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TECHNOLOGY INTEGRATION OF CAMBODIAN HIGHER EDUCATION: EMERGING CHANGES SINCE COVID-19 AND NOTABLE CHALLENGES

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ABSTRACT

The second decade of the 21st century marks the time the Royal Government of Cambodia (RGC) officially directs the nation's public sector, economy, and society to accelerate technology adoption and digital transformation. This present study aims to observe developments of such direction in Cambodian higher education (HE) sub-sector before and in response to Covid-19 by (1) examining policies and interventions on technology integration of HE system and institutions and (2) analysing perceptions and behaviours of Cambodian faculty members towards technology integration in their instruction. At the system level, the study found that Covid-19 has driven active ICT-related responses of the whole education sector and pushed the Cambodian HE sub-sector to revisit some of its strategies and targets set in the ICT-in-Education policies and plans prior to Covid-19. For HE, emerging areas of concern are how to further innovate HEMIS to support ministerial and institutional monitoring of HEI performance and how to achieve the pre-Covid-19 target of the Cambodian Open and Distance Learning (ODL) platform for it can help Cambodia address the issue of low HE enrolment and limited quantity and quality of online education. Covid-19 also provides a context to accelerate ICT integration at Cambodian HEIs. At the institutional level, online teaching and learning become one of the most engaged aspects of ICT integration to respond to the crisis. Some Cambodian HEIs take the opportunity to advance their mobile-technology-based administrative practices (e.g., creating or using mobile apps for enrolment, payment, and communication). However, institutional-level data still showed some challenges of ICT integration, particularly the clear lack of full-fledged online education programs and platforms at most HEIs and the on-going pedagogical challenges in efficiently and effectively integrating technologies. In further analyses at the level of individual faculty members, the data indicated positive perceptions towards technology readiness in overall. Comparative analyses of the data collected in the early outbreak (2020) and that in the later phase (2022) of Covid-19 also showed a slight increase in Cambodian faculty members' perceived innovativeness towards technology and a decrease in their perceived insecurity towards technology. Yet, the different sub-constructs of technology readiness (i.e., optimism, innovativeness, insecurity, and discomfort) may vary in magnitude by age (younger vs elder), teaching subject (IT-specialized vs non-IT-specialized), HEI orientation (public vs private), and/or

HEI type (university-type HEIs vs post-secondary TVETIs) of the faculty members. Correlational analyses of our data detected further that individual agency-driven capabilities and institutional supports influence the faculty members' technology application behaviour during Covid-19. That said, perceived ICT competence, ICT-supported teaching experience, perceived institutional support in terms of policy and leadership, and perceived institutional support in terms of infrastructure and finance statistically significantly influence technology application behaviour during the emergency. Overall, Covid-19 is a wake-up call for the system governing bodies, institutional leaders, and faculty members of Cambodian HE sub-sector to take uncertainties more seriously, and so these key actors have to plan and implement technology integration with a more transformative and consolidative approach within and across different HE levels (from system policies to instructional practices).

TABLE OF CONTENT

Abstract 1
Table of Content 3
1. Introduction 5
1.1. Research background and problems 5
1.2. Research questions and objectives 6
1.3. Key concepts and conceptual framework 7
2. Research Methodology 10
2.1. Research approach 10
2.2. Qualitative data and analyses 10
2.3. Quantitative data and analyses 11
3. Findings 12
3.1. Finding I: Policies and interventions of technology integration 12
3.1.1. HE system 12
3.1.1.1. Situation before the Covid-19 outbreak 12
3.1.1.2. Changes since the Covid-19 outbreak 14
3.1.1.3. Remaining challenges at the system level 15
3.1.2. HE institutions 17
3.1.2.1. Situation before the Covid-19 outbreak 17
3.1.2.2. Changes since the Covid-19 outbreak 19
3.1.2.3. Remaining challenges at the institutional level 22
3.2. Finding II: Faculty members' perceptions and behaviours towards technology integration 26
3.2.1. Magnitudes, changes, and variations since Covid-19 26
3.2.1.1. Perceived technology readiness 26
3.2.1.2. Perceived technology impacts 27
3.2.1.3. Technology application behaviour during Covid-19 28
3.2.1.4. Perceived future technology integration 30
3.2.2. Correlates of technology application behaviour during Covid-19 and perceived future technology integration 31
4. Discussions 34
5. Conclusions and Policy Recommendations 39
Acknowledgements 41
References 42
Appendices 47
Appendix 1: Appendices related to Cambodian higher education system and institutions 47

Appendix 2: Appendices related to research methodologies 49
Appendix 3: Appendices related to findings from quantitative data analyses 60

1.Introduction

1.1.Research background and problems

Global context: Covid-19 pandemic – along with economic downturn, climate change, energy scarcity, and geo-political wars – has more or less associated emerging national and international development discourses to the notion "crises". Negative impacts caused by the pandemic on different development sectors of a nation are not trivial. They create a sense of urgency for those sectors to adopt and integrate technologies and to do so in an inclusive, ethical, and sustainable way.

In the education sector, while such crises cause tremendous disruption to the global promise to achieve Sustainable Development Goals of education (SDG 4), they also present an opportunity to rethink how we can adapt our education systems at different levels to future challenges (Green et al., 2021). Such rethinking generally points to the need to embrace technologies (and especially improve connectivity), which is no longer an optional choice but a necessary requirement for the 21st-century schools and education sector (Broadband Commission for Sustainable Development, 2020). The question on technologies in the education sector both in the pandemic and post-pandemic context is not whether or why we should integrate them but how we can integrate them efficiently and effectively.

Technology and connectivity are especially important for higher education (HE) sub-sector. Attempts to achieve the SDG 4 targets related to HE (such as Target 4.3, Target 4.4, and somehow Target 4.b and 4.c) by 2030 (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2019) in the face of Covid-19 and other concurrent global crises require that national HE system governing bodies and higher education institutions (HEIs) as well as faculty members and students build collective capabilities to adopt and integrate appropriate technologies that fit into their own context of development. That in turn will make the whole HE sub-sector of a country technologically ready and adaptable to crises and so able to continue performing their knowledge-driven roles to contribute to building a more resilient and sustainable future for our planet.

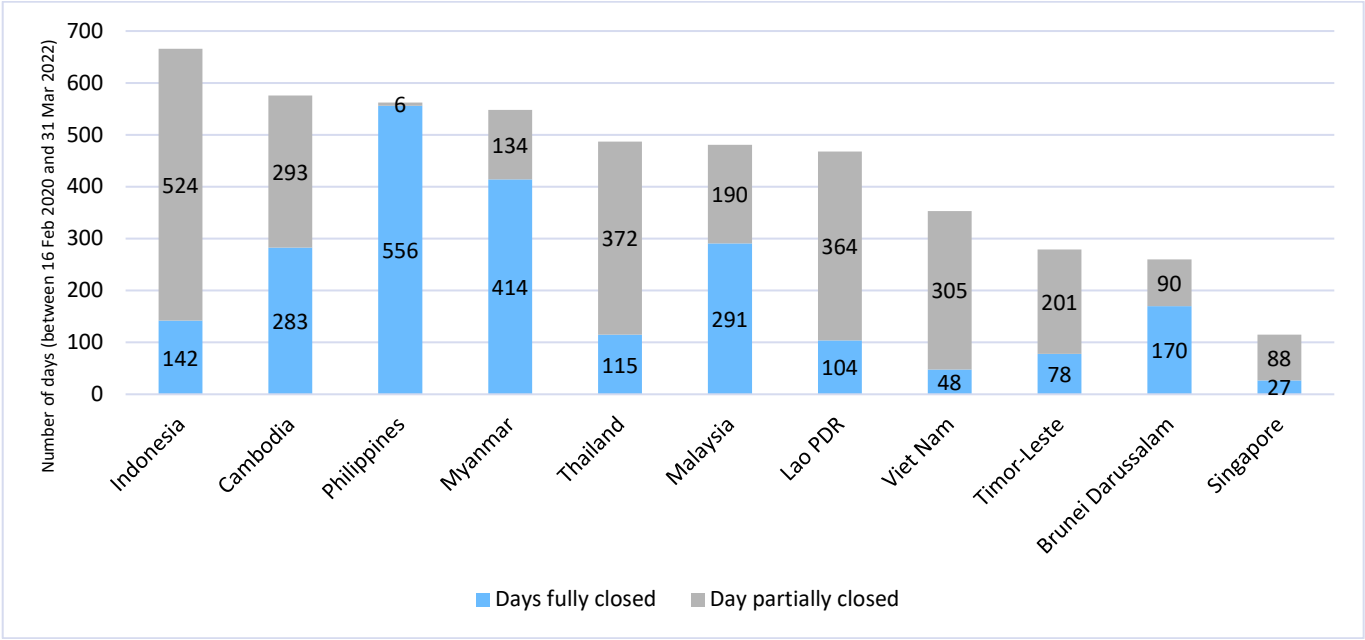
Cambodian context: In Cambodia, technology is one of the three major discourses that intersect the development mechanism of its education sector in this third decade of the 21st century. The three discourses include (1) the national strategy of the Royal Government of Cambodia (RGC) on technology-supported approach to sectoral and societal developments (particularly, on digital transformation), (2) a vision to transform the 21st-century Cambodian education sector on the path of sustainable development and towards knowledge society, and (3) the disruption caused by the Covid-19.

The impact of Covid-19 on Cambodian education is quite significant. According to the data from UNESCO's map on school closure, between 16 February 2020 and 31 March 2022, Cambodia closed her schools for 576 days (both fully and partially), which is longer than the period of school closure in most ASEAN

countries, except Indonesia (666 days) (see Figure 1). Though Cambodia suffers far less in terms of life loss due to Covid-19, long-term school and HEI closure still imply learning loss of students and perhaps earning loss of faculty members and lower functionality and survivability of those institutions.

These trends bring some technology-related questions to the Cambodian HE sub-sector at different levels. At system level, the question is whether Cambodian ICT-in-Education policies and plans issued before Covid-19 (see Ministry of Education, Youth and Sport [MoEYS], 2004, 2010, 2014a, 2018) have been effectively implemented, contributed to helping the HE system respond to Covid-19, and remained relevant for Cambodian HE development in the post-pandemic context. Second, at institutional level, the concern is on whether and how Cambodian HEIs (including post-secondary TVET institutions) have approached ICTs (see the discussion in, for example, Som et al., 2021) in order to address Covid-19 issues and to prepare for recovery from the pandemic. Finally – in light of all the above-mentioned RGC's digital strategies, MoEYS's sectoral vision on ICTs, and the crises-laden social context – the key question at instructional level is whether and how Cambodian faculty members have embraced technologies to respond to the pandemic (see Chet et al., 2022; Cifuentes-Faura et al., 2021) and to prepare themselves beyond the pandemic.

Figure 1: Status of school closure in ASEAN countries during Covid-19



Source: UNESCO Institute for Statistics based on UNESCO map on school closures (https://en.unesco.org/covid19/educationresponse), accessed on 06th November 2022

1.2.Research questions and objectives

The current study seeks to understand how technologies have been integrated into Cambodian HE (at system, institutional, and faculty-member level) and how such integration process has evolved across time periods (before, in the early outbreak, and in the later phase of Covid-19). Two main exploratory research questions and corresponding research objectives are defined as follows:

A. Whole system perspective: How have Cambodian HE system governing bodies and HE institutions planned and integrated technologies before and in response to the Covid-19 pandemic?

- **Objective A1:** to *examine* policies, plans, resources, interventions, and outcomes of technology integration of Cambodian HE system and institutions before and in response to Covid-19,
- **Objective A2:** to *explore* perceptions of HE policy makers, HEI leaders, and faculty members on challenges of and shaped by policy interventions and practices of technology integration,

B. Faculty member-focused perspective: How and to what extent have Cambodian faculty members embraced and integrated technologies at instructional level in response to the Covid-19 pandemic?

- **Objective B1:** to *assess* the level of and *observe* variation in technology readiness, technology impact, technology application behaviour, and perception towards future technology integration, as perceived by Cambodian faculty members during Covid-19,
- **Objective B2:** to *compare* the level of technology readiness and technology impact, as perceived by Cambodian faculty members between the early outbreak (2020) and the later phase (2022) of Covid-19, and
- **Objective B3:** to *identify* factors associated with Cambodian faculty members' technology application behaviour during Covid-19 and their perception towards future technology integration beyond the pandemic.

1.3.Key concepts and conceptual framework

Concepts of technology in education: Over time, technology in education has been discoursed in relation to at least two major ideas: ICT in or for Education (ICT4E) in the broader context of information society and Educational Technology (EdTech) in the broader context of digital transformation.

UNESCO defines ICT in Education as "the intersection of ICT and education that pertains to multiple perspectives including the use of ICT as a *provision medium* by providers of educational programmes, to enable or expand access to learning opportunities; the use of ICT as *pedagogical tools* by teachers and learners to improve the relevance and quality of teaching and learning processes; and the *development of ICT competences or digital skills* needed for living, learning, and working in our increasingly technology-rich world" (UNESCO, 2022, p. 13). As for Cambodia, according to its very first ICT in education policy, ICTs encompass computer technology, computer networks, email and internet, and also radio and television (MoEYS, 2004, p. 6). These tools are acknowledged as technologies to support the governance and management of the education system and improve teaching and learning. For the HE sub-sector, Balasubramanian et al. (2009) broadly count practices such as open universities, e-Learning platforms and approaches, HEMIS, Open Educational Resources (OERs), ICTs for research, and other advanced technologies applicable for education as parts of ICTs in HE.

On the other hand, EdTech has been defined by Roblyer (2016, p. 29) as "a combination of the processes and tools involved in addressing educational needs and problems, with an emphasis on applying the most current digital and information tools". EdTech, according to Weller (2018), ranges from E-learning and E-learning standards (e.g., SCORM), E-portfolio, and OERs to learning analytics, Artificial Intelligence (AI), and Blockchain. In Cambodian EduTech Roadmap (see Ministry of Industry, Science, Technology & Innovation [MISTI], 2022, p. 40), EdTech constitutes both basic technologies (computer, internet, electricity) and those technologies more specific for educational purposes (e.g., Learning Management System (LMS), School Management System (SMS), EMIS, e-learning platform, and gamified software).

Clearly, ICT4E and EdTech are overlapping concepts in many ways though some previous researchers have tried to distinguish them (see Baxi, 2016). Both concepts cover not only instructional technologies (which deal with teaching and learning applications) but also non-instructional technologies (which deal with administrative process of educational institutions) (Balasubramanian et al., 2009; Roblyer, 2016; Technology in Schools Task Force, 2002). In this study, the concept of technology in education incorporates both the ICT4E and EdTech concepts discussed above.

Concepts of technology integration in education: Research areas of technology integration in education have remained disharmonized, with concepts, their measurements, and their relative positions disconnected and scattered in different directions (Krug & Arntzen, 2010, p. 80). The concept of technology integration becomes more complicated when we try to examine its working mechanisms, guiding theoretical frameworks, focused policy areas, and/or technical aspects at different levels of education.

In general, technology integration is a process that comprises different phases to accomplish. Two approaches that treat technology integration as a process emerge in the body of literature: (1) technology integration as a whole-system process (which is generally discussed in policy research by international organizations, national governments, and educational institutions) and (2) technology integration into instructional process (which is more dominant in the academic research literature).

From the whole-system perspective, technology integration is generally viewed as a continuous process for people and institutions to use and adapt to technologies (generally in a standardized way) in the management of schools and in teaching and learning (Edutopia, 2007; Pine-Thomas, 2017; Roblyer, 2016; Technology in Schools Task Force, 2002). In most education systems, the whole-system process of ICT integration involves not only what happens at the institutional level but also policies and interventions at the national level (see, for example, Kozma, 2008; Trucano, 2016). In times of crises such as Covid-19, Green et al. (2021) suggest that the whole-system framework of adaptability (i.e., multi-stakeholder cooperation, inclusion, and flexibility) is appropriate when it comes to using technologies to build resilient education institutions and systems.

From the instructional perspective, the most simplistic definition (and standard measure) of technology integration constitutes availability, access, and use of technology by educators in instruction and to improve learning outcomes

(Hew & Brush, 2007; Inan & Lowther, 2010; Jones, 2015; Karkouti, 2021; Knezek & Christensen, 2016; Spector et al., 2014). In this sense, the concept of technology integration is behavioural, applied, and so observable. Key conceptual models of technology integration into instruction – such as the LoTi framework, ACOT, TPACK, SAMR, TIM (see Bonfiglio-Pavisich, 2018) – suggest that the connection among technologies, pedagogy, and content knowledge are intrinsic to the concept of technology integration. Likewise, instructional technology integration is an incremental process (Karkouti, 2021), which requires educators to make efforts to master the various integration phases and steps. Technology integration into instruction constitutes the notion of technology adaptability (Mardiana, 2020), which refers to whether and how individual educators can adapt to both foundational and emerging technologies and technological changes (e.g., change from face-to-face to online classes).

Thus, we define technology integration in education in our study as the process of applying and adapting to ICT4E and/or EdTech to achieve expected learning outcomes, improve teaching and learning processes, and promote efficiency of working system of an educational institution. It should be noted that, in this study, we observe technology integration of Cambodian HE system, which constitutes both the HE sub-sector and the post-secondary TVET sub-sector (see Appendix 1.1 and 2.7 for more information about Cambodian post-secondary education and training system).

Brief conceptual framework of factors influencing technology integration into instruction: Integrating ICTs in HE is inevitable (Balasubramanian et al., 2009, p. 31), but the process is not simplistic. Factors at different levels influence teachers' technology integration in a very complicated way (Inan & Lowther, 2010, p. 147).

Contextual, systemic, and institutional factors: The Organization for Economic Cooperation and Development (OECD) (2021b, p. 20) explains that the performance of digital transformation of HE institutions and systems is a multi-level, multi-factor phenomenon. First, the performance is directly influenced by digital practices (in teaching, learning, research, and engagement) of educators. Digital practices are then influenced by HEI's strategies. And those institutional strategies are further shaped by policies and contextual factors.

Such conceptual mechanism also applies to the context of Covid-19. First, the Covid-19 emergency, as a contextual factor, pushes HEIs to adapt to new technologies quickly. Then, in many countries, the government issues policies and regulations and allocates resources to guide HEIs on how to cope with such emergency. At the same time or in response to the government's direction, HEIs develop strategies and support relevant groups and/or individuals. Such institutional supports – standard and curriculum support; a shared vision of technology integration; required policies and systemic improvement; access to resources; skilled personnel excellent in professional practices; technical assistance; appropriate teaching assessment; engaged communities and/or digital citizenship; and digital age learning culture and subject culture (Hew & Brush, 2007; Larson et al., 2009; Roblyer, 2016) – have influences on educational practices of those who receive them. More specifically, Inan and Lowther (2010, p. 146) detect that

computer availability, technical support, and overall support directly influence technology readiness and indirectly affect technology integration of teachers.

Individual factors: Individual factors that influence teachers' technology integration consist of many variables. In Inan and Lowther's model of technology integration, for example, technology readiness has the highest total effect and carries most of the indirect effects on technology integration (Inan & Lowther, 2010, p. 146). This readiness-integration relationship is also acknowledged in the meta-analytic framework to explain technology uses by Blut and Wang (2020, p. 653). Technology competence (e.g., computer proficiency or technology-integrated pedagogical skills) also determines technology integration (Inan & Lowther, 2010, p. 146; Knezek & Christensen, 2016, p. 323). According to Hew and Brush (2007, p. 232), knowledge and skills and professional development are important parts of the approach to successfully integrate technologies into instruction. Teachers' belief in technology impacts is arguably another key predictor of technology integration, according to Inan and Lowther (2010). To explain in a reversed way, Karkouti (2021) asserts that "disbelief about technology's benefits" partially influences teachers' decision not to integrate technologies. This explanation further corroborates a broad, qualitative claim that teachers' philosophy and attitudes influence technology integration (Javeri, 2002). Besides these, other individual-level variables (e.g., age, received training, intention to use technology) are also discussed or debated in the body of literature that aims to explain technology integration of teachers.

2.Research Methodology

2.1.Research approach

We adopted a multi-methods research approach. A multi-methods research is one that uses more than one approach within a qualitative or quantitative paradigm (Salmons, 2015, p. 522). Anguera et al. (2018) believe that "a study will be multi-methods when, driven by a common overall research goal, it uses a series of complementary methodologies, chosen according to a given criterion…". We collected different types of datasets at different phases – i.e., the early outbreak of Covid-19 (2020), the later phase of Covid-19 (2022), and before the Covid-19 outbreak – to get the most relevant information that addresses our research questions.

2.2.Qualitative data and analyses

Key Informant Interview (KII): KII samples were collected purposively, targeting those actors responsible for technologies at different levels of HE. The total sample size is 20 informants, classified into four groups: (1) two system-level policy makers, (2) five institution-level HEI leaders, (3) eight faculty members, and (4) five students (see Appendix 2.2 for the samples' characteristics). Four separate interview guides were developed for the different groups of interviewees. Each guide inquires on such basic themes as ICT-related policy and institutional support; necessity and impact of ICTs; technology readiness and usage experience; technology application during Covid-19;

challenges in technology application; and future direction, while specific questions (e.g., on HEMIS and OER) were included for particular group of interviewees. The interviews were conducted between 15th August and 15th September 2022.

KII data were analysed using the method of thematic analyses (see Guest et al., 2012). Thematic coding was performed in two stages. We started by deductively developing codes – based on our research objectives, conceptual framework, and interview guides – and inductively coding all the 20 full transcripts thoroughly and line by line. Then we iteratively connected and categorized those deductive and inductive codes into sub-themes and main themes. Nvivo-12 was mainly used to perform the coding and analyses of the KII data.

Documentary data: Documentary data on or related to technology and technology integration (e.g., policies, plans, regulations, and reports) were collected from MoEYS, MLVT, and relevant ministries. There were 28 documents, issued before and since Covid-19, collected (see Appendix 2.1). Among them, four policies and plans specific to ICTs in education – (1) Policy and Strategies on ICT in Education in Cambodia (2004), (2) Master Plan for ICT in Education (2009-2013), (3) Master Plan on Education Management Information System (2014-2018), and (4) the second Policy and Strategies on ICT in Education (2018) (MoEYS, 2004, 2010, 2014a, 2018) – were critically reviewed. The other documents were reviewed to enrich and cross-validate information in these four key policies and plans.

To a large extent, the review procedure follows the READ approach (Ready – Extract – Analyse – Distill) (Dalglish et al., 2021). We first gathered and organized all the selected documents in Citavi-6. We then broadly read, identified and extracted key information from those documents, generating 103 knowledge objects (as of 31st December 2022). Based on these knowledge objects, we critically re-read and coded the four key ICT-in-Education policies and plans in another software, Nvivo-12, by focusing only on specific themes guided by the Kozma's framework for comparative analysis of ICT policy and Trucano's SABER-ICT policy framework (see Kozma, n.d.; Trucano, 2016) – i.e., policy and strategic framework; implementation and operational framework; guiding principles; and monitoring and evaluation framework. Most relevant information and knowledge extracted and thematized through the two phases of broad review and critical analyses were then prepared in Excel 2019 and distilled in our report in the form of narratives and quotes.

2.3.Quantitative data and analyses

Survey data: Survey data is our primary quantitative data. There are two surveys of faculty members and one survey of students. The first-phase survey of faculty members was conducted between September and November 2020, and the second-phase survey between August and September 2022. 370 faculty members from 18 HEIs participated in the first-phase survey, and 290 faculty members (from the list of the 370 first-phase survey participants) joined the second survey, but only 280 cases of them could be used for analyses (see Appendix 2.5 for detailed characteristics of faculty members). The survey of students was conducted between July and September 2020, with

1,338 students from 22 HEIs taking part (see Appendix 2.6 and 2.7 for detailed characteristics of students and participating HEIs). Please also refer to Appendix 2.4 for the list of key variables, indicators, and scales used in the survey questionnaires.

To analyse the survey datasets, we used different methods for different research objectives – (1) *descriptive statistical measures* (such as percentage and mean score) to assess the magnitude of the observed variables in the study; (2) *comparative statistical tests* (i.e., parametric tests of difference such as independent-sample t-test as well as non-parametric ones such as Mann-Whitney test) to observe patterns of variation in specific observed variables by respondents' attributes (e.g., age, teaching subject, HEI location); (3) *comparative statistical tests across times* (i.e., paired-sample t-test) to observe changes in certain variables between the early phase and the later phase of Covid-19; and (4) *associational statistical methods* (i.e., path analyses) to observe direct and mediating relationships among variables in a pre-specified model to explain technology application behaviour during Covid-19 and perceived future technology integration of Cambodian faculty members (see Appendix 2.3 for the specified path model and hypotheses). Stata 14.2., together with Excel 2019, was used in a complementary way for all quantitative data analyses.

Secondary quantitative data: Secondary quantitative data with indicators related to (1) Cambodian HE (e.g., Gross Enrolment Rate (GER), percentage of government's expenditure on HE), (2) technologies at HEIs (e.g., HEIs with accessible website, HEIs providing access to different media platforms), and (3) impacts of Covid-19 on HE (e.g., number of days of school/university closure) were used where relevant throughout this report (see Appendix 2.8 for detailed list and link of the secondary quantitative datasets). Those datasets were collected via direct download from online data portals or converted from published sources. Those sources include Cambodian MoEYS and MLVT (and relevant ministries), UNESCO's online data portals, and website or social media pages (e.g., Facebook) of Cambodian HEIs. Descriptive statistical measures were used in Excel 2019, and results of the analyses were presented in tables or graphs as attached in appendices (see Appendix 1.1, 1.2, 3.2).

3.Findings

3.1.Finding I: Policies and interventions of technology integration

3.1.1.HE system

3.1.1.1. Situation before the Covid-19 outbreak

Cambodia has issued ICT-in-Education policies and plans for the system level of its education sector before Covid-19. The Cambodian Law on Education requires MoEYS to regulate science and technology at all levels of Cambodian education sector (see National Assembly, 2007, p. 10). MoEYS issued its first ICT-in-Education policy in 2004 and its second in 2018 (see MoEYS, 2004, 2018). In spite of different times and contexts, the two policies prioritize five strategic areas: (1) ICT infrastructure and facilities, (2) ICT-based governance and management,

(3) human resource development in ICT, (4) ICT support in teaching and learning, and (5) funding for ICT-related developments. Since 2010, MoEYS has operationalized these strategic policy areas into various plans for actions at all levels of education – including the master plan for ICT in education (MoEYS, 2010), the master plan on Education Management Information System (EMIS) (MoEYS, 2014a), the national-level Education Strategic Plan (ESP) 2014-2018 (MoEYS, 2014b, pp. 21–45), and the current ESP 2019-2023 (MoEYS, 2019a, pp. 58–61).

The HE sub-sector (under MoEYS) and the post-secondary TVET sub-sector (under MLVT) also entail specific strategies and targets for ICT integration. Before Covid-19, the focused policy areas specific for the HE sub-sector included building ICT infrastructure at HEIs (e.g., electricity, computer, basic software, internet); equipping students with advanced ICT skills in their professional competency; supporting ICT-integrated instruction of lecturers; establishing Open and Distance Learning (ODL) and National Open University; and providing access to information and web-based, digitized HE resources (especially, in Khmer language) (MoEYS, 2010, p. 12). The 2010 master plan notes:

> **To meet the increased demands and expectations of their students, lecturers in higher education institutions of Cambodia will have to systematically use ICT to teach their classes, to share information with their students, to promote student-centred learning, and to evaluate their students. This Master Plan will therefore need to ensure that all teachers not only are computer literate, but also understand how to use ICT to improve their administrative and pedagogical skills. (MoEYS, 2010, p. 12)**

Accordingly, Cambodian HE Roadmap, one of the most important documents for the sub-sector, sets some specific ICT-related targets as follows: making HEMIS at the system level fully functional by 2022, ensuring that all HEIs implement accounting software by 2027, helping all faculty members integrate ICTs in teaching and learning by 2032 (MoEYS, 2017, 34, 55, 56). Similarly, among the 73 indicators of the nine standards of Cambodian HE quality assurance framework, at least five indicators (i.e., Item 6, 12, 13, 114 of Standard 6 and Item 5 of Standard 7) are related to ICTs (Accreditation Committee of Cambodia [ACC], 2016, pp. 26–36). The 2019 national standard for HEI accreditation further regulates that HEIs must reserve budget packages for professional development of faculty members and staff on teaching and learning, research, information technologies, and others (MoEYS, 2019b, p. 14).

MLVT, which supervises around 20 percent of institutions in the list of 130 HEIs (as of 2022), also embraces strategies to promote TVET distance education and improve TVET Management Information System (TVETMIS) and Labour Market Information System (LMIS), as stated in its National TVET Policy 2017-2025 (Ministry of Labour and Vocational Training [MLVT], 2017, 9, 13). MLVT launched its TVETMIS web portal even before Covid-19. These strategies apply to all levels of the TVET sub-sector, so incorporating its post-secondary level.

These sub-sectors' policies and plans treat ICTs both as a field of study (or an occupational field) and as a cross-cutting tool and mechanism to support other functions (e.g., teaching/training, learning, research, administration). The most important goals of those policies and plans are to adopt ICTs to enhance HE governance and management at the system level as well as to improve teaching and learning modalities and approaches at the institutional level. In other words, before Covid-19, both ministries and their directorates aim to use ICTs to supplement (rather than replace) the traditional physical system of governance and management as well as the face-to-face modality and approach to teaching and learning.

3.1.1.2. Changes since the Covid-19 outbreak

ICT-related responses at the system level during Covid-19 have been active and set ground for future digital preparedness of Cambodian education sector. To curb Covid-19, Cambodian MoEYS issued the Cambodian Education Response Plan to Covid-19 in July 2020 (MoEYS, 2020b) and later on defined key strategies for the sector to recover from the pandemic in the national Strategic Framework and Program to Restore and Promote Cambodian Economy in the Post-Pandemic Context (2021-2023) (Royal Government of Cambodia [RGC], 2021). The main focus of these documents is on safe and adaptable continuation of education during Covid-19 and resilient recovery (with continuous digital transformation of education) in the post-pandemic context. They re-highlight and imply the need for ICTs to address all teaching and learning and administrative challenges facing educational institutions and educators during Covid-19 and beyond. Along with RGC's and MoEYS's responses to Covid-19, the Ministry of Science, Technology, and Innovation (MISTI) has also issued the EduTech Roadmap (MISTI, 2022), setting a framework on how Cambodian educational institutions may develop their EdTech systems.

In general, major MoEYS's system-level policy actions related to ICTs in education during Covid-19 incorporate setting guidance (including Standard Operation Procedure (SOP), regulations, and protocols) to operate and manage schools safely; providing support (such as technical advice, funding, and training) on online teaching and learning to ensure continuation of education; and taking various actions to digitally reform education (in areas such as educational information sharing, virtual collaboration among educators, and resource development in the OER platform). Education-related digital platforms by MoEYS and MLVT grow rapidly or become more active during the pandemic (e.g., MoEYS's social media platforms, MoEYS's e-learning app, MLVT e-learning app, school management system (SMS), OER). Private online learning platforms (such as Sangapac and E-school Cambodia) as well as those developed by private educational institutions are also subsequently launched, some of which receive official approval by MoEYS to provide their services. Specific for the HE sub-sector, the current Education Congress report highlights key actions such as the issuance of Directive No. 52 to reopen public and private HEIs, examination of online learning status at selected HEIs, training and development of staff capacity, and development of guidebook and relevant technologies for online/distance learning (MoEYS, 2022, p. 107).

Covid-19 also pushes the HE and post-secondary TVET sub-sectors to revisit their early unachievable ICT-related targets. A major move in policy of the HE sub-sector is the issuance of the Cambodian Cyber University

Network (CCUN) in a sub-decree approved on 14th January 2022, which is likely an important mission for the future of online education in Cambodia. CCUN is seemingly built on the idea of "cyber campus consortium" stated in the 2004 policy (MoEYS, 2004, p. 16), the aim to establish an open university in Cambodia by 2027 (MoEYS, 2017, p. 45), and perhaps the hope to continue the ASEAN Cyber University (ACU) initiative that has already concluded (Institute of Technology of Cambodia [ITC], 2022, p. 25). The interviewed key informant from DGHE emphasized the importance of CCUN as follows:

> **Now the ministry has pushed it to another level by creating the Cambodian Cyber University Network, approved by a sub-decree. This network has been a topic of wide discussion among our public universities, and we plan to extend its scope to include private universities. Now, we have developed an investment project to support six universities to start implementing the agenda in the Cambodian Cyber University Network … There are two main implications here … both students and lecturers to study in online teaching and learning with a vibrant Learning Management System (LMS) … Using this system [LMS], simply speaking, helps ensure equity for students enrolling in HEIs. The term equity here means both students in Phnom Penh city and provinces gain the opportunity to receive quality education … Another thing is that it provides an opportunity for our lecturers and students to register in courses provided by lecturers in foreign countries. [PM1, 24th August 2022]**

As for the post-secondary TVET sub-sector, one of the most important achievements during Covid-19 is the development and launch of its TVET e-learning platform at the system level. The interviewed key informant from DGTVET described the platform:

> **Now, in terms of IT physical infrastructure, we have it in place. Also, since the outbreak of Covid-19, we have created our TVET e-learning platform … What we have done with that platform includes our inputting of lessons (after we produce those lessons) … Teachers have their presentation slides and they have their lesson plans … We have produced thousands of them … inputted into the platform. [PM2, 15th September 2022]**

3.1.1.3. Remaining challenges at the system level

The development, utilization, and improvement of HEMIS and TVETMIS and how the systems can be integrated with other MIS's seem to remain a big challenge at the post-secondary level of Cambodian education. For the HE sub-sector, even though the HE Roadmap aims to make HEMIS fully functional by 2022, our interview with the key informant leading this sub-sector suggests otherwise. The interviewee asserted:

> **We still have a big challenge in terms of capacity of such uses (of technologies) … Let's talk, for example, about the Higher Education Management Information System (HEMIS).**

> **Until now, frankly speaking, (we still use) … I mean it is not yet efficient … and there are still many challenges … with regards to this. [PM1, 24th August 2022]**

As for the post-secondary TVET sub-sector, even though a web portal of TVETMIS is available, quantities and qualities of data accessible to external stakeholders are still limited in certain ways. MLVT's LMIS is also seemingly inaccessible yet to the public.

In fact, other MIS's (i.e., EMIS, QMIS, HRMIS, FMIS, NFE-MIS) stated in the 2010 EMIS masterplan (MoEYS, 2010) for different levels of the whole Cambodian education sector still need a lot more developments and improvements. Two critical aspects of the challenge are how these different systems can be integrated to create a robust education data environment and how to make those systems accessible openly. The current status of HEMIS, TVETMIS, and other MIS's puts a question mark, for one thing, on whether Cambodian relevant ministries and educational institutions under their supervision can draw on quality data to make decisions and to support teaching and learning; and, for another, on whether these actors are accountable to the public in terms of supply of reliable educational information and data.

According to our interview, the lack of and/or the inability to retain human resources capable of information technology partially leads to a slow progress in HEMIS development, utilization, and improvement. The interviewee explained that poor management of HEMIS and organizational knowledge by the people in charge could be detrimental to data quality and the whole practice of HE quality assurance and accountability. MoEYS's latest Achievement Report (2020a, p. 83) highlighted this concern on human resource for the entire education sector (not just the HE sub-sector), specifically pointing to the lack of officials with expertise in programming languages (i.e., PHP and MySQL), networking (i.e., Cisco), mobile software development (i.e., iOS and Android), and open source development (i.e., RatHat, Unix, Linux) as well as the lack of officials with ICT expertise to update data in the new information management databases (such as EMIS, QEMIS, SDS, and SRC).

HEMIS is not just an issue at the system level. At institutional level, Cambodian HEIs are also challenged in coordinating and consolidating the process of generating and sharing their information and data and linking them with the HEMIS (or TVETMIS and LMIS) platforms of the ministries. But, at the institutional level, the concern is not very much about human experts. The interviewed HE policy maker made the following remark on the real situation of HEMIS at HEIs:

> **As for HEIs, they have expertise, but it depends on leadership and coordination. At some universities […] even those ones that have used technologies and so forth, when we go and ask for information, we can say that the uses of technologies to manage administration and the whole system of universities are still not smooth. That is because, when we go and ask for information from them, the information is not provided responsively … (well, not unresponsive) … I mean the information is not that we want.**

The provided information is still not accurate. If we record the information into the technological system, it has to be accurate, right? But now that is not the case. [PM1, 24th August 2022]

HEMIS is a cross-level challenge since both the system-level policy makers and the HEI-level leaders are still unable to consolidate this process. It should be noted that, as of 2022, only 24 Cambodian HEIs (around 18 percent) have provided data for HEMIS; only 17 have established internal quality assurance system; and only five have joined the tracer study led by DGHE (see Appendix 1.2.).

Besides the challenge of HEMIS, concerns on the idea of Open and Distance Learning (ODL) and open university in Cambodia – discussed 20 years ago (see MoEYS, 2010) – continue to prevail despite the issuance of the current CCUN sub-decree. First and foremost, concerns come to the fore because a detailed plan on how the CCUN platform is developed and how it will function is not yet available. Whether this platform is linked to the attempt to build a national open university in Cambodia by 2027 (MoEYS, 2017, p. 45) and whether the platform will provide flexible learning pathways with professionally-acknowledged and quality-assured credentials for its participants are not yet clear. Whether this platform has a potential to digitally reshape and renew Cambodian HE structures and culture has also remained vague.

Also, the current conceptualization of CCUN includes only six public universities under the World Bank loaned Higher Education Improvement Project (HEIP) 2018-2024. This fact points first to a question of equity in the participation of different types of local Cambodian HEIs (e.g., private HEIs) and their academics (e.g., part-time faculty members) in the HE development process. Second, it raises a concern on how to operate that platform after the loaned project is completed. With all these concerns raised, stakeholders need to take into consideration approaches to ensure that CCUN is not just another platform that physically exists but has neither substances nor capacities to be inclusive and sustainable.

3.1.2.HE institutions

3.1.2.1. Situation before the Covid-19 outbreak

At the institutional level in general, specific ICT integration policy was rarely available before Covid-19. Among the 121 Cambodian HEIs (MoEYS, 2017) before Covid-19, we could only obtain one publicly released ICT policy and plan of the Royal University of Phnom Penh (RUPP) (see Royal University of Phnom Penh [RUPP], 2017). RUPP's ICT policy and plan document is a comprehensive policy focusing on six areas: connectivity and common network services; learning and research; university management and administration; ICT resources; change management; and monitoring and evaluation (RUPP, 2017, pp. 7–9).

Even without a specific ICT integration policy, certain Cambodian universities incorporated ICT-related goals and activities in their institution's strategic plan. The 2014-2018 strategic plan of National University of Management (NUM) aims to promote new technologies in order to improve the outcomes of the university's operation and sets a

number of activities (i.e., Activity 2.1.4; 2.1.6; 3.1.6; 5.1.3; and 6.2.5) which range from using technology facilities to support library and research function to using technology to support financial management (National University of Management [NUM], 2014, p. 17). Similarly, a short strategic plan of the Institute of Technology of Cambodia (ITC) mentioned the need to consider technology in the curriculum to ensure technological skills of the graduates and technology for capacity development of leading and academic staff (ITC, n.d.). These strategies are guided by the ICT-in-Education master plan (MoEYS, 2010) and the quality assurance framework (ACC, 2016; MoEYS, 2019b).

Before Covid-19, access to ICT at HEIs has already been considered part of the foundational infrastructure needed by HEIs to operate administratively and to support different institutional functions. Some HEIs in our interview reportedly have technology-enabled administrative systems long before Covid-19 – e.g., accounting and financial management system and system to manage student enrolment. Using software such as Microsoft Access or Excel to develop databases to manage different administrative, accounting, financial, and/or human resource tasks is a common example of how ICTs are integrated to operate the institution. Our interviewed HEI leaders generally claimed that ICT facilities as such at their institution were adequate to perform necessary administrative roles before Covid-19. One private HEI's leading member reported:

> **For administrative work, we have an online system even before the COVID-19 pandemic. We have created the system for a long time already. I do not remember how many years but, for things like checking transcripts online, we have it before COVID-19. We can allow the students or their guardians to access it. [LM4, 19th August 2022]**

Likewise, Cambodian HEIs generally provide basic ICT hardware and software for collective uses among faculty members or among students in their teaching and learning activities (particularly, for presentation during lectures and assignments, for communication among colleagues or between teachers and students, and for research and information sharing purposes). Few computer labs for faculty members and students and access to the internet at certain spots within the campus (for example, library and main meeting rooms) are generally reported in our interview.

Leading members of some HEIs further reported developing or having their own LMS or having access to such similar system before Covid-19. ITC, for example, developed its own so-called e-Learning centre and e-learning platform, using Moodle, before the pandemic. According to the ITC's Director Report (ITC, 2022, p. 25), the ITC's e-Learning centre and multi-media studio were established in 2012 as part of the 2020-concluded ASEAN Cyber University (ACU) project, constituting content development room, operation room, and LMS servers. Likewise, some HEIs (i.e., RUPP, CADT, and IIC) are reported to have tested similar system before Covid-19 (Richardson, 2008; Som et al., 2021; United Nations Economic and Social Commission for Asia and the Pacific [UNESCAP], 2017). Three private HEIs participating in our interview claimed to have developed their own LMS or had access to one (e.g., Google Classroom) before Covid-19.

Despite having these basic ICT facilities, the 121 HEIs reported differences in the quantity, quality, and accessibility of those ICT facilities before Covid-19. Most of our interviewees (policy makers, HEI leaders, and faculty members) still see their LMS platforms as not fully-functional or think there was no reason to use them fully before Covid-19. Whether such facilities and platforms at HEIs conform to the required standards (ACC, 2016, pp. 32–34) is not known because only ten Cambodian HEIs were accredited as of 2021 (MoEYS, 2022, p. 109).

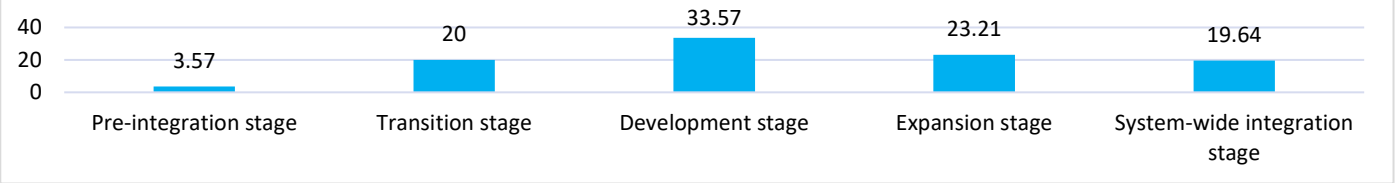
3.1.2.2. Changes since the Covid-19 outbreak

Specific policy on ICT integration at Cambodian HEIs has remained absent since the Covid-19 outbreak. However, some forms of documentation to regulate online teaching and learning were developed by Cambodian HEIs in response to the formal requirement of MoEYS before those HEIs can operate their online teaching and learning during Covid-19. Certain universities have also tried to be more innovative with their ICT strategies. In the new NUM's Strategic Plan 2019-2023, for example, Activity 1.1.3 stated:

> **The university promotes newly updated methodologies through using technology, especially ICT, and inviting company managers or experts to interact or share their experiences. (NUM, 2019, p. 7)**

HEIs' ICT-related interventions to curb and respond to Covid-19 are active and collective. Key interventions include the formulation of Covid-19-response committee at HEI, actions to ensure safe teaching and learning (including protocols for distancing during hybrid instruction), actions to ensure continuation of education and HEI functionality (both in terms of teaching and learning and students' payments), training for faculty members and students, and structural changes in various administrative aspects (e.g., deployment of digital payment system and digital financial reporting system). Cambodian HE policy makers, HEI leaders, and faculty members agree that the promotion of ICTs at HEIs has happened before Covid-19 but that Covid-19 provides a context for HEIs and their actors to collectively accelerate ICT accessibility, use, and innovation at the institutional level. Such agreement corroborates well with our phase-two survey data of faculty members, which suggests that 33.57 percent of the participants consider their HEI at the development stage of ICT integration, 23.21 at the expansion stage, and 19.64 at the system-wide integration stage (see Figure 2).

Figure 2: Percentage of faculty members by their perceived level of ICT integration at their HEI during Covid-19

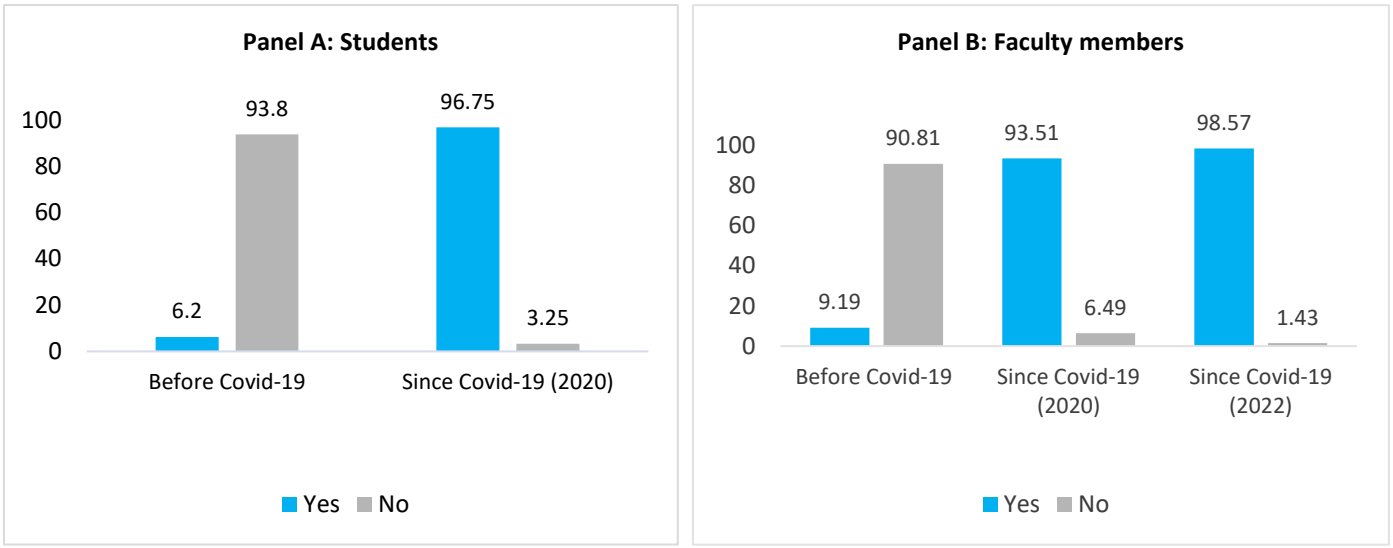


Source: Faculty member survey 2022 (n = 280)
Note: See Appendix 2.4 for detailed explanation of each stage.

Another undeniable change since Covid-19 is that all actors of Cambodian HEIs (i.e., HEI leaders, administrators, faculty members, and students) get more exposed to online teaching and learning. HEI leaders are believed to be

key decision makers that influence how HEIs use ICTs to respond to Covid-19 – from choosing which online teaching software application/platform to preparing system of technology support for faculty members and students. Likewise, Cambodian faculty members and students begin to acquaint themselves with different ICT tools and ICT-supported approaches to online teaching and learning. Before Covid-19, only 6.2 percent of our surveyed students (n=1,338) joined some kinds of online learning, whilst close to 97 percent of them reported joining online classes in our first-phase survey during Covid-19 (n = 1,323) (see Figure 3). Similarly, only around 9 percent of Cambodian faculty members had experience teaching online before Covid-19 (n = 370), whereas 93.51 percent taught online during the first year of the outbreak (n=370), and up to 99 percent have taught online in the second year of Covid-19 (see Figure 3).

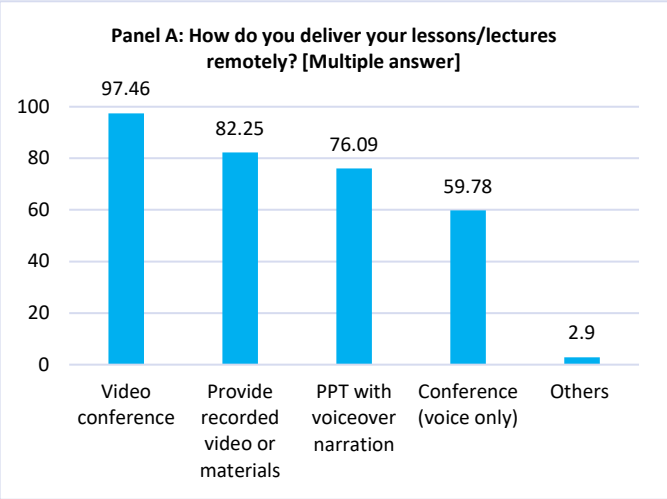
Figure 3: Trend in online learning participation by Cambodian faculty members and students before and since the Covid-19 outbreak



Source: For student survey (2020), before Covid-19, n = 1338 and, since Covid-19, n = 1323; For faculty member surveys (2020 and 2022): Before Covid-19 (n = 370), First year of Covid-19 (n = 370), and Second year of Covid-19 (n = 280)

Because of such a sudden switch to online teaching and learning, Cambodian HEIs have become more aware of asynchronous learning management platforms (e.g., Google Classroom), video-conferencing platforms for synchronous teaching and learning (e.g., Telegram, Google Meet, Zoom, and MS Teams), and emerging ICT tools for material development (e.g., video making tools in PPT) and those for resource searching and sharing. In our later-phase survey of faculty members in 2022, 97.46 percent of them experienced using video conference and 76.09 percent reported using PowerPoint with voice narration as a means to deliver lessons/lecturers online (see Figure 4). Data also show that mobile-phone-based access to and use of technologies have become more favourable for both students and faculty members. 85.51 percent of the respondents reported using Telegram to deliver lessons/lectures online/from a distance; 68.12 percent reported using Zoom, and 51.81 percent reported using Google Meet.

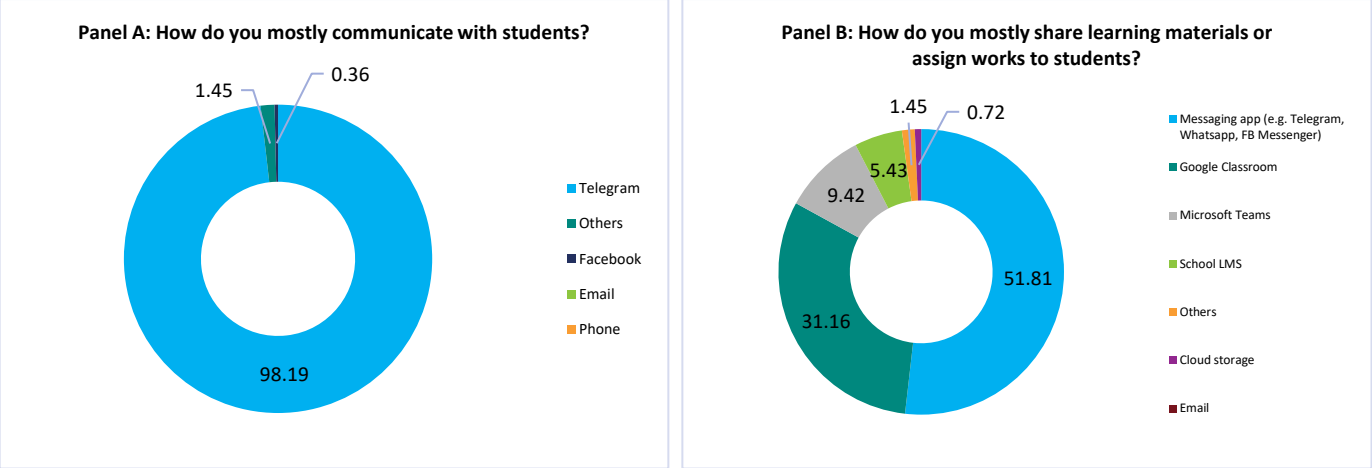
Figure 4: Software applications or platforms for online teaching employed by Cambodian faculty members in the later phase of Covid-19 (2022)



Source: Faculty member survey 2022 (n=246)

Telegram is also the most preferred platform for faculty members (98 percent) to communicate with students, whilst messaging apps in general (e.g., Telegram, Whatsapp, FB messenger) become popular for learning resource sharing with students (52 percent), followed by Google Classroom (31 percent) (see Figure 5).

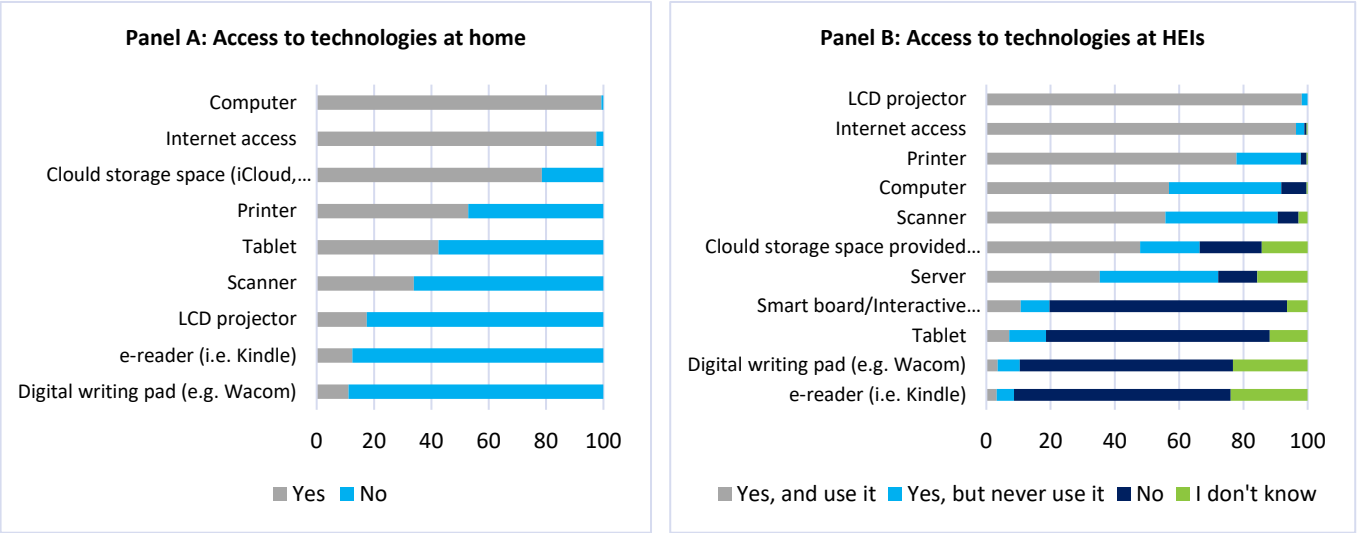
Figure 5: Medium of communicate between faculty members and students in the later phase of Covid-19 (2022)



Source: Faculty member survey 2022 (n=246)

Basic ICT tools for faculty members and students at Cambodian HEIs in our survey are generally available during Covid-19. Our survey data of faculty members indicate that Cambodian HEIs generally provide internet access and basic ICT tools for teaching, learning and administration (such as LCD projectors, computers, printers, and scanners). Around 98 percent of faculty members use LCD provided by their HEIs and around 96 percent access the internet at their HEIs (see Figure 6), while they tend to prefer using their own laptops for teaching and learning. Other non-basic tools (such as smart board/interactive whiteboard, tablet, digital writing pad, or e-reader) are rarely provided to faculty members and students by HEIs. The survey data further shows that nearly a hundred percent of faculty members have access to computers and the internet at home (see Figure 6).

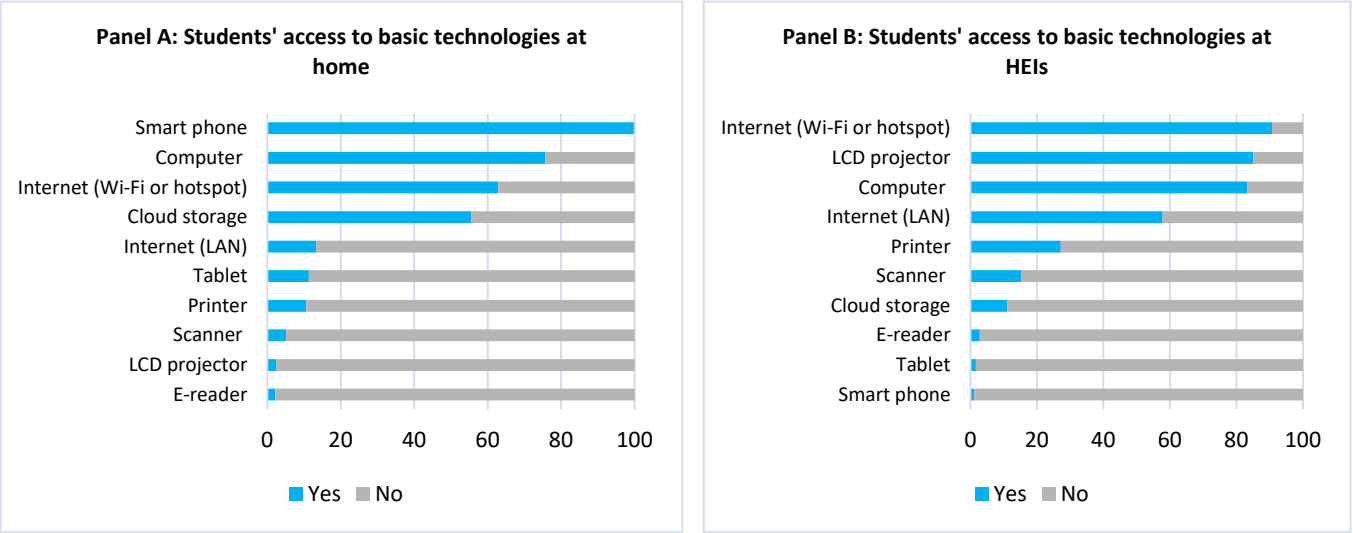
Figure 6: Faculty members' access to technology tools at home and HEI since Covid-19



Source: Faculty member survey 2022 (n = 280)

Similarly, around 90 percent of students in the first-phase survey reported having access to the internet through Wi-Fi or hotspot and 83.26 percent to computers at their HEI (see Figure 7). However, when asked if they can access computers freely at their HEI during office hours, 37.52 percent claimed they can only access them during specific lessons/sessions. At home, close to 100 percent of the students reported having access to smart phones, around 76 percent to computers, and around 63 percent to the internet through Wi-Fi or hotspot.

Figure 7: Students' access to basic technology tools at home and HEI since Covid-19



Source: Student survey 2020 (n = 1,338)

3.1.2.3. Remaining challenges at the institutional level

Despite increased exposure to online teaching and learning due to Covid 19, Cambodian HEIs still face various challenges in developing and delivering their online education. There are many areas of online education development that Cambodian HEIs find challenging, from policies to procedures. Among the concerns are the development of digital content and resources for students to learn in a ubiquitous environment and a personalized

manner; the mechanism to pay or incentivize faculty members who engage in content development and online teaching; and/or the policy on intellectual properties to protect the developed and delivered contents. In our interview, an HEI leading member claimed that developing a full-fledged synchronous and asynchronous online education platform enabled by advanced technologies is one of the main concerns of ICT integration at his institution:

> **So far, there has been only one program that gets stuck – that is, the Cyber Program. It is complicated. First, we need to create a platform controlled by AI, which is already a difficult thing. Another challenge is about the contents to be shown on the platform. We need highly-talented lecturers, with knowledge and presentation skills; we need technical expertise in video making, which makes the contents short but meaningful, so that the students who participate in the Cyber Program can understand the contents well, which ensures the quality of learning, and so they [the students] can get credits without physical presence. [LM2, 15th August 2022]**

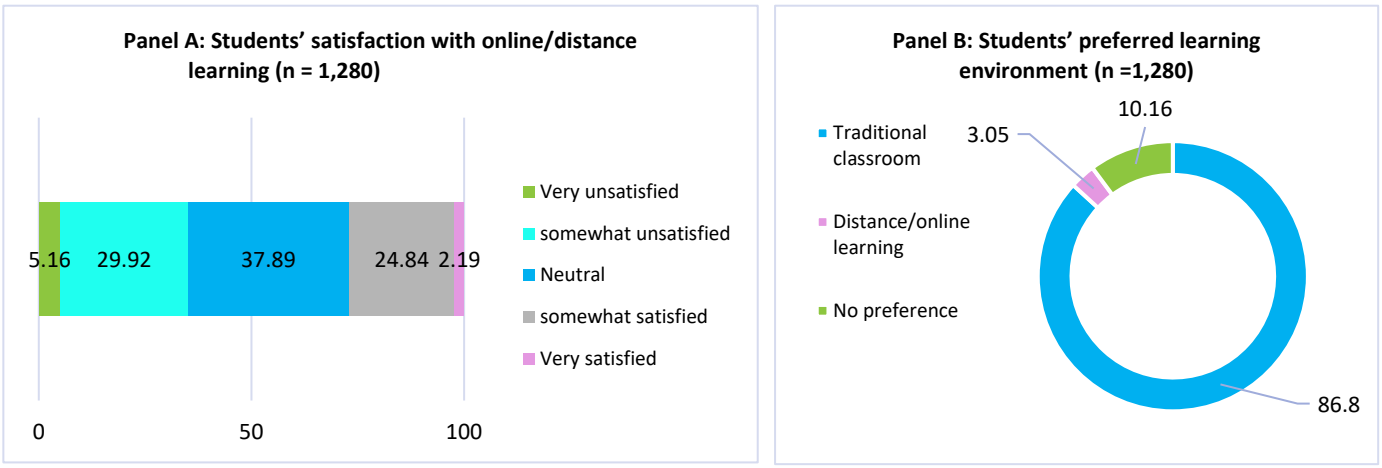
Our qualitative data suggest that Cambodian HEIs also have an ambiguous idea on how to deliver online education programs in parallel with their existing physical education programs after the pandemic. At the time of data collection, most HEIs' leaders are considering and working on how to deliver their online programs independently as well as how to combine the online education platforms and the onsite education platforms at their institution. They need a standardized model that can be used by all faculty members. So far, there have not been such collectively agreed standards in Cambodia to assure the quality of online education programs as well as education programs that allow students to enrol in both online and onsite courses. The Cambodian quality assurance framework has not incorporated such standards yet. In principle, Cambodian HEIs need a transformative model of online education (whether delivered independently or in combination with onsite programs), which can promote HE quality and is designed under consideration of both international best practices and local appropriacy.

Online teaching and learning at Cambodian HEIs are also problematic from a pedagogical point of view. Though the exposure to online teaching and learning has increased during Covid-19, there is low satisfaction in such exposure among Cambodian students. About 35 percent (n = 1,280) of Cambodian students are somewhat unsatisfied or very unsatisfied with their online learning experiences, and another 38 percent are neutral about online learning. Around 87 percent of the students (n = 1,280) still prefer traditional face-to-face learning environment (see Figure 8).

Likewise, the surveys of faculty members in both phases also show that the participants still prefer face-to-face teaching and learning medium to others. In the first-phase survey, around 57 percent (n = 346) choose face-to-face approach as their preferred medium of instruction, and only 7.80 percent prefer online and/or distance teaching and learning medium. Almost the same trends are observed in the second-phase survey (i.e., 47.83 percent and 3.99

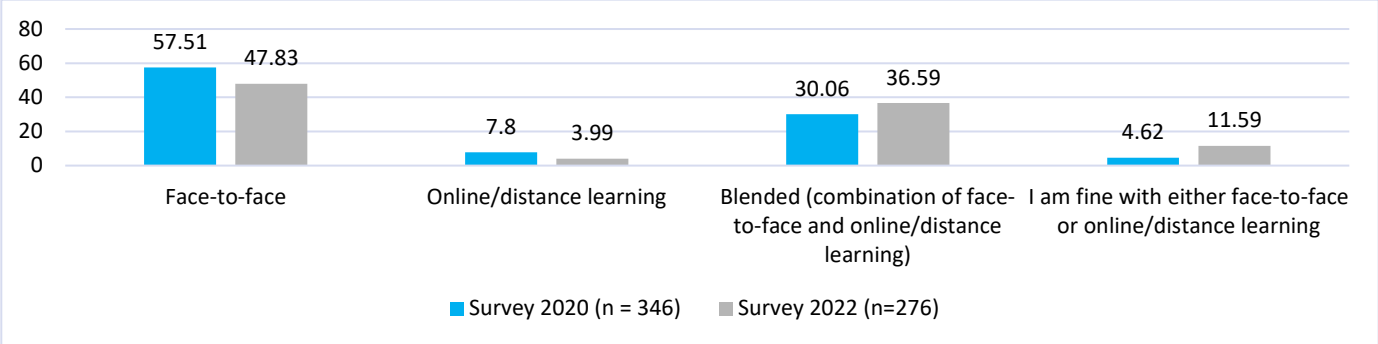
percent respectively). Compared between the first and the second phase survey, however, there is a growing trend of preference for blended learning medium (see Figure 9), which somehow implies that Cambodian faculty members begin to show interest in the blended medium of instruction. Yet, in both phases of the survey in overall, the proportion of faculty members preferring blended learning medium and those who are fine with either face-to-face or online learning medium are generally lower than the proportion of those preferring face-to-face medium.

Figure 8: Students' perception on online/distance learning during Covid-19



Source: Student survey 2020

Figure 9: Faculty members' preference for teaching and learning approach during different phases of Covid-19

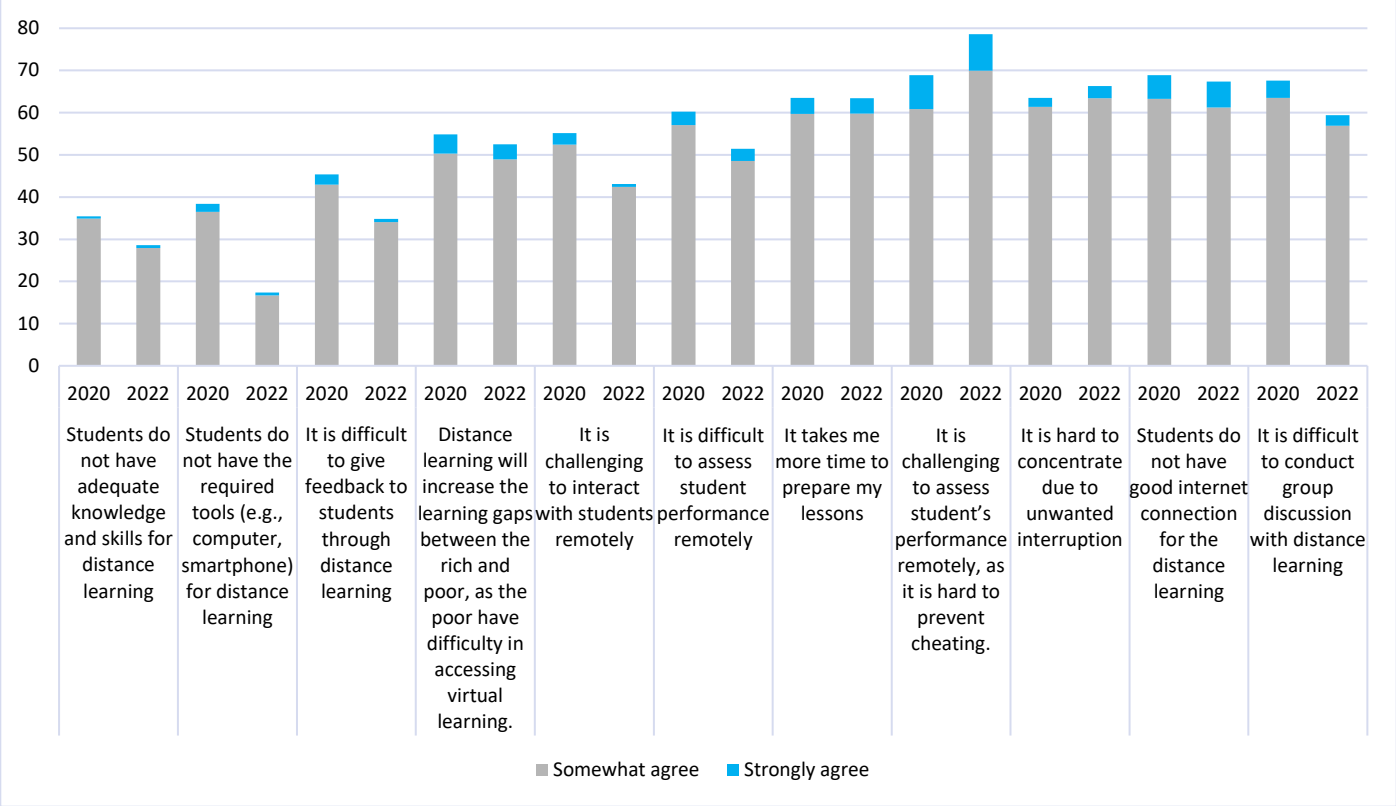


Source: Faculty member survey 2020 and 2022

In truth, Cambodian faculty members face various pedagogical challenges in terms of online teaching and learning throughout the Covid-19 period. Figure 10 shows that close to 80 percent of Cambodian faculty members in the second phase of the survey are still challenged in avoiding cheating during remote assessment. Between 50 and 70 percent of them are also challenged in various other aspects – including difficulty in conducting group discussion, poor internet connection from the student side, situational interruptions during online teaching and learning (e.g., raining), longer time for lesson preparation, technical strain in remote assessment, and widening learning gaps between students of different socio-economic backgrounds. The proportion of faculty members reporting other challenges – such as students' knowledge about distance learning, access to technological tools, feedback giving, and interaction between faculty members and students – is lower and continues to decline when compared between the first-phase and the second-phase survey data

(see Figure 10). These trends raise concerns that the adoption of ICT tools for online teaching and learning during Covid-19 might not translate into improved pedagogical practices and students' learning outcomes yet.

Figure 10: Perceived challenges of online teaching and learning by faculty members at different phases of Covid-19



Source: Faculty member survey 2020 (n=370) and 2022 (n = 276)

In the early outbreak of Covid-19, some faculty members are even reported not knowing how to use online teaching software applications:

> **So, I think, both our lecturers and students face difficulties. As I said, in the first semester [of Covid-19], some lecturers could not even find a way to log in to the online platform, but now both the lecturers and students are accustomed to that. [HL3, 15th August 2022]**

Besides the issue of online education platforms and online teaching and learning pedagogies, the attempt to digitally transform Cambodian HEIs, as expected in various government policies, may face both technical and financial obstacles. According to our interview, a major concern is that EdTechs are something new for Cambodian HEI leaders, administrators, and faculty members. Experts who understand how to integrate ICTs (to operate educational institutions as well as in teaching and learning) and to manage those more advanced EdTechs (such as LMS, SMS, learning analytics, or AI for education) are still rare at HEIs. To implement comprehensive digital transformation, the government, as well as HEIs, need technical expertise not only to resolve the currently fragmented ICT systems of the education sector but also to expedite the process of digitizing educational resources

and digitalizing the organizational operation of HEIs and to solve major teaching and learning crises that may arise due to the lack of understanding and experience in EdTechs.

Relevant data further suggests that infrastructural and financial resources for digital transformation (both in upgrading ICT facilities and adopting more advanced EdTechs) are either limited at some Cambodian HEIs or not sustainable at others. It should be noted that until now only around 62 percent of Cambodian HEIs, among the 120 HEIs in the list of Cambodian HE Roadmap (as of 31st December 2022), have had an accessible website (see Appendix 3.2). While HEIs in many countries use website as their most basic information platform, Cambodian HEIs tend to use Facebook page more – almost 90 percent of them have at least a Facebook page). And, according to the same data source, only some 10 percent of Cambodian HEIs have at least one downloadable mobile app; some of those apps are still under development (see Appendix 3.2). Comprehensive digital transformation of Cambodian HEIs is still far from reality and requires a serious level of investment from the government and relevant stakeholders.

3.2.Finding II: Faculty members' perceptions and behaviours towards technology integration

3.2.1. Magnitudes, changes, and variations since Covid-19

Technology integration into instruction in our study was observed at individual faculty-member level and constituted measures of perceived technology readiness, perceived technology impacts, technology application behaviour during Covid-19, and perceived future technology integration. To observe changes in these variables, we compared their magnitudes between the survey data collected immediately after the Covid-19 outbreak and two years after.

3.2.1.1. Perceived technology readiness

Are Cambodian faculty members technologically ready at the early phase (2020) and the later phase (2022) of Covid-19? In our study, perceived technology readiness is a concept measured by 16 items classified into four sub-constructs – i.e., optimism (4 items), innovativeness (4 items), discomfort (4 items), and insecurity (4 items) (see Appendix 2.4). While optimism and innovativeness are considered motivators of technology readiness, discomfort and insecurity are inhibitors.

Overall, Cambodian faculty members have a positive perception on their technology readiness, and they become even more positive at the later phase of Covid-19. Our analyses show that, on a scale from 1 to 5, Cambodian faculty members are highly optimistic about technology ($\bar{x}$ = 4.16), and they also show a fairly high level of innovativeness ($\bar{x}$ = 3.54). On the other hand, their level of discomfort ($\bar{x}$ = 2.95) and insecurity ($\bar{x}$ = 3.07) are still moderate (see Table 1). Compared between the two phases of Covid-19, Cambodian faculty members slightly become more innovative and less insecure towards technology (see Table 1). However, the effect size of the difference of both the increased level of innovativeness (Cohen's d = -.16 or eta^2 = 0.025) and the decreased level of insecurity (Cohen's d = 0.18 or eta^2 = 0.029) is small.

Table 1: Magnitude of sub-constructs of Technology Readiness Index (TRI) of Cambodian faculty members at different phases of Covid-19

TRI sub-constructs	Year	$\bar{x}$	sd	min	max	ca	t	p
Optimism (motivator)	2020	4.16	0.47	2.5	5	0.83	0.35	0.73
	2022	4.15	0.40	2.75	5	0.73		
Innovativeness (motivator)	2020	3.45	0.58	2	5	0.70	-2.68	0.01**
	2022	3.54	0.55	1.5	5	0.66		
Discomfort (inhibitor)	2020	2.97	0.61	1	5	0.52	0.39	0.69
	2022	2.95	0.59	1.5	4.25	0.55		
Insecurity (inhibitor)	2020	3.19	0.63	1.5	5	0.57	2.91	0.004***
	2022	3.07	0.64	1.5	4.5	0.58		

Source: Faculty member survey 2020 and 2022
Note: $\bar{x}$ = mean; sd = standard deviation; min = minimum value; max = maximum value; ca = Cronbach's alpha; t = paired-sample t-test; p = p-value; df = degree of freedom (df = 279); n = 280 for the paired-sample t-test analyses; *** p<0.01, ** p<0.05, * p<0.1

Despite overall positivity, our analyses show some differences in technology readiness of Cambodian faculty members by their age, teaching subject, HEI orientation, and/or HEI type (see Appendix 3.1 for details analyses). Faculty members from university-type HEIs show a statistically significantly higher level of optimism than their counterparts from post-secondary TVETIs (t=-2.31; p<0.05). Younger faculty members (t=3.68; p<0.05), faculty members instructing IT or computer science subjects (F=3.51; p<0.05), and, again, faculty members from university-type HEIs (t=-2.73; p<0.05) posit a higher magnitude of innovativeness than their counterparts (older faculty members, faculty members instructing social science or other science subjects, and faculty members from post-secondary TVETIs respectively). On the other hand, in terms of inhibitors of technology readiness, faculty members from public HEIs show a higher level of discomfort than those from private HEIs (t=-1.98; p<0.05). Faculty members instructing IT or computer science subjects show a lower level of insecurity than those instructing social science or other science subjects (F=4.23; p<0.05).

3.2.1.2. Perceived technology impacts

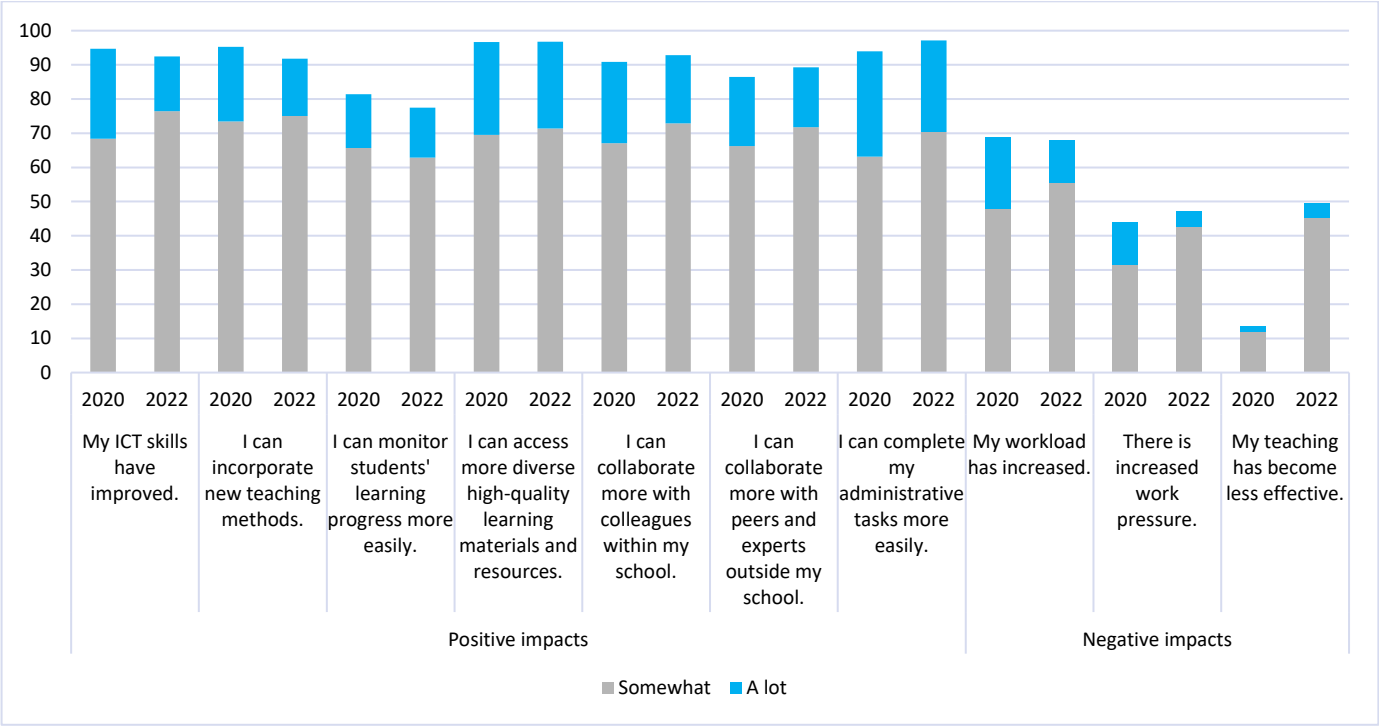
Do Cambodian faculty members think that technology has an impact on or is beneficial for their profession? Ten items containing 7 statements of positive impacts and 3 statements of negative impacts (measured by a 4-point Likert scale) were used to answer this question (see Appendix 2.4).

Our data suggest that a large proportion of them acknowledge that technology positively impacts their profession. At least 70 percent of Cambodian faculty members (in both the 2020 and 2022 surveys) think that there is positive impact of technology on their profession in terms of improved ICT skills, incorporating new teaching methods, monitoring learning progress, accessing quality materials, collaborating with internal and external colleagues, and completing administrative tasks (see Figure 11). The proportion of Cambodian faculty members thinking that technology has negative impact on them professionally is relatively lower in general, compared to the proportion of them having positive perceptions on technology impacts (see Figure 11). However, the level of magnitude is still considerable. Close to 70 percent (in both the 2020 and 2022 surveys) think that using

technologies increases their workloads, around 50 percent (in the second-phase survey) think their teaching becomes less effective (compared to usual teaching in physical classroom), and around 40 percent (in both surveys) are concerned with work pressures caused by technologies. Furthermore, the magnitudes of perceived technology impacts between the 2020 and 2022 surveys were compared using pair-sampled t-tests, with the results showing no statistically significant differences in overall.

Further analyses show statistically significant differences in both perceived positive and negative technology impacts by certain background variables of faculty members (i.e., age, highest degree, HEI orientation, and HEI type) (see Appendix 3.1). Older faculty members posit a higher level of perceived negative technology impacts than their younger counterparts ($t=-2.20$; $p<0.05$). Furthermore, faculty members obtaining a master's or a doctoral degree ($F = 4.68$; $p<0.05$), faculty members from private HEIs ($t=2.43$; $p<0.05$), and faculty members from university-type HEIs ($t=-4.62$; $p<0.05$) posit a higher level of perceived positive impacts than their counterparts (i.e., faculty members obtain a bachelor degree (or lower), faculty members from public HEIs, and faculty members from post-secondary TVETIs).

Figure 11: Perceived technology impacts of Cambodian faculty members



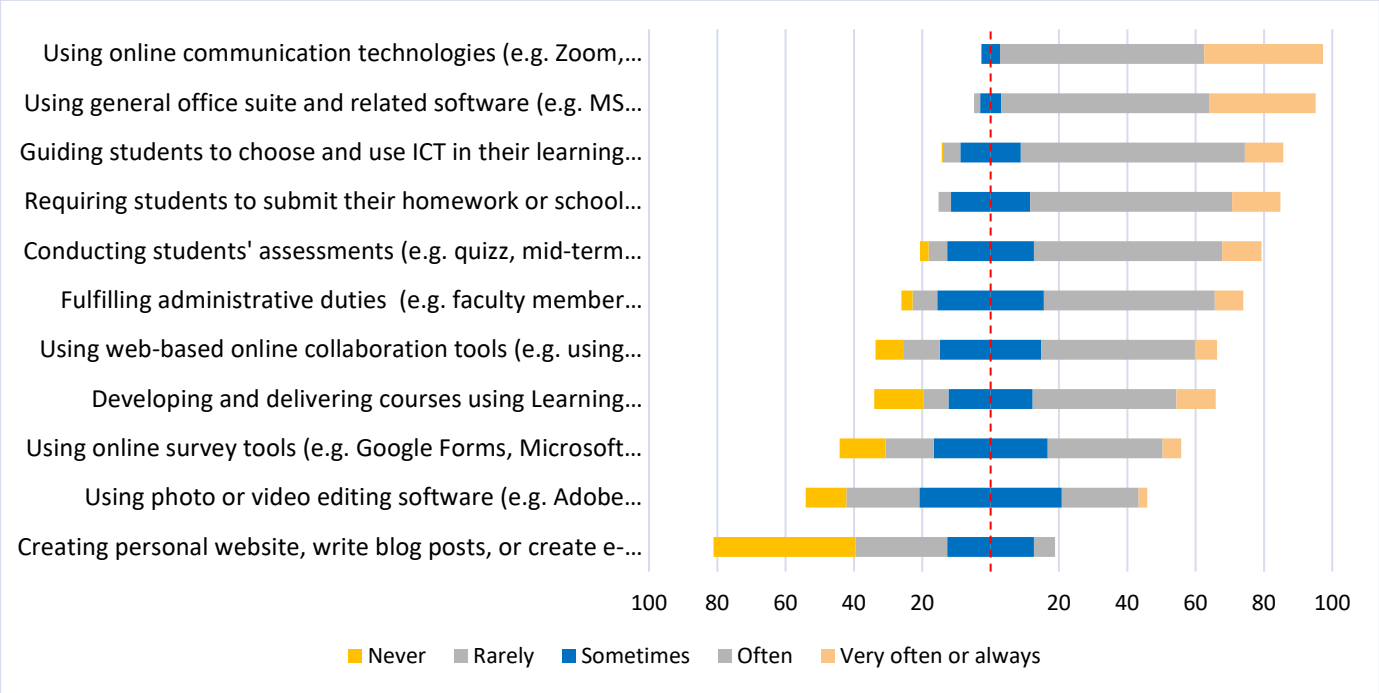
Source: Faculty member survey 2020 (n = 361) and 2022 (n = 280)

3.2.1.3. Technology application behaviour during Covid-19

How do Cambodian faculty members apply technologies in the Covid-19 context? To capture their technology application behaviours, we used 11 behavioural-scale items that observe different areas of practices in our latest survey conducted in 2022 (see Appendix 2.4).

Analyses show that during Covid-19 there are technology application areas in which Cambodian faculty members are well exposed and those in which they are less exposed. For the well-exposed areas, Figure 12 suggests that almost 100 percent of them reported often or always using online communication technologies and using general office suites to produce learning materials during Covid-19. Likewise, almost 77 percent often or always requiring their students to use ICTs to complete assignments; around 73 percent often or always guiding students to choose or use technology tools; around 67 percent often or always conducting assessments via digital means; and around 58 percent often or always fulfilling administrative duties via digital medium. However, a considerable proportion of Cambodian faculty members are not well exposed to certain areas. 18.84 percent of them reported never or rarely using online collaboration tools; 21.74 never or rarely developing and delivering courses using LMS; 27.54 percent never or rarely using online survey tools to conduct research to improve teaching; 33.34 percent never or rarely using photo or video editing software to produce materials to support students' learning; and 68.48 percent never or rarely writing blogs or creating personal website or e-portfolio as a platform to share information and/or interact with students.

Figure 12: Self-reported technology application behaviours of Cambodian faculty members during Covid-19 (in %)



Source: Faculty member survey 2022 (n=276)

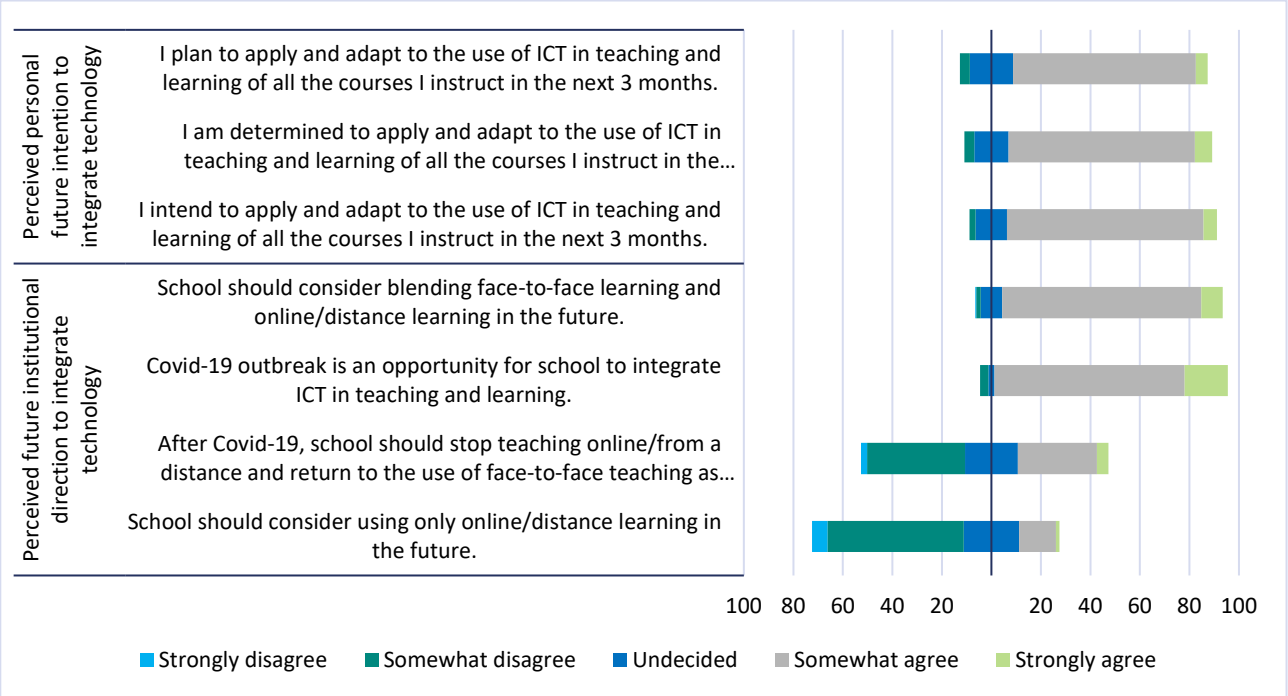
Technology application behaviour of Cambodian faculty members varies by their teaching subjects, highest degree, HEI location, and HEI orientation, and HEI type (see Appendix 3.1)**.** Specifically, faculty members instructing IT or computer science subject ($F=5.49$; $p<0.05$), those obtain a master's degree or higher ($F = 5.93$; $p<0.05$), those from Phnom Penh based HEIs ($t =-2.04$, $p<0.05$), those teaching at private HEIs ($t=2.12$; $p<0.05$), and those working at university-type HEIs ($t=-4.63$; $p<0.05$) applied technologies more frequently during Covid-19 than their counterparts.

3.2.1.4. Perceived future technology integration

Do Cambodian faculty members have positive perceptions towards future technology integration into instruction (particularly, after the Covid-19 pandemic)? Perceived future technology integration was measured by seven items (see Appendix 2.4), grouped into perceived personal future intention to integrate technology and perceived institutional future direction to integrate technology.

Faculty members show a very high level of positive perception towards both dimensions of perceived future technology integration. More than 80 percent of the respondents either somewhat agree or strongly agree with the three items on personal intention to apply and adapt to ICT into teaching and learning. As for their perception on future technology integration of their institution, almost 90 percent somewhat or strongly agree that their HEIs should blend online and physical teaching and learning mediums, and around 94 percent somewhat or strongly agree that Covid-19 is an opportunity for HEIs to integrate ICTs. Additional two items to cross-check the consistency of the responses suggest further that the respondents are steady with their reported perceptions (with 42.03 percent of the respondents somewhat or strongly disagreeing when asked whether school should stop teaching online/from a distance and use only face-to-face teaching as before, and 61.23 percent somewhat or strongly disagreeing when asked to rate whether school should consider using only online/distance learning in the future) (see Figure 13).

Figure 13: Perceived future technology integration into instruction of Cambodian faculty members (in %)



Source: Faculty member survey 2022 (n = 276)

Further analyses suggest that the magnitude of perceived future technology integration statistically significantly varies by HEI type. That said, faculty members from university-type HEIs show a more positive perception on future

technology integration, compared to their counterparts from post-secondary TVETIs (t = -3.71, p<0.05) (see Appendix 3.1).

3.2.2. Correlates of technology application behaviour during Covid-19 and perceived future technology integration

In this section, we specifically aimed to examine what factors explain technology application behaviour during Covid-19 (see Model 4, Table 2) and what factors explain perceived future technology integration (see Model 5, Table 2) of Cambodian faculty members. However, our analyses further offer findings on factors associated with their perceived technology readiness (see Model 3), perceived technology impacts (see Model 2), and perceived ICT competence (see Model 1). Guided by our literature review, we chose to adapt Inan & Lowther's empirical model to explain technology integration in education (see Inan & Lowther, 2010, p. 141). Appendix 2.3 illustrates all variables and hypothesized relationships of our adapted model. We used path analysis to test our model because it allows us to identify determinants that explain more than one endogenous variable and capture both their direct and mediating effects.

Direct effect: Our path analyses (after model modification) suggest that year of teaching (b = .007; SE = .003; p = 0.027; B = .126), perceived technology readiness (b = .184; SE = .072; p = 0.011; B = .16), perceived technology impacts (b = .182; SE = .081; p = 0.025; B = .141), and technology application behaviour during Covid-19 (b = .134; SE = .042; p = 0.02; B= .191) have direct positive influence on Cambodian faculty members' perceived future technology integration (see Model 5, Table 2). These four significant exogeneous variables explain 14.8 percent of the variation in the perceived future technology integration. Comparing the standardized coefficients (B) among these significant variables, technology application behaviour during Covid-19 has the strongest effect on perceived future technology integration.

Secondly, our analyses (see Model 4, Table 2) suggest that year of teaching (b = .009; SE = .004; p = .013; B = .11), perceived ICT competence (b = .484; SE = .044; p = .000; B = .572), and perceived infrastructural and financial support (b = .13; SE = .049; p = .008; B = .164) directly and positively influence Cambodian technology application behaviour during Covid-19. These significant exogenous variables explain 50.1 percent of the variation in the technology application behaviour during Covid-19, with perceived ICT competence the most influential correlate (B = .572). It should be noticed that perceived policy and leadership support (b = 0.11; SE = 0.062) and technology-supported teaching experience (b = 0.057; SE = 0.031) are also statistically significant but at p-value less than 0.1, suggesting that these two variables may also have some influences on technology application behaviour during Covid-19 of Cambodian faculty members, but such influences could not be captured in the current dataset.

Besides, our main path model also shows that perceived technology impact of Cambodian faculty members is explained by perceived policy and leadership support (b = .095; SE = .043; p = .025; B = .171) and technology-supported teaching experience before Covid-19 (b = .049; SE = .02; p = .015; B = .134) (R^2 = 0.162) (see Model 3,

Table 2). Perceived technology readiness of Cambodian faculty members is explained by only perceived ICT competence (b = .176; SE = .03; p = .000; B =.34) (R^2 = 0.179) (see Model 2, Table 2). And, finally, perceived ICT competence is explained by year of teaching (b = -.016; SE = .005; p = .001; B = -.171), perceived policy and leadership support (b = .22; SE = .09; p = .014; B = .182), technology-supported teaching experience before Covid-19 (b = .216; SE = .044; p = .000; B = .272), and received training on technology integration in teaching and learning (b = .237; SE = .07; p = .001; B = .186) (see Model 1, Table 2), with an R^2 of 0.211. In this last model, year of teaching has negative influence on perceived ICT competence.

Mediating effect: Using Stata's *medsem* command under the principles of Baron and Kenny's approach, we also detected an indirect mediating effect of ICT competence on the relationship between technology-supported teaching experience and perceived technology readiness, which is a complete mediation (Indirect effect = 0.105; SE = .023; z = 4.464; p =.000; RIT =.647; RID =1.835). Other hypothesized mediating effects in our model (see Appendix 2.3) are not statistically significant.

Goodness of fit indices: In our final modified path model (with direct and mediating effects) (see Appendix 2.3), we obtained an acceptable goodness of fit indices, with Chi-squared (model vs saturated) = 4.726 (p = .693); RMSEA = 0.000 (p<= 0.05); TLI = 1.030; CFI = 1.000; and CD = 0.406. The overall R^2 of the whole path model is .406.

In order to understand whether the detected influence of exogenous variables on our endogenous variables in the main path model changes if we analyse our samples by their different attributes (i.e., by age, teaching subject, HEI orientation, HEI location), we performed further sub-group analyses. We detected changes in the status of statistical significance of a number of exogeneous variables (see Appendix 3.3 for detailed statistics), implying that, in a real-world setting, we need to interpret the detected influences in our main model (Table 2) with caution (especially, in terms of sample size).

For example, when the path analyses were performed separately by the age of the participants (1 = 41 or younger; 2 = Older than 41), perceived technology readiness remains a statistically significant predictor of perceived future technology integration for only the older-than-41 group. This implies that younger faculty members' perceived technology readiness does not influence their perceived future technology integration. Similarly, when the data was analysed by separating the samples into social sciences and related fields (coded 0) and sciences and related fields (coded 1), perceived technology readiness remained a statistically significant determinant of perceived future technology integration for only the faculty members of social science and related fields. For separated analyses of HEI location (0 = Province; 1 = Phnom Penh), perceived technology readiness and perceived technology impacts remain a statistically significant correlate of perceived future technology integration for only Phnom Penh-based faculty members. As for HEI orientation (0 = Private; 1 = Public), perceived technology readiness became an insignificant predictor of perceived future technology integration when the data is separated by public and private HEIs.

Table 2: Main path models of technology application behaviour during Covid-19 and perceived future technology integration of Cambodian faculty members

Variables	(Model 1) Perceived ICT competence	(Model 2) Perceived technology readiness	(Model 3) Perceived technology impacts	(Model 4) Technology application behaviour	(Model 5) Perceived future technology integration
Perceived ICT competence		0.176***		0.484***	
		(0.030)		(0.044)	
Perceived technology readiness				0.036	0.184**
				(0.080)	(0.072)
Perceived technology impact				0.043	0.182**
				(0.094)	(0.081)
Year of teaching	-0.016***	-0.004	-0.001	0.009**	0.007**
	(0.005)	(0.003)	(0.002)	(0.004)	(0.003)
Perceived policy and leadership support	0.220**	0.063	0.095**	0.110*	
	(0.090)	(0.048)	(0.043)	(0.062)	
Perceived infrastructure and financial support	0.027	0.037	0.054	0.130***	
	(0.072)	(0.038)	(0.034)	(0.049)	
Perceived human and technical support	0.001	0.001	0.064*	-0.043	
	(0.071)	(0.037)	(0.034)	(0.048)	
Technology-supported teaching experience	0.216***		0.049**	0.057*	
	(0.044)		(0.020)	(0.031)	
Received ICT integration training	0.237***	-0.018	-0.011	0.037	
	(0.070)	(0.037)	(0.033)	(0.048)	
Technology application behaviour					0.134***
					(0.042)
Constant	1.523***	2.533***	2.037***	0.586*	1.859***
	(0.304)	(0.161)	(0.144)	(0.312)	(0.268)
R^2	0.211	0.179	0.162	0.501	0.148
Observations	280	280	280	280	280

Note: Unstandardized coefficient (b) reported in the table; Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; (1), (2), (3), (4), and (5) are different endogenous variables in the model (see Appendix 2.3).

Such changes in the status of statistical significance also take place for other endogenous variables in the model (i.e., technology application during Covid-19, perceived technology readiness, perceived technology impacts, and perceived ICT competence). What is noticeable, however, is that perceived ICT competence remains a strong determinant of perceived technology readiness and technology application behaviour during Covid-19 regardless of the analyses of separate samples, suggesting that individual ICT competence is an important determinant in our tested models.

4.Discussions

The main purpose of this study is to comprehend how and to what extent actors at different levels within Cambodian HE system have embraced and integrated technologies. Our analyses of relevant policies at the system level, developments at the institutional level, and actual integration of ICTs at the faculty-member level before and since the Covid-19 outbreak show evidence of both positive changes and lingering issues within and across each level.

System-level mechanism of ICT integration: unempowering coordination and defied result-based approach

Multiple pieces of data confirm that Cambodian HE governing bodies and relevant departments of MoEYS have taken measured policy responses to curb negative impacts of Covid-19. Considering the unusual conditions of Covid-19 and the unpreparedness of the system for such a crisis, most HE stakeholders participating in this study acknowledge that the system-level ICT-related actions to respond to Covid-19 by the ministry are acceptable.

Despite positive feedback on the ministry's responses to the pandemic, Covid-19 discloses various ICT-related policy failures of Cambodian HE. Some pre-Covid-19 targets set in the ICT-in-Education policies and plans (MoEYS, 2004, 2010, 2018) and in other HE sub-sectors' plans (MoEYS, 2014b, 2017) are either unaccomplished or slowly implemented. The attempt to build the Open and Distance Learning (ODL) platform and the national open university in Cambodia (MoEYS, 2004, 2010, 2017), for example, have failed to materialize until now. Consequently, the policy promises to increase enrolment, improve equity, provide quality content, or promote lifelong learning at HE level through ODL and technologies cannot be fully realized. Even certain achieved policy targets (such as MoEYS e-learning and OER platforms) need further improvements in both quantity and quality. Our data suggest that faculty members and students at HE level have not widely accessed or used those resources. HEMIS and other relevant MIS's (TVETMIS or LMIS) platforms also need to be further innovated, integrated, and openly accessible beyond their current scope. Otherwise, the expectation that management information systems can leverage MoEYS's and MLVT's capability to use data-driven and evidence-based approach to govern and support HEIs (MoEYS, 2014a, 2018) will remain only in policy papers. Our analyses of ICT-in-Education policies, focusing on Cambodian HE sub-sector, clearly add to Richardson's findings (2008, 2009, 2011) that most Cambodian ICT-in-Education strategies have not been achieved yet.

In order to better evaluate ICT-in-Education policies (especially, for the HE sub-sector), Cambodian ministries and relevant departments need a clearer and collectively agreed monitoring and evaluation plan, committed expert teams, and a political will to justly and openly conduct such monitoring and evaluation. Monitoring and evaluation is an important aspect of international ICT-in-Education policies and plans (Kozma, n.d., 2008; Trucano, 2016). In the Cambodian ICT-in-Education policies and plans, the sections on monitoring and evaluation are generally brief, and there seems to be no clear breakdown of financial package for each strategic area in the 2010 mater plan. It is hard to observe clearly how much and in what budget chapters money are allocated to achieve the stated indicators, objectives, and missions in the policies. Likewise, relevant data and specific evaluation reports of the previous ICT-in-Education policies and plans are not available publicly.

In addition to monitoring and evaluation, the lack of mechanisms to avail, retain, and grow expert teams with information technologies and knowledge management capabilities at the directorate or departments responsible for HE is a concern for ICT integration at HE-system level. This issue makes coordination across levels (i.e., system, institution, and faculty-member level) and within each level (e.g., between HEMIS coordinating team and other MIS's coordinating teams at the system level) deeply challenging and so causes troubles in collecting and generating high-quality data from HEIs or post-secondary TVETIs. Close observers understand that without sincere acknowledgement of the coordination issue and a rule-based political will to solve them, building a well-integrated ICT system across different levels of HE in Cambodia will continue to face hardship (see, for instance, Richardson, 2008, 2011). It should be noted that structural root causes (such as poor state salary, little opportunities for non-salary incentives, and unsatisfactory working environment) have remained unsettled, making it hard for relevant directorate or departments to fully use their able experts and talents to perform complex ICT-integration tasks. Also, HEIs may not collaborate in inputting data for HEMIS because current regulatory and market pressures for evidence-based quality on Cambodian HEIs have remained relaxing.

Development of online education at HEIs: unmet quality standards and discounted accountability obligation

Covid-19 also provides a context for ICT integration to accelerate at HEIs. As observed in research findings elsewhere (OECD, 2021a; World Bank Group, 2020), the exposure of HEIs' leaders, administrators, faculty members, and students to online teaching and learning and the improvement in mobile-technology-enabled administrative practices at HEIs appear to be common practices of ICT integration at institutional level during Covid-19. Leaders and other relevant actors of Cambodian HEIs need to continue teaching and learning activities to ensure institutional as well as professional survival.

However, Cambodian HEIs, varied by their own conditions, are still challenged in many ways in terms of their current practices of ICT integration and their future outlook towards comprehensive digital transformation.

Firstly, most Cambodian HEIs have not had full-fledged and high-quality online education platforms. The sudden exposure to online teaching and learning during Covid-19 only provides a good experience in operating synchronous

online meetings thanks to the impossibility for teachers and students to meet face to face. Other more important areas of online education – i.e., systemic use of LMS, availability of digital educational materials and resources for asynchronous learning, strategic design of mediums of online education delivery, full implementation of quality standards for online teaching and learning, and other administrative polices or regulations that set standards for online education – are still being developed at certain Cambodian HEIs or simply overlooked by others. In fact, the practices during the pandemic do not contribute to addressing major Cambodian HE issues such as low enrolment and concerns on quality.

Furthermore, whether via the lens of the new Cambodian EdTech Framework (MISTI, 2022) or of various international frameworks for ICT integration or digital transformation of HE (see Balasubramanian et al., 2009; Hage, 2021; Toledo, 2005), what most Cambodian HEIs expose to during Covid-19 is still far from achieving standardized ICT integration or digital transformation at their institution. Our data suggest that Cambodian HEIs still face difficulty in integrating their existing ICT tools and systems with emerging EdTech tools and systems (e.g., accounting and financial report systems, SMS, LMS, learning analytics) in a way that is cost-effective and functional in the long run. After the pandemic, more time is needed for Cambodian HEIs to study how to integrate technologies systematically and comprehensively. Literature suggests that it is a big mistake to install technologies without understanding students' needs, impose technology systems from the top down without adequate consultation, use inappropriate content from other regions of the world without proper customization, and develop low-quality contents with poorly instructional design (Balasubramanian et al., 2009, p. 24).

To explain the above-discussed challenges with online education development and delivery, our multiple sets of data point to the lack of talented and committed faculty members (or relevant personnel) to develop digital content and materials; inadequate experience and understanding of best practices in developing online courses and programs; and to some extent concerns on financial capitals to deploy and sustain online education platforms after being developed. Additional to these factors, Cambodian HE system and HEIs do not seem to share the same vision on how to build a robust, mutually-beneficial ICT-enabled online education system.

Secondly, whether ICT integration and digital transformation at the institutional level can be used to improve the accountability of Cambodian HEIs is a concern. Our analyses of data collected during Covid-19 suggest, for example, that older faculty members have lower level of perceived innovativeness in using technology than their younger peers do.Moreover, non-IT faculty members not only have lower level of perceived innovativeness but also higher sense of perceived insecurity towards technology, compared to their IT-specialized counterparts. This gap widened during Covid-19 as faculty members could not collaborate when integrating technologies into teaching and learning. An implied question from such finding is whether Cambodian HEIs have been accountable enough to different groups of their faculty members and students, especially the vulnerable ones.

Likewise, as discussed earlier, most Cambodian HEIs have not provided data for the ministry's HEMIS database, which makes it hard to monitor and evaluate the quality and performance of those HEIs and their staff. It is

concludable to a large extent that most HEIs are not accountable in terms of supply of reliable data and information to their supervising ministries and the public even though, in fact, HEIs themselves can reap benefits from generating those institutional data. It should be highlighted that HE accountability issue in Cambodia, which was expected to be addressed by means of ICTs and technologies, has remained overlooked, if not ignored.

The infancy of internal quality assurance units at HEIs, lack of institutional research and learning strategies, challenges in HE accreditation practices, and politics at HEIs are perhaps some of the explanations for the inability of Cambodian HEIs to use technologies-enabled approaches to achieve accountability. Also, specific to our datasets, ICT integration at Cambodian HEIs is somehow not a drive from within the institution but a phenomenon occasioned by external influences and contextual needs – i.e., the Covid-19 outbreak, the government's digital transformation direction, and the effect of rapid advancement of EdTechs. This implies that current positive changes in online education or technology-enabled administration of HEIs can be more of a superficial change**.**

Faculty members' positive perceptions on technology and the need to ensure meaningful integration

Cambodian faculty members' responses in both the surveys and interviews suggest that embracing and integrating technologies into instruction during the Covid-19 emergency is manageable to a large extent. Faculty members who are reportedly shocked during the early outbreak of Covid-19 generally become more positive in perceptions towards their technology readiness and acknowledge positive impacts brought by technologies on their profession as they go through the Covid-19 years. Similar to findings in other countries, our study shows collective agreement among faculty members that integrating digital technologies is inevitable (Balasubramanian et al., 2009, p. 31) and will be further intensified in the post-pandemic context (OECD, 2021a, p. 37).

Despite such positive perceptions, Cambodian faculty members in general have not practiced certain areas of technology integration – especially, in using educational technologies to develop online courses, programs, or relevant teaching and learning materials; to collaborate or engage with online communities for professional purposes; and/or to conduct research to improve teaching and learning. The limitation in these application areas indicates that the pandemic-driven technology integration by Cambodian faculty members may not yield satisfactory learning outcomes yet. Corroborating with most local literature (see Chet et al., 2022), our data shows that Cambodian students are not very satisfied with online learning during Covid-19. According to the literature, they are also less engaged in learning, their well-being is affected, and the idea of remote-only approach to teaching and learning at HE level may not work in the long run (Cifuentes-Faura et al., 2021). Our study further confirms that faculty members still confront various pedagogical issues – such as difficulty in remote assessment, group work during online classes, and interruptions during teaching and learning. Such results may render the earlier-discussed positive perceptions of faculty members invalid in the future because most educators will not integrate technologies if they continue to see no significant positive changes in students' learning outcomes (Means, 2010, p. 287). In other words, technology integration beyond the emergency context needs to be more meaningful.

Technology integration capability as a key factor

Both institutional supports and individual agency-driven capabilities positively influence technology application behaviour of Cambodian faculty members during the pandemic.

It is obvious that supportive leadership with clear decision and guidance and strong technical support team at HEIs (or their departments) are necessary for faculty members to adopt and adapt to ICT tools and processes that allow them to continue teaching and learning during the pandemic. Likewise, infrastructural and financial support from HEIs, rapidly provided in accordance with changing situations of the pandemic, is an important institutional tactic that determines whether or to what extent faculty members at a particular HEI can apply technologies. In fact, it could cost significantly to engage Cambodian faculty members in implementing online teaching and learning, but most Cambodian HEIs were able to avail financial and technological resources necessary for use during the emergency (e.g., by seeking free access to certain software from technology companies or using their internal human resources with IT skills to manage the system-operation or capacity-building process). To some extent, our research results add to findings in existing literature (see Hew & Brush, 2007; Inan & Lowther, 2010; Larson et al., 2009) by highlighting the important role of institutional support in empowering faculty members to apply and embrace technologies, especially in response to crises.

Yet, what we want to emphasize more from our study is the individual capability factor. Our data suggest that Cambodian faculty members with higher ICT competence and more experience in technology-supported teaching before Covid-19 apply technologies more actively during the pandemic. Without doubt, major models of technology integration (e.g., TPACK, SAMR, TIM, ACOT) require teachers or faculty members to understand technologies (particularly, ICTs) to a certain degree (Bonfiglio-Pavisich, 2018; Chea et al., 2022; Inan & Lowther, 2010; Knezek & Christensen, 2016) in order for them to generate positive learning outcomes through their technology-enhanced instruction. Our qualitative data further emphasizes that faculty members who have a strong interest in technologies and an independent attitude towards learning and understanding new technologies generally have used ICTs and multi-media platforms long before Covid-19, and hence they do not find applying ICTs during Covid-19 a burden at all. Through our quantitative analyses, ICT competence also positively influences perception on technology readiness of Cambodian faculty members, which possibly allows them to feel less uncomfortable and insecure even if they have to engage in using new technologies. Adding to individual competence, experiences teaching using technologies before Covid-19 also has a direct influence on technology application behaviour of Cambodian faculty members during Covid-19. Our analysis indicates especially that ICT competence mediates that direct effect of technology-supported teaching experiences before Covid-19 on technology application behaviour during Covid-19.

One implication from our study is the importance of professional development on technology integration for Cambodian faculty members. We boldly highlight the need for faculty members to take individual agencies in building their ability to explore, master, and apply technologies in different areas of their professional practices. The

UNESCO ICT Competency Framework for teachers (UNESCO, 2018, p. 19) suggest that teachers' learning and application of digital skills should be a continuous professional growth throughout their careers, and it takes efforts to master that (Means, 2010, p. 285). Technology integration into instruction, especially at HE level, is a diverse and constantly changing area, but training and learning resources available for capacity development in this area are also abundant. So, opportunities to engage in professional development in this area are rich for faculty members, regardless of whether their HEIs provide such opportunities or not.

Based on lessons learnt from the analyses of our data during Covid-19, a key principle in building Cambodian faculty members' capacity to integrate technologies is perhaps to expose them more to best practices in the transformative pedagogical model of instruction. Such technology-enhanced model constitutes various recommended practices – particularly, the use of ubiquitous learning resources that encourages personalized learning, active-collaborative learning, experiential learning, inquiry-based learning, constructivist approach to instruction, and/or job-ready approach to higher education. Such practices may remedy the specific problem of low satisfaction in online and technology-supported education of Cambodian students while addressing various major HE issues in Cambodia (such as limited learners-centred pedagogy or poor lifelong learning habit). Another principle is that teachers need to integrate ICTs to promote their knowledge acquisition, knowledge deepening, and knowledge creation (UNESCO, 2018, p. 21). Embracing this principle, faculty members can exploit technologies for the improvement of their other roles – such as research, community engagement, and international engagement – which are not covered in this study but embedded in the holistic conceptualization of technology integration or digital transformation of HE (see Balasubramanian et al., 2009; Hage, 2021).

5.Conclusions and Policy Recommendations

Overall, our findings do not diverge from a general conclusion that Covid-19 brings both opportunities and challenges to Cambodian HE system (Chea et al., 2020; Heng, 2021; Som et al., 2021). Covid-19 is a wake-up call for all Cambodian HE actors to take changes more seriously and so to embrace ICTs more strategically and accountably in order to transform HE practices and performance. Challenges related to management information systems; establishment of system-level ODL platforms; development of institution-level online/e-learning courses, programs, or modalities; provision of equitable and inclusive technology-related support to faculty members; and enhancement of technology integration capabilities of faculty members are major Covid-19-derived lessons. Relevant HE actors may need to consider and address these challenges subsequently after the pandemic. Our study offers the following recommendations:

System level: The governing bodies need to address the gap in coordination within and between the system and institutional level in order to build a robust ICT-enabled HE governance and management mechanism. The problem in developing and utilizing HEMIS needs to be reconsidered by relevant stakeholders. Beyond HEMIS, HE policy makers may need to develop new policies and plans specific on ICT integration or digital transformation of

Cambodian HE sub-sector. In doing that, they need to take into consideration how ICTs can address major issues of Cambodian HE and post-secondary TVET sub-sectors (e.g., low HE enrolment or the lack of data-driven governance practice). Such policies and plans need to incorporate a clearer and more empowering framework for cross-level coordination, results-based monitoring and evaluation, and accountability orientation.

Institutional level: HEIs and post-secondary TVETIs need to continue providing active and more equitable institutional support on ICT integration beyond emergency needs. Rather than relaxing their ICT-related institutional and instructional reforms, Cambodian HEIs are better off furthering their ICT integration and digital transformation actions in the post-pandemic context. There is a need to transform their online teaching and learning experiences during Covid-19 into a full-fledged, standardized, and more flexible online education platform. Such a new online education component at each HEI can be developed and designed to provide an alternative means for students to access HE while establishing another mechanism for the institution to generate income. HEIs need to conduct clear investigation on costs and benefits of different modalities to deliver online education. Forming partnerships with private EdTech companies and collaborating among HEIs remain a sound strategy for Cambodian HEIs to boost ICT integration and digital transformation.

Faculty member level: All actors need to contribute to deepening faculty members' individual agencies in ICT integration into teaching and learning. This means that faculty members need to continue embracing ICTs even after the post-pandemic context by re-conceptualizing an appropriate technology integration framework that fits into their own teaching and learning context. Re-conceptualizing here can mean various things – from understanding the technology-pedagogy-knowledge connection to seeking new opportunities to grow their technology-enabled teaching and learning experiences. The area of ICT integration is, therefore, a must-have element in future professional development programs at Cambodian HEIs as well as in the future professional competency framework of Cambodian faculty members.

In the post-pandemic context, a more systemic approach to ICT integration and digital transformation remains relevant and paramount for Cambodian HE and post-secondary TVET sub-sector development as these sub-sectors seek to transform in accordance with the national digital transformation movement. Technology integration and digital transformation of Cambodian HE cannot be successful if its operation is not well-integrated within and across the system, institution, and instruction levels; not trusted by all stakeholders; and not independently and collectively acted upon by key actors (especially, faculty members).

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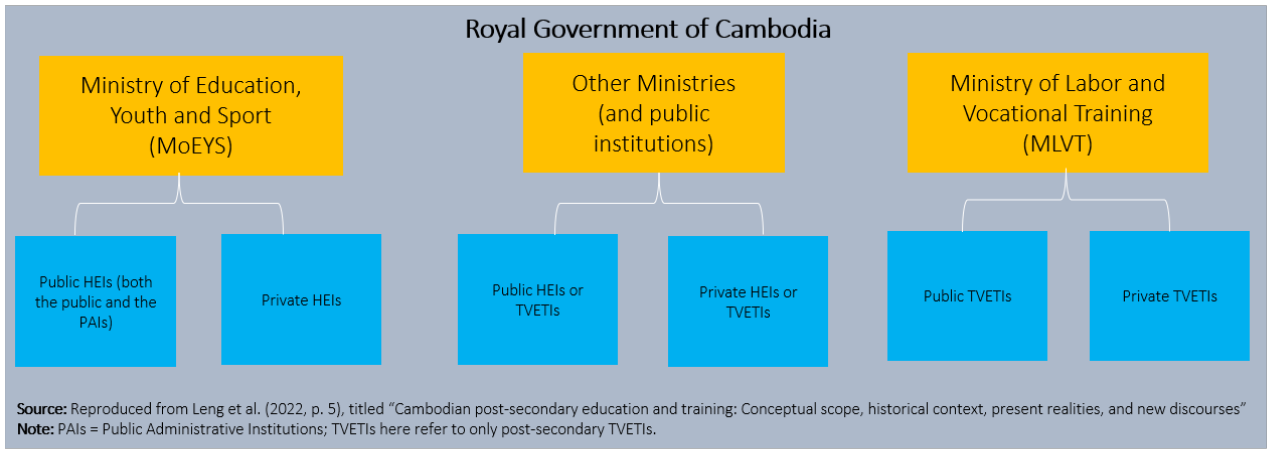
APPENDICES

Appendix 1: Appendices related to Cambodian higher education system and institutions

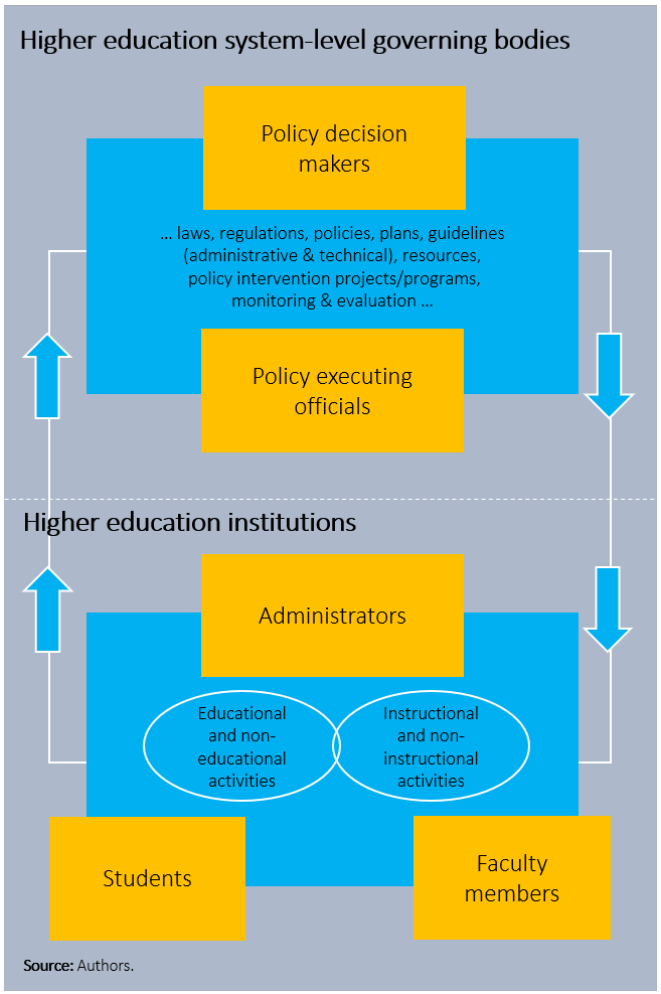
Appendix 1.1. Dashboard showing key aspects of Cambodian HE

a. Stylized structure of Cambodian post-secondary education and training (PSET) system governance and types of institutions



Source: Reproduced from Leng et al. (2022, p. 5), titled "Cambodian post-secondary education and training: Conceptual scope, historical context, present realities, and new discourses"
Note: PAIs = Public Administrative Institutions; TVETIs here refer to only post-secondary TVETIs.

b. Stylized systemic view of mutual influences between activities at HE system level and those at institutional level in Cambodia



Source: Authors.

c. Basic information of Cambodian education financing

Sections	Items	2019	2020	2021	2022	2023
Financing resources available for Cambodian education sector	Government expenditure on education (in million Riel)	3,229,604	3,577,655	3,975,988	4,423,847	4,925,415
	❑ Government expenditure on education (as % of GDP)	2.97%	3.01%	3.04%	3.07%	3.10%
	❑ Government expenditure on education (as % of total expenditure)	18.40%	18.60%	18.80%	18.90%	19.10%
	External fund (PIP) (in million Riel)	553,640	583,371	492,561	402,562	330,806
	Total available financing resources (in million Riel)	3,783,244	4,161,026	4,468,549	4,826,409	5,256,221
Financing needs by sub-sector	Total ESP projected financing needs (in million Riel)	3,817,885	4,175,203	4,529,349	4,877,838	5,289,762
	❑ Early childhood education (%)	6.46%	6.57%	6.54%	6.29%	6.36%
	❑ Primary education (%)	51.59%	50.54%	48.94%	48.30%	47.26%
	❑ Secondary education (%)	28.64%	28.49%	30.09%	30.77%	31.42%
	❑ Higher education (%)	9.63%	10.51%	10.62%	10.76%	11.07%
	❑ Non-formal education (%)	1.10%	1.37%	1.35%	1.51%	1.53%
	❑ Youth (%)	0.70%	0.77%	0.77%	0.73%	0.72%
	❑ Sport (%)	1.88%	1.76%	1.69%	1.65%	1.64%

Source: MoEYS Education Strategic Plan (ESP) 2019-2023 (2019, p.66); Note: There are gaps between available resources and projected financial needs.

Appendix 1.2. Some key policy indicators of Cambodian HE sub-sector performance

Indicators	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
▪ Gross enrolment rate (18-22 years old) from MoEYS's Congress Report	14.00	10.86	10.49	11.57	12.00	13.30	12.43
▪ Gross enrolment rate (18-22 years old) from UNESCO Institute of Statistics	13.14	N/A	13.13	13.69	14.74	N/A	N/A
▪ Total number of enrolled students in the system of a particular academic year	217,840*	207,423 *	211,484*	222,879*	201,910*	198,363*	N/A
▪ Number of full-time academic staff with doctoral degree 1.	1,016 (13,502)	1,278 (14,960)	1,309 (16,167)	1,368 (16,525)	1,391 (16,676)	1,437 (16,438)	N/A
▪ Number of HEIs	121	N/A	125	N/A	128	130	N/A
▪ Number of Centers of Excellence	N/A	N/A	N/A	N/A	1	2	3
▪ Number of HEIs that implement internal quality assurance system	N/A	N/A	N/A	N/A	10	16	17
▪ Number of HEIs accredited	N/A	N/A	N/A	N/A	10	10	10
▪ Number of HEIs that provide input data into HEMIS	N/A	N/A	N/A	N/A	13	24	24
▪ Number of HEIs that complete tracer studies (conducted by DGHE)	N/A	N/A	N/A	N/A	5	5	5

Sources: Reproduced from various latest MoEYS Annual Congress Reports (2016, 2017, 2019, 2021, 2022);
Notes:

- N/A = Not Available;
- * = Sum of number of students of associate degree, bachelor degree, master's degree, and doctoral degree programs (reported in the Congress Reports);
- (…) = Total number of full-time academic staff (reported in the Congress Reports); part-time academic staff are not included in this number.

Appendix 2: Appendices related to research methodologies

Appendix 2.1. List of documents on or related to ICTs and ICTs in education in Cambodia

By sector		List of documents	
		Technology related documents	**General documents**
Education and training sectors	**Before Covid-19**	• Policy and strategies on Information and Communication Technology in Education in Cambodia (December 2004) • Master plan for Information and Communication Technology in Education 2009-2013 (December 2010) • Map of Education Management Information System (EMIS) 2014-2018 (March 2014) • Policy and Strategies on Information and Communication Technology in Education in Cambodia (May 2018) • Information and Communication Technology Policy 2017-2020 of Royal University of Phnom Penh (2017)	• Law on Education (December 2007) • Cambodia Education 2030 Roadmap: Sustainable Development – Goal 4 (February 2019) • Cambodia Education Strategic Plan 2006-2010 (December 2005) • Cambodia Education Strategic Plan 2014-2018 (March 2014) • Policy on Science, Technology, Engineering, and Mathematics (STEM) Education (March 2016) • Cambodia Education Strategic Plan 2019-2023 (June 2019) • National Technical Vocational Education and Training Policy 2017-2025 (2017) • National Policy on Lifelong Learning (2019) • Handbook on Higher Education Quality Assurance System (2016) • Cambodian Guidelines and Rubrics for National Standards for Accreditation of Higher Education Institutions (2019)
	Since Covid-19	• Cambodia Education Response Plan to Covid 19 Pandemic (July 2020) • EduTech Roadmap (2022)	• Result-Based Policy Framework and Public Investment Program in Education 2022-2030 (February 2022)
Other sectors	**Before Covid-19**	• Policy on Information and Communication Technology (ICT) 2020: Towards ICT Connected and Readiness (April 2016) • Cambodia's National Science and Technology Master Plan 2014-2020 (December 2013) • National Policy on Science, Technology and Innovation 2020-2030 (2019)	• Rectangular Strategy for "Growth, Employment, Equity and Efficiency: Building the Foundation toward Realizing the Cambodia Vision 2050" Phase IV (September 2018) • National Strategic Development Plan 2019-2023 (2019) • Cambodia Industrial Development Policy 2015-2025 (2015)
	Since Covid-19	• Cambodia Digital Economy and Society Policy Framework 2021 – 2025 (2021) • Cambodia's Science, Technology and Innovation Roadmap 2030 (2021) • Cambodia Digital Government 2022-2035 (January 2022)	• Strategic Framework and Economic Recovery Plan for Post-Covid-19 Life in the New Normal 2021-2023 (December 2021)

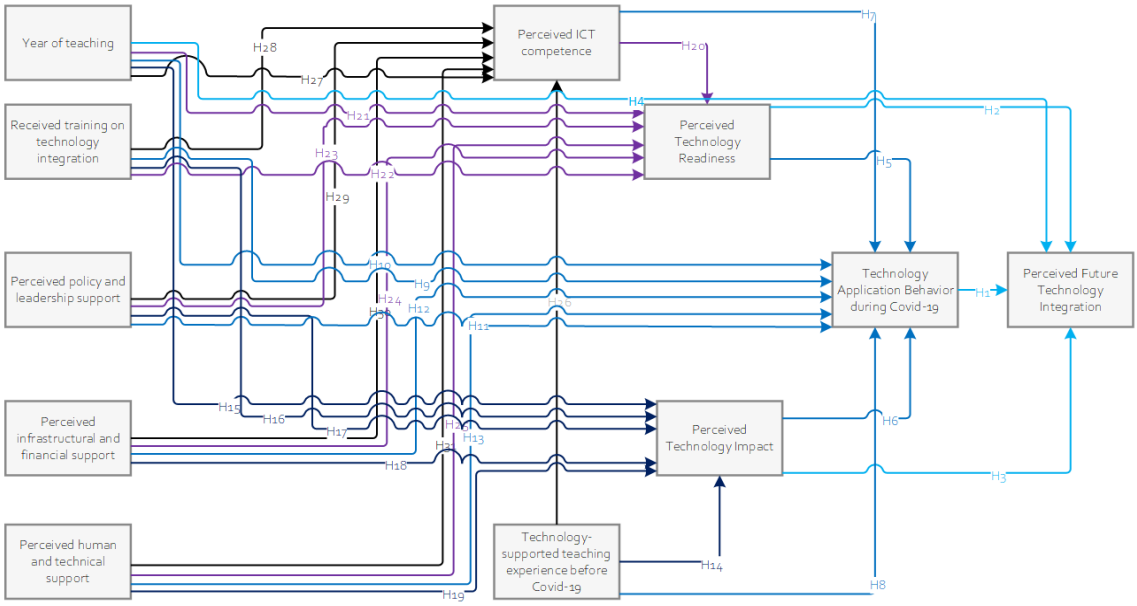
Source: Authors

Appendix 2.2. List and characteristics of key informants

No.	Code	Interviewee group	Sex	Description of affiliation	Description of position	Interview Date
1	PM1	Policy maker	Male	MoEYS, DGHE	Leading and policy decision making position	24-Aug-22
2	PM2	Policy maker	Male	MLVT, DGTVET	Leading and policy decision making position	15-Sep-22
3	HL1	Higher education leader/administrator	Male	A public, province-based university	Vice dean (of a faculty)	10-Sep-22
4	HL2	Higher education leader/administrator	Male	A public, province-based university	Vice rector (Multiple areas of responsibilities)	30-Aug-22
5	HL3	Higher education leader/administrator	Male	A public, Phnom-Penh-based university	Vice rector (Finance & Research)	15-Aug-22
6	HL4	Higher education leader/administrator	Male	A private, Phnom-Penh-based university	Vice rector (Assessment)	19-Aug-22
7	HL5	Higher education leader/administrator	Male	A private, Phnom-Penh-based university	Vice dean (of a faculty)	18-Aug-22
8	FM1	Faculty member	Male	A private, Phnom-Penh-based university	Lecturer (Part-time, Core English) & vice-rector (Full-time)	19-Aug-22
9	FM2	Faculty member	Male	A public, province-based university	Lecturer (Part-time, Academic Writing)	30-Aug-22
10	FM3	Faculty member	Male	A public, province-based university	Lecturer (Part-time, Information Technology)	30-Aug-22
11	FM4	Faculty member	Male	A private, Phnom-Penh-based university	Lecturer (Part-time, Educational Administration & Leadership) & assistant to vice dean of a faculty (Full-time)	16-Aug-22
12	FM5	Faculty member	Male	A public, province-based university	Lecturer (Part-time, English & Political Science) & librarian (full-time)	8-Sep-22
13	FM6	Faculty member	Male	A public, province-based university	Lecturer (Part-time, English) & vice dean of a faculty (full-time)	11-Sep-22
14	FM7	Faculty member	Male	A private, Phnom-Penh-based university	Lecturer (Part-time, Khmer Studies)	16-Aug-22
15	FM8	Faculty member	Male	A public, Phnom-Penh-based university	Lecturer (Part-time, Management & Information Technology)	15-Aug-22
16	SS1	Student	Female	A private, Phnom-Penh-based university	Student (Year 4, Accounting)	29-Aug-22
17	SS2	Student	Female	A private, Phnom-Penh-based university	Student (Year 3, English)	20-Aug-22
18	SS3	Student	Female	A public, Phnom-Penh-based university	Student (Year 1, Finance and Banking)	15-Aug-22
19	SS4	Student	Male	A public, province-based university	Student (Year 3, English)	10-Sep-22
20	SS5	Student	Male	A private, Phnom-Penh-based university	Student (Year4; Management)	19-Aug-22

Note: All interviews were fully transcribed.

Appendix 2.3. Post-modified path model of correlates of technology application behavior during Covid-19 and perceived future technology integration of Cambodian faculty members



Hypotheses:

Endogenous Variable (1): Perceived ICT competence

- **H26:** The more frequently Cambodian faculty members apply basic technologies in their instruction before Covid-19, the more competent Cambodian faculty members think they are in ICT.
- **H27:** The longer teaching experience of Cambodian faculty members have, the more competent Cambodian faculty members think they are in ICT.
- **H28:** Faculty members who used to receive training on ICT integration in teaching and learning think they are more competent in ICT.
- **H29:** The more policy-related and leadership support Cambodian faculty members receive from their HEI, the more competent Cambodian faculty members think they are in ICT.
- **H30:** The more infrastructural and financial support Cambodian faculty members receive from their HEI, the more competent Cambodian faculty members think they are in ICT.
- **H31:** The more human and technical support Cambodian faculty members receive from their HEI, the more competent Cambodian faculty members think they are in ICT.

Endogenous Variable (2): Perceived technology readiness

- **H20:** The more competent Cambodian faculty members think they are in ICT, the more technologically ready they are.
- **H21:** The longer teaching experience of Cambodian faculty members have, the more technologically ready they are.
- **H22:** Faculty members who used to receive training on ICT integration in teaching and learning are more technologically ready.
- **H23:** The more policy-related and leadership support Cambodian faculty members receive from their HEI, the more technologically ready they are.
- **H24:** The more infrastructural and financial support Cambodian faculty members receive from their HEI, the more technologically ready they are.
- **H25:** The more human and technical support Cambodian faculty members receive from their HEI, the more technologically ready they are.

Endogenous Variable (3): Perceived technology impacts

- **H14:** The more frequently Cambodian faculty members apply basic technologies in their instruction before Covid-19, the more positive they view impacts of technologies on their profession.
- **H15:** The longer teaching experience Cambodian faculty members have, the more positive they view impacts of technologies on their profession.
- **H16:** Faculty members who used to receive training on ICT integration in teaching and learning acknowledge more impacts of technologies on their profession.
- **H17:** The more policy-related and leadership support Cambodian faculty members receive from their HEI, the more positive they view impacts of technologies on their profession.
- **H18:** The more infrastructural and financial support Cambodian faculty members receive from their HEI, the more positive they view impacts of technologies on their profession.
- **H19:** The more human and technical support Cambodian faculty members receive from their HEI, the more positive they view impacts of technologies on their profession.

Endogenous Variable (4): Technology application behavior

- **H5:** The more technologically ready Cambodian faculty members think they are, the more frequently they apply various technologies in instruction during Covid-19.
- **H6:** The more positive Cambodian faculty members are on impacts of technologies on their profession, the more frequently they apply various technologies in instruction during Covid-19.
- **H7:** The more competent Cambodian faculty members think they are in ICT, the more frequently they apply various technologies in instruction during Covid-19.
- **H8:** The more frequently Cambodian faculty members apply basic technologies in their instruction before Covid-19, the more frequently they apply various technologies in instruction during Covid-19.
- **H9:** Faculty members who used to receive training on ICT integration in teaching and learning apply various technologies in instruction during Covid-19 more frequently.
- **H10:** The longer teaching experience of Cambodian faculty members, the more frequently they apply various technologies in instruction during Covid-19.
- **H11:** The more policy-related and leadership support Cambodian faculty members receive from their HEI, the more frequently they apply various technologies in instruction during Covid-19.
- **H12:** The more infrastructural and financial support Cambodian faculty members receive from their HEI, the more frequently they apply various technologies in instruction during Covid-19.
- **H13:** The more human and technical support Cambodian faculty members receive from their HEI, the more frequently they apply various technologies in instruction during Covid-19.

Endogenous Variable (5): Perceived future technology integration

- **H1:** The more frequently Cambodian faculty members apply various technologies in instruction during Covid-19, the higher the magnitude of their perceived future technology integration after the pandemic.
- **H2:** The more technologically ready Cambodian faculty members are, the higher the magnitude of their perceived future technology integration after the pandemic.
- **H3:** The more positive Cambodian faculty members are on impacts of technologies on their profession, the higher the magnitude of their perceived future technology integration after the pandemic.
- **H4:** The longer teaching experience Cambodian faculty members have, the higher the magnitude of their perceived future technology integration after the pandemic.

Note:

- Authors' construction (based on Inan & Lowther's model with further adjustments)
- By constructing the model this way, certain endogenous variables (e.g., perceived ICT competence, perceived technology readiness, perceived technology impacts, and technology application behaviors) become mediators.

Appendix 2.4. Measures of all variables in the analyses of different research objectives

Constructs	Sub-constructs	Items in Survey 2 (code in Stata)	Items (full description)
Perceived institutional support	**Perceived policy and leadership support**	q4_2_4as2	School has policy to encourage lecturers to use ICT in teaching.
		q4_2_4a1s2	School shares with all faculty members a written policy on strategies to integrate ICT in teaching and learning.
		q4_2_4a2s2	Faculty members have received documents related to standards of using ICT in teaching and learning.
		q4_2_4c2s2	School leader set forth a clear direction for faculty members to use ICT in teaching and learning activities.
	Perceived financial and infrastructural support	q4_2_4bs2	School has sufficient ICT infrastructure for students.
		q4_2_4cs2	School has sufficient ICT infrastructure for faculty members.
		q4_2_4c1s2	School has budget packages to support faculty members who want to integrate ICT in teaching and learning.
	Perceived human and technical support	q4_2_4ds2	School has enough faculty members with adequate ICT skills for teaching.
		q4_2_4es2	ICT-related technical support from school is sufficient.
Perceived ICT competence	**Perceived general ICT competence**	q6_1as2	I can use MS Word to produce a document (e.g., write a letter).
		q6_1a1s2	I can use MS Excel for budgeting or administrative works.
		q6_1bs2	I can use MS PowerPoint to produce presentations with simple animation.
		q6_1cs2	I can take photos and show them on computer.
		q6_1ds2	I can file electronic documents into folders and sub-folders on the computer (by using software such as Zip, WinRAR).
		q6_1es2	I can use statistical software (such as SPSS or STATA) for research and data analysis.
		q6_1fs2	I can create a website and launch it officially on internet.
		q6_1gs2	I can use photo editing software.
		q6_1hs2	I can use video editing software.
		q6_1is2	I can use email for official communication.
		q6_1js2	I can purchase software that I need from the official website of that software.
		q6_1ks2	I can protect my digital devices from virus or cyber attack.
		q6_1ls2	I know how to ensure that my experience on the internet is safe and secure.
	Perceived instructional ICT competence	q6_2bs2	I know which teaching/learning situations are suitable for which kinds of ICT use.
		q6_2cs2	I can find useful curriculum resources on the internet.
		q6_2es2	I can use ICT for giving effective presentations/explanations.

		q6_2fs2	I can create video lessons and upload them to social media platforms (such as YouTube or Facebook) or share them with my students.
		q6_2gs2	I can use a Learning Management System platform (e.g., Moodle, Google Classroom, Talent LMS)
		q6_2hs2	I can create my professional e-portfolio and show it officially on the internet.
		q6_2is2	I understand how to work in group (e.g., to edit a piece of document) on the internet or cloud platform.
Technology-supported teaching experience (before Covid-19) *		q4_2_3a	Use equipment and hands-on materials (e.g., overhead projector)
		q4_2_3b	Use general office suite (e.g., word-processing, spreadsheet, presentation software)
		q4_2_3c	Use photo or video editing programs
		q4_2_3d	I share learning materials in digital format to my students.
		q4_2_3e	Students need to submit their homework or assignment in digital formats.
Perceived technology readiness **	**Optimism (motivator)**	q5_1_1s2	New technologies contribute to a better quality of life.
		q5_1_2s2	Technology gives me more freedom of mobility.
		q5_1_3s2	Technology gives people more control over their daily lives.
		q5_1_4s2	Technology makes me more productive in my personal life.
	Innovativeness (motivator)	q5_1_5s2	Other people come to me for advice on new technologies.
		q5_1_6s2	In general, I am among the first in my circle of friends to acquire new technology when it appears.
		q5_1_7s2	I can usually figure out new high-tech products and services without help from others.
		q5_1_8s2	I keep up with the latest technological developments in my areas of interest
	Discomfort (inhibitor)	q5_1_9s2	When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.
		q5_1_10s2	Technical support lines are not helpful because they don't explain things in terms I understand.
		q5_1_11s2	Sometimes, I think that technology systems are not designed for use by ordinary people.
		q5_1_12s2	There is no such thing as a manual for a high-tech product or service that's written in plain language.
	Insecurity (inhibitor)	q5_1_13s2	People are too dependent on technology to do things for them.
		q5_1_14s2	Too much technology distracts people to a point that is harmful.
		q5_1_15s2	Technology lowers the quality of relationships by reducing personal interaction.
		q5_1_16s2	I do not feel confident doing business with a place that can only be reached online.
Perceived technology impact	**Perceived technology positive impact**	q4_2_5as2	My ICT skills have improved.
		q4_2_5bs2	I can incorporate new teaching methods.
		q4_2_5cs2	I can monitor students' learning progress more easily.
		q4_2_5ds2	I can access more diverse high-quality learning materials and resources.

		q4_2_5es2	I can collaborate more with colleagues within my school.
		q4_2_5fs2	I can collaborate more with peers and experts outside my school.
		q4_2_5gs2	I can complete my administrative tasks more easily.
		q4_2_5hs2	My workload has increased.
	Perceived technology negative impact	q4_2_5is2	There is increased work pressure.
		q4_2_5js2	My teaching has become less effective.
		q4_2_5ks2	My stress or depression level has increased.
Technology application behavior		q7_7_1s2	Using online communication technologies (e.g., Zoom, Microsoft Teams, Google Meet, Telegram, WhatsApp, Email) as a medium for teaching and learning, to share information, and/or for other official communications
		q7_7_2s2	Using general office suite and related software (e.g., MS Word, Excel, PowerPoint, Adobe Acrobat Reader) as tools for producing learning materials, administrative documents, and/or students' assignments
		q7_7_3s2	Using photo or video editing software (e.g., Adobe Photoshop, Adobe Premiere Pro, Camtasia, DaVinci, Filmora) to produce videos, infographics or other digital image materials to support students' learning
		q7_7_4s2	Creating personal website, write blog posts, or create e-portfolio to further share and interact with students on courses that you instruct
		q7_7_5s2	Requiring students to submit their homework or school assignments in digital format (e.g., in Word, Excel, PowerPoint, PDF, video format, or other digital formats related to the course you teach)
		q7_7_5as2	Guiding students to choose and use ICT in their learning of the subject you instruct
		q7_7_6s2	Developing and delivering courses using Learning Management System (LMS) (e.g., Moodle, Google Classroom, Talent LMS)
		q7_7_7s2	Conducting students' assessments (e.g., quiz, mid-term exam, final exam) via digital means (e.g., administering exam via LMS or computer-based testing systems)
		q7_7_8s2	Fulfilling administrative duties (e.g., faculty member meeting, communication with administrator, attendance check, making appointment, signing contract) for my school via digital medium
		q7_7_9s2	Using web-based online collaboration tools (e.g., using Google Docs for writing and editing documents) among students or between students and instructor
		q7_7_10s2	Using online survey tools (e.g., Google Forms, Microsoft Forms, SurveyMonkey) to collect data from students for research purpose or to improve teaching
Perceived future technology integration	**Perceived institutional direction to integrate technology**	q7_24qs2	School should consider blending face-to-face learning and online/distance learning in the future.
		q7_24q1s2	School should consider using only online/distance learning in the future.
		q7_24rs2	Covid-19 outbreak is an opportunity for school to integrate ICT in teaching and learning.
		q7_24r1s2re	After Covid-19, school should stop teaching online/from a distance and return to the use of face-to-face teaching as before.
	Perceived personal intention to integrate technology	q7_24ts2	I intend to apply and adapt to the use of ICT in teaching and learning of all the courses I instruct in the next 3 months.
		q7_24us2	I am determined to apply and adapt to the use of ICT in teaching and learning of all the courses I instruct in the next 3 months.

		q7_24vs2	I plan to apply and adapt to the use of ICT in teaching and learning of all the courses I instruct in the next 3 months.
Perceived level of technology integration at HEIs ***		q7_25ds2	*Pre-integration stage:* This stage is characterized by few faculty members using technology (in teaching and learning, research and other professional activities). There is a clear lack of infrastructure to provide technology-related funding, support, leadership and resources. *Transition stage:* This stage is characterized by faculty members showing increased interest and vision for the use and integration of technology. There are requirements for a standard of technology uses for instruction (and in research and other academic roles). *Development stage:* This stage is characterized by school/university beginning to complete tasks that enable them to infuse technologies throughout the curriculum (e.g., by providing computers for faculty members' uses, building high quality computer labs, hiring specialists in education technology, and implementing new faculty development programs on ICT). *Expansion stage:* This stage is characterized by further movement in the school/university toward providing the needed educational technologies (both in general and for particular purposes) to ensure faculty success in technology integration. *System-wide integration stage:* This stage is characterized by clear evidence of professional level of educational technology competency standards, not only for faculty members but also for students. Technologies are fully imbedded into academic degree programs, other functions, and different levels of the school/university.

Note:

- *Technology-supported teaching experience was from the 2020 survey
- ** Adopted fully from Parasuraman (2000) and Parasuraman & Colby (2014)
- *** Adopted and adjusted from Toledo (2005)

Appendix 2.5. Characteristics of faculty members participating in the later phase of survey (2022) (n = 280)

Variable	Attribute	F	%	M	SD	CA
Variables in the main path model						
Year of teaching (n =280)	1 = 12 years or less	146	52.14	12.64	6.71	
	2 = More than 12 years	134	47.86			
Received training on ICT integration (n = 280)	0 = No training on ICT integration	150	53.57			
	1 = Having training on ICT integration	130	46.43			
Perceived policy and leadership support (n = 280)	4 items			4.00	0.53	0.81
Perceived financial and infrastructural support (n = 280)	3 items			3.56	0.68	0.78
Perceived technical and human resource support (n = 280)	2 items			3.83	0.61	0.74
Perceived ICT competence (n = 280)	20 items			3.16	0.64	0.94
Technology -supported teaching experience (n = 274)	5 items			3.49	0.80	0.70
Perceived technology readiness (n = 280)	16 items (8 reversed)			3.42	0.33	0.64
Perceived positive technology impact (n = 280)	7 items			3.11	0.36	0.82
Technology application behaviour (n = 276)	11 items			3.44	0.54	0.83
Perceived future technology integration (n = 276)	7 items (1 reversed)			3.58	0.38	0.62
Demographic variables						
Sex (n = 280)	1 = Male	257	91.79			
	2 = Female	23	8.21			
Age (n = 280)	1 = 41 or younger	172	61.43	40.83	8.31	
	2 = Older than 41	108	38.57			
Teaching subject (n = 261)	0 = Social sciences and related fields	185	70.88			
	1 = Sciences and related fields	76	29.12			
HEI location (n = 280)	0 = Province	61	21.79			
	1 = Phnom Penh	219	78.21			
HEI orientation (n = 280)	0 = Private	132	47.14			
	1 = Public	148	52.86			
HEI type (n = 280)	0 = Supervised by MLVT	54	19.29			
	1 = Supervised by MoEYS	226	80.71			

Note: F = frequency; % = percentage; M = mean; SD = standard deviation; CA = Cronbach's Alpha

Appendix 2.6. Characteristics of students participating in the survey (n = 1,338) in the early phase of Covid-19

Variables	Attributes	F	%	M	SD
Sex	1 = Male	666	49.78		
	2 = Female	672	50.22		
Age	1 = 21 or younger	916	68.46	21.26	2.71
	2 = Older than 21	422	31.54		
HEI orientation	0 = Public	910	68.01		
	1 = Private	428	31.99		
HEI location	0 = Phnom Penh	1079	80.64		
	1 = Province	259	19.36		
HEI type	0 = Supervised by MLVT	180	13.45		
	1 = Supervised by MoEYS	1154	86.25		
	2 = Supervised by others	4	0.3		

Note: F = frequency; % = percentage; M = mean; SD = standard deviation; N/A = not applicable

Appendix 2.7. List and characteristics of HEIs participating in the study (by different methods of data collection)

No.	HEI pseudonym	Faculty member survey 1	Faculty member survey 2	Student survey 1	Participation in KII	HEI type	HEI orientation	HEI location
1	EuA	☑	☑	☑	☑	Under MoEYS	Private	Phnom Penh
2	RiS	☑	☑	☑	☑	Under MoEYS	Public	Province
3	MeC	☑	☑	☑	☑	Under MoEYS	Private	Phnom Penh
4	InP	☑	☑	☑	…	Under MoEYS	Private	Phnom Penh
5	LeR	☑	☑	☑	…	Under MoEYS	Public	Phnom Penh
6	BrB	☑	☑	☑	…	Under MoEYS	Private	Phnom Penh
7	BaN	☑	☑	☑	☑	Under MoEYS	Public	Province
8	UnP	☑	☑	☑	☑	Under MoEYS	Private	Phnom Penh
9	MaN	☑	☑	☑	☑	Under MoEYS	Public	Phnom Penh
10	MaU	☑	☑	☑	…	Under MoEYS	Private	Province
11	AsS	☑	☑	☑	…	Under MoEYS	Private	Phnom Penh
12	SeI	☑	☑	☑	…	Under MoEYS	Private	Phnom Penh
13	PoK	☑	☑	☑	…	Under MLVT	Public	Province
14	KoP	☑	☑	☑	…	Under MLVT	Public	Phnom Penh
15	InT	☑	☑	…	…	Under MoEYS	Public	Phnom Penh
16	BiN	☑	☑	☑	…	Under MLVT	Public	Phnom Penh
17	UnC	☑	☑	…	…	Under MoEYS	Private	Phnom Penh
18	ReH	☑	☑	…	…	Under MoEYS	Private	Phnom Penh
19	UnW	…	…	☑	…	Under MoEYS	Private	Phnom Penh
20	ChU	…	…	☑	…	Under MoEYS	Private	Phnom Penh
21	CaU	…	…	☑	…	Under MoEYS	Private	Phnom Penh
22	IcN	…	…	☑	…	Under MLVT	Public	Phnom Penh
23	DiA	…	…	☑	…	Under MoPT	Public	Phnom Penh
24	InB	…	…	☑	…	Under MoEYS	Private	Phnom Penh
25	CaE	…	…	☑	…	Under MoEYS	Private	Phnom Penh

Notes:

- Pseudonym was used instead of real name of each HEI to avoid breach of confidentiality.
- ☑ = Participating; … = Not participating
- The sampled HEIs cover 14.06 percent of the total 128 HEIs as of 2021 for faculty member survey and 17.19 percent for student survey.

Appendix 2.8. Themes, indicators, and sources of collected quantitative secondary datasets

Themes	Indicators	Institution	Data/Information (link)
Covid-19	▪ Number of days of school closure	UNESCO Institute of Statistics	UNESCO map on school closures (https://en.unesco.org/covid19/educationresponse)
Education & higher education	▪ Gross Enrolment Rate (GER)	▪ MoEYS ▪ UNESCO	▪ MoEYS's Congress Reports (different years) ▪ UNESCO Institute of Statistics database
	▪ Government expenditure on education (as % of GDP)	MoEYS	MoEYS' Education Strategic Plan 2019-2023
	▪ Total financing resource available 2019-2023 (in million Riel)	MoEYS	MoEYS' Education Strategic Plan 2019-2023
	▪ Financing need for HE sub-sector 2019-2023 (as % of total projected financing needs)	MoEYS	MoEYS' Education Strategic Plan 2019-2023
ICT and digital technology indicators at Cambodian HEIs	▪ % of HEI with an accessible website (as of 31st December 2022)	Individual HEI listed in HE Roadmap (2017) by MoEYS	Direct access to HEIs' website and keying in data in Excel (see Appendix 3.2)
	▪ % of HEI with an official Facebook page (as of 31st December 2022)	Individual HEI listed in HE Roadmap (2017) by MoEYS	Direct access to HEIs' official Facebook page and keying in data in Excel (see Appendix 3.2)
	▪ % of HEI with at least one downloadable App in Play Store (as of 31st December 2022)	Individual HEI listed in HE Roadmap (2017) by MoEYS	Direct download from Play Store and keying in data in Excel (see Appendix 3.2)

Notes: Some information were not generated from raw data due to inaccessibility to those datasets; rather, we used information from published materials.

Appendix 3: Appendices related to findings from quantitative data analyses

Appendix 3.1. Detailed results of independent sample t-test and one-way ANOVA (F-test) in Objective B1 and B2

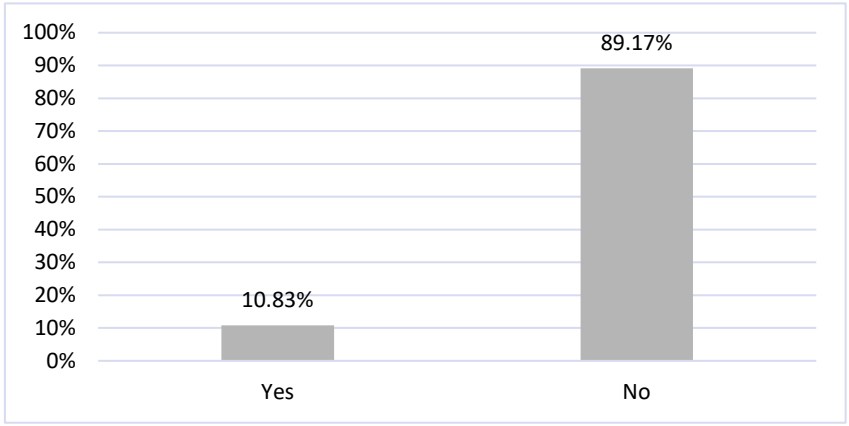
Variables	Attributes	n	Optimism		Innovativeness		Discomfort		Insecurity		General ICT competences		Instructional ICT competences		Positive impacts		Negative impacts		Technology application behavior		Future technology integration	
			Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)	Mean (SD)	t-test/F-test (p-value)
Sex	Male	257	4.16 (0.39)	1.11	3.56 (0.56)	1.48	2.95 (0.61)	0.14	3.08 (0.65)	0.47	3.10 (0.67)	1.10	3.30 (0.68)	0.59	3.11 (0.36)	1.22	2.24 (0.53)	0.42	3.44 (0.53)	0.48	3.59 (0.38)	0.83
	Female	23	4.07 (0.45)	(0.27)	3.38 (0.43)	(0.14)	2.93 (0.48)	(0.89)	3.01 (0.57)	(0.64)	2.94 (0.54)	(0.27)	3.22 (0.55)	(0.56)	3.02 (0.28)	(0.23)	2.19 (0.40)	(0.68)	3.38 (0.62)	(0.63)	3.52 (0.40)	(0.41)
Age	41 or younger	172	4.17 (0.41)	0.80	3.64 (0.52)	3.68	2.93 (0.63)	-0.78	3.07 (0.65)	-0.03	3.25 (0.64)	5.53	3.46 (0.64)	5.49	3.10 (0.35)	-0.11	2.18 (0.55)	-2.20	3.48 (0.53)	1.64	3.58 (0.37)	0.00
	Older than 41	108	4.13 (0.38)	(0.43)	3.39 (0.56)	(0.00)	2.99 (0.54)	(0.43)	3.07 (0.63)	(0.98)	2.83 (0.61)	(0.00)	3.03 (0.63)	(0.00)	3.11 (0.37)	(0.92)	2.32 (0.45)	(0.03)	3.37 (0.56)	(0.10)	3.58 (0.39)	(1.00)
Teaching subject	Social science and related fields	185	4.16 (0.40)		3.50 (0.54)		2.99 (0.58)		3.14 (0.66)		2.98 (0.59)		3.24 (0.65)		3.12 (0.36)		2.22 (0.51)		3.42 (0.53)		3.60 (0.39)	
	Science and engineering, but not IT and computer science	35	4.17 (0.35)	0.00 (1.00)	3.58 (0.63)	3.51 (0.03)	2.91 (0.60)	2.02 (0.13)	2.83 (0.60)	4.23 (0.02)	2.80 (0.59)	35.90 (0.00)	2.99 (0.54)	20.31 (0.00)	3.02 (0.30)	(1.18) 0.31	2.24 (0.50)	0.02 (0.98)	3.20 (0.53)	5.49 (0.00)	3.49 (0.29)	1.10 (0.34)
	IT and computer science	41	4.16 (0.41)		3.75 (0.50)		2.79 (0.58)		2.97 (0.48)		3.77 (0.55)		3.83 (0.53)		3.13 (0.36)		2.23 (0.58)		3.61 (0.55)		3.58 (0.41)	
Highest degree	Bachelor's degree (or below)	25	4.08 (0.34)		3.45 (0.63)		2.84 (0.59)		2.89 (0.59)		2.80 (0.83)		2.91 (0.63)		2.91 (0.24)		2.11 (0.43)		3.11 (0.52)		3.58 (0.33)	
	Master's degree	197	4.15 (0.40)	0.97 (0.38)	3.56 (0.52)	0.62 (0.54)	2.94 (0.61)	0.97 (0.38)	3.05 (0.64)	2.83 (0.06)	3.13 (0.65)	2.71 (0.07)	3.34 (0.67)	4.84 (0.01)	3.11 (0.36)	4.68 (0.01)	2.23 (0.53)	0.99 (0.37)	3.45 (0.53)	5.93 (0.00)	3.58 (0.39)	0.12 (0.89)

	Doctoral degree	58	4.21 (0.43)		3.51 (0.62)		3.03 (0.53)		3.22 (0.65)		3.08 (0.60)		3.30 (0.63)		3.16 (0.36)		2.28 (0.53)		3.54 (0.53)		3.61 (0.37)	
HEI location	Province	61	4.24 (0.44)	1.87	3.50 (0.59)	-0.62	2.99 (0.57)	0.55	2.97 (0.69)	-1.43	3.00 (0.77)	-1.17	3.20 (0.72)	-1.32	3.07 (0.38)	-0.76	2.13 (0.51)	-1.72	3.31 (0.60)	-2.04	3.66 (0.39)	1.66
	Phnom Penh	219	4.13 (0.38)	(0.06)	3.55 (0.54)	(0.53)	2.94 (0.60)	(0.59)	3.10 (0.62)	(0.15)	3.11 (0.63)	(0.24)	3.32 (0.65)	(0.19)	3.11 (0.35)	(0.45)	2.26 (0.52)	(0.09)	3.47 (0.52)	(0.04)	3.56 (0.37)	(0.10)
HEI orientation	Private	132	4.15 (0.41)	-0.08	3.61 (0.56)	1.88	2.88 (0.60)	-1.98	3.09 (0.67)	0.50	3.14 (0.64)	1.29	3.42 (0.65)	3.07	3.16 (0.35)	2.43	2.27 (0.54)	1.08	3.51 (0.54)	2.12	3.61 (0.37)	1.08
	Public	148	4.16 (0.39)	(0.94)	3.48 (0.54)	(0.06)	3.02 (0.58)	(0.05)	3.05 (0.61)	(0.62)	3.04 (0.68)	(0.20)	3.18 (0.67)	(0.00)	3.06 (0.36)	(0.02)	2.20 (0.50)	(0.28)	3.37 (0.54)	(0.03)	3.56 (0.39)	(0.28)
HE type	Supervised by MLVT/TVET	54	4.04 (0.26)	-2.31	3.36 (0.55)	-2.73	3.00 (0.57)	0.61	3.11 (0.61)	0.46	2.83 (0.66)	-3.29	2.94 (0.63)	-4.55	2.91 (0.27)	-4.62	2.15 (0.42)	-1.32	3.14 (0.51)	-4.63	3.42 (0.36)	-3.71
	Supervised by MoEYS/University	226	4.18 (0.42)	(0.02)	3.59 (0.54)	(0.01)	2.94 (0.60)	(0.54)	3.06 (0.65)	(0.65)	3.15 (0.65)	(0.00)	3.38 (0.65)	(0.00)	3.15 (0.36)	(0.00)	2.25 (0.54)	(0.19)	3.51 (0.53)	(0.00)	3.63 (0.37)	(0.00)

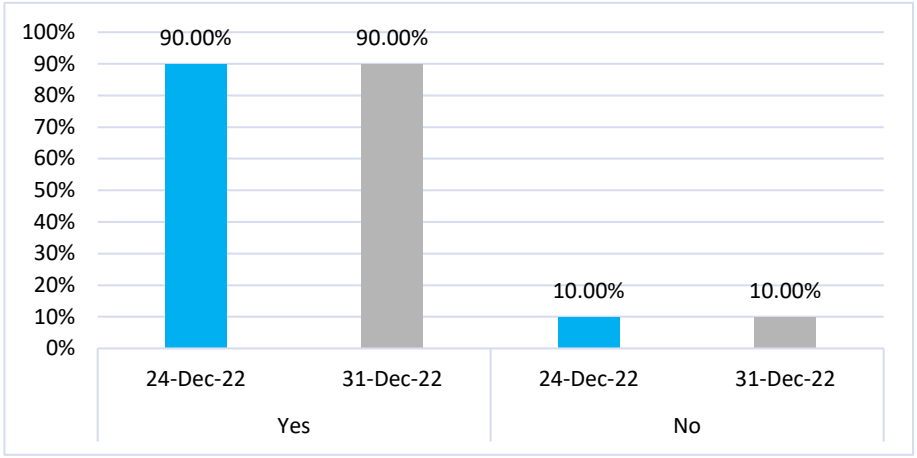
Note: Highlighted orange are statistically significant variables.

Appendix 3.2. Dashboard showing percentage of Cambodian HEIs with accessible website, official Facebook page, and mobile app(s) as of 31st December 2022

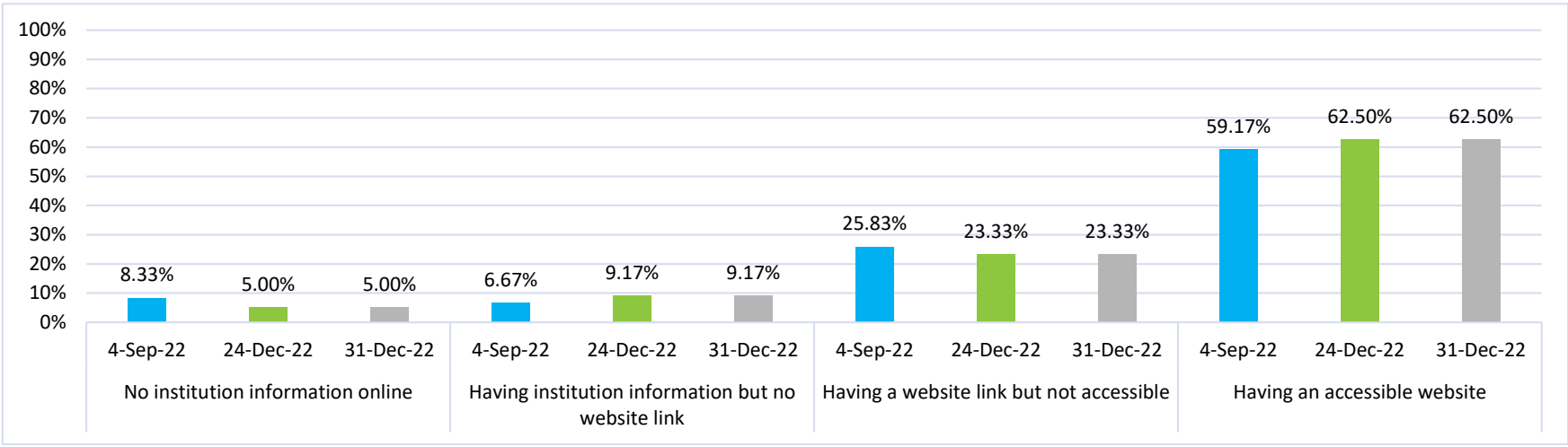
a. Cambodian HEIs with at least one downloadable mobile app in Play Store (as of 31st December 2022)



b. Cambodian HEIs with a Facebook page (as of 31st December 2022)



c. Cambodian HEIs with an accessible website (as of 31st December 2022)



Source: Collected by authors by directly accessing the website and official Facebook page and downloading the app(s) of each Cambodian HEI listed in the HEI Roadmap (2017, pp. 61-66)
Note: n = 120 HEIs

Appendix 3.3. Sub-group analyses of the path model

a. By age

Variable	(Model 1) Perceived ICT competence		(Model 2) Perceived technology readiness		(Model 3) Perceived technology impacts		(Model 4) Technology application behaviour		(Model 5) Perceived future technology integration	
	41 or younger	*Older than 41*	*41 or younger*	*Older than 41*	*41 or younger*	*Older than 41*	*41 or younger*	*Older than 41*	*41 or younger*	*Older than 41*
Perceived ICT competence			0.169***	0.192***			0.433***	0.602***		
			(0.042)	(0.048)			(0.055)	(0.080)		
Perceived technology readiness							0.111	-0.124	-0.023	0.543***
							(0.095)	(0.141)	(0.086)	(0.121)
Perceived technology impacts							0.0965	-0.128	0.254***	0.0121
							(0.108)	(0.179)	(0.095)	(0.144)
Year of teaching	0.000	-0.001	-0.005	-0.004	0.005	-0.002	0.006	0.007	0.005	0.011**
	(0.009)	(0.008)	(0.005)	(0.004)	(0.005)	(0.003)	(0.006)	(0.006)	(0.006)	(0.005)
Perceived policy and leadership support	0.262**	0.126	0.086	0.005	0.109**	0.100	0.162**	0.020		
	(0.103)	(0.171)	(0.059)	(0.090)	(0.053)	(0.076)	(0.071)	(0.128)		
Perceived infrastructure and financial support	0.000	0.153	0.018	0.054	0.029	0.108**	0.062	0.274***		
	(0.088)	(0.119)	(0.049)	(0.063)	(0.046)	(0.053)	(0.059)	(0.091)		
Perceived human and technical support	0.017	0.015	0.025	-0.021	0.081*	0.042	-0.030	-0.054		
	(0.088)	(0.117)	(0.049)	(0.062)	(0.046)	(0.052)	(0.060)	(0.087)		
Technology-supported teaching experience	0.16***	0.280***			0.037	0.069**	0.04	0.082		
	(0.055)	(0.070)			(0.027)	(0.030)	(0.037)	(0.056)		

Received ICT integration training	0.227**	0.183*	-0.021	-0.005	-0.001	-0.054	0.080	-0.016		
	(0.089)	(0.104)	(0.050)	(0.056)	(0.046)	(0.046)	(0.061)	(0.080)		
Technology application behaviour									0.211***	0.045
									(0.055)	(0.063)
Constant	1.537***	0.765	2.444***	2.742***	1.993***	1.854***	0.37	1.157*	2.112***	1.387***
	(0.364)	(0.555)	(0.207)	(0.290)	(0.188)	(0.245)	(0.360)	(0.600)	(0.311)	(0.475)

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

b. **By teaching subject**

	(Model 1)		**(Model 2)**		**(Model 3)**		**(Model 4)**		**(Model 5)**	
	Perceived ICT competence		**Perceived technology readiness**		**Perceived technology impacts**		**Technology application behaviour**		**Perceived future technology integration**	
Variable	***Social science related fields***	***Science related fields***	***Social science related fields***	***Science related fields***	***Social science related fields***	***Science related fields***	***Social science related fields***	***Science related fields***	***Social science related fields***	***Science related fields***
Perceived ICT competence			0.193***	0.057			0.576***	0.454***		
			(0.039)	(0.050)			(0.056)	(0.083)		
Perceived technology readiness							0.046	0.091	0.250***	0.092
							(0.095)	(0.178)	(0.097)	(0.136)
Perceived technology impacts							-0.001	-0.011	0.133	0.251*
							(0.113)	(0.179)	(0.107)	(0.138)
Year of teaching	-0.0220***	-0.003	-0.004	-0.005	-0.004	0.000	0.005	0.014*	0.006	0.007
	(0.006)	(0.010)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.007)	(0.004)	(0.006)
Perceived policy and leadership support	0.249**	0.077	0.031	0.087	0.115**	0.021	0.073	0.116		
	(0.104)	(0.165)	(0.058)	(0.080)	(0.053)	(0.079)	(0.073)	(0.119)		
Perceived infrastructure and financial support	-0.054	0.316**	0.007	0.147**	0.020	0.148**	0.145***	0.173		
	(0.080)	(0.150)	(0.044)	(0.073)	(0.041)	(0.072)	(0.054)	(0.114)		

Perceived human and technical support	0.041	-0.300*	0.050	-0.180**	0.101***	-0.079	-0.055	0.029		
	(0.076)	(0.179)	(0.042)	(0.088)	(0.038)	(0.086)	(0.052)	(0.134)		
Technology-supported teaching experience	0.157***	0.330***			0.039	0.082**	0.073**	0.017		
	(0.051)	(0.086)			(0.025)	(0.039)	(0.035)	(0.068)		
Received ICT integration training	0.221***	0.274*	-0.029	0.065	0.013	-0.070	0.062	-0.063		
	(0.079)	(0.141)	(0.044)	(0.068)	(0.040)	(0.067)	(0.055)	(0.106)		
Technology application behaviour									0.131**	0.151**
									(0.056)	(0.071)
Constant	1.749***	1.839***	2.528***	3.171***	2.020***	2.418***	0.567	0.22	1.823***	1.866***
	(0.333)	(0.703)	(0.189)	(0.349)	(0.168)	(0.333)	(0.355)	(0.798)	(0.348)	(0.522)

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

c. By HEI location

Variable	(Model 1)		(Model 2)		(Model 3)		(Model 4)		(Model 5)	
	Perceived ICT competence		Perceived technology readiness		Perceived technology impacts		Technology application behaviour		Perceived future technology integration	
	Province	*Phnom Penh*	*Province*	*Phnom Penh*	*Province*	*Phnom Penh*	*Province*	*Phnom Penh*	*Province*	*Phnom Penh*
Perceived ICT competence			0.161***	0.181***			0.478***	0.476***		
			(0.062)	(0.035)			(0.097)	(0.051)		
Perceived technology readiness							0.047	0.035	0.137	0.202**
							(0.173)	(0.090)	(0.122)	(0.084)
Perceived technology impacts							0.209	-0.003	-0.044	0.206**
							(0.222)	(0.107)	(0.150)	(0.093)
Year of teaching	-0.00204	-0.0210***	0.000583	-0.00304	0.00769	-0.000763	0.00486	0.00891**	0.0171**	0.00920**
	(0.017)	(0.005)	(0.008)	(0.003)	(0.008)	(0.003)	(0.011)	(0.004)	(0.008)	(0.004)

Perceived policy and leadership support	0.0912	0.271***	0.097	0.052	0.053	0.125***	0.129	0.102		
	(0.196)	(0.100)	(0.096)	(0.055)	(0.088)	(0.048)	(0.125)	(0.073)		
Perceived infrastructure and financial support	-0.031	0.048	0.014	0.040	0.025	0.059	0.072	0.159***		
	(0.157)	(0.081)	(0.077)	(0.044)	(0.071)	(0.038)	(0.100)	(0.057)		
Perceived human and technical support	0.029	-0.032	-0.047	0.043	0.031	0.099**	-0.014	-0.060		
	(0.141)	(0.084)	(0.069)	(0.045)	(0.063)	(0.040)	(0.090)	(0.060)		
Technology-supported teaching experience	0.147	0.213***			0.057	0.034	0.048	0.066*		
	(0.117)	(0.047)			(0.050)	(0.022)	(0.075)	(0.035)		
Received ICT integration training	0.412**	0.186***	0.030	-0.032	0.097	-0.046	-0.024	0.050		
	(0.198)	(0.072)	(0.092)	(0.040)	(0.088)	(0.035)	(0.130)	(0.052)		
Technology application behaviour									0.364***	0.084*
									(0.075)	(0.049)
Constant	2.081***	1.489***	2.688***	2.371***	2.315***	1.813***	0.168	0.708**	1.964***	1.837***
	(0.747)	(0.342)	(0.349)	(0.190)	(0.331)	(0.162)	(0.732)	(0.347)	(0.449)	(0.314)

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

d. By HEI orientation

Variable	(Model 1) Perceived ICT competence		(Model 2) Perceived technology readiness		(Model 3) Perceived technology impacts		(Model 4) Technology application behaviour		(Model 5) Perceived future technology integration	
	Private	*Public*	*Private*	*Public*	*Private*	*Public*	*Private*	*Public*	*Private*	*Public*
Perceived ICT competence			0.148***	0.195***			0.520***	0.440***		
			(0.046)	(0.040)			(0.057)	(0.065)		
Perceived technology readiness							0.018	0.036	0.199*	0.157
							(0.102)	(0.119)	(0.104)	(0.100)

Perceived technology impacts							-0.090	0.163	0.110	0.248**
							(0.126)	(0.141)	(0.117)	(0.114)
Year of teaching	-0.0173**	-0.0165**	-0.006	-0.003	0.001	-0.004	0.005	0.013***	0.005	0.009**
	(0.007)	(0.007)	(0.004)	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.004)
Perceived policy and leadership support	0.155	0.239**	0.068	0.062	0.169***	0.045	0.176*	0.095		
	(0.142)	(0.119)	(0.079)	(0.060)	(0.065)	(0.057)	(0.094)	(0.083)		
Perceived infrastructure and financial support	0.056	0.010	0.036	0.036	0.037	0.076*	0.260***	0.058		
	(0.118)	(0.093)	(0.066)	(0.047)	(0.054)	(0.045)	(0.075)	(0.065)		
Perceived human and technical support	0.037	-0.029	-0.009	0.007	0.068	0.040	-0.137*	0.004		
	(0.116)	(0.094)	(0.064)	(0.047)	(0.053)	(0.045)	(0.073)	(0.065)		
Technology-supported teaching experience	0.236***	0.194***			0.068**	0.025	0.061	0.057		
	(0.061)	(0.064)			(0.027)	(0.029)	(0.041)	(0.045)		
Received ICT integration training	0.284***	0.188*	0.041	-0.061	0.020	-0.042	0.079	0.030		
	(0.099)	(0.099)	(0.057)	(0.050)	(0.045)	(0.047)	(0.065)	(0.070)		
Technology application behaviour									0.077	0.178***
									(0.062)	(0.058)
Constant	1.485***	1.697***	2.651***	2.461***	1.662***	2.383***	0.566	0.446	2.252***	1.581***
	(0.449)	(0.444)	(0.256)	(0.218)	(0.206)	(0.210)	(0.423)	(0.462)	(0.414)	(0.352)

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1