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Financial and Human-Capital Barriers to Technology Adoption Among Women in Cambodia's SMEs: Implications for Digital Skills and Economic Education

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ABSTRACT

Purpose of the study: This study examines the barriers that constrain technology adoption among women working in Cambodia's small and medium-sized enterprises (SMEs), classifies them using the Technology-Organization-Environment (TOE) framework, and tests how perceived barriers relate to the drivers of adoption and to women's educational background, in order to identify implications for economic education, particularly financial literacy, entrepreneurship training and digital competency development.

Methodology: A convergent mixed-methods design was used. An 11-item barrier scale (Cronbach's $\alpha = 0.864$) was administered online to 121 women working in Cambodian SMEs, and key informant interviews were held with eight purposively selected women owners, managers and professionals. Survey data were analysed in SPSS using descriptive statistics, chi-square tests and Pearson correlation; interview data were analysed thematically and integrated with the survey results through a joint display.

Main Findings: Agreement that barriers exist was modest overall (mean = 3.51). Organizational barriers were rated highest (mean = 3.59), led by technology maintenance costs (3.69), difficulty hiring suitable employees (3.63) and insufficient funds to purchase technology (3.60), while internet cost and speed and strategic-fit barriers drew neutral responses. Interviews confirmed cost, skills, security and regulatory barriers and added resistance to change and complexity, which the survey did not measure. Educational attainment was associated with the level of technology used ($\chi^2 = 19.27$, $p = .004$), although this association does not establish that education causes more advanced use, and perceived adoption drivers correlated moderately and positively with perceived barriers ($r = 0.49$, $p < .001$).

Novelty/Originality of this study: Complementing earlier work on the same population that addressed drivers, benefits and coping strategies, this study isolates the barrier side of adoption and shows that the binding constraints are internal financial and human-capital resources rather than infrastructure. For economic education, the findings suggest that financial literacy programmes should address budgeting for the full lifecycle cost of technology, not only its purchase; that entrepreneurship training should cover technology investment decisions, security risks and managing change in small firms; and that digital competency development should prioritise women with lower educational attainment. The study identifies these needs from observed barriers; it does not evaluate the effectiveness of any training intervention.

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1. INTRODUCTION

Small and medium-sized enterprises (SMEs) form the backbone of Cambodia's private sector. They make up the overwhelming majority of firms and a large share of employment, and women own or run most of them, particularly in retail, trade and services [1] . Most of these businesses are micro or small, many operate informally, and they rely heavily on the owner's own savings, which limits their capacity to invest in productivity-enhancing tools [2]. As digital payments, social-media commerce and online public services become part of everyday business, the ability to adopt and then sustain technology is increasingly a condition of SME survival rather than an optional advantage [3], [4] .

Research on SME technology adoption has mostly explained why firms adopt, emphasising perceived usefulness, ease of use and expected performance gains [5], [6]. The obstacles that prevent or slow adoption have received less systematic attention, even though small firms are known to face resource poverty: limited capital, thin management layers and few specialist staff [7], [8]. For women, these firm-level constraints interact with gendered constraints on access to finance, networks, training and time [9]-[11]. Evidence from developing economies shows that financial and digital literacy shape whether women-led SMEs can convert technology into growth [12] and that entrepreneurship training is rarely designed around women's needs [13] .

An earlier analysis of women working in Cambodian SMEs examined what motivates them to adopt technology, the benefits they perceive and the coping strategies they use [14]. It found strong agreement on drivers such as smoother business control and better client service, and a strong association between those drivers and perceived benefits. The barriers themselves were not analysed in that article; they formed a separate strand of the broader doctoral project from which both studies derive [15]. Understanding which barriers matter most, and for whom, is important because digital-inclusion efforts often concentrate on access and infrastructure, whereas the constraints women experience inside their firms may lie elsewhere. Less is known about the role that education plays in helping women manage these constraints. Research on financial literacy has concentrated on personal and household decisions such as saving, borrowing and retirement planning, rather than on firms' technology investments [16]. Evaluations of business and entrepreneurship training in developing countries report modest and varied effects on business practices and profits, and rarely examine technology adoption as an outcome[17]. Studies of women entrepreneurs have shown that financial and digital literacy are associated with SME growth [12] and that entrepreneurship education seldom addresses women's needs [13], but they do not identify which specific adoption barriers these competencies would need to address. In Cambodia, there is little evidence linking the barriers women face in adopting technology to the educational support that could help them overcome those barriers.

This article addresses that gap. Using survey and interview data from women working in Cambodian SMEs, it asks: (1) which barriers to technology adoption do women perceive most strongly; (2) how are these barriers distributed across the technological, organizational and environmental contexts of the TOE framework; (3) how do interview accounts confirm, qualify or extend the survey results; and (4) how do perceived barriers relate to the drivers of adoption and to women's educational background? By answering these questions, the study identifies the competencies in financial literacy, entrepreneurship and digital skills that support for women in SMEs would need to develop. It does not evaluate the effectiveness of any educational intervention.

The TOE framework holds that a firm's adoption of an innovation depends on its technological context (the characteristics and availability of the technology and its supporting infrastructure), its organizational context (resources, skills, structure and managerial commitment) and its environmental context (competitive pressure, regulation and the wider support system) [18], [19]. It is widely used in SME research because it captures resource constraints that individual-level models such as TAM and UTAUT leave out [20], [21]. In small firms the organizational context often dominates: the owner-manager's knowledge, the availability of skilled staff and the firm's financial slack largely decide whether an innovation is adopted and sustained [7], [22], [23]. Classifying barriers through TOE therefore lets this study ask whether women's main problem is infrastructure, internal capacity or the external institutional environment.

Prior studies point to several recurring barriers. Cost is the most consistently reported: beyond the initial purchase, maintenance, upgrades and support add recurring expenses that small firms struggle to absorb [24]-[26]. Skills are a second constraint, both in the owner's own capability and in the difficulty of recruiting and retaining staff who can run new systems [6], [27]. Security risks and weak legal protection create uncertainty that discourages firms from moving transactions online [28], [29]. while the affordability and quality of connectivity remain uneven across developing economies, with women less likely than men to be online [30]. Studies of SME e-commerce in Indonesia and Malaysia likewise identify limited resources, skills and organizational readiness as primary barriers [31], [32] and research elsewhere stresses social and cultural factors [33]. In Cambodia, women's economic roles are further shaped by norms around family responsibility and suitable work [34] and women

entrepreneurs report particular difficulty in obtaining formal credit [2], [35].Together, these studies suggest that barriers for women in SMEs are likely to be concentrated in the organizational context, a proposition this study tests directly.

Economic education offers one route to reducing these barriers, because several of them depend on what owners and managers know as much as on what their firms can afford. Financial literacy (the ability to understand and apply financial concepts in decisions) shapes how individuals budget, borrow and plan, and it is lower on average among women and in developing economies [16], [36]. For technology adoption, this matters at each stage. Understanding the full cost of a system, including maintenance, upgrades, subscriptions and support rather than only its purchase price, requires the ability to read and compare costs over time. Evaluating whether an investment is worthwhile requires weighing those costs against expected gains in efficiency or sales. Managing scarce funds requires budgeting and cash-flow skills, which simple, practical financial training has been shown to improve among microentrepreneurs [37]. Entrepreneurship education adds the capacity to make investment decisions, assess risks and lead change within a firm [13]. Digital competence covers not only using tools but identifying which digital solutions fit a business's needs and using them safely [38] . Each of these competencies corresponds to a barrier examined in this study: the cost of acquiring and maintaining technology, insufficient funds, the difficulty of hiring and developing skilled staff, security risks and the fit between technology and business needs.

This study is novel in three respects. First, it isolates the barrier side of technology adoption among women working in Cambodian SMEs, a group that runs most of the country's businesses but has rarely been studied in this way. Second, it combines survey and interview evidence and classifies barriers through the TOE framework, showing whether women's main constraints lie in infrastructure, in their firms' internal resources or in the external environment. Third, it links each barrier to the financial, entrepreneurial and digital competencies that economic education could develop, connecting research on technology adoption with research on financial literacy and entrepreneurship education. The research is also urgent. Digital payments, online sales and electronic tax filing are quickly becoming standard business requirements in Cambodia, the COVID-19 pandemic accelerated this shift, and national policy now aims to raise digital adoption among enterprises of all sizes [39]. Women-run firms that cannot afford, sustain or use these technologies risk falling further behind, and education and support programmes need evidence on which barriers to address first. The primary objective of this study is therefore to examine the financial and human-capital barriers to technology adoption among women working in Cambodia's SMEs and to identify their implications for financial literacy, entrepreneurship training and digital skills development.

2. RESEARCH METHOD

2.1. Research Design

The study used a convergent parallel mixed-methods design in which quantitative and qualitative data were collected in the same period, analysed separately and then integrated Technology and Innovation Report 2018 [40], [41]. The survey measured how strongly women agreed that specific barriers affect technology adoption in their SMEs, while the interviews explored how these barriers are experienced and whether other barriers exist that the survey did not capture. Integration took place at the interpretation stage through a joint display that compares the two strands barrier by barrier [41]. The data come from the doctoral project described in [15]. Results on adoption drivers, benefits and coping strategies from the same survey have been reported in [14]. The barrier scale, the interview data, the TOE classification and the education and correlation analyses presented here have not been published before.

2.2. Data Types and Data Sources

Primary data were obtained from two sources. The first was an online survey of 121 women working in Cambodian SMEs as owners, managers, supervisors or staff, regardless of sector. The required sample was estimated with the Raosoft calculator for a population of about 459,738 women-owned or women-run SMEs, taken as 61% of an estimated 753,670 SMEs, at a 95% confidence level, a 9% margin of error and a 50% response distribution [14]. Because no sampling frame of women in SMEs exists, convenience sampling through the researcher's professional networks was used [42]. The second source was key informant interviews (KIIs) with eight women selected purposively for their experience of technology decisions in SMEs. Eight interviews is consistent with evidence that the main themes in relatively homogeneous groups emerge within the first six to twelve interviews [43]. The survey questionnaire and the interview guide are summarised in Table 1 and Table 2. Secondary data from government, development-partner and academic sources were used to describe the Cambodian SME context and to derive the survey items and the TOE classification of barriers. The survey questionnaire and the interview guide are summarised in Table 1 and Table 2.

Table 1. Instrument Grid of the Survey Questionnaire

Variable	Indicator	Item no.	No. of items	Scale	Source
Respondent profile	Age, education, job title, years of work experience, kind of technology used	II.1–II.5	5	Categorical / open-ended	Developed for the study
Adoption drivers (α = 0.883)	Operational optimization and control	III.5, III.6, III.9	3	5-point Likert (1 = strongly disagree, 5 = strongly agree)	Mam et al. [14]
	Client and business relationships	III.3, III.7, III.8	3		
	Market expansion and growth	III.4, III.10	2		
	Information management and accessibility	III.1, III.13, III.14	3		
	Cost considerations	III.2	1		
	Competitive conditions	III.11, III.12	2		
Barriers to technology adoption (α = 0.864)	*Technological:* internet cost, internet speed, technical support, security, fit with business needs	V.1, V.2, V.3, V.4, V.10	5	5-point Likert (1 = strongly disagree, 5 = strongly agree)	OECD [26]; Thong [7] ; Venkatesh and Bala [6] ; UNCTAD [28] :
	Organizational: funds, maintenance costs, hiring suitable employees, adoption plan	V.6, V.7, V.8, V.9	4		
	Environmental: legal framework, competitive pressure	V.5, V.11	2		
Total items analysed			30		

Note: The questionnaire also contained sections on benefits (16 items) and coping strategies (7 items), reported in [14]. Item numbers refer to questionnaire sections: II = respondent profile, III = adoption drivers, V = barriers

Table 2. Instrument Grid of the Key Informant Interview Guide

Theme	Guide questions	Purpose in this study
Background	Education level; type and size of business; years in the business (B1–B3)	Informant profile (Table 4)
Technology use	Main reasons for using technology; newly adopted technologies and why (C1–C2)	Context for barrier accounts
Benefits	Benefits of technology; effects on performance and expansion (D1–D3)	Context for barrier accounts
Barriers	Perception of technology during COVID-19; barriers experienced and why (E1–E2)	Barrier themes and integration with the survey (Section 3.4, Table 7)
Strategies	Strategies used to strengthen technology adoption (F1)	Coping strategies (Section 3.4)
Follow-up probe	Awareness of government policies supporting SMEs' use of technology	Regulation and policy awareness theme

Note: Questions were open-ended, and follow-up probes were used where needed

2.3. Research Procedures

The survey instrument contained demographic questions and four Likert-scale sections; this article uses the section on barriers. Its 11 items were adapted from SME adoption studies covering connectivity, technical support, security, legal frameworks, finance, maintenance, staffing, planning, fit with business needs and competitive pressure [6], [7], [26], [28]. Each item was rated from 1 (strongly disagree) to 5 (strongly agree). Internal consistency was high (Cronbach's α = 0.864), well above the conventional 0.70 threshold [44]. The questionnaire was distributed as a Google Forms link. Participation was voluntary and no identifying information was required. The interview guide covered reasons for using technology, benefits, barriers and strategies for

overcoming them. Interviews were held in person or online, depending on each participant's preference, and were recorded and transcribed. The research procedure is summarised in Figure 1.

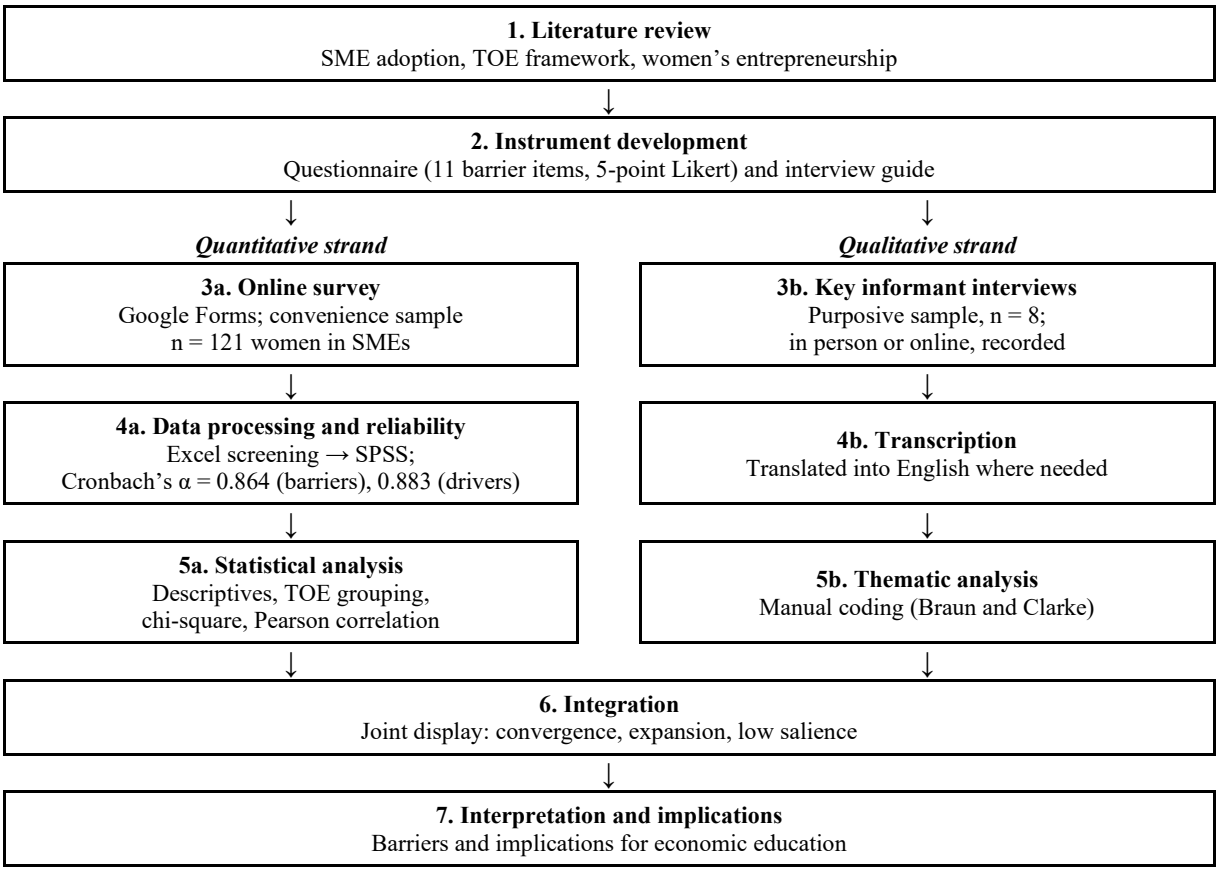

Figure 1. Research Procedure

2.4. Data Collection and Processing Techniques

Survey responses were exported from Google Forms to Excel, screened for completeness and imported into SPSS. Item means were interpreted on the following scale: 1.00-1.49 strongly disagree, 1.50-2.49 disagree, 2.50-3.49 neutral, 3.50-4.49 agree and 4.50-5.00 strongly agree. Before the analysis, each barrier item was assigned to one TOE context using the framework's definitions [18], [45]: technological (connectivity, technical support, security and fit of technology to business needs), organizational (funds, maintenance costs, hiring and planning) or environmental (legal framework and competitive pressure). Interviews were conducted in Khmer or English, transcribed and, where necessary, translated into English, and the transcripts were coded manually. Quotations in Section 3.4 are reproduced from the English transcripts with minimal editing: omissions are marked with ellipses and clarifying words with square brackets. Informants are identified only by code (P1-P8).

2.5. Data Analysis Techniques

Quantitative analysis used frequencies and percentages for the respondent profile and means and standard deviations for barrier items and TOE contexts. A chi-square test of independence examined the association between educational attainment and the kind of technology used, with Cramér's V as the effect size. Because some expected cell counts were small, the test was repeated with the master's and doctoral groups combined as a robustness check. Pearson correlation measured the relationship between the composite score for adoption drivers (14 items, $\alpha = 0.883$) and the composite barrier score, interpreted using Cohen's conventions [45]. Qualitative analysis followed the six phases of thematic analysis: familiarisation, initial coding, searching for themes, reviewing themes, defining themes and reporting[46]. The resulting barrier themes were then set beside the survey results in a joint display and each comparison was classified as convergence, expansion (a barrier found in only one strand) or low salience in both strands [41].

3. RESULTS AND DISCUSSION

This section first profiles the survey respondents and key informants, then presents the survey ratings of barriers and their distribution across the TOE contexts. It goes on to integrate the interview themes and closes with the analyses of education and of the relationship between adoption drivers and barriers. Section 3.7 then discusses the implications of these findings for economic education.

3.1. Profile of Respondents and Key Informants

The survey sample was young to mid-career and highly educated (Table 3). Almost 40% of respondents were aged 30 or below and about 82% held at least a bachelor's degree. Staff made up about one-third of respondents and business owners and chief executives a little over one-third, with supervisors (about 20%) and general managers (about 12%) making up most of the remainder. Work experience was spread across the range: about 31% had one to three years and 35% more than nine years. Just over half of respondents mainly used job-related technology such as accounting, sales or communication software, about a third relied on basic tools, and about 15% used advanced or up-to-date technology.

Table 3. Profile of Survey Respondents (n = 121)

Characteristic	Category	n	%
Age (years)	25 and below	25	20.7
	26-30	22	18.2
	31-35	20	16.5
	36-40	27	22.3
	41-45	17	14.0
	46 and above	10	8.3
Education	High school	19	15.7
	Bachelor's degree	58	47.9
	Master's degree	42	34.7
	Doctoral degree	2	1.7
Kind of technology used	Basic	39	32.2
	Job-related	64	52.9
	Advanced / up-to-date	18	14.9

The eight key informants combined owners, shareholders, managers and professionals with between 2 and 17 years in SMEs (Table 4). Two ran private medical clinics, one was deputy director of a law firm and the others worked in private companies in management, marketing and accounting roles. Owners and shareholders tended to have longer tenure, which gave them direct experience of financing and maintaining technology over time.

Table 4. Profile of Key Informants (n = 8)

Informant	Role	Sector	Years in SME	Education
P1	Business development and coordination manager	Private company	5	Bachelor's
P2	Proprietor	Medical clinic	8	Bachelor's
P3	Owner	Private company	17	Bachelor's
P4	Accountant	Private company	2	Master's
P5	Marketing director and shareholder	Private company	10	Master's
P6	Deputy director	Law firm	2	PhD candidate
P7	Shareholder	Private company	5	Bachelor's
P8	Proprietor	Medical clinic	11	Master's

3.2. Perceived Barriers to Technology Adoption

Women's agreement that barriers exist was modest overall, with a general weighted average of 3.51 (Table 5). This is noticeably lower than the agreement the same respondents expressed with adoption drivers and benefits [14], which suggests that women in Cambodian SMEs see technology mainly as an opportunity and its obstacles as real but secondary. The 11 items split into two groups: five fell in the agree range and six in the neutral range.

The barriers women agreed with most concern the cost of sustaining technology and the people needed to run it. Maintenance costs ranked highest (M = 3.69, SD = 0.88), above the cost of buying technology in the first place (M = 3.60, SD = 0.92). Recurring outlays for updates, repairs, subscriptions and support therefore weigh

more heavily than the purchase decision itself, consistent with research showing that the business value of IT depends on complementary investment after acquisition [25], [47]. Difficulty hiring suitable employees came second (M = 3.63, SD = 0.90): SMEs compete with larger firms for scarce digitally skilled workers and can rarely offer comparable pay or career paths [27], [23]. Concern about security (M = 3.60, SD = 0.97) and the lack of a legal framework for SME technology (M = 3.55, SD = 0.96) completed the agreed barriers, reflecting the risks of fraud, data loss and unclear liability that accompany online transactions [28], [29].

Table 5. Barriers to Technology Adoption Among Women Working in Cambodia's SMEs

Barriers	TOE	Mean	Description	SD
1. Expensive access to the internet	T	3.36	Neutral	1.04
2. Slow internet access	T	3.49	Neutral	0.98
3. Lack of support with technology	T	3.49	Neutral	0.93
4. Lack of security in utilizing technology	T	3.60	Agree	0.97
5. Lack of a legal framework for SMEs' technology	E	3.55	Agree	0.96
6. Insufficient funds to purchase technology tools	O	3.60	Agree	0.92
7. Maintenance costs for technology	O	3.69	Agree	0.88
8. Challenges of hiring suitable employees	O	3.63	Agree	0.90
9. No clear plan to promote technology adoption	O	3.42	Neutral	0.97
10. Business needs not met by technology	T	3.36	Neutral	1.02
11. Firm under pressure from competitors to adopt technology	E	3.46	Neutral	1.04
General Weighted Average		3.51	Agree	0.89

Note: T = technological, O = organizational, E = environmental context. Cronbach's α = 0.864; n = 121.

The neutral items are informative too. The cost and speed of internet access (M = 3.36 and 3.49) were not seen as decisive barriers, which suggests that for this well-educated group, most of whom are likely to work in or near urban centres, basic connectivity is no longer the main constraint. The same cannot be assumed for rural or less-educated women, for whom affordability and coverage remain significant [30]. Strategic-fit items (no clear plan to promote adoption, technology not meeting business needs, and competitive pressure) also attracted neutral ratings. The largest standard deviations (1.02-1.04) occurred on internet cost, business-needs fit and competitive pressure, showing that respondents were divided on these items rather than uniformly indifferent.

3.3. Barriers Through the TOE Lens

Grouping the items by TOE context shows that the organizational context dominates (Table 6). Organizational barriers had the highest mean (3.59), and three of the four were in the agree range. Technological barriers had the lowest mean (3.46), with only security reaching agreement. The two environmental barriers fell in between (3.51). The pattern is consistent with SME adoption research showing that internal readiness (financial resources, skills and managerial attention) explains adoption better than the availability of the technology itself [7], [8], [20]. In other words, women in Cambodian SMEs are not primarily held back by whether technology exists or can be reached, but by whether their firms can afford to keep it running and can find people to use it.

Table 6. Barriers Grouped by TOE Context

TOE context	Items	Mean	Range	Items agreed
Organizational	Funds; maintenance costs; hiring suitable employees; no clear plan	3.59	3.42-3.69	3 of 4
Environmental	Legal framework; competitive pressure	3.51	3.46-3.55	1 of 2
Technological	Internet cost; internet speed; technical support; security; fit with business needs	3.46	3.3-3.60	1 of 5

Note: Context means are unweighted averages of item means in Table 3.

The TOE grouping is conceptual, not empirically derived, and the context means are averages of item means. They show where barriers cluster, but the three contexts have not been validated as separate subscales.

3.4. Interview Themes and Integration with the Survey

Thematic analysis of the interviews produced six barrier themes: high costs of implementing and maintaining technology, lack of knowledge and skills, resistance to change, security concerns, complexity of new systems, and regulatory and compliance issues. Each is illustrated below with quotations from the informants. The theme descriptions report what informants said; our interpretation of the learning needs these accounts imply is presented separately at the end of this section (Table 8).

High costs. Informants described costs as continuing rather than one-off. P1 summarised the problem: "Technology can be expensive to implement and maintain." For P4, the move to remote work during COVID-19 created an unplanned expense: "we need to buy a bigger server because all the employees at home all can't use the server like at the company, the company has to run out of money to buy a bigger server to store all the files." Cost also shaped decisions about advanced tools. P2 had not yet adopted an AI-assisted diagnostic system because "it's quite expensive … it's more than 10,000 USD", and P3 asked how such spending could be recovered: "I spend money on technology, how much should I increase the price?" P5's firm had postponed further investment altogether: "because of the current economic we have not figured out about technology yet because of the costing involvement."

Knowledge and skills. The most frequent concern was a shortage of people who know how to use technology. P3 explained that when owners lack the skills themselves, the cost shifts to hiring: "If we do not know how to use [it], we need to find someone who knows how [to] use it and to get the professional staff and pay them to use it." P6, who advises other SMEs, saw digital literacy as their main obstacle: "not many people are equipped with digital knowledge, especially the advanced ones, so they still use [the] traditional way of working." P5 put it most vividly: "you need quality people to implement the technology because if there is no qualified person to use it, then technology will become like a rock." P8 reached the same conclusion about her own clinic: "I need someone to help manage the section, and they need to be trained." P1 added that "not everyone knows all the tools that could be useful to them."

Resistance to change and workforce management. P1 observed that "employees may resist new tools or processes", and P6 described SME clients who "prefer to meet in person … sometimes they refuse to meet online", concluding that "they still need to build their mindset." Two owners also linked online work to a loss of control over staff. P7 recalled that during COVID-19 "we are difficult to control our staff because we work online … they can't complete tasks on time and can't reach the target", and P8 noted that a junior employee who "sits in front of the computer … can take time to do personal things."

Security. Security was raised by most informants and was often tied to legal uncertainty. P3 put it directly:

> *the market is now very competitive and we are worried about hackers ... It is also a concern about protection, fear of theft through technology, we do not yet have clear laws to protect us, so some businesses we do not dare to expand.* (P3)

For P7, whose firm handles clients' confidential documents, the risk came through clients' hacked accounts: "they sent us … their confidential information. After someone hacked their account [the hacker] can access … [the] email and copy all important information and we are difficult to control it." P6 cautioned that "even AI or other advanced technology can be find from open source but to some extent it's not safe", and P8 described a fraudulent AI-generated request for a money transfer, adding: "For me personally, I do not trust it 100%."

Complexity. P1 identified the difficulty of ensuring "seamless integration with existing systems". P5 described how complex applications break down in daily use: when staff "have a lot of comment or a lot of function to complete sometime they tends to forget or they don't fill all the requirement criteria then getting error … so it cannot get the result as what we expected from that technology." P8 stressed that staff must understand a technology and its limits before relying on it.

Regulation and policy awareness. Regulatory concerns went beyond security. P3 noted the absence of clear procedures for electronic transfers: "if we transferred money from A to B, we do not have a clear procedure." P2 had held back from importing an AI diagnostic device partly because it was not yet officially recognised: "I'm afraid to bring it to the government". Informants also knew little about government support for SMEs. P7 had "never read the information in depth", and P2 remarked that "the business community may know a little, but the health sector may not."

Table 7 integrates the two strands. Four barrier domains converge: cost, skills, security and regulation were agreed in the survey and raised independently in the interviews, which strengthens confidence that they are the main constraints. Connectivity and strategic fit were neutral in the survey and received little attention in the interviews. Only P4 mentioned connectivity, noting that during remote work "if the internet is isolated from the server, we are also blocked". On strategic fit, P6 argued that the need to invest "depend [s] of the size of the company and the need of advanced technology. Because some business, the nature of their business, they don't need advanced technology, so why they need to invest in technology?" P5 made the same point about cost: "it is depend on the size of the company … we don't need to invest a lot of money on technology we can use the existing platform". This firm-specific view is consistent with the divided survey responses on these items. Resistance to change and complexity are an expansion. They appear only in the interviews because the survey did not measure them, yet they are central to adoption theory as organizational inertia [23], innovation complexity [48] and effort expectancy [5]. Their absence from the instrument is a limitation, and future surveys of women in SMEs should include them.

Table 7. Joint Display of Survey and Interview Findings on Barrier

Barrier domain	Survey evidence	Interview evidence	Integration
Cost of acquiring and maintaining technology	Funds 3.60; maintenance 3.69 (agree)	High implementation and maintenance costs	Convergence
Skills and human capital	Hiring 3.63 (agree); technical support 3.49 (neutral)	Lack of knowledge; limited access to training and support	Convergence
Security	Lack of security 3.60 (agree)	Data breaches and cyber threats	Convergence
Regulation	Legal framework 3.55 (agree)	Regulatory and compliance issues	Convergence
Connectivity	Internet cost 3.36; speed 3.49 (neutral)	Raised once: internet or server outages during remote work (P4)	Low salience in both
Strategic fit and competition	No plan 3.42; needs not met 3.36; competitor pressure 3.46 (neutral)	Need for technology depends on the business (P5, P6)	Low salience; varies by firm
Resistance to change and complexity	Not measured	Reluctance to change routines; complexity of new systems; supervising staff online	Expansion (interview only)

The integrated findings also help explain the coping strategies reported for the same population. Human-capital development and leadership engagement were the most strongly endorsed strategies [14] , which matches the human-capital barriers identified here. In the interviews, informants added continuous learning, pilot projects and collaboration as ways of managing adoption. P1 recommended "pilot projects: test new technologies on a smaller scale before full adoption" and P7's firm trains every new employee on the systems it uses and has IT staff check each computer monthly for viruses. Piloting is a particularly apt response to complexity and resistance: it allows staff to try a system on a small scale and see results before committing, which reflects the trialability and observability conditions of diffusion theory [48].

Learning needs identified from the interviews. The accounts above describe barriers rather than educational needs, and informants were not asked about training directly. Interpreting their statements, however, we identify seven learning needs that educational programmes for women in SMEs could address (Table 8). Some needs were described by informants themselves: P7's firm trains every new employee on its systems, and P1 recommended periodic training sessions and pilot projects. Others are our inferences. Informants described skills shortages ("technology will become like a rock" without qualified people, P5), errors when staff use complex applications (P5), and staff who resist or neglect new routines (P1, P6, P7, P8). We read these accounts as pointing to a need for practical, hands-on digital training on the systems a firm actually uses, rather than general awareness courses. Informants also faced costly, uncertain investment choices: an AI diagnostic system costing more than 10,000 USD (P2), how to price products to recover technology costs (P3), and whether to build or buy a system (P5). We read these as pointing to financial planning exercises and structured technology decision-making activities. The low awareness of regulation and government support (P2, P3, P7) suggests a further need for accessible information on digital rules and support programmes. These learning needs are inferred from reported barriers; the study did not assess informants' skills or test any training.

Table 8. Learning Needs Inferred from the Interview Findings

Learning need (authors' interpretation)	Basis in interview statements	Possible learning activity
Practical, role-specific digital skills	Shortage of skilled staff and the cost of hiring them (P3, P5, P8); not knowing which tools exist (P1)	Hands-on training on the firm's own systems; structured onboarding for new staff, as practised by P7's firm
Using complex systems correctly	Errors when staff skip required steps in complex applications (P5); integration with existing systems (P1)	Step-by-step workflow practice, checklists and refresher sessions after system updates

Learning need (authors' interpretation)	Basis in interview statements	Possible learning activity
Leading change and supervising digital work	Employees resisting new tools (P1); clients preferring in-person meetings (P6); difficulty supervising staff online (P7, P8)	Change-management and remote-supervision training for owners and managers; pilot projects before full adoption (P1)
Financial planning for technology	Unplanned server costs (P4); expensive equipment (P2); recovering costs through prices (P3); postponed investment (P5)	Exercises in lifecycle cost budgeting, payback estimation and pricing (see Section 3.7.1)
Technology-related decision-making	Building versus buying a system (P5); whether advanced technology is needed at all (P6); regulatory status of new equipment (P2)	Case-based activities comparing options by business need, cost, security and legal requirements
Digital security awareness	Hacking and data leaks (P3, P7); unsafe open-source tools (P6); AI-generated payment fraud (P8)	Practical training on passwords, phishing and scam recognition, and protecting client data; routine IT checks (P7)
Awareness of regulation and support	Unclear rules for electronic transfers (P3); limited knowledge of government support (P2, P7)	Briefings on e-transaction rules, data protection and available SME support programmes

Note: Learning needs are the authors' interpretation of the interview findings; they were not directly measured.

3.5. Education, Technology Level and the Human-Capital Barrier

Educational attainment was significantly associated with the kind of technology women used (Table 9). Among high-school graduates, 68.4% relied mainly on basic technology, compared with 32.8% of bachelor's degree holders and 15.9% of those with postgraduate degrees. Conversely, two-thirds of postgraduates used job-related technology. Use of up-to-date technology, however, was similar across the three main groups (13.8%–16.7%). The original four-group test was significant ($\chi^2(6) = 19.27$, $p = .004$, Cramér's $V = 0.28$), but four cells (33.3%) had expected counts below five, mainly because only two respondents held doctorates. With master's and doctoral holders combined, the association remained significant and of similar size ($\chi^2(4) = 18.34$, $p = .001$, Cramér's $V = 0.28$), with only one cell (11.1%) below five.

Table 9. Educational Attainment and Kind of Technology Used

Education	Basic	Job-related	Up-to-date	Total
High school	13 (68.4%)	3 (15.8%)	3 (15.8%)	19
Bachelor's degree	19 (32.8%)	31 (53.4%)	8 (13.8%)	58
Master's degree	7 (16.7%)	28 (66.7%)	7 (16.7%)	42
Doctoral degree	0 (0.0%)	2 (100%)	0 (0.0%)	2
Total	39 (32.2%)	64 (52.9%)	18 (14.9%)	121

Note: Four groups: $\chi^2(6) = 19.27$, $p = .004$; likelihood ratio = 20.60, $p = .002$; Cramér's $V = 0.28$; 4 cells (33.3%) with expected count < 5. Master's and doctoral combined (n = 44: 7, 30, 7): $\chi^2(4) = 18.34$, $p = .001$; Cramér's $V = 0.28$; 1 cell (11.1%) with expected count < 5.

This association should not be read as evidence that formal education causes more advanced technology adoption. The data are cross-sectional, so the direction of the relationship cannot be established: women whose work already requires job-related technology may be more likely to pursue further study, just as education may equip women to use such technology. Other factors may also explain part of the association. In the dissertation data, educational attainment was also related to respondents' age[15] , and job role, firm size and sector, which were not controlled in this analysis, may shape both a woman's education and the technology she uses at work. The chi-square test shows only that the two variables are related in this sample.

With these caveats, the pattern is consistent with the human-capital barrier identified in the survey and interviews. Women with secondary education were concentrated in basic technology use, and firms reported difficulty hiring people with digital skills, so skills appear to be a constraint both inside the firm and in the labour pool it draws on. Evidence from other developing economies points the same way: digital and financial literacy have been associated with the growth of women-led SME [12], and participation in gender-inclusive entrepreneurship education and training has been associated with technology adoption [13]. Because this sample

is far more educated than the general population of women in SMEs, the gap between education levels may be larger in the wider population.

For economic education and digital competency development, the results suggest two implications. First, the clearest difference between education groups lay in the shift from basic to job-related technology, such as accounting, sales and communication software, rather than in the use of advanced technology. Programmes for women with secondary education could therefore focus on the practical competencies this shift requires: using business software, managing digital records and payments, and working safely online. These correspond to the information, communication, safety and problem-solving areas of established digital competence frameworks [38]. Second, a degree was not sufficient for advanced use: only 16.7% of master's degree holders used up-to-date technology, about the same proportion as high-school graduates. This suggests that general formal education does not by itself provide the specific competencies needed to select and use advanced tools, and that targeted digital competency development, alongside financial and entrepreneurial training (Section 3.7), may be needed at all education levels. These are implications for programme design inferred from an association; whether such training changes technology use would need to be tested in future research.

3.6. Relationship Between Adoption Drivers and Perceived Barriers

Perceived adoption drivers and perceived barriers were positively and moderately correlated ($r = 0.4885$, $p < .001$; Table 10), with about 24% shared variance. If barriers simply deterred adoption, one would expect women who see strong reasons to adopt to report weaker barriers, or no relationship at all. The positive association instead suggests that barriers are experienced through engagement: women who rely more heavily on technology for control, client service and growth are also the ones who confront its maintenance costs, staffing needs and security risks. Research on post-adoption use likewise finds that both the value and the problems of e-business become visible only once technology is embedded in operations [21].

Table 10. Correlation Between Adoption Drivers and Perceived Barrier

Variables	r	p-value	r^2	Level of correlation
Adoption drivers – Perceived barriers	0.4885	< .001	0.24	Moderate positive

Note: n = 121. Significant at $p < .05$. Adoption drivers: 14 items ($\alpha = 0.883$); barriers: 11 items ($\alpha = 0.864$).

Two cautions apply. First, the design is cross-sectional, so the direction of the relationship cannot be established. Second, both scales were self-reported in the same questionnaire, so part of the correlation may reflect common-method variance or a general tendency to agree. With these caveats, the result implies that barriers are better understood as frictions that slow the deepening of adoption than as reasons women avoid technology altogether. Support therefore needs to reach women who are already adopting, not only those who have yet to start.

Comparison with previous research. Several of these results are consistent with earlier studies. The dominance of organizational barriers matches the long-standing finding that internal resources and owner-manager capabilities shape adoption in small firm [7], [8], [20]. A recent umbrella review of technology adoption in SMEs in developing countries reached a similar conclusion: knowledge and skills (about 31% of coded barrier mentions) and resources and finance (about 24%) were the most frequently reported barriers, ahead of technological issues (about 16%) [49]. The prominence of implementation and maintenance costs, and informants' view that the need for technology depends on the size and nature of the firm, echo findings that SMEs struggle with the time, skills and money needed to build and sustain digital systems suited to their specific needs [50]. Studies of SME e-commerce in Indonesia and Malaysia likewise identified limited resources and skills as primary barriers [31], [32] and recent Cambodian evidence shows that digital adoption among tourism MSMEs remains uneven and relatively low [51]. The link between education, skills and technology use is consistent with evidence that financial and digital literacy are associated with the performance of women-led SMEs [12], [52] and that gender-inclusive entrepreneurship education and training is associated with technology adoption [13]. The positive relationship between adoption drivers and perceived barriers agrees with post-adoption research showing that the problems of e-business, like its value, become visible once technology is embedded in operations [21]. One result differs from the wider literature. Connectivity and infrastructure are frequently reported barriers in developing countries [30], [49], yet respondents in this study rated internet cost and speed as neutral, which probably reflects a well-educated sample likely concentrated in urban areas.

Implications and limitations. Theoretically, the findings support the use of the TOE framework for studying women-run SMEs and suggest that, in this context, the organizational context deserves particular attention, since internal financial and human-capital resources mattered more than the availability of technology. They also suggest treating barriers as part of the adoption process rather than only as obstacles that precede it, since perceived barriers rose with the strength of adoption drivers. Practically, the findings suggest that support for women in SMEs should move beyond access to technology towards helping firms sustain it: covering recurring costs, developing staff skills and building the financial, entrepreneurial and digital competencies discussed in

Section 3.7. These implications must be read in light of the study's limitations. The convenience sample was well educated and reached through professional networks, so the results cannot be generalised to all women in Cambodian SMEs, particularly rural and less-educated women. All measures were self-reported and cross-sectional, which prevents causal conclusions and leaves room for common-method bias. The eight interviews drew mainly on owners and managers, with two from the health-care sector. The TOE grouping was conceptual rather than statistically validated, and the survey did not measure resistance to change or complexity. Financial literacy, entrepreneurial skills and digital competence were not measured directly, so the educational implications are inferred rather than tested. Finally, the study did not include a comparison with men-led SMEs.

3.7. Implications for Economic Education

The findings point to several areas where economic education could help women in SMEs manage the barriers identified in this study. The study did not measure financial knowledge, entrepreneurial skills or digital competence, nor did it test any training intervention. The implications below are therefore inferred from the barriers that respondents and informants reported, and they indicate what educational programmes might address rather than what this study has shown to be effective. Table 11 summarises how each educational area responds to the barriers identified.

3.7.1. Financial Education and the Cost of Technology

The strongest survey barriers were financial. Maintenance costs (M = 3.69) were rated above insufficient funds to purchase technology (M = 3.60), and informants described costs that continued long after adoption. P4's firm had to buy a larger server when staff began working from home, P2 had postponed an AI diagnostic system costing more than 10,000 USD, and P5's firm had delayed further investment "because of the costing involvement." These accounts suggest four areas in which financial education for SME owners and managers could be relevant. The first is understanding recurring technology expenses. Because maintenance was rated as a greater barrier than purchase, training could help women anticipate the full lifecycle cost of a system, including subscriptions, licences, updates, repairs and technical support, rather than only its purchase price. This is consistent with evidence that the business value of IT depends on continued, complementary investment after acquisition [25].

The second is budgeting. Insufficient funds and unplanned costs, such as P4's server upgrade, indicate a need to set aside money for technology in the regular business budget and to build in reserves for unexpected expenses. Simple, practical rules for separating business and personal money and tracking cash flow have been shown to improve the financial practices of microentrepreneurs [37]. The third is cost-benefit assessment. P3 asked how much she should raise her prices to recover technology spending, and P5 judged that buying an existing platform was cheaper than building her own. Both are investment decisions that require comparing costs with expected gains in efficiency, sales or control. Training in basic investment appraisal, such as estimating payback periods and comparing alternatives, could support these decisions.

The fourth is financial planning. Several informants linked their adoption decisions to the wider economic situation and to limited access to finance. Planning when and how to fund technology, whether from savings, credit or leasing, and preparing the documentation that lenders require, could help women whose firms rely mainly on the owner's own resources [2]. Financial literacy is known to shape how people budget, borrow and plan [16], and financial and digital literacy have been associated with the growth of women-led SMEs [12]. Whether training in these areas would reduce technology-related barriers for women in Cambodian SMEs, however, remains to be tested. Evaluations of business training in developing countries report modest average effects, with gains in profits and sales of around 5–10% [53], so such programmes should be designed around specific, practical decisions like those described above.

3.7.2. Entrepreneurship Education and Workplace Learning

The second set of implications concerns the difficulty of hiring suitable employees (M = 3.63) and the limited digital knowledge described in the interviews. These barriers involve three groups with different learning needs. For women owners and managers, entrepreneurship education could build the competencies needed to select technology: judging whether a tool fits the firm's needs, comparing building with buying, as P5 described, weighing security and legal risks, and planning implementation in stages. Entrepreneurship education and training have been associated with technology adoption when they are designed with women's needs in mind [13], and recent evidence suggests that business training is more effective when it is adapted to gender, local context and practical problems [53]. For managers, the interviews also point to competencies in leading change and supervising digital work, since informants described staff who resisted new tools (P1, P6) or were difficult to supervise online (P7, P8). Organizational inertia is a well-established obstacle to innovation [23], and managers who can explain the purpose of a new system, involve staff early and set clear expectations for online work are better placed to overcome it.

For employees, workplace learning may be a practical alternative to recruiting scarce skilled staff. Informants already described elements of it: P7's firm trains every new employee on its systems and communication tools, and P1 recommended periodic training sessions and pilot projects. Structured onboarding, on-the-job coaching, peer learning and short refresher sessions after system updates would allow SMEs to develop skills they cannot easily hire, and pilot projects give staff a low-risk way to learn a new system before it is fully adopted [48] because the human-capital barrier lay both inside firms and in the wider labour pool (Section 3.5), such workplace learning would complement rather than replace formal education. Whether it reduces hiring difficulties for women-run SMEs remains a question for future research.

3.7.3. Digital Competency Development

The third set of implications concerns digital competence. The association between education and technology level (Table 9) suggests that the clearest need is the practical competence to move from basic to job-related technology, such as accounting, sales and communication software, especially among women with secondary education. Established frameworks describe digital competence in terms of information and data literacy, communication and collaboration, digital content creation, safety and problem solving, including identifying needs and suitable technological responses [38]. The barriers in this study correspond to several of these areas. Security concerns (M = 3.60) and the hacking and fraud described by P3, P6, P7 and P8 point to safety competences; errors in complex applications (P5) and difficulty integrating systems (P1) point to competences in using and troubleshooting business systems; and uncertainty over whether technology meets business needs points to the ability to identify appropriate digital tools. Cambodia's national digital economy policy already identifies digital skills for businesses and citizens as a priority [39]. The findings suggest that programmes for women in SMEs would be most useful if they are practical, linked to the systems women actually use, and combined with the financial and entrepreneurial content described above. Table 11 summarises these areas and the barriers they respond to.

Table 11. Educational Areas and the Barriers They Address

Educational area	Barriers addressed in this study	Possible programme content
Financial literacy and business budgeting	Maintenance costs; insufficient funds; unplanned costs (P4, P5)	Lifecycle cost budgeting, cash-flow planning and reserves for technology
Technology investment appraisal	Costly, uncertain investments (P2, P3, P5); technology not meeting business needs	Payback estimation, cost-benefit comparison, build-or-buy and pricing decisions
Entrepreneurship education	No clear adoption plan; resistance to change; security and legal risks	Technology strategy, risk assessment, change leadership and staged implementation
Workplace learning	Difficulty hiring suitable employees; skills shortages (P3, P5, P8)	Onboarding, on-the-job coaching, peer learning and pilot projects
Digital skills development	Complexity; security concerns; basic technology use among women with secondary education	Business software, digital records and payments, cybersecurity, and choosing suitable digital tools

Note: Programme content is inferred from the barriers identified; it was not tested in this study.

4. CONCLUSION

This study examined the financial and human-capital barriers to technology adoption among women working in Cambodia's small and medium-sized enterprises (SMEs) and their implications for economic education. The findings revealed that perceived barriers were modest overall, with organizational barriers emerging as the most prominent within the Technology-Organization-Environment (TOE) framework. Technology maintenance costs, insufficient funds, difficulty hiring suitable employees, security concerns, and limitations in the legal framework were among the principal barriers identified. The interviews reinforced these findings while revealing additional challenges involving resistance to change and technological complexity. Educational attainment was significantly associated with the type of technology used, while perceived adoption drivers showed a moderate positive correlation with perceived barriers. This relationship suggests that women who perceive stronger motivations for technology adoption also tend to report greater barriers; however, the cross-sectional findings do not establish whether these barriers arise before, during, or after adoption.

The findings highlight the relevance of economic education in addressing the financial and human-capital challenges experienced by women in Cambodian SMEs. Financial literacy programmes could strengthen budgeting, investment appraisal, and planning for the recurring costs of technology. Entrepreneurship education could support informed technology investment decisions, risk assessment, and organizational change, while workplace learning and practical digital skills development could help address workforce capability gaps. These

educational implications are derived from the barriers identified rather than from direct assessments of participants' competencies or evaluations of training effectiveness. Complementary policy measures addressing technology-related costs, regulatory clarity, and digital security could further support women's participation in the digital economy.

Future research should examine the effectiveness of financial literacy, entrepreneurship education, and digital skills training in reducing technology adoption barriers. Further studies should directly measure relevant competencies, incorporate resistance to change and technological complexity into survey instruments, and examine the validity of the TOE classification. Broader and more representative samples, including rural women, women with lower educational attainment, and comparisons with men-led SMEs, would improve the generalizability of findings. Longitudinal research could also provide a clearer understanding of how perceived barriers evolve throughout the technology adoption process.

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ETHICAL APPROVAL

This article is derived from a broader research project, a PhD dissertation submitted for the PhD in Business Administration at The University of Cambodia, Phnom Penh, Cambodia, which formally approved the study. Participation in the survey and interviews was voluntary.

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