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Navigating the New Digital Landscape: The Role of ICT Accessibility and Competency in Enhancing Educational Quality in Cambodian Public Higher Education

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ABSTRACT

Cambodia's expanding digital economy has positioned the modernization of higher education as a pivotal force in national development. Within this transformation, Information and Communication Technology (ICT) is indispensable; however, prior research has largely centered on access issues, often termed the "first-level digital divide." Addressing this gap, the present study offers empirical evidence from Cambodian public universities by examining and comparing the roles of ICT accessibility and ICT competency in shaping students' perceptions of educational quality. The primary objective was to determine both their individual and relative contributions.

Employing a quantitative methodology, data were obtained through surveys administered to 306 students from five public universities. Data analysis using SmartPLS 3.0 and Partial Least Squares Structural Equation Modeling (PLS-SEM) involved validation of the measurement model and hypothesis testing. Results confirm that ICT accessibility ($\beta = 0.255$, $p < 0.001$) and ICT competency ($\beta = 0.309$, $p < 0.001$) exert significant positive effects on perceived educational quality, with competency showing a stronger influence. This finding highlights the "second-level digital divide," where disparities in skills outweigh those of access. The structural model demonstrated an explanatory power of 15.3% for the variance in educational quality.

The study contributes theoretically by substantiating the second-level digital divide and practically by providing evidence-based guidance for higher education development in Cambodia. Specifically, it underscores the necessity of a dual-focus strategy: continued investment in digital infrastructure alongside systematic initiatives to strengthen digital competencies. Such an integrated approach is vital to advancing educational quality and, ultimately, supporting Cambodia's broader socio-economic development agenda.

Keywords: ICT Accessibility, ICT Competency, Quality Education, Digital Divide, Cambodian Higher Education,

INTRODUCTION

Cambodia's higher education sector stands at a pivotal moment in its development. As the country continues to experience rapid economic growth and social transformation, public universities are under increasing pressure to produce graduates who can thrive in a competitive, technology-driven regional and global economy. The Royal Government of Cambodia and the Ministry of Education, Youth and Sport (MoEYS) have explicitly highlighted the importance of digital skills and infrastructure in national strategic documents such as the " Cambodia Digital Economy and Society Policy Framework 2021-2035" and the "Education Strategic Plan 2024-2028"(MoEYS, 2024). These policies recognize that Information and Communication Technology (ICT) is no longer a luxury but a fundamental pillar for educational modernization, research innovation, and administrative efficiency.

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However, the integration of ICT into Cambodia's public higher education system is a complex challenge characterized by a significant and multifaceted digital divide. This divide is not merely about the availability of computers or internet connectivity—though these remain considerable hurdles—but extends to a deeper chasm in the ability to effectively harness technology for teaching, learning, and research. While some urban institutions may have relatively better infrastructure, the system as a whole grapples with inconsistent ICT accessibility, encompassing unreliable internet bandwidth, a shortage of modern computing facilities, limited access to digital academic journals and software, and a lack of assistive technologies for students with disabilities. This uneven access creates a stark disparity between urban and rural institutions and threatens to exacerbate existing educational inequalities.

Furthermore, even where infrastructure exists, its potential impact on the quality of education is often unrealized due to a second critical gap: ICT competency. This challenge manifests at multiple levels. Many academic staff, experts in their fields, have not been sufficiently trained in digital pedagogy—the art of using technology to create engaging, interactive, and effective learning experiences. Similarly, students often enter university with varying levels of digital literacy, frequently limited to basic social media use rather than the critical information literacy, online collaboration, and technical skills required for academic success and future employment. Administrative staff may also lack the skills to implement digital management systems that streamline university operations.

This research posits that ICT accessibility (the opportunity) and ICT competency (the skill) are not independent factors but are deeply interconnected and mutually reinforcing. The provision of advanced technology without comprehensive training leads to underutilized and wasted resources. Conversely, training initiatives are futile without the reliable technological foundation upon which to build skills. It is the combined effect of these two variables that is hypothesized to be a crucial driver in enhancing the overall quality of Cambodian public higher education.

Therefore, this study seeks to investigate the following question: To what extent does the interaction between ICT accessibility and ICT competency predict perceived and actual quality of education in Cambodian public universities?

By examining this relationship, this research aims to provide university leaders, policymakers, and international development partners with an evidence-based model for strategic investment. The ultimate goal is to offer clear insights into how Cambodia can build a more robust, equitable, and high-quality higher education system that effectively prepares its graduates to become innovators and leaders in the ASEAN digital economy.

LITERATURE REVIEW

The integration of Information and Communication Technology (ICT) into education has been a subject of extensive global research, recognized as a transformative force with the potential to significantly enhance the quality of teaching and learning. This review synthesizes literature exploring the triad of ICT accessibility (the provision of infrastructure and tools), ICT competency (the skills to use them effectively), and their collective impact on educational quality. The consensus across studies is that while accessibility is a fundamental prerequisite, it is the development of human competency that unlocks technology's true potential to improve educational outcomes(Bong & Chen, 2024).

Access to technology is the non-negotiable first step in the integration process. Bindu CN (2016), in a broad literature review, establishes that ICT provides powerful tools for transforming education from a traditional, teacher-centric model to a dynamic, learner-centric one. This transformation is contingent on the availability of resources like computers, reliable internet, and digital learning materials. The literature positions accessibility as the gateway that enables innovative pedagogical methods, including interactive simulations, virtual laboratories, and access to a global repository of information, thereby expanding the boundaries of the classroom (Bindu CN, 2016; Saravanakumar, 2018).

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However, a critical theme emerging from the research is that mere availability does not guarantee effectiveness. Tokareva et al., (2021) identify infrastructure and readiness as key predictors for the successful implementation of ICT in higher education, highlighting that a lack of access remains a primary barrier in many contexts, effectively creating a digital divide between institutions.

The literature overwhelmingly identifies ICT competency—encompassing digital, technological, and internet literacy—as the critical catalyst that transforms access into quality. Several studies break down this competency across different educational actors:

Student Competency: Yeşilyurt & Vezne, (2023) demonstrate that students' digital, technological, and internet literacies are significant positive predictors of their attitude toward computer-supported education. Favorable attitudes are directly linked to higher engagement and, consequently, better learning outcomes.

Lecturer Competency: The role of educator proficiency is perhaps the most emphasized. Dang et al., (2024) provide empirical evidence from higher education, finding that the digital competence of lecturers has a direct and positive impact on perceived student learning value. Competent lecturers can design more engaging, interactive, and effective learning experiences, thereby directly elevating educational quality. Similarly, Gorghiu et al., (2018) argue that enriching the ICT competences of university students, particularly those training to be teachers, is a "key factor for their success." This underscores the importance of embedding these skills in professional development to create a multiplier effect in the education system.

Administrative Competency: D Amutha, (2020) expands the scope, noting that ICT competency also improves the quality of education through efficient administrative management, enabling better data handling, communication, and institutional planning.

The combined effect of access and competency manifests in multiple dimensions of educational quality, as outlined in the literature:

Enhanced Teaching and Learning Processes: ICT facilitates more interactive, collaborative, and personalized learning environments (Bindu CN, 2016; Saravanakumar, 2018). D Amutha, (2020) concludes that ICT acts as a "powerful catalyst for change," making education more accessible, engaging, and effective.

Development of 21st-Century Skills: Beyond academic knowledge, the effective use of ICT fosters critical thinking, creativity, collaboration, and information literacy—skills essential for success in the modern world (Gorghiu et al., 2018; Yeşilyurt & Vezne, 2023).

Increased Equity and Inclusion: When implemented correctly, ICT can help bridge educational gaps by providing diverse learners with tools and resources tailored to their individual needs (Amutha, 2020).

The synthesized literature presents a clear narrative: ICT accessibility and ICT competency are interdependent variables that collectively determine the quality of education. Infrastructure provides the opportunity, but human capital determines the outcome. A deficiency in either component leads to suboptimal results; technology without skill is wasted, and skill without technology is frustrated(Zou et al., 2024).

While the existing research robustly establishes this relationship in general terms, a clear gap exists for context-specific studies, particularly in developing economies like Cambodia. Research focused on the Cambodian public higher education sector is needed to understand the unique challenges and predictors of success within its specific infrastructural, cultural, and economic landscape. Future studies should quantitatively measure the interaction between these variables to provide policymakers with a definitive model for strategic investment in both technology and human capacity building

Hypotheses and Theoretical Framework

H1: Has a positive effect relationship between ICT accessibility and the perceived quality of education in Cambodian public universities.

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H2: Has a positive effect relationship between ICT competency and the perceived quality of education in Cambodian public universities.

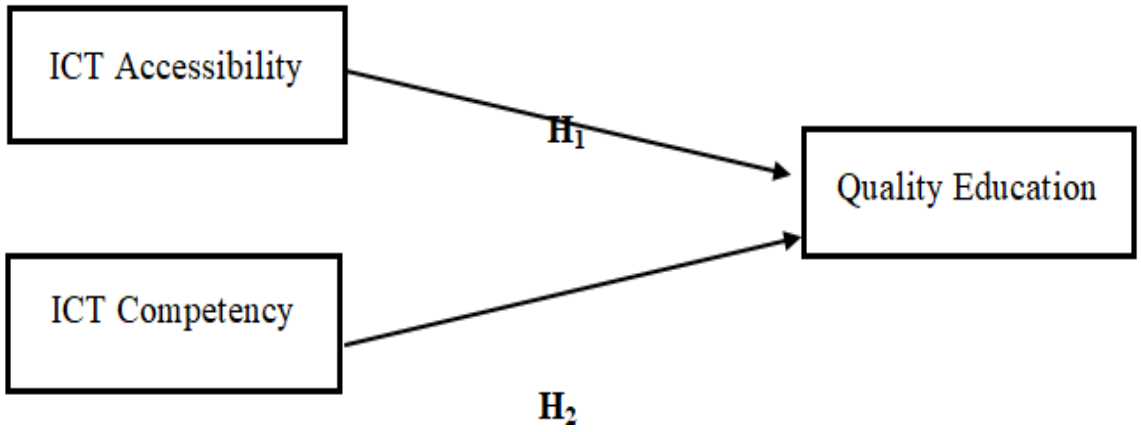

Figure 1: Theoretical Framework

METHODOLOGY

The research design can be defined as the framework that is appropriate for any given research, depending on its nature or the challenges it addresses. Quantitative research is a scientific strategy that involves experiments or systematic approaches to identify control samples and evaluate individual activities (Hoy & Adams, 2015). Additionally, , Lawrence Neuman, (2014) defines a population as a broad group of individuals or cases from which a sample is selected for the purpose of generalizing. In line with this, the current study focuses on students from specific public universities in Cambodia. These public universities were chosen for this study for several key reasons. Furthermore, as highlighted by Additionally, Krejcie & DW Morgan, (1970) stated that the growing demand for research has driven efforts to develop a realistic approach for calculating the sample size required to accurately reflect the population under study.

Meanwhile, the questionnaire was meticulously developed using validated items corresponding to the study's key constructs. A pilot study was carried out to evaluate the instrument's internal consistency and reliability. The results revealed that Cronbach's alpha coefficients for the majority of the constructs ranged from 0.725 to 0.886, thereby exceeding the commonly accepted threshold of 0.70 (JC Nunnally, 1978). Following the pilot validation, hard copies of the finalized questionnaires were distributed to students at selected 5 public universities in Cambodia to ensure efficient and effective data collection. In total, 346 hard-copy questionnaires were distributed to students across selected public higher education institutions in Cambodia. This effort yielded 312 returned surveys, representing a response rate of approximately 90.1%. Upon screening the responses, 40 questionnaires were excluded due to substantial incomplete data. Consequently, 306 fully completed and valid questionnaires were retained for subsequent analysis. Thus, the overall response rate was 88.4%, which is considered acceptable for quantitative analysis.

The primary constructs in the study were assessed using a five-point Likert scale, with response options ranging from 1 (strongly disagree) to 5 (strongly agree) (R Likert, 1932). The questionnaire was divided into four sections. Items addressing Digital literacy were designed to reflect the technological context, drawing on established frameworks. ICT competency measures were adapted from previously validated scales, while quality education was assessed using multiple dimensions based on prior educational research.

SmartPLS software was utilized in the present study to evaluate the proposed research framework, as it is a widely adopted tool for quantitative data analysis. Specifically, SmartPLS facilitated the assessment of the structural model, enabling the examination of the model's predictive capacity and the relationships among the constructs (Hair et al., 2017). In this study, SmartPLS 3.0 was employed to estimate both the measurement model (external model), which involved evaluating constructs' consistency and strength, and the structural model (internal model), which assessed the hypothesized relationships between latent variables.

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Table 1: The demographic characteristics of the respondents

Factors	***Classification***	***Repetition***	***Proportion***
Gender	Male	201	65.7
	Female	105	34.3
Age	Below 20yrs	65	21.2
	21-23yrs	194	63.4
	24-26yrs	42	13.7
	Above 26yrs	5	1.6
Institutions	Institute of Technology Cambodia	106	34.6
	Royal University of Phnom Penh	50	16.3
	Royal University of Agriculture	91	29.7
	National University of Battam Bang	44	14.4
	University of Heng Samrin Thboung Khmum	15	4.9
N		***306***	

RESULT

Measurement Model Evaluation

Table 2, the reliability, and validity of the constructs were confirmed using Cronbach's alpha, composite reliability (CR), AVE, and discriminant validity, following (Hair et al., 2017). All constructs demonstrated strong internal consistency (α and CR > 0.962) and convergent validity (AVE > 0.639). Items with loadings between 0.70 and 0.90 were kept in the model.

Table 2**:** Construct Reliability and Validity

Construct	***Items***	***Loadings***	***Cronbach Alpha***	***Composite Reliability***	***Average Variance Extracted***
ICT Accessibility	ITA1	0.827	0.919	0.934	0.639
	ITA2	0.797			
	ITA3	0.799			
	ITA4	0.825			
	ITA5	0.886			
	ITA6	0.771			
	ITA7	0.756			

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	ITA8	0.725			
ICT Competency	ITC1	0.870	0.930	0.943	0.704
	ITC2	0.840			
	ITC3	0.878			
	ITC4	0.846			
	ITC5	0.784			
	ITC6	0.832			
	ITC7	0.820			
Quality Education	QE1	0.836	0.956	0.962	0.716
	QE10	0.823			
	QE2	0.862			
	QE3	0.883			
	QE4	0.871			
	QE5	0.850			
	QE6	0.866			
	QE7	0.789			
	QE8	0.865			
	QE9	0.812			

Table 3 confirms the constructs are distinct. Following the Fornell & Larcker, (1981), the square root of each construct's AVE (ICT Accessibility: 0.799, ICT Competency: 0.839, Quality Education: 0.846) was higher than its correlations with other constructs. This establishes discriminant validity and confirms the strength of the measurement model.

Table 3**:** Latent Variable Correlations (Fornel-Larcker Criterion)

Constructs	***ITA***	***ITC***	***QE***
ICT Accessibility	0.799		
ICT Competency	-0.004	0.839	
Quality Education	0.246	0.303	0.846

Table 4, discriminant validity was further supported using the Heterotrait-Monotrait Ratio (HTMT), with all values below the 0.90 threshold (Henseler et al., 2016). Specifically, the values for ITA–ITC (0.068), ITA–QE (0.259), and ITC–QE (0.303) demonstrate a clear separation between the constructs, thereby confirming robust discriminant validity within the measurement model.

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Table 4: Discriminant Validity (Heterotrait-Monotrait Ratio - HTMT)

Constructs	***ITA***	***ITC***	***QE***
ICT Accessibility			
ICT Competency	0.068		
Quality Education	0.259	0.303	

Structural Model Evaluation

After confirming the validity of the measurement model, the R^2 values were examined to determine how well the exogenous variables explain the endogenous constructs. Higher R^2 values reflect greater explanatory power. As outlined by Chin, (1998), R^2 values greater than 0.67 signify strong explanatory power, values ranging from 0.33 to 0.67 indicate a moderate level, values between 0.19 and 0.33 are viewed as weak, and those below 0.19 are considered inadequate. As presented in Table 5, an R^2 of 0.153 indicates that 15.3% of the variability in Quality Education can be explained by the predictors included in the regression model. This suggests a weak effect size, depending on the context and field (e.g., in social sciences, this might be considered acceptable; in physics or engineering, it would be low). The minimal decrease from R^2 to adjusted R^2 indicates that the model's predictors possess genuine explanatory value without overfitting. Nonetheless, the low magnitude of the adjusted R^2 (0.148) signifies that the model explains only a modest portion of the variance, implying that significant unexplained factors influencing Quality Education remain absent from the model.

Table 5: Coefficient of Determination (R Square)

Constructs	**R-square**	**R-square adjusted**
Quality Education	0.153	0.148

Additionally Cohen, (1988), f^2 effect sizes were assessed to determine the extent to which each exogenous variable influences the R^2 values of the endogenous constructs Cohen, (1988). As a standard benchmark, effect sizes (f^2) are typically categorized as small (0.02), medium (0.15), or large (0.35). Table 6 reveals that ICT Accessibility has a small effect size of 0.072 on quality education, indicating a meaningful and statistically relevant influence. This suggests that as ICT Accessibility among students or educators increases, the perceived or actual quality of education improves in a measurable way. Such a finding highlights the importance of digital competence not just as a technical skill, but as a foundational component of modern educational environments that enhances teaching and learning. In contrast, ICT competency shows a smaller effect size of 0.109, reflecting a comparatively limited influence on quality education. While still statistically relevant, its weaker effect implies that technical proficiency with ICT tools alone may not strongly drive educational quality unless integrated meaningfully into pedagogical practice. These results suggest that while both digital literacy and ICT competency are important, emphasis should be placed more heavily on developing digital literacy in order to achieve greater educational impact.

Table 6: Effect Sizes (f^2) Analysis

Quality Education	***Effect Size***	***Decisions***
ICT Accessibility	0.072	Small
ICT Competency	0.109	Small

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Furthermore, Q^2 values were derived using the blindfolding procedure to evaluate the model's predictive relevance; values greater than zero suggest that the model has sufficient predictive accuracy (Henseler & Sarstedt, 2013).. The construct Quality Education shows an SSE (sum of squared errors) of 3060.000 and an SSO (sum of squares total) of 2445.800, yielding a 1–SSE/SSO value of 0.103. This value represents the explained variance in Quality Education by the model, equivalent to an R^2 of 0.103, or 10.3% in Table 7.

Table 7: Construct Cross Validated Redundancy (Q2)

Constructs	***SSE***	***SSO***	***1-SSE/SSO***
Quality Education	3060.000	2745.800	0.103

Note: *SSO - Systematic Sources of Output; SSE - Systematic Sources of Error*

Therefore, the SRMR values for both the saturated and estimated models are 0.065, which falls below the recommended threshold of 0.10. This indicates that the model applied in this study demonstrates a good fit (Henseler & Sarstedt, 2013; Hu et al., 1999). A summary of the structural model indicators is presented in Table 8.

Table 8: Goodness of Fit of The Model

Item	***Saturated Model***	***Estimated Model***
SRMR	0.065	0.065
d_ULS	1.371	1.371
d_G	0.896	0.896
Chi-Square	1488.499	1488.499
NFI	0.788	0.788

Hypothesis Testing

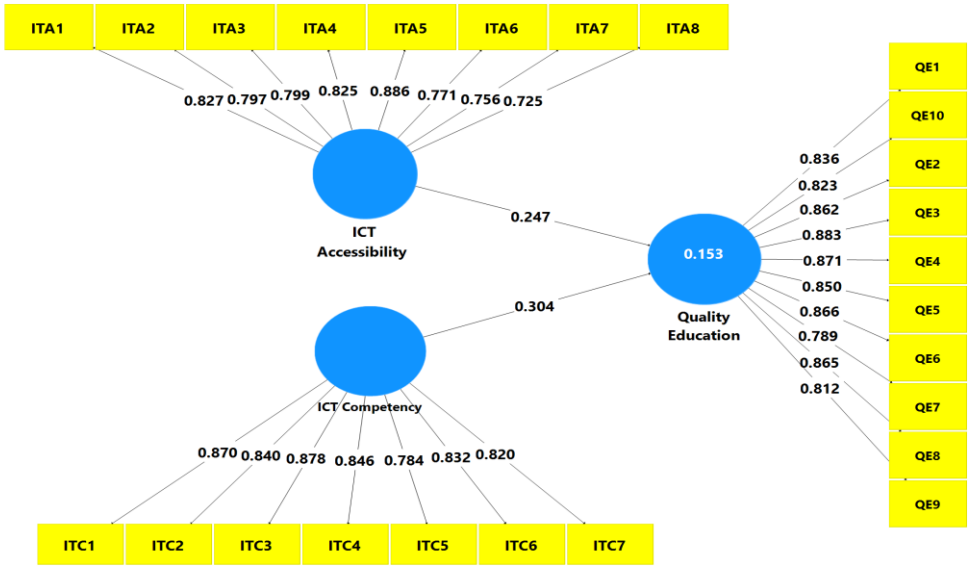

Figure 2: Path Model Significant

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Table 9 shows, the results indicate that ICT accessibility has a significant and positive effect on the perceived quality of education ($\beta = 0.255$, $p < 0.001$), demonstrating that the availability of digital infrastructure is a foundational determinant of educational quality. This finding is consistent with previous studies that emphasize the critical role of access to ICT resources—such as computers, stable internet, software, and digital learning materials—in facilitating effective teaching and learning (Bindu CN, 2016; D Amutha, 2020; Yeşilyurt & Vezne, 2023). The path coefficient suggests that improvements in students' perceived access to ICT resources are associated with meaningful increases in their evaluation of educational quality, highlighting the importance of first-level digital inclusion. Without adequate access, efforts to integrate technology into learning environments are severely constrained, as infrastructure forms the baseline upon which effective ICT utilization depends. Practically, these findings underscore the need for higher education institutions and policymakers in Cambodia to ensure equitable and reliable access to ICT resources, providing the essential conditions for both teaching innovation and student engagement. Moreover, by addressing accessibility gaps, universities can lay the groundwork for further initiatives aimed at enhancing digital competencies and maximizing the impact of ICT on learning outcomes..

The analysis demonstrates that ICT competency exerts a significant and positive influence on the perceived quality of education ($\beta = 0.309$, $p < 0.001$), indicating that students' ability to effectively use digital tools is a critical determinant of educational outcomes. This finding aligns with prior research emphasizing that while access to technology is essential, the skills and competencies to leverage ICT are even more influential in enhancing learning experiences (D Amutha, 2020; Saravanakumar, 2018; Tokareva et al., 2021). The relatively higher path coefficient compared to ICT accessibility suggests that the "second-level digital divide"—differences in digital skills—has a stronger impact on educational quality than access alone. Practically, this underscores the necessity for higher education institutions to implement structured digital literacy programs, training initiatives, and pedagogical strategies that build both technical and cognitive ICT competencies among students. By prioritizing skill development alongside infrastructure investment, universities can ensure that technology is not only available but also meaningfully utilized to improve learning outcomes and overall educational quality. These findings contribute to the theoretical understanding of the second-level digital divide, highlighting that competency-driven interventions are crucial for realizing the transformative potential of ICT in higher education.

Table 9: Direct Effect Hypotheses Testing

Hypothesis	***Coef.***	***Se***	***T value***	***P values***	***Decision***
ICT Accessibility -> Quality Education	0.255	0.053	4.670	0.000	*Supported*
ICT Competency -> Quality Education	0.309	0.047	6.461	0.000	*Supported*

Note: Coef. = Coefficient; se = standard error.

CONCLUSION

This study examined the relationship between ICT accessibility, ICT competency, and the perceived quality of education in Cambodian public universities. The findings confirm that both factors significantly and positively influence educational quality, highlighting the need for simultaneous investment in infrastructure (internet, hardware, software) and human capacity (digital literacy training for students and pedagogical development for lecturers). Importantly, ICT competency ($\beta = 0.309$) was found to have a stronger effect than ICT accessibility ($\beta = 0.255$), underscoring that skills, rather than access alone, are the greater determinant of educational quality.

Although the model's explanatory power ($R^2 = 0.153$) may appear modest, it is meaningful in the complex context of educational research, where numerous variables shape quality outcomes. The result demonstrates that ICT factors alone explain a notable share of the variance, reinforcing their role as a critical lever for

improving higher education. The study's validity is further strengthened by rigorous measurement, which confirmed the reliability and distinctiveness of the constructs used.

To translate these findings into practice, a coordinated multi-stakeholder strategy is essential. Universities should embed digital literacy into curricula and support faculty in developing Technological Pedagogical Content Knowledge (TPACK), while national policymakers must align infrastructure investment with capacity-building programs under frameworks such as the Cambodia Digital Economy and Society Policy. Future research should explore additional drivers of educational quality and identify the most effective training and access models to maximize the impact of ICT on higher education outcomes.

This study is limited by its focus on a few Cambodian universities, which may reduce generalizability. The cross-sectional design also restricts causal inferences. Future research should use longitudinal designs, include more diverse samples, and investigate additional factors like institutional support or teaching methods to better understand how ICT accessibility and ICT competency affect education quality.

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