DG1 and conducted EFA a second time. The final EFA results, including only the observed variables that met the necessary criteria, are presented in Tables 3 and 4.

Table 3. KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.968
Bartlett's Test of Sphericity	Approx. Chi-Square	18408.308
	df	1128
	Sig.	0.000

Table 4. Percentage variation of observed variables

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	**Variance %**	**Cumulative %**	**Total**	**Variance %**	**Cumulative %**	**Total**
1	23.685	49.344	49.344	23.404	48.758	48.758	17.732
2	3.898	8.121	57.465	3.558	7.413	56.172	18.853
3	1.823	3.797	61.262	1.588	3.307	59.479	18.663
4	1.595	3.323	64.586	1.359	2.832	62.311	15.598
5	1.441	3.002	67.587	1.155	2.407	64.718	15.991
6	1.343	2.797	70.384	1.046	2.180	66.898	18.141
7	1.216	2.533	72.917	0.897	1.870	68.768	7.537
8	1.117	2.327	75.244	0.794	1.655	70.423	8.632
9	0.686	1.430	76.675				
….	….	….	…				
48	0.098	0.203	100.000				

4-2-3- Testing the Scale through Confirmatory Factor Analysis CFA

Testing the suitability of the model: The results of confirmatory factor analysis (CFA) for assessing the scales in the research model show that the model has 961 degrees of freedom (df = 961), with a Chi-square test value of 2174.159 and a p-value = 0.000. The detailed model fit indices are as follows: CMIN/df = 2.262 < 3.0, indicating a good level of fit. The absolute fit index (not adjusted for degrees of freedom) for both the structural and measurement models with the survey data is GFI = 0.809 (> 0.8), which is acceptable. The comparative fit index (CFI) = 0.927 > 0.8 also falls within an acceptable range. The RMSEA = 0.056 < 0.06 indicates a good model fit, and the Tucker–Lewis Index (TLI) = 0.922 > 0.8 further confirms the model's adequacy. Based on these results, it can be concluded that the model is theoretically sound and possesses practical and applied significance.

The results of the CFA analysis show the relationship between the observed variables and the converging factors, so for the CFA results to be consistent with the market data, it should be considered. Normalized Beta coefficients are >0.5.

4-2-4- Testing the Research Hypothesis by Linear Structural Model SEM

SEM analysis results: The results of the structural equation modeling (SEM) show a Chi-square test value = 2029.751 with df = 961 and a P-value = 0.000. The detailed goodness-of-fit indices for the overall model are as follows: Chi-square/df = 2.112 < 3.0, indicating a good fit. The absolute fit index (without adjusting for degrees of freedom) for both the structural and measurement models using the survey data is: CFI = 0.822 > 0.8, which is within the acceptable range. The RMSEA = 0.053 < 0.06 also reflects a good model fit. The TLI = 0.933 > 0.8 is acceptable. The GFI = 0.822 > 0.8 indicates that the model fits well with the market data (see Figure 3 and Table 5).
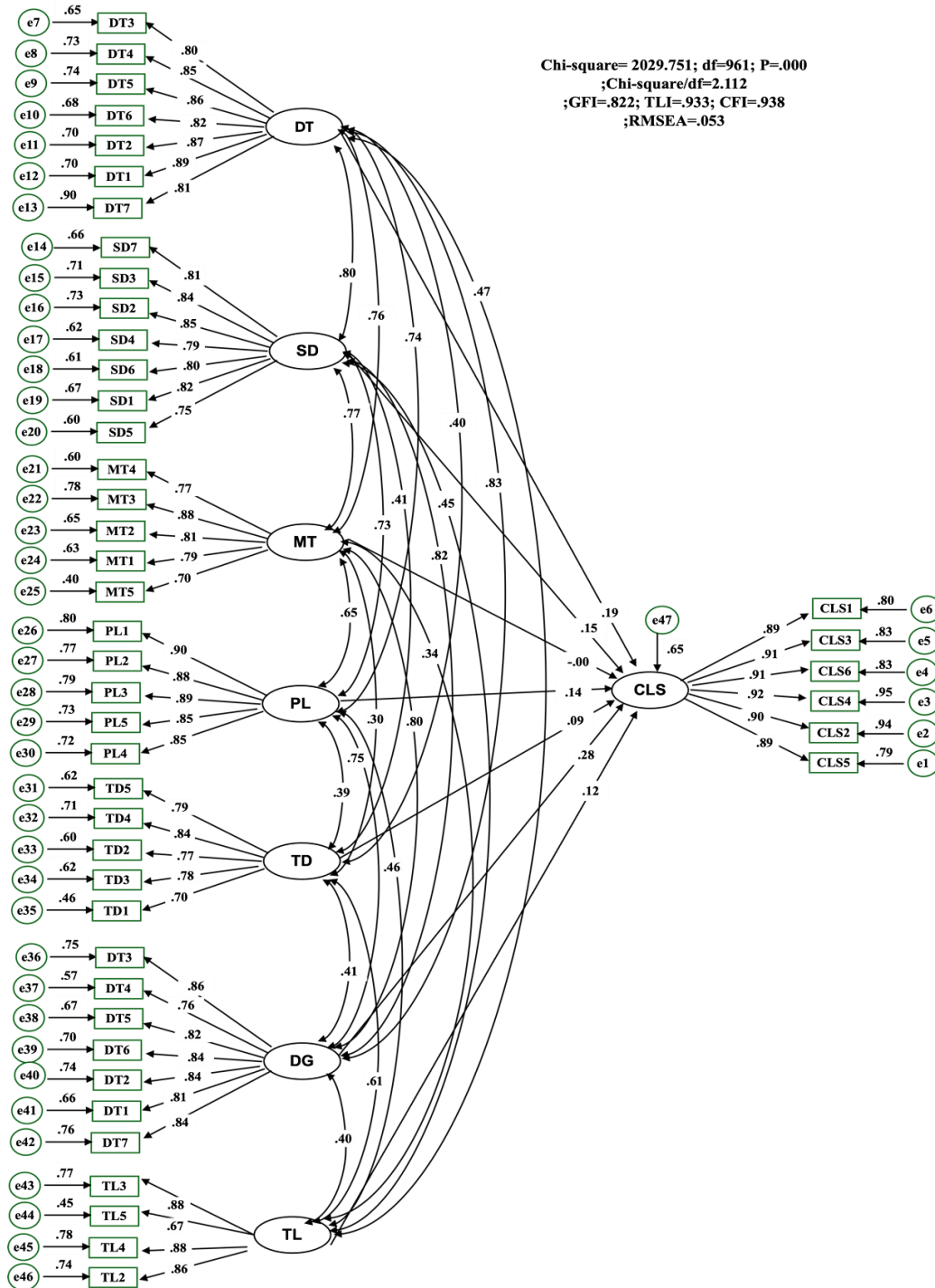
Chi-square= 2029.751; df=961; P=.000
;Chi-square/df=2.112
;GFI=.822; TLI=.933; CFI=.938
;RMSEA=.053

Figure 3. SEM analysis results

Table 5. Estimation results and hypothesis testing by SEM

Relationship			Beta	S.E.	C.R.	P	Standardize Beta
CLS	←	DT	0.220	0.087	2.529	0.011	0.187
CLS	←	SD	0.150	0.077	1.957	0.050	0.149
CLS	←	MT	-0.001	0.066	-0.012	0.990	-0.001
CLS	←	PL	0.142	0.058	2.450	0.014	0.141
CLS	←	TD	0.112	0.055	2.050	0.040	0.094
CLS	←	DG	0.308	0.092	3.333	***	0.279
CLS	←	TL	0.125	0.051	2.435	0.015	0.116

Note: SE: standard deviation; CR: critical value; P: significance level; ***: p < 0.001.

The test results indicate that the factors of Training and Development (DT), Employee Placement (SD), Welfare (PL), Recruitment (TD), Performance Appraisal (DG), and Salary and Benefit (TL) are significantly associated with Human Resource Quality (CLS), with p-value < 0.05 and standardized beta coefficients showing positive values. This demonstrates that these factors have a positive impact on the quality of human resources at the 95% confidence level. Conversely, the Working Environment (MT), with a p-value > 0.05, does not have a statistically significant impact on Human Resource Quality (CLS) at the same significance level. The standardized beta coefficients for the influencing factors reveal that Performance Appraisal has the strongest impact on human resource quality, with a coefficient of 0.279. This is followed by Training and Development (0.187), Employee Placement (0.149), Welfare (0.141), Salary and Benefit (0.116), and Recruitment, which has the lowest effect with a coefficient of 0.094.

The coefficient R^2 determines the degree of impact of the independent variables on the dependent variable of the model.

The coefficient of determination is 0.648, proving that the included factors in the model explain 64.8% of the variation in commercial banks' human resource quality in the context of digital transformation. In social science research, especially the study of factors affecting the dependent variable, the ability to explain the model greater than 50% is acceptable [49].

The results of the hypothesis testing are summarized in Table 6:

Table 6. The results of the hypothesis testing

No.	Hypothesis	Result
1	Hypothesis 1. Human resource training and development has a positive impact on human resource quality in the context of digital transformation.	Accepted
2	Hypothesis 2. Employee placement has a positive impact on human resource quality in the context of digital transformation.	Accepted
3	Hypothesis 3. Salary and benefits have a positive impact on human resource quality in the context of digital transformation.	Accepted
4	Hypothesis 4. The working environment has a positive impact on the quality of human resources in the context of digital transformation.	Not accepted
5	Hypothesis 5. Performance appraisal has a positive effect on human resource quality in the context of digital transformation.	Accepted
6	Hypothesis 6. Recruitment has a positive impact on human resource quality in the context of digital transformation	Accepted
7	Hypothesis 7. Welfare has a positive impact on human resource quality in the context of digital transformation	Accepted

4-2-5- Human Resource Quality

The human resource quality was measured by knowledge and skill (specialized knowledge, work experience, ability to apply knowledge at work, knowledge of digital transformation, foreign languages, advanced skills, cognitive skills, behavior skills); physical health (the level of responsibility for tasks that require agility and flexibility health condition ability to work overtime based on health chronic diseases), the BMI indicator, attitude and working style (discipline, responsibility, work spirit, independence). (See table 7 and table 8)

Table 7. Human resource quality

Scale	Mean	Standard deviation
1. Knowledge and skill	4.03	
2. Physical health	4.11	
3. Attitude and work style scale	4.21	0.7

Table 8. BMI of employee

Range	BMI (WHO)	Number
Underweight	< 18.5	35
Healthy Weight	18.5 - 24.9	289
Overweight	25 - 29.9	70
Obese	30 - 34.9	9
Total		**403**

5- Discussion and Implications

5-1- Discussion

5-1-1- Performance Appraisal Positively Impact Human Resource Quality in the Context of Digital Transformation

Evaluation of job performance plays a role in having the greatest positive effect on the quality of human resources in the era of digital transformation with a beta value of 0.279. The performance appraisal results will be applied to several

HR tasks: compensation determination, determining training requirements, recognizing accomplishments, promoting and rotating employees. The job performance assessment criteria are specifically developed with the highest average score (4.04), leaders regularly monitor and verify the indicators assigned to employees (3.83), which is 0.785 lower than the standard. It clearly shows that the process is not sufficiently accurate and requires an improvement in indicators. This result is consistent with the conclusion of Tran Thuy Linh (2021) in "The system of tools and criteria for staff evaluation" that some commercial banks have not issued regulations on staff evaluation comprehensively. In many cases, officers were appointed to high positions, which was not exactly acceptable to them.

5-1-2- Human Resource Training and Development has a Positive Impact on Human Resource Quality in the Context of Digital Transformation

Human resource training and development has the second largest impact on the quality of human resources in the context of digital transformation with a beta index of 0.187, which shows the importance of training in improving the quality of human resources in the digital context. The evaluation of human resource training and development takes into account the following factors: identifying training needs; developing training and retraining programs that are appropriate to employees' work needs; annually organizing professional training; effectively carrying out employee training and retraining according to the plan; routinely evaluating employee training and retraining; and ensuring that training programs for digital transformation are timely and appropriate for the requirements. The survey results demonstrate that, compared to the other criteria (3.81 and 3.8), the average score for digital transformation training programs that are timely and relevant to the employee's work requirements is much lower. Professional training gets the highest average score (4.05), indicating that banks have historically placed more emphasis on professional training and less emphasis on transfer-related training activities. Several specialist training courses have included digital transformation material, although there are still few of them. Besides, the application of digitization in training courses is also being focused on by banks, improving the efficiency of training activities. However, the bank does not always focus on enhancing the knowledge of foreign languages and cutting-edge technology for all employees; only a limited number of young employees are invested in it, while banks pay less attention to training elderly personnel.

5-1-3- Employee Placement has a Positive Impact on the Quality of Human Resources in the Context of Digital Transformation

Employee placement has the third strongest positive influence on human resource quality in the context of digital transformation, with a standardized beta coefficient of 0.149. Appropriately assigning personnel based on professional qualifications, capabilities, personality traits, and personal preferences—as well as maintaining a rational personnel structure within departments, providing clear job descriptions, implementing a grading system for labor evaluation, and recognizing high-performing employees—has a measurable positive impact on human resource quality within the banking sector. However, current employee placement policies in commercial banks have not performed as effectively as other HR policies. The average scores for the evaluated criteria are all below 4, ranging from 3.62 to 3.89. The lowest-rated criterion concerns aligning labor assignments with employees' personalities and preferences, while the highest-rated relates to recruiting qualified employees. Commercial banks are advised to place greater emphasis on aligning employee assignments with individual preferences and personality traits. Doing so would enhance workforce engagement and optimize organizational performance. Additionally, there should be a stronger focus on improving organizational structure and overall human resource quality. Notably, some banks still lack a comprehensive human resource strategy, with HR management operating separately from organizational development objectives. Furthermore, human resource planning often lacks a master or matrix plan that clearly defines the locations requiring team development, along with the appropriate scale and number of personnel. As a result, planning remains misaligned with overall organizational efficiency and strategic goals.

5-1-4- Welfare has a Positive Impact on Human Resource Quality in the Context of Digital Transformation

With a Beta value of 0.141, welfare ranks as the fourth most significant positive factor influencing human resource quality in the context of digital transformation. One of the strengths of modern commercial banks lies in their welfare policies, which contribute positively to improving the quality of their human resources. Employees generally expressed strong agreement with the adequacy of the welfare benefits provided, with most ratings close to or above 4. Enhancing employees' spiritual well-being plays a vital role in supporting their mental health. In practice, employees in commercial banks often work under high pressure, and regular spiritual or morale-boosting activities can help improve their motivation, commitment, and overall performance. Emulation programs have also been effectively implemented by many commercial banks. However, among the various welfare criteria, "Caring for the spiritual life of employees" received the lowest score and therefore requires focused improvement.

5-1-5- Salary and Benefits have a Positive Impact on Human Resource Quality in the Context of Digital Transformation

Salary and benefits represent the fifth most significant positive factor affecting human resource quality in the context of digital transformation, with a Beta value of 0.116. Compensation tied to job performance—assessed through specific

KPIs and job complexity—has served as a motivating factor for employees to enhance their work quality. Additionally, salary plays an important role in supporting both the physical and mental well-being of employees. At present, the average salary in commercial banks is relatively high compared to other industries. However, in some commercial banks, salary policies still show several limitations. For instance, compensation and bonus systems have not been adequately developed for positions requiring additional support. Employees who exceed expectations in terms of performance or sales results are often not sufficiently recognized or rewarded. There are also no clear policies regarding merit-based salary increases, promotions beyond established levels, or performance-based incentives. Instead, compensation decisions are frequently based on seniority and academic qualifications. Furthermore, in certain institutions, employee and management evaluations are conducted in a superficial or emotional manner, lacking systematic oversight and objectivity.

5-1-6- Recruitment has a Positive Impact on Human Resource Quality in the Context of Digital Transformation

Recruitment has a positive impact on the quality of human resources in the context of digital transformation, with a beta coefficient of 0.094. Currently, commercial banks—particularly smaller institutions—face considerable difficulty in attracting high-quality candidates. Skilled and experienced personnel are in high demand across the banking sector, yet remain in short supply due to intense competition. This competition occurs not only between small and large banks but also between domestic and foreign financial institutions. In practice, state-owned and large commercial banks tend to have the upper hand in recruitment, owing to their stronger compensation capabilities. Additionally, many candidates perceive employment in larger banks as more favorable due to the professional and multicultural work environment. Foreign banks, in particular, are often seen as more attractive workplaces than their local counterparts. Moreover, the recruitment practices in some commercial banks lack adequate outreach and do not follow a structured process to ensure an effective intake of external talent. Recruitment is frequently based on referrals, personal networks, and family connections, and in many cases, the recruitment criteria remain superficial and misaligned with the actual job requirements. Furthermore, the recruitment strategies of certain banks have failed to meet their long-term human resource needs. In some instances, staff selection criteria do not reflect the regional context, or the specific demands of the roles being filled. Post-recruitment evaluations also often fall short of adhering to the competency frameworks defined for each position, contributing to a high—and rising—rate of employee turnover after each recruitment cycle.

5-1-7- The Working Environment has no Statistically Significant Impact on Human Resource Quality in the Context of Digital Transformation

The working environment received the lowest score among all the evaluated factors. Key elements that contribute significantly to human resource development include flexible working conditions, a comfortable physical environment, availability of extracurricular activities, fair distribution of workload, limited overtime requirements, and provision of designated areas for meals and rest during breaks. However, these aspects are often neglected in efforts to enhance employees' health, knowledge, and attitudes—attributes that are essential for successfully carrying out new tasks associated with digital transformation. Moreover, the working environment directly affects employees' ability to meet qualification standards and to complete tasks efficiently and on time in the digital era. Therefore, banks should focus on improving their working conditions so that this factor can positively contribute to human resource quality, as has been observed in other sectors such as tourism in Ho Chi Minh City [31], Vietnam National Assembly Television [32], and SeABank Vietnam [3].

5-1-8- Human Resource Quality in Digital Transformation

According to Table 7, the attitude and working style criterion has the highest average score (mean=4.21), followed by physical strength (mean=4.11), and the lowest is knowledge and skill (mean=4.03).

Knowledge and Skill

An analysis of the knowledge and skill variable reveals that specialized knowledge and the ability to apply knowledge in the workplace received the highest scores, accompanied by low standard deviations (mean = 4.19). However, knowledge related to digital transformation scored slightly lower, with a mean of 4.07. Through in-depth interviews with experts, the research team also identified that the number of training programs focused on digital transformation remains limited compared to other topics. Most digital transformation training is delivered through on-the-job instruction, mentoring, or the distribution of instructional materials when new technologies are introduced. As a result, employees often feel they lack a thorough understanding of changes related to specific areas, such as risk management and business strategy. Additionally, foreign language proficiency received the lowest average score among all the criteria, along with the highest standard deviation (mean = 3.91). Currently, foreign language skills are commonly required at the recruitment stage, but limited advanced training is provided thereafter. Consequently, only employees in positions that regularly involve foreign language use tend to maintain and improve these skills, while others do not. In the context of digital transformation, foreign language proficiency is an essential competency that enables employees to access and adapt to technology more efficiently. This remains a notable weakness that banks need to address.

Advanced skills and behavioral skills are considered strong assets of human resources in commercial banks, with mean scores of 4.00 and 4.01, respectively. The relatively young average age of commercial bank employees contributes to their ease of access to modern technologies. As a result, the criteria "Ability to use advanced modern equipment and software" and "Proficiency in utilizing facilities, technology, and equipment for digital transformation" both received high average scores (mean = 4.05 and 4.08).

In contrast, cognitive skills received the lowest average score (mean = 3.99). Within this category, critical thinking scored particularly low (mean = 3.95), which may be attributed to the nature of banking tasks that require employees to adhere strictly to standardized procedures to minimize operational risks. However, in the context of digital innovation, both critical and creative thinking are essential skills that must be strengthened to enable employees to adapt effectively to rapid and ongoing change. Digital transformation has intensified competition among commercial banks, introducing new and formidable competitors such as fintech firms and telecommunications companies. Financial products and services are becoming increasingly diverse, innovative, and dynamic. As a result, the traditional emphasis on specialization in bank organizational structures is being replaced by the need for a broader skill set and interdisciplinary knowledge. Cognitive skills—such as logical reasoning, creativity, and critical thinking—will be crucial, particularly in fostering the capacity for lifelong learning.

Mehta (2016) also highlighted the intense competition within the banking sector, emphasizing that only those banks capable of rapid adaptation will be able to withstand the pace of change. The swift evolution and complexity of new techniques and skills compel banks to reassess and adapt their operations. This demands capacity building across skills, knowledge domains, and communication strategies among bank personnel to ensure alignment with evolving market conditions.

Physical Health

The physical health indicators show positive outcomes and represent a strength of commercial banks in the context of digital transformation. Most employees perceive themselves as being in good health, capable of working overtime, and handling tasks that require agility and flexibility. However, the average score of 4.15 regarding chronic illnesses is a point of concern. To address this, commercial banks should focus on improving workplace conditions and promoting work-life balance to help reduce the prevalence of such health issues.

Mental and social well-being also reflect favorable results, with a mean score of 4.11. Bank employees generally report feeling confident, optimistic, and content, with a strong sense of integration within the workplace community. Nevertheless, the criterion "Ability to calmly handle difficulties in life and work" received the lowest rating within this category. This suggests that employees in commercial banks face considerable work-related stress. Therefore, banks should implement more targeted strategies to help staff better manage psychological pressure and enhance emotional resilience.

Attitude and Work Style

Attitude and working style received the highest average scores among all evaluated criteria groups (mean = 4.21). Employees demonstrated a strong sense of responsibility, professionalism, independence, creativity, innovation, motivation, job satisfaction, and adherence to discipline, laws, and organizational norms. These outcomes align closely with the training policies of commercial banks, which prioritize professional development, as well as with the organizational culture that emphasizes employee satisfaction and motivation. Consequently, attitude and working style emerged as the most highly rated dimensions. However, given the rapid advancements in science and technology, along with increasing economic and societal instability and unpredictability, the enhancement of cognitive skills has become an urgent priority for commercial banks moving forward.

5-2- Implications (Suggested Solutions) and Limitations

First, improve the working environment to enhance employees' physical well-being. In order to increase the positive impact of the work environment on human resource quality, commercial banks should: - Create flexible and comfortable working conditions in terms of time and space (e.g., enabling remote work); - Allocate workload and working hours appropriately; - Limit overtime requirements; - Enhance the quality of dining and rest facilities for employees.

Second, strengthen training initiatives to improve employees' intellectual capacity through the following measures: (1) Expand training programs focused on digital transformation and the implementation of digital banking models; (2) Enhance training that develops skills such as creative thinking, critical thinking, problem-solving, teamwork, conflict resolution, independent data-driven decision-making, digital technology operation, and adherence to procedures for delivering digital banking services; (3) Develop and implement training programs to improve ethical standards among banking staff, raise awareness of information security practices, promote a culture of learning and innovation, and encourage an agile, creative working environment. Additionally, accelerate the application of scientific research outcomes to enhance business efficiency; (4) Design training programs aimed at preparing finance and banking professionals for internationally recognized certifications.

Third, increase efficiency in workforce utilization and recruitment. A systematic approach to job analysis, workforce planning, recruitment, job placement, and training should be adopted to raise employee morale and productivity by: (1) Updating the job performance standards clearly and specifically to guide both employees and recruitment efforts in matching the right candidate to the right role; (2) Adopting the principle of "hiring the right person, not necessarily the best person"; (3) Ensuring the recruitment process is broadly communicated, transparent, and aligned with standard procedures to attract qualified external candidates.

Fourth, foster spiritual well-being to support the physical and mental health of employees. This can be achieved through: (1) Regularly organizing extracurricular activities and team-building events to strengthen cohesion among employees and between employees and management. These also improve teamwork and serve as motivational tools; (2) Enhancing workplace empathy through practices such as regular employee visits and establishing a culture of care and communication between leadership and staff. Leaders should model these values, and the HR department should actively listen to employee needs to develop policies that improve satisfaction; (3) Establishing extracurricular and professional clubs for employees to engage in both personal and professional development.

Fifth, enhance performance evaluation processes. To improve the effectiveness of employee performance assessments, commercial banks should: (1) Clarify and specify performance evaluation criteria to ensure they are measurable and well-understood; (2) Ensure that managers evaluate employee performance objectively; (3) Encourage employee development by conducting performance review meetings and providing constructive feedback, enabling employees to recognize their strengths and areas for improvement. Based on this feedback, targeted measures can be implemented to motivate staff and enhance their future job performance.

Finally, refine salary and welfare policies by: (1) Ensuring transparency and openness in the communication of salary, bonus, and benefits policies; (2) Establishing a diverse range of employee welfare programs and incentive systems.

A key limitation of this study is its exclusive focus on Vietnam's commercial banking sector in the context of digital transformation and human resource quality enhancement. While the examination of Vietnam offers meaningful insights into a specific national context, it limits the generalizability of the findings to the broader international banking landscape. Countries differ significantly in terms of regulatory environments, technological infrastructures, and cultural contexts, all of which can influence digital transformation strategies and outcomes. As such, the applicability of this study's conclusions to commercial banks in other countries may be constrained. Future research should consider incorporating more diverse samples across various geographic regions to provide a more comprehensive understanding of the complex challenges and strategies related to human resource development in the global context of digital banking transformation.

6- Conclusion

The Fourth Industrial Revolution has significantly influenced economic, political, and social domains, with the finance and banking sector standing out as one of the fields most recognized for its application of advanced technologies. This study reviewed previous research, developed a conceptual framework, and employed direct survey methods to collect both primary and secondary data to assess the current state of human resources in commercial banks amid digital transformation.

The findings reveal that the quality of human resources in commercial banks during the digital era, while meeting the basic job requirements, remains below the standard observed among managers in earlier periods. Among the evaluated dimensions, "attitude and working style" received the highest average score (mean = 4.21), followed by "physical health" (mean = 4.11), while "knowledge and skills" received the lowest score (mean = 4.03). Factors such as recruitment, employee placement, salary and benefits, performance appraisal, and training and development all have a statistically significant positive impact on human resource quality. In contrast, the "working environment" was found to have no significant effect.

Based on these findings, the research team proposes six sets of solutions aimed at improving human resource quality: enhancing the work environment to improve physical well-being; promoting training activities to strengthen intellectual capacity; improving the efficiency of recruitment and employee utilization; supporting employees' spiritual well-being to enhance both mental and physical strength; strengthening performance evaluation systems; and refining salary and benefits policies.

A key limitation of this study is its focus on a single national context—Vietnam—specifically within the commercial banking sector during the digital transformation. While the findings offer valuable insights, they may not be generalizable to other countries due to differences in regulatory systems, technological infrastructure, and cultural factors. Future research could expand the scope by including data from diverse regions, thereby offering a more comprehensive understanding of the challenges and strategies involved in developing human resources for digital banking transformation.

7- Declarations

7-1- Author Contributions

Conceptualization, T.H.L. and V.H.N.; methodology, T.H.L., V.H.N., and P.T.H.A.; validation, V.H.N.; investigation, V.H.N.; resources, V.H.N. and P.T.H.A.; writing—original draft preparation, T.H.L., V.H.N., and P.T.H.A.; writing—review and editing, T.H.L., V.H.N., and P.T.H.A. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7-3- Funding

7-4- Institutional Review Board Statement

Not applicable.

7-5- Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

7-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I: Measurement of Items

Respondents were asked to indicate the degree to which they agree or disagree with the following items related to the quality of human resources in the context of digital transformation. All the items were measured on a five- point scale ranging from 1, 'strongly disagree' to 5, 'strongly agree'.

No.		Code	Source
I	*The quality of human resources in the context of digital transformation*		
1	I am healthy enough to perform the new work required by the digital transformation.	CLS1	
2	I am knowledgeable enough to perform the new role arising from the digital transformation.	CLS2	
3	I am qualified for the new position created by the digital transformation	CLS3	Le & Nguyen (2022) [3]
4	I have a positive attitude when doing new jobs due to digital transformation	CLS4	
5	I complete the new work on time due to the digital transformation	CLS5	
6	I finish the task with the proper level of work that is new as a result of digital transformation.	CLS6	
II	*Training and development*		
1	Training needs are identified using a formal performance evaluation method	DT1	Nguyen (2017) [12]
2	Training and retraining programs are suitable to the needs of employees	DT2	
3	Professional training is organized every year	DT3	
4	Training and development are planed effectively	DT4	Amin et al. (2014) [38]
5	Training and retraining evaluations are conducted on a regular basis.	DT5	
6	The bank has digital transformation training programs suitable to the job requirements of employees	DT6	Suggestion by the author group
7	The bank has training programs for digital transformation in a timely manner, in line with job requirements	DT7	Suggestion by the author group
III	*Employee placement*		
1	Labor allocation is based on professional qualifications	SD1	
2	Workforce distribution is based on capability.	SD2	Pham (2018) [33]
3	The human resource structures in departments are appropriate	SD3	
4	There is a job description for each working position	SD4	Tessema & Soeters (2006) [41]
5	A grading system for assessing labor quality is present	SD5	Pham (2018) [33]
6	Talents are appropriately utilized	SD6	
7	Jobs are designed to suit each employee's personality and preferences.	SD7	Suggestion by the author group
IV	*Salary and benefits*		
1	Compensation reflects employee performance at work.	TL1	
2	Employees pay, including salaries and bonuses, are in accordance with the company's financial results.	TL2	Tessema & Soeters (2006) [41]
3	The salary and bonus system encourages better performance	TL3	
4	Company offers an appealing and diversified compensation structure	TL4	
5	The salary and bonus policy are clear, public and transparent for employees	TL5	Suggestion of the author group
V	*Work environment*		
1	The work environment is flexible in terms of time and workplace	MT1	Nguyen & Le (2020) [31]
2	The bank regularly organizes extracurricular activities and clubs for employees	MT2	
3	The workload and working time are divided properly	MT3	Nguyen & Nguyen (2020) [32]
4	The requirement for working overtime is limited	MT4	
5	The banks offer a place for staffs to eat and sleep during the lunch breaks	MT5	Le & Nguyen (2022) [3]
VI	*Performance appraisal*		
1	All jobs are updated in the job description	DG1	
2	All jobs are defined with clear scope and responsibilities	DG2	
3	Staffs' responsibilities are equivalent with authority	DG3	Nguyen & Nguyen (2020) [32]
4	The performance assesment criteria are measurable	DG4	
5	Supervisors regularly monitor and check the targets assigned to employees	DG5	
6	The supervisors objectively evaluate the employee performance	DG6	
7	Employees are satisfied with performance appraisal results	DG7	Le & Nguyen (2022) [3]
8	Employees are motived by their performance appraisal results	DG8	

VII		**Recruitment**		
1	The recruitment system is effective		TD1	
2	Selection criteria are clearly and objectively defined		TD2	Nguyen (2015) [30]
3	The selected candidate has suitable capabilities and personal traits		TD3	
4	The recruitment process is public and transparent		TD4	Pham (2018) [33]
5	The bank has a strategy to attract talents		TD5	
VIII		**Welfare**		
1	Caring and support are provided to employees who face difficulties		CS1	
2	Health care and a safe working environment is provided		CS2	
3	Employee welfare policies are provided in a timely manner		CS3	Pham (2018) [33]
4	The rewards and discipline policies are well implemented		CS4	
5	Employees' spiritual health is taken care of		CS5	
IX		**Physical health**		
1	The level of responsibility for tasks that require agility and flexibility		TC1	
2	Ability to work overtime based on health		TC2	Nguyen (2017) [12]
3	Health condition		TC3	
4	Chronic diseases		TC4	
X		**Mental and social health**		
1	Confidence		TT1	
2	Calmly handling difficulties in life and work		TT2	Nguyen et al. (2019) [8]
3	Optimistic, happy		TT3	
4	Level of integration into the working community		TT4	
XI		**Knowledge**		
1	Specialized knowledge		KT1	
2	Work experience		KT2	Nguyen et al. (2019) [8]
3	Ability to apply knowledge at work		KT3	
4	Knowledge of digital transformation		KT4	Authors suggested
5	Knowledge of foreign languages		KT5	Nguyen et al. (2019) [8]
XII		**Advanced skill**		
1	Dexterity at work		CM1	Nguyen et al. (2019) [8]
2	Do the job with high efficiency		CM2	Nguyen & Nguyen (2020) [32]
3	Know how to use advanced modern equipment and software		CM3	Ala-Mutka (2011) [26]; Spires et al. (2018) [27] ; Riina, et al. 2022 [28]
4	Know how to use facilities, technology and equipment for digital transformation		CM4	
XIII		**Cognitive skills**		
1	Logical thinking		NT1	
2	Creative thinking		NT2	Nguyen et al. (2019) [8]
3	Critical thinking		NT3	
XIV		**Behavioral skills**		
1	Communication skills		HV1	Salman et al. (2020) [43]
2	Teamwork skill		HV2	Nguyen et al. (2019) [8]
3	Time management skills		HV3	
4	Resolving conflicts skill		HV4	Nguyen et al. (2019) [8]
5	Ability to work independently		HV5	Nguyen et al. (2019) [8]
XV		**Attitude and work style**		
1	Maintain discipline and follow the laws and norms.			
2	Have a sense of responsibility at work		PC1	Nguyen (2017) [12]
3	Work spirit		PC2	
4	Independence and responsibility.		PC3	Nguyen et al. (2019) [8]