International Journal of Technology, Policy and Management

ISSN online: 1741-5292 - ISSN print: 1468-4322
https://www.inderscience.com/ijtpm

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DOI: 10.1504/IJTPM.2024.10055762

Article History:

Received:	28 September 2022
Last revised:	06 January 2023
Accepted:	06 January 2023
Published online:	11 January 2024

Critical factors inhibiting information and communication technology (ICT) adoption in Côte d'Ivoire: a study of small and medium enterprises (SMEs) in metropolitan Abidjan

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Abstract: The paper aims to investigate and categorise the barriers influencing information and communication technology (ICT) adoption among small and medium-sized enterprises (SMEs). A questionnaire-based survey was used to collect data from 77 owners/managers of SMEs in metropolitan Abidjan, Côte d'Ivoire. A research framework based on the technology-organisation-environment-individual-economy (T-O-E-I-E) model was used to guide the research effort. The results suggest that technological, economic and environmental factors such as unreliable basic fixed internet, cybercrime, a lack of government support and a high cost of access to fixed broadband internet are the most significant barriers to ICT adoption in the sample. Manufacturing firms had the most difficulties adopting ICTs; smaller enterprises also had more difficulties. The findings of this study offer valuable insights to SME owners/managers, policy-makers, financial institutions and local ICT companies wishing to understand why SMEs are slow to adopt ICTs, and actions that can be taken to strengthen the level of ICT adoption among SMEs.

Keywords: ICT adoption; small and medium-sized enterprises; T-O-E-I-E; barriers; critical factors; Côte d'Ivoire.

Reference to this paper should be made as follows: Assiélou, N.G. and Bourgault, M. (2024) 'Critical factors inhibiting information and communication technology (ICT) adoption in Côte d'Ivoire: a study of small and medium enterprises (SMEs) in metropolitan Abidjan', *Int. J. Technology, Policy and Management*, Vol. 24, No. 1, pp.19–49.

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1 Introduction

Small and medium-sized enterprises (SMEs)[1] play a critical role in job creation and economic diversification (Agboh, 2015; Mushtaq et al., 2022). They represent the major source of employment and the most important income source in most countries, especially in the developing countries[2] (Abor and Quartey, 2010; Kyakulumbye and Pather, 2022). For instance, SMEs account for 80% of urban population and contribute 60% of GDP in China (Sham, 2014). In Africa, SMEs are the major vehicles of economic development and the highest contributors to the gross domestic product (GDP) of countries (Pekane and Tanner, 2017). SMEs make up 90% of the private sector and provide approximately 80% of jobs in Africa; Sub-Saharan Africa alone has 44 million SMEs (Runde et al., 2021). In Côte d'Ivoire, 98% of the businesses in 2018 were SMEs, which accounted for about 20% of GDP and 12% of domestic investment, and provided 23% of the labour force (African Development Bank, 2018, pp.XXII). The national economy has recorded strong growth ranging from 8% to 10% since 2012. Despite the importance of SMEs in the national economy, their contribution to economic growth remains low and they are often unable to compete well on the global market due to internal and external constraints.

Information and communication technologies (ICTs) are vital for the development of businesses, can improve their competitiveness and generate competitive advantage (Abdullah et al., 2018; Apulu and Ige, 2011; Asrani, 2021). ICTs are a collection of technologies that are used to store, manipulate, receive and transmit digital data (Chibelushi and Costello, 2009). Thus, ICTs are tools that can assist SMEs in growing their business (Marnewick, 2014). They have the potential to provide access to new markets and give SMEs the ability to compete with larger companies (Tan et al., 2009), reduce costs (Ongori and Migiro, 2011), provide enhanced customer service (Afolayan et al., 2015), and change the way in which organisations operate (Iyanda and Ojo, 2008).

Although ICTs can provide SMEs with opportunities and benefits, these firms face numerous challenges that put pressure on them and impede the adoption of ICTs. ICT adoption has uncertain consequences on business performance (Mondal and Chakrabarti, 2021); specifically, many SMEs fail to implement and maintain ICT systems (Alam, 2009). According to Awa and Ojiabo (2016), SMEs rarely have the necessary experience and resources to effectively implement ICTs. Most SMEs will not adopt ICTs at all if the benefits do not outweigh the costs of developing and maintaining their system (OECD, 2004). Many studies have been carried out on factors that inhibit and/or facilitate adoption of ICTs in developed and developing countries, especially in sub-Saharan Africa. Nevertheless, very little research has been done on ICT adoption within the specific context of Ivorian SMEs. Despite the increasing pace of technological development in recent decades, the level of ICT adoption by SMEs in Côte d'Ivoire remains low, as is prevalent across Africa where ICT adoption is perceived with scepticism (Kyakulumbye and Pather, 2022; Owusu-Agyei et al., 2020). This is confirmed by the country's position in the Networked Readiness Index (NRI) 2020, a classification published annually by the Portulans Institute, which ranks all the countries in the world according to their level of ICT readiness (Dutta and Lanvin, 2020). Côte d'Ivoire, ranked in 115th place, lags behind other West African countries such as Senegal (100th), Ghana (98th) and Cape Verde (86th). This reveals that ICT development in the country, especially in SMEs, has not yet reached its full potential and some improvements could and should be made to enhance the level of ICT adoption.

SMEs face many challenges that impede ICT adoption and limit access to critical information on the market; these challenges include poor telecommunication infrastructures, cybercrime, financial constraints, inadequate power supply and lack of government support (Apulu and Ige, 2011; Nandan, 2012; Ozumba and Shakantu, 2018). The literature mentions many factors that could inhibit ICT adoption especially by SMEs. It is important for researchers, practitioners and political decision-makers to understand the barriers to ICT adoption, in order to prevent ICT adoption failure in SMEs, allocate resources, and make appropriate IT investment decisions. However, the challenges faced by SMEs may be specific and inherent to a particular country. This study aims to address the literature gap by identifying the barriers that affect Ivorian SMEs.

Drawing on the technology-organisation-environment-individual-economy (T-O-E-I-E) framework (Skoko et al. (2006; Assiélou and Bourgault, 2022), this paper explores the barriers to ICT adoption within a sample of 77 Ivorian firms located in metropolitan Abidjan. The T-O-E-I-E model was chosen for this study because the challenges that impede ICT adoption are related not only to SMEs' technological, organisational and environment contexts but also to their individual and economic contexts.

The remainder of this paper is structured as follows. First, the theoretical framework, research model and constructs of the study are described. Next, the research methodology, the data analysis and the main results of the questionnaire-based survey are presented. This is followed by a discussion of the implications of the findings, suggestions for future research, and the conclusion.

2 Theoretical framework and empirical review

2.1 T-O-E-I-E framework

An extensive literature review revealed critical barriers that affect ICT adoption by SMEs. Several approaches, theories and methods were used to identify them and group them into categories. They provide different perspectives for analysing the adoption of ICTs. The most common approaches are the Technology Acceptance Model (Davis, 1989), technology-organisation-environment (T-O-E) model (Tornatzky and Fleischer, 1990), theory of planned behaviour (Ajzen, 1991) and T-O-E-I-E model (Skoko et al., 2006; Assiélou and Bourgault, 2022).

The evaluation of models led to the choice of the T-O-E-I-E framework for this study (see Table 1). Based on the T-O-E model, which has received more empirical and theoretical support from existing studies than most other models (Awa and Ojiabo, 2016), the T-O-E-I-E framework incorporates two important issues that SMEs face, namely individual context and economic context. The T-O-E framework, which examines ICT adoption and diffusion according to technology, organisation and environment contexts, is not theoretically adequate to examine the adoption and diffusion of ICTs in SMEs (Premkumar, 2003). According to Awa et al. (2017), the T-O-E framework should incorporate other adoption theories that integrate the individual context. Decision-making concerning ICT adoption is greatly influenced by economic issues (Ramdani et al., 2013). The integration of these two contexts helps to better explain and predict the probability of ICT adoption or non-adoption by SMEs. The T-O-E-I-E model seems most appropriate for the study of barriers to ICT adoption among Ivorian SMEs because it focuses on their realities and needs (Assiélou and Bourgault, 2022).

Taking a broad view, the T-O-E-I-E framework enables one to categorise ICT barriers affecting SMEs into five contexts: technology, organisation, environment, individual and economy.

The technological context refers to the existing technological structure and users' perceptions of technological attributes; it describes the characteristics of the existing technologies and the technical skills available in a company (Ilin et al., 2017). Technological factors include compatibility, trialability, complexity, relative advantage and observability (Awa et al., 2015; Singh and Mansotra, 2019).

The organisational environment plays a significant role in ICT adoption. It refers to the resources and characteristics of the company that constrain ICT adoption (Gono et al., 2016). Factors such as firm size, top management support, lack of skilled staff, and workers' or users' participation and involvement were found to be consistently related to ICT adoption (Eze et al., 2019; Hamad et al., 2018).

The external environment refers to the area in which a firm conducts its activities (Bayo-Moriones and Lera-López, 2007). Factors found to influence the adoption of ICTs include the nature of the industry, competitive pressure, trading partners and government regulation (Ilin et al., 2017; Ramdani et al., 2013; Singh and Mansotra, 2019).

It is essential to take the individual context into account, as individuals (employees, managers) use ICTs for their daily work (Skoko et al., 2006). According to Awa et al. (2017), the adoption of ICTs depends largely on decision-makers' feelings. Factors found to influence the adoption and diffusion of ICTs include lack of familiarity with ICTs, owner/manager attitudes toward ICT adoption, time constraints, and increased workloads (Afolayan et al., 2015; Gagnon et al., 2012; Omiunu, 2019).

Table 1 Relevance of theories to the present research

Models and theories	*Constructs/Focus*	*Relevance to the paper*
Technology acceptance model (TAM)	• It focuses on two key constructs (perceived usefulness and perceived ease of use) to predict individual attitudes toward ICT adoption addressed ICT adoption • It addresses ICT adoption at the individual level	• It neglects social, psychological and interpersonal factors • Restricting the model to two core determinants limits its explanatory and predictive ability and means it cannot handle the issue of technology adoption
Theory of planned behaviour (TPB)	• It complements TAM with constructs such as perceived behavioural control and subjective norms to explain and predict IT adoption behaviours • It addresses ICT adoption at the individual level	• It leaves out the relationships between SMEs' managers, employees and external stakeholders • It ignores the idiosyncrasies of individual SMEs
Technology-organisation-environment (T-O-E) model	• It argues that three features of an enterprise's context (technological, organisational and environmental contexts) influence ICT adoption • It examines ICT adoption in an organisational context	• It leaves out the characteristics of individuals, such as top management support • It places little emphasis on economic issues such as a lack of financial resources and ICT costs
Technology-organisation-environment-individual-economy (T-O-E-I-E) model	• It enriches the T-O-E by incorporating individual and economic factors to assess ICT adoption by SMEs • It examines ICT adoption in an organisational context	• It takes advantage of the strengths of the TOE and incorporates constructs that overlap with those of the TAM and TPB • It seems more consistent and more useful for this study • It provides more generic explanatory constructs for analysing ICT adoption at the organisation level than other models

The economic context relates to issues that affect the economic feasibility of ICTs. Factors that significantly influence the adoption of ICTs include lack of financial resources, high ICT costs, and perceived benefits (Maryama and Suhongb, 2022; Oh et al., 2012).

2.2 Barriers to ICT adoption

The barriers affecting ICT adoption among SMEs have been widely investigated in the literature. They are particularly large in developing countries, especially in sub-Saharan Africa. Unlike large organisations, SMEs adopt technologies more slowly. They are often badly prepared and lack the financial, technical and human resources to adopt ICTs. However, ICT use can improve opportunities for SMEs to compete on equal terms with larger organisations (Alberto and Fernando, 2007).

Firms that adopt ICTs in developing countries face a variety of issues. For example, in Tanzania, SMEs face problems that can be categorised along two dimensions: firm-bound factors such as investment power and influence of the owner, and context-based factors like cyber safety and adequacy of access to infrastructure (Yonazi and Marondo, 2014).

Mutula and Van Brakel (2006) state in their study that the major barriers to ICT adoption by SMEs in Botswana include lack of technical support, inadequate telecommunication service quality, lack of financial resources and frequent internet downtime.

Kapurubandara (2009) identified a variety of factors inhibiting the adoption of ICTs and e-commerce technologies; these factors can be classified as internal vs. external barriers. Internal barriers, which exist within the company, typically include lack of IT skills and expertise, the owner's unawareness of the perceived benefits, insufficient information about the benefits, and lack of financial resources. External barriers, which are found outside the organisation, include lack of government support and inadequate telecommunication infrastructure.

A study by Ardjouman (2014) revealed that ICT costs, an unreliable electricity supply, inadequate infrastructure, limited access to internet, government policies, negative attitudes toward technology and lack of technical know-how are major challenges to the adoption of ICTs by SMEs in Côte d'Ivoire.

Afolayan et al. (2015) explored the use of information technologies among SMEs in Lagos, Nigeria. They found that the factors inhibiting ICT adoption include lack of knowledge of ICT solutions, reliability and security issues, inadequate perceived benefits, lack of support from management, limited access to capital, poor infrastructure, and an unstable electricity supply.

Ozumba and Shakantu (2018) pointed out that relevant challenges to ICT adoption can be classified as technical, legal, information-related, knowledge/skills-based, industry/organisational, project-specific, management-related and end-user-related challenges, as well as challenges specific to settings and government.

A qualitative study of Assiélou and Bourgault (2022), using semi-structured surveys of 15 senior executives of institutions, agencies and ministries in Côte d'Ivoire, working in the field of ICT and SMEs, permitted to identify 12 main barriers preventing Ivorian SMEs from adopting ICTs. These barriers were classified, using the T-O-E-I-E framework: technological factors (cybercrime and ICT security, lack of ICT infrastructure, quality of ICT services), organisational factors (lack of ICT development and skills), environmental factors (lack of awareness of ICT, lack of ICT-related support), individual factors (attachment to traditional business practices, perceived usefulness of ICT, employees' reluctance to change), economic factors (ICT asset costs, ICT service costs, lack of financial resources). However, the perspective of SME owners/managers is not considered in this previous research.

In this study, the ICT adoption barriers proposed by Assiélou and Bourgault (2022) have been supplemented by others identified in the literature, with the aim of covering most challenges encountered by SMEs. An overview of these ICT adoption barriers, categorised according to the T-O-E-I-E framework, is shown in Table 2.

Table 2 Categorisation of ICT-related barriers from literature review

Context	*Barriers*	*Authors/Sources*
Technology	1. Lack of customised ICT products for SMEs	Chitura et al. (2008), Nandan (2012), Tan (2010), Tiwari (2011)
	2. Limited access to appropriate technology	Okundaye (2016), Tiwari (2011)
	3. Perceived complexity	Gagnon et al. (2012), Ramdani et al. (2013), Tan et al. (2009), Yoo et al. (2021)
	4. Poor support from ICT vendors	Assiélou and Bourgault (2022), Awa et al. (2015), Gholami et al. (2011), Macredie and Mijinyawa (2011), Maduku et al. (2016), Tan (2010)
	5. Lack of compatibility for hardware and software	Chitura et al. (2008), Faloye (2014), Gagnon et al. (2012), Savoldelli et al. (2014), Yoo et al. (2021)
	6. Lack of maintenance of ICT equipment	Goi (2008), Harris et al. (2015), Ozumba and Shakantu (2018)
	7. Confidentiality and security related concerns	Abou-Shouk et al. (2013), Afolayan et al. (2015), Assiélou and Bourgault (2022), Eze et al. (2019), Gagnon et al. (2012), Kapurubandara (2009), Manuere et al. (2012), Mwila and Ngoyi (2019), Nyandoro (2016), Ongori and Migiro (2010), Savoldelli et al. (2014), Tan et al. (2010)
	8. Poor service from ISP providers	Afolayan et al. (2015), Apulu and Ige (2011), Arendt (2008), Assiélou and Bourgault (2022), Maryama and Suhongb (2022), Nyandoro (2016), Ongori and Migiro (2010)
	9. Cybercrime	Assiélou and Bourgault (2022), Faloye (2014), Gholami et al. (2011), Maryama and Suhongb (2022), Mwila and Ngoyi (2019)
	10. Unreliable ICT services	Afolayan et al. (2015), Apulu and Ige (2011), Arendt (2008), Mwila and Ngoyi (2019), Nyandoro (2016), Ongori and Migiro (2010), Ulhaq et al. (2022)
	10.1 Fixed-telephone	
	10.2 Basic fixed internet	
	10.3 Fixed broadband internet	
	10.4 Basic mobile internet	
	10.5 Mobile broadband internet	
	11. Lack of infrastructure	Abdullah et al. (2018), Abou-Shouk et al. (2013), Afolayan et al. (2015), Apulu and Ige (2011), Ardjouman (2014), Asrani (2021), Assiélou and Bourgault (2022), Awa et al. (2015), Busaidi et al. (2019), Faloye (2014), Kapurubandara (2009), Manuere et al. (2012), Mbuyisa and Leonard (2017), Mwila and Ngoyi (2019), Nandan (2012), Nyandoro (2016), Olatokun and Bankole (2011), Ongori and Migiro (2010), Tiwari (2011), Ulhaq et al. (2022)

Table 2 Categorisation of ICT-related barriers from literature review (continued)

Context	*Barriers*	*Authors/Sources*
Technology	12. Inadequate power supply	Abdullah et al. (2018), Apulu and Ige (2011), Ardjouman (2014), Asrani (2021), Faloye (2014), Maryama and Suhongb (2022), Olatokun and Bankole (2011)
	13. Limited knowledge of e-commerce models	Kapurubandara (2009), Olatokun and Bankole (2011)
	14. Limited availability of online banking services	Abdullah et al. (2018), Olatokun and Bankole (2011)
Organisation	15. Company size	Afolayan et al. (2015), Awa et al. (2015), Gono et al. (2016), Nandan (2012), Olatokun and Bankole (2011), Tan (2010)
	16. Firm age	Olatokun and Bankole (2011), Haugh and Robson (2005)
	17. Perceived benefits	Alam (2009), Eze et al. (2019), Guohua et al. (2022), Nyandoro (2016), Olatokun and Bankole (2011), San-Martín and Jiménez (2015)
	18. Lack of strategic vision	Chitura et al. (2008), Mbuyisa and Leonard (2017), Nandan (2012)
	19. Organisational culture	Afolayan et al. (2015), Kabongo and Okpara (2014)
	20. Financial constraint	Abdullah et al. (2018), Apulu and Ige (2011), Asrani (2021), Assiélou and Bourgault (2022), Awa et al. (2015), Eze et al. (2019), Kapurubandara (2009), Nandan (2012), Olatokun and Bankole (2011), Mushtaq et al. (2022), Ongori and Migiro (2010), Tan (2010)
	21. Lack of time	Chitura et al. (2008), Gagnon et al. (2012), Kapurubandara (2009), Manuere et al. (2012)
	22. Lack of employees with required skills and knowledge	Abdullah et al. (2018), Abou-Shouk et al. (2013), Afolayan et al. (2015), Apulu and Ige (2011), Ardjouman (2014), Assiélou and Bourgault (2022), Busaidi et al. (2019), Chitura et al. (2008), Gono et al. (2016), Kapurubandara (2009), Manuere et al. (2012), Mbuyisa and Leonard (2017), Nandan (2012), Nyandoro (2016), Olatokun and Bankole (2011), Ongori and Migiro (2010), Savoldelli et al. (2014), Tan et al. (2010)
Environment	23. Type of business	Arendt (2008), Olatokun and Bankole (2011)
	24. Technology change and evolution	Chitura et al. (2008), Goi (2008)
	25. Changes in business environment	Eze et al. (2019), Mpofu and Watkins-Mathys (2011), Nandan (2012)
	26. Unfavourable economic environment	Chibelushi and Costello (2009), Manuere et al. (2012), Mpofu and Watkins-Mathys (2011)

Table 2 Categorisation of ICT-related barriers from literature review (continued)

Context	*Barriers*	*Authors/Sources*
Environment	27. Lack of government support	Abdullah et al. (2018), Abou-Shouk et al. (2013), Apulu and Ige (2011), Ardjouman (2014), Awa et al. (2015), Faloye (2014), Ongori and Migiro (2010)
	28. Lack of policy and institutional framework	Abdullah et al. (2018), Asrani (2021), Busaidi et al. (2019), Eze et al. (2019), Faloye (2014), Kapurubandara (2009), Manuere et al. (2012), Mbuyisa and Leonard (2017), Tiwari (2011)
	29. Low bank account and credit card penetration	Kapurubandara (2009), Olatokun and Bankole (2011), Zaied (2012)
	30. Language barriers	Abdullah et al. (2018), Alam (2009), Gholami et al. (2011)
Individual	31. Lack of ICT literacy and familiarity	Abdullah et al. (2018), Asrani (2021), Manuere et al. (2012), Nyandoro (2016), Olatokun and Bankole (2011), Ongori and Migiro (2010), Tiwari (2011)
	32. Previous bad experience	Baporikar (2013), San-Martín and Jiménez (2015), Van Scheers (2016)
	33. Owner/manager attitudes towards ICT adoption	Afolayan et al. (2015), Awa et al. (2015)
	34. Perceived usefulness of the technology	Afolayan et al. (2015), Assiélou and Bourgault (2022), Gagnon et al. (2012, Guohua et al. (2022), Ulhaq et al. (2022)
	35. Lack of education and training of employees	Apulu and Ige (2011), Eze et al. (2019), Gagnon et al. (2012), Gono et al. (2016)
	36. Fear of new technology among employees	Baporikar (2013), Raymond et al. (2012)
	37. Reluctance to change the work practices	Assiélou and Bourgault (2022), Busaidi et al. (2019), Goi (2008), Mbuyisa and Leonard (2017), Savoldelli et al. (2014), Tan (2010), Yoo et al. (2021)
	38. Fears of job loss	Biagi and Falk (2017), Iyanda and Ojo (2008), Tan (2010)
Economy	39. High cost of ICT equipment and implementation	Abou-Shouk et al. (2013), Apulu and Ige (2011), Ardjouman (2014), Asrani (2021), Assiélou and Bourgault (2022), Busaidi et al. (2019), Olatokun and Bankole (2011), Gagnon et al. (2012), Kapurubandara (2009), Maryama and Suhongb (2022), Mbuyisa and Leonard (2017), Mwila and Ngoyi (2019), Tan et al. (2010), Tiwari (2011)
	40. High cost of maintenance	Apulu and Ige (2011), Goi (2008), Harris et al. (2015), Mwila and Ngoyi (2019), Ozumba and Shakantu (2018), Tiwari (2011)

Table 2 Categorisation of ICT-related barriers from literature review (continued)

Context	*Barriers*	*Authors/Sources*
Economy	41. High cost of training employees	Apulu and Ige (2011), Maduku et al. (2016), Maryama and Suhongb (2022)
	42. High cost of access to telecommunications	Abdullah et al. (2018), Afolayan et al. (2015), Assiélou and Bourgault (2022), Busaidi et al. (2019), Kapurubandara (2009), Maryama and Suhongb (2022), Mbuyisa and Leonard (2017), Nandan (2012), Nyandoro (2016), Ongori and Migiro (2010)
	42.1 Fixed-telephone	
	42.2 Mobile telephone	
	42.3 Basic fixed internet	
	42.4 Fixed broadband internet	
	42.5 Basic mobile internet	
	42.6 Mobile broadband internet	
	43. Taxes and duties on ICT equipment and services	Cant and Wiid (2016, Mpofu et Watkins-Mathys (2011), Mwila and Ngoyi (2019)

Few studies have been conducted on the challenges of ICT adoption by SMEs in Côte d'Ivoire. Identifying the factors that inhibit ICT adoption and use may be useful for SMEs owners/managers to adapt their ICT implementation and utilisation decisions, for decision-makers to turn identified issues into opportunities (Moshood et al., 2020), and for the government and SME promotion organisations to provide appropriate support and information in order to enhance the development of ICTs among SMEs. This paper attempts to address this gap by investigating the main barriers that hinder ICT adoption by SMEs in Abidjan.

3 Methodology

3.1 Approach and participants

To identify and explain the critical factors inhibiting ICT adoption in SMEs, it was necessary to understand the concrete realities faced by stakeholders (managers and employees) involved in the adoption process.

The data for this study were collected from September 2018 to May 2019. A questionnaire-based survey was conducted among owners/managers in Ivorian SMEs in order to obtain a precise description of their concrete realities and the challenges hindering the adoption of ICTs. Owners/managers of SMEs were chosen as respondents because their role is central to the company and their actions affect all business activities (Ghobakhloo and Tang, 2013); they oversee all the operations of their companies and are therefore in the best position to understand their current operations and future trends (Tan et al., 2009).

To identify the target population of SMEs, the Ivorian business directory produced by the Chamber of Industry and Commerce of Côte d'Ivoire (CIC-CI) was used. It included 9181 small and large companies, 42% in the service sector, 31% in trade, 26% in industry and 1% in agriculture. The survey was restricted to metropolitan Abidjan for logistical reasons and because 8263 companies are located in this administrative territory, representing approximately 90% of all companies registered with the CIC-CI. To produce statistically valid results, a threshold of 70 responding companies was set for this study. Given that this study targeted only small and medium-sized organisations, the quota sampling method was adopted to randomly choose a list of 210 small companies from the business directory, namely three times the desired number, based on the proportion of companies in each sector (see Table 3). Given the very low percentage of agricultural companies in the business directory, this sector was not included in the study. As mentioned above, in Côte d'Ivoire, SMEs are defined as companies that employ fewer than 200 employees and generate an annual turnover, net of tax, of less than 1 billion XOF (Ardjouman, 2014). However, data about the annual turnover of companies were not always available (22% of missing values) in the business directory (Table 4). Therefore, we based the selection of companies on the number of full-time employees and the sector of activity.

Table 3 Sample selection according to the quota sampling method

Type of industry	*Original sample*	*Expected sample*	*Final sample*
1, Agriculture	2	1	0
2, Trade	65	22	18
3, Manufacturing	55	18	20
4, Service	88	29	39
Total	210	70	77

Expected sample – Distribution of the desired number of SMEs, Original sample – Three times the expected sample, Final survey sample – Distribution of SMEs really interviewed.

The sampling frame of this study is deemed representative; all tests comparing our sample of companies with the population of SMEs in the business directory are not significant, according to the available data from the CIC-CI, by activity sector, business size and turnover. The results of the chi-square tests are significant at $p < 0.05$. The selected companies were contacted by telephone and email to request an appointment to explain the nature, objectives and scope of the study and complete the questionnaire. Respondents were promised anonymity to reduce reluctance and apprehension. The researchers took the time to meet the participants personally to encourage them to take part in the survey and ensure that the questionnaires were properly completed. This data collection approach was chosen in order to obtain only completed questionnaires. Out of the initial list of 210, 77 SME owners/managers participated in the survey, and their questionnaires formed the main database used for this study (Table 3): a satisfactory response rate of approximately 37% for an exploratory study such as this one. Table 4 shows the profiles of the companies that participated in this study, in terms of type of industry, annual sales turnover, number of full-time employees, owner/manager's level of education, and business age.

Table 4 Companies' profiles

Category	*Items*	*Frequency*	*Percentage*
Type of industry	Trade	18	23.0
	Manufacturing	20	27.0
	Service	39	50.0
Gender	Males	62	80.5
	Females	15	19.5
Number of full-time employees	<10	22	28.6
	10–49	43	55.8
	49–199	12	15.6
Annual sales turnover (millions XOF)	<11	7	9.1
	11–100	13	16.9
	101–500	14	18.2
	501–1000	13	16.9
	>1000	8	10.4
	Missing data	22	28.6
Business age	<5	7	9.1
	5–9	22	28.6
	10–19	26	33.8
	>19	19	24.7
	Missing data	3	3.9
Owner/Manager's level of education	College diploma or less	11	14.3
	Bachelor's degree	17	22.1
	Postgraduate degree	32	41.6
	PhD degree	14	18.2
	Missing data	3	3.9

3.2 Questionnaire design

The questions included in the questionnaire were based on the barriers to ICT adoption proposed by Assiélou and Bourgault (2022) and supplemented by others identified in the literature (see Table 2), and categorised according to the T-O-E-I-E framework. For each question, respondents were asked to indicate their degree of agreement or disagreement with the statement that the factor can inhibit ICT adoption. The effect of each barrier was measured using a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. For data analysis purposes, the 5-point Likert scale was redefined as follows:

- 5, 4: Strongly agree, agree → 1: Barrier
- 3, 2, 1: Neutral, disagree, strongly disagree → 0 = No barrier.

Thus, a factor is perceived as a barrier when the respondents either agreed or strongly agreed that it can inhibit the ICT adoption; otherwise, it is not considered as a barrier.

The questionnaire also included some questions on respondent characteristics such as education, occupation and gender, as well as questions on company profiles such as number of employees, firm age and annual sales turnover.

3.3 Reliability and validity

The reliability scores for all constructs were measured by Cronbach's alpha (α). The reliability scores used in this study ranged from 0.813 to 0.921 – all values higher than 0.70, which suggests high internal consistency among the constructs used in this study (Awang et al., 2010). Table 5 shows the reliability scores for all constructs and the number of items in each one.

Table 5 Coefficient a values and number of items of all the variables

Construct	*α*	*Items*
Technology	0.824	18
Organisation	0.954	8
Environment	0.785	8
Individual	0.815	8
Economy	0.845	10

4 Data analysis and results

We present the results of the survey to illustrate the barriers to ICT adoption according to firm size and sector of activity. This study used the T-O-E-I-E framework to investigate factors inhibiting the adoption of ICTs in SMEs based in Abidjan, Côte d'Ivoire. The results have been grouped into three sections for the purpose of analysis and discussions.

The tables show the percentage of indications that is associated with each selected factor. In each case, two columns indicate the percentage (proportion) and the number of people (frequency) who considered the factor to be a barrier (respondents either agreed or strongly agreed). Assessing the impact of a factor on ICT adoption consists in determining SME managers' degree of agreement with the statement that this factor can inhibit the ICT adoption process.

A ranking order, based on frequency and proportion, is derived for the analysis of occurrence. The set of rankings provides insight into the effect of different barriers to ICT adoption. Key barriers to ICT adoption in Ivorian SMEs selected for this study are the factors for which the percentage of indication is equal or superior to 50% (i.e., they are identified as barriers by half of survey respondents). Conversely, factors cited by less than 15% of respondents will be considered as non-limiting factors for ICT adoption. The results are shown in Tables A1–A8 (see Appendix).

Statistical analysis of differences in the 52 ICT barriers between activity sectors (trade, manufacturing, service) and business sizes (micro enterprises, small enterprises, medium enterprises) involved the use of the Mann-Whitney U-test. The difference between two independent groups of firms was measured by a non-parametric test because outcomes are not normally distributed. In this paper, three levels of α are specified, namely $\alpha = 0.01$*** (very strong presumption), $\alpha = 0.05$** (strong presumption) and

$\alpha = 0.1$* (weak presumption). Statistical significance of the Mann-Whitney U-tests is shown in Tables A5 and A9 (see Appendix).

4.1 Assessment of ICT barriers for the SME sample

The respondents' answers to the questions included in the questionnaire concerning their degree of agreement with the claim that the identified factors can inhibit ICT adoption are presented in Table A1. Surveyed owners/managers were asked to rate 52 barriers on a scale of 1 to 5, where 1 means 'strongly disagree,' and 5 means "strongly agree". This 5-point Likert scale has been redefined as "no barrier" for scores of 1, 2 and 3, and 'barrier' for 4 and 5.

Eight factors were identified by respondents in the survey as the most salient barriers to ICT adoption (threshold of 50% agreement). The findings of the study suggest that the major challenges to ICT adoption among Ivorian companies seem to emerge from the technological context (4 barriers), economic context (2 barriers) and environmental context (2 barriers); no organisational or individual barriers met this requirement.

The findings showed that, from the owners/managers' perspective, the four most critical barriers to the adoption of ICTs by Ivorian SMEs are technological factors: unreliable basic fixed internet (63.6%), unreliable fixed broadband internet (63.6%), inadequate power supply (58.4%) and cybercrime (55.8%).

Unreliable fixed internet (basic or broadband) is perceived as the most crucial issue impeding the adoption of ICTs by SMEs in Abidjan; it limits their ability to use internet-based technologies properly. Unreliable internet is characteristic of most sub-Saharan African countries, as highlighted by various earlier studies (e.g., Apulu and Ige, 2011, Ardjouman, 2014). Ardjouman (2014) found that 78.5% of the respondents to his survey perceived limited access to internet as a major barrier. This is similar to observations by Mwila and Ngoyi (2019), who found poor internet services to be a major barrier to access to ICTs.

Limited and inadequate power supply is another major barrier affecting the effective use of ICTs in Ivorian SMEs. In his study, Ardjouman (2014) found that 72% of the Ivorian SMEs that responded perceived the limited and unreliable power as a barrier to ICT adoption by SMEs. This finding is also in line with the results of Agboh (2015), who posited that the unreliable power supply and frequent power outages discourage SMEs from adopting ICTs. An inadequate power supply is still a challenge in many developing countries, particularly those in sub-Saharan Africa, as observed in various other studies (Akinbile and Oni, 2016; Apulu and Ige, 2011).

It is not surprising that cybercrime is one of the main barriers to ICT adoption. Cybercrime was viewed by 55.8% of the companies as a scourge undermining Ivorian society and curbing businesses' enthusiasm for ICT adoption. It prevents companies from taking full advantage of the benefits of ICTs. The finding is in accordance with those of Mwila and Ngoyi (2019) and Assiélou and Bourgault (2022), who found cybercrime to be a key challenge that prevents Zambian and Ivoirian companies from using ICTs.

Interestingly, the cost of ICT services is also a major economic obstacle to ICT adoption by Ivorian SMEs. This is consistent with Irefin et al.'s (2012) finding that cost is a major barrier for Nigerian small and medium enterprises (SMEs) in adopting ICTs. Indeed, the access cost of fixed broadband internet (51.9%) and basic fixed internet (50.6%) are the strongest economic factors assessed in this study. SME owners/managers often do not have sufficient resources to adopt ICTs; this explains why they are

sometimes skeptical about investing in ICTs (Apulu and Ige, 2011). This result confirms the findings of Assiélou and Bourgault (2022), who found that the cost of affordable ICT services was cited by 80% of Ivorian senior managers as a major barrier to ICT adoption for Ivorian SMEs.

Similarly, the results show that ICT adoption was also inhibited by the lack of a policy and institutional framework (51.9%) and lack of government support (51.9%). This is in line with the findings of Ardjouman's (2014) survey, in which 51.5% of respondents agreed that they had difficulties adopting ICTs due to limited government support. The result also concurs with the findings of the study conducted in Nigeria by Irefin et al. (2012). In the studies conducted by Faloye (2014) and Abdullah et al. (2018), lack of a policy and institutional framework was a major barrier to the use of e-commerce by Nigerian SMEs and e-business by Yemeni SMEs.

On the other hand, three factors related to the individual and organisational contexts did not seem to inhibit the adoption of ICTs in firms, from the respondents' perspective. The vast majority of respondents (94.8%) disagreed that firm age was a reason for not adopting ICTs. Most of the respondents also disagreed that perceived benefit (88.3%) or fear of job loss (85.7%) were reasons for not adopting ICTs. This is contrary to the study by Olatokun and Bankole (2011), which found that perceived benefits (63%) are a main reason for Nigerian SMEs' not adopting e-business technology. Similarly, Akinbile and Oni (2016) found that fear of massive job losses in the construction industry is a credible challenge that needs be overcome to improve ICT adoption.

4.2 Assessment of ICT barriers according to activity sector

The analysis of the survey data reveals that there are significant differences between activity sectors in the way barriers were perceived.

As indicated in Tables A2–A5, manufacturing firms proved to have the most difficulties adopting ICTs. Indeed, 20 out of the 52 factors were mentioned by manufacturing owners/managers as barriers (50% or more agreement), compared to 11 barriers for companies in the trade sector and 8 barriers for companies in the service sector. Moreover, the intensity of ICT barriers is low for service companies (maximum of 59% agreement) but higher for trade and manufacturing companies (up to 77.8% and 80%, respectively). Only three factors are considered sufficiently problematic by respondents in all activity sectors (trade, manufacturing and service): unreliable basic fixed internet (77.8%, 70% and 53.8% agreement, respectively), unreliable fixed broadband internet (77.8%, 70% and 53.8% agreement, respectively) and inadequate power supply (55.6%, 60% and 59% agreement, respectively).

Although the two most problematic factors for manufacturing companies are economic barriers, namely the high cost of access to fixed broadband internet (80% agreement) and basic fixed internet (75% agreement), they are more affected by technological barriers, which account for 9 out of 20 barriers. In the case of service companies, the most inhibiting factors are also technological barriers (4 out of 8 barriers), whereas economic barriers are the most important for trade firms (5 out of 11 barriers). It is arguable that service companies are companies that tend to have an advanced level of ICT adoption.

The results show that manufacturing firms are more likely to be affected by language barriers (55% agreement) than trade firms (38.9% agreement; statistically significant, $p = 0.0990$*) or service firms (43.6%; statistically non-significant, $p = 1.1753$).

Moreover, they seem to need more government support (70%) to improve their level of ICT adoption, unlike service companies (56.4% agreement; statistically significant, $p = 0.0040$***) and trade companies (22.2% agreement; statistically significant, $p = 0.0745$*).

Other major barriers to ICT adoption among service and manufacturing firms are the high cost of access to telecommunication services (fixed telephone, fixed and mobile internet) (more than 50% agreement in each case) and lack of education and training of employees (50% and 55% agreement, respectively); this is not the case for service companies, where less than 36% of respondents find them problematic in each case. Specifically, regarding the high cost of access to fixed broadband internet and basic fixed internet, by comparison with service firms for which these factors are barriers in less than 36% of cases, their impact on ICT adoption is greatest for manufacturing firms (80% and 75%, respectively; statistically significant, $p = 0.0015$*** and $p = 0.0048$***, respectively) and for trade firms (55.6% in each case; statistically non-significant, $p = 0.2860$ and $p = 0.2117$, respectively).

Another salient barrier is cybercrime, which appears to be less disruptive for trade firms (44%), by comparison with 65% of manufacturing firms and 56.4% of service firms (no significant difference, $p = 0.2640$ and $p = 0.7557$, respectively). This is contrary to the study by Faloye (2014), which found cybercrime to be one of the major constraints affecting e-commerce adoption in small businesses in Nigeria's retail sector. Furthermore, lack of education and training of employees seems to be a major issue for trade and service firms (55.6% and 53.8% agreement, respectively), in contrast to manufacturing firms (30% agreement; no significant difference, $p = 0.3170$ and $p = 0.4161$, respectively).

Two-thirds (65%) of manufacturing firms agreed that lack of customised ICT products for SMEs impedes ICT adoption; this ratio is 27.8% and 28.2%, respectively, for the trade and service sectors (statistically significant, $p = 0.0410$** and $p = 0.0447$**, respectively).

On the other hand, firm age is the least important factor influencing ICT adoption (over 92% disagreement) in all activity sectors. This effect is strongest for trade firms, for which no respondent agreed that it hindered ICT adoption. In the case of manufacturing and service firms, 95% and 92.3%, respectively, of respondents disagreed. Factors that do not constitute a barrier to ICT adoption for trade firms are mainly environmental (88.9% or more disagreement concerning 4 out of 8 barriers), individual and organisational for manufacturing firms (85% or more disagreement concerning 4 out of 5 barriers), and organisational for service firms (89.7% or more disagreement concerning 3 out of 6 barriers).

The lack of infrastructure, which does not appear to hinder ICT adoption by service firms (12.8% agreement) or trade firms (27.8% agreement), is a major obstacle for manufacturing firms (50% agreement; statistically significant, $p = 0.0062$***; no significant difference, $p = 0.1120$, respectively). This result confirms the findings of many studies (Mwila and Ngoyi, 2019; Ozumba and Shakantu, 2018), who found that network coverage and infrastructure were cited as the greatest hindrance to ICT adoption in South African construction industry and SMEs in Zambia. On the other hand, this result somewhat contradicts those of Assélou and Bourgault (2022) in which the lack of infrastructure was recognised by 60% of the respondents as a major obstacle to adoption for all Ivorian SMEs.

Furthermore, technology change and evolution does not seem to be a major issue for trade firms (11.1% agreement) and service firms (10.3% agreement); however, this was less true of manufacturing firms (30% agreement; statistically significant, $p = 0.0930$* and $p = 0.0736$*, respectively).

4.3 Assessment of ICT barriers according to business size

The results also revealed significant differences in how businesses of different sizes perceived barriers (Tables A6–A9).

Medium enterprises (50 to 199 employees) had the fewest difficulties adopting ICTs, compared to micro enterprises (up to 10 employees) and small enterprises (11 to 49 employees), as demonstrated by the results of this study. Indeed, medium enterprises were in over 50% agreement that only 5 factors inhibited their ICT adoption, compared to agreement on 12 barriers for micro enterprises and 13 for small enterprises.

The findings of the study suggest that the major barriers to ICT adoption among medium enterprises are essentially technological (66.7% agreement concerning 2 out of 5 barriers) and economic (50% agreement concerning 3 out of 5 barriers). The respondents from small enterprises believed that the most problematic factors are technological (5 out of 11 barriers), economic (4 out of 11 barriers) and environmental (2 out of 11 barriers). As for micro enterprises, their major perceived barriers are primarily technological and environmental (4 out of 12 barriers in each case) and economic (3 out of 12 barriers).

An important finding was that cybercrime was perceived as less disruptive by medium enterprises (33.3%), in comparison with 59.1% of micro enterprises (statistically non-significant, $p = 0.2310$) and 60.5% of small enterprises (statistically significant, $p = 0.0997$*). This is also the case for the lack of a policy and institutional framework (33.3% agreement) for medium-sized firms, in contrast to 51.2% of small enterprises (statistically non-significant, $p = 0.2257$) and 63.6% of micro enterprises (statistically significant, $p = 0.0320$**).

The results also show that micro and small enterprises are more affected by lack of government support (54.5% and 55.8%, respectively), compared to medium enterprises (33.3%; statistically non-significant, $p = 0.2040$ and $p = 0.2740$, respectively). This result confirms those of Tan et al. (2010), who found that micro and small enterprises perceive government support as hindering their adoption intention because they are unaware of the financial and technical assistance the government provides.

Another salient barrier is financial constraints, which appear to be more of a problem for micro enterprises (59.1% agreement) than for small (32.6% agreement) and medium enterprises (25% agreement; statistically significant, $p = 0.0252$** and $p = 0.0310$**, respectively). This confirms that smaller companies are more handicapped by the lack of financial resources to adopt ICTs than larger companies (Agboh, 2015; Bayo-Moriones and Lera-López, 2007). This seems to contradict the study by Jaganathan et al. (2018), which showed that 86.8% of Malaysian rural-based SMEs agreed that they had difficulty obtaining funding to support ICT implementation.

The respondents from micro enterprises believed that they were more affected by language barriers (59.1% agreement) than small (41.9% agreement; statistically significant, $p = 0.0727$*) and medium enterprises (33.3%; statistically non-significant, $p = 0.1460$). Similarly, 59.1% of micro enterprises agreed that the unfavourable economic environment was a barrier to ICT adoption, in comparison with 30.2% of small firms

(statistically significant, $p = 0.0130$**) and 25% of medium enterprises (statistically significant, $p = 0.0250$**).

On the other hand, factors that do not seem to constitute a barrier are mostly individual (3 out of 6 factors) for micro enterprises, organisational (3 out of 5 factors) for small enterprises, and environmental (2 out of 4) for medium enterprises.

Firm age remains the single factor that is unanimously recognised by respondents from all size categories as having no impact on ICT adoption (95.5, 95.3 and 91.7 disagreement for micro, SMEs, respectively). There are no statistically significant differences between these activity sectors in this regard. Moreover, the perceived benefits of ICTs do not seem to be a barrier for micro enterprises (96.5% disagreement) or small enterprises (89.7% disagreement); for medium enterprises, the disagreement proportion was 83.3%. Again, there was no significant difference ($p = 0.7900$ and $p = 0.5049$, respectively) in the different size categories in this regard.

5 Implications for practice

This paper presents the key barriers identified as inhibiting the adoption of ICTs for all Ivorian SMEs, for each activity sector (trade, manufacturing, service) and each business size (micro, small, medium), using the T-O-E-I-E framework. The factors inhibiting ICT adoption that were identified in each case can be categorised according to two dimensions:

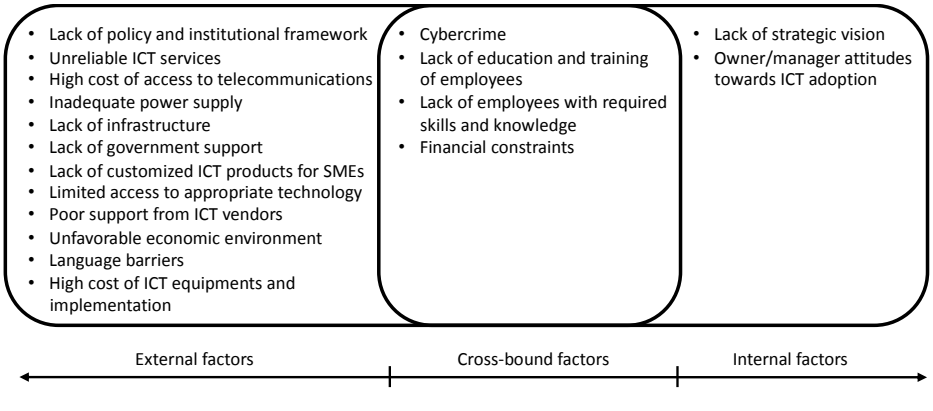
1 internal factors that must be addressed by the SMEs themselves

2 external factors that must be addressed by actors such as the government, banks, telecommunications operators and ICT companies

3 cross-boundary factors that lie on the boundary between the two dimensions and therefore require concerted efforts by both groups of stakeholders (Figure 1).

The major actions that can be done to strengthen the level of ICT adoption among SMEs are discussed below.

Figure 1 Summary of key ICT barriers



Government support and policy: SMEs, unlike large organisations, require some government support in order to attain their goals (Apulu and Ige, 2011). Therefore, government need to increase its support to SMEs in order to create the right environment for business growth and boost their ICT adoption level. Upstream awareness of the ICT use must be made during the creation of companies to bring them to integrate ICT into their management plan. Since factors that affect the appropriate adoption of ICTs by Ivorian SMEs seem to depend greatly on activity sector and firm size, the government needs to adapt its technological support depending on SMEs' distinctive characteristics and their level of hindrance to ICT use. Special emphasis should be placed on micro and small companies in the manufacturing sector, which are more likely to face ICT adoption barriers than others, especially medium companies in the service sector, which deal with fewer barriers. Government also needs to provide the required enabling environment, policies and regulations for the development of ICTs, so that SMEs can both prosper at home and compete worldwide. Moreover, significant investments must be made by the government and telecommunications operators to improve the quantity, quality, reliability and resilience of infrastructure, such as electricity and telecommunications, in order to enable SMEs to invest more in ICTs and adopt them efficiently. The actions of ANSUT (National Agency of Universal Telecommunications Service), one of whose missions is to build a 7000 km fiberoptic network to cover the entire country and consequently reduce the digital divide between rural and urban areas, need to intensify harder. In rural and remote areas, the government must speed up the creation of cybercentres in which experts could teach various ways of using ICTs in a business context. According to World Bank Enterprise Surveys (2016), 79% of Ivorian firms experienced electrical outages, averaging 3.5 power outages in a typical month. Initiatives, such as the National Electricity Digitalization and Access (NEDA) operation, with financial support from the World Bank to increase access to electricity at a lower cost (World Bank, 2022), should be encouraged and reinforced. Suffering from a low level of infrastructure investment, barely 16% of revenue, the government should use incentives to stimulate private investment in order to speed up the infrastructure development. Public-private partnerships (PPPs) must be preferred to ensure long-term private financing in public infrastructure (OECD, 2016). Moreover, the government have to modify specifications for telecommunications operators to oblige them to offer a minimum geographical coverage of the country.

Lowering ICT prices: Government, telecommunications operators and ICT companies need to make efforts to lower the cost of ICT products and services in order to further stimulate their adoption by SMEs. The praiseworthy government initiative of reducing customs duties (from 44.6% to 6.5%) on various ICT products (computer hardware, tablet computers and mobile phones), regulated by Ordinance No. 2015-503 of July 8, 2015,[3] should be reinforced and include all ICT products. Telecommunications operators need to reduce the rates for their services to encourage SMEs to adopt ICTs. ICT companies tend to target larger companies because they have more financial resources and can pay for advanced ICT solutions (Tan, 2010). Thus, these companies need to become more active in addressing the issues affecting ICT adoption among SMEs by giving them reliable, appropriate, less expensive, tailor-made technology solutions that take their specific needs into account. Similarly, the government should encourage ICT R&D by launching more local ICT incubators (e.g., the Ivorian educational tablet Qelasy[4]) to reduce the import of ICT products.

Improving skills, knowledge and capabilities: Major improvements in the education system are necessary to boost the level of ICT skills and knowledge, and build productive human capital. ICT had to be at the heart of the learning experience. Many owners/managers and employees in SMEs are not familiar with the basics of ICTs and lack the technical skills required to adopt them. Sometimes, they do not recognise the value of adopting certain types of technologies and are unwilling to invest in training employees. Developing the educational level of SMEs' owners/managers is crucial since their role is central and their decisions affect all of a company's business activities (Ghobakhloo and Tang, 2013). Since most companies provide little or no formal training (Mutula and Van Brakel, 2007), lower-cost ICT training sessions and information campaigns should be made available to SMEs to allow them to further develop their in-house ICT expertise and also help owners/managers learn about the benefits of using ICTs and guiding them in their digital transformation.

Access to financing: Banks must considerably reduce the refusal rate for SMEs' loan applications, especially for ICT needs to stimulate these firms' development and give them the financial resources that would let them adopt ICTs. Accordingly, the government should provide incentives for banks to offer more long-term credit to SMEs, and guarantee funds to cover credit risks. Likewise, SMEs need to recognise the key benefits of ICTs and place more emphasis on adopting them. Given the already tight budgets of SMEs, their ICT budgets are usually small to nonexistent (Tan, 2010). Owners/managers should consider ICT acquisition as an opportunity for their development and plan for an appropriate budget for ICT needs.

Cybercrime and ICT security: Most Ivorian SMEs are willing to adopt ICTs, but cybercrime represents a huge constraint. To encourage SMEs, the government should strengthen data protection measures, secure the ICT environment and give them tools to combat all forms of ICT fraud. More IT awareness programs should be made available to SMEs to increase their awareness of IT system security and persuade them to adopt ICT solutions. Similarly, SMEs need to increase their material and human resources to protect themselves against ICT-related damages.

Although this study has provided a good understanding of the factors influencing ICT adoption among Ivorian SMEs, it has some limitations. First, although the final sample of 77 SMEs was representative of the target population, there were not enough data to carry out all the desired sector-specific and size-specific analyses. Further research with a larger sample could be beneficial to obtain robust results. Second, the SME target population was concentrated in Abidjan. This restricted geographical focus could make generalisation across the country difficult. Therefore, future studies should cover other regions of the country in order to verify and clarify the results and ensure there are no significant regional differences. Finally, this study did not analyse the impact of ICT barriers on SMEs over time. Future research could be conducted to analyse the longitudinal impact of barriers on ICT adoption.

6 Conclusions

SMEs in developing countries such as Côte d'Ivoire represent the backbone of the national economy (Tan et al., 2010). ICTs can assist them in enhancing their competitive advantage on the global market. However, SMEs face numerous barriers to ICT adoption.

The overall aim of this paper was to investigate the key challenges to ICT adoption by Ivorian SMEs in more depth, using the T-O-E-I-E framework. Barriers to ICT adoption proposed by Assiélou and Bourgault (2022) and supplemented by others identified in the literature, particularly in sub-Saharan African context, were used to conduct a questionnaire-based survey among 77 owners/managers in Ivorian SMEs.

The results revealed that the main factors inhibiting the adoption of ICTs in Ivorian SMEs are technological: unreliable fixed internet (basic and broadband), cybercrime, and the inadequate power supply; economic: the high cost of access to fixed broadband internet, basic internet, and fixed telephone services; and environmental: lack of government support and lack of a policy and institutional framework. There were some differences between key ICT barriers depending on activity sector and business size. Manufacturing enterprises seem to encounter more difficulties adopting ICTs than enterprises in other activity sectors. Similarly, it appears that more ICT barriers affect micro and small enterprises than medium enterprises. Moreover, the results show that most factors inhibiting ICT adoption are external to the firm and will have to be addressed by the government and other stakeholders. In order to efficiently overcome these barriers, actions that should be undertaken to enhance the level of ICT adoption among SMEs must be activity-specific and/or size-specific. SMEs for their part need to enhance their in-house ICT skills and change their attitudes in order to succeed in their digital transformation.

The agriculture sector was not captured in the survey; therefore, future scholars are challenged to take up a survey in this direction. This study represents a good foundation for future research with a view to enhancing adoption of ICTs by SMEs in Côte d'Ivoire.

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Notes

[1]In this study, SMEs are firms with fewer than 200 employees and generate an annual turnover less than 1 billion XOF (approximately US $1.6 million).

[2]We used the terminology 'developing countries' because, according to UNCTAD (2022), 31 over 54 countries in Sub-Saharan Africa are classified as 'least developed countries' and the others as "developing countries that are not least developed countries". The term "emerging economies" is mostly used to refer to countries such as China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, Bulgaria …

[3]https://www.douanes.ci/sites/default/files/base_documentaire/3296.pdf

[4]https://fr.unesco.org/creativity/policy-monitoring-platform/qelazy-cote-divoire-presente-sa

Appendix: Summary of the survey results

See Tables A1–A9.

Table A1 Agreement frequency and proportion table for ICT barriers in all SMEs by respondents

Count	*ICT barriers*	*Frequency*	*Proportion (%)*	*Rank*
1	Unreliable basic fixed internet	49	63.6	1
2	Unreliable fixed broadband internet	49	63.6	1
3	Inadequate power supply	45	58.4	3
4	Cybercrime	43	55.8	4
5	High cost of access to fixed broadband internet	40	51.9	5
6	Lack of government support	40	51.9	5
7	Lack of policy and institutional framework	40	51.9	5
8	High cost of access to basic fixed internet	39	50.6	8
…	…	…	…	…
50	Fear of job loss	11	14.3	50
51	Perceived benefits	9	11.7	51
52	Firm age	4	5.2	52

Table A2 Agreement frequency and proportion table for ICT barriers in trade sector SMEs by respondents

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
1	Unreliable basic fixed internet	14	77.8	1
2	Unreliable fixed broadband internet	14	77.8	1
3	High cost of access to basic mobile internet	11	61.1	3
4	High cost of access to mobile broadband internet	11	61.1	3
5	Lack of education and training of employees	10	55.6	5
6	High cost of access to basic fixed internet	10	55.6	5
7	High cost of access to fixed broadband internet	10	55.6	5
8	Inadequate power supply	9	55.6	5
9	High cost of access to mobile telephone	9	50.0	9
10	Lack of employees with required skills and knowledge	9	50.0	9
11	Lack of policy and institutional framework	9	50.0	9
…	…	…	…	…
45	Previous bad experience	2	11.1	45
46	Fear of job loss	2	11.1	45
47	High cost of training employees	2	11.1	45

Table A2 Agreement frequency and proportion table for ICT barriers in trade sector SMEs by respondents (continued)

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
48	Changes in business environment	2	11.1	45
49	Technology change and evolution	2	11.1	45
50	Low bank account and credit card penetration	2	11.1	45
51	Type of business	1	5.6	51
52	Firm age	0	0.0	52

Table A3 Agreement frequency and proportion table for ICT barriers in manufacturing sector SMEs by respondents

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
1	High cost of access to fixed broadband internet	16	80.0	1
2	High cost of access to basic fixed internet	15	75.0	2
3	Unreliable basic fixed internet	14	70.0	3
4	Unreliable fixed broadband internet	14	70.0	3
5	Lack of government support	14	70.0	3
6	Lack of customised ICT products for SMEs	13	65.0	6
7	Cybercrime	13	65.0	7
8	High cost of access to mobile telephone	12	60.0	8
9	Inadequate power supply	12	60.0	8
10	High cost of access to mobile broadband internet	12	60.0	8
11	Language barriers	11	55.0	11
12	High cost of access to fixed telephone	11	55.0	11
13	Lack of employees with required skills and knowledge	11	55.0	11
14	Lack of strategic vision	11	55.0	11
15	Lack of infrastructure	10	50.0	15
16	Owner/manager attitudes towards ICT adoption	10	50.0	15
17	High cost of access to basic mobile internet	10	50.0	15
18	Limited access to appropriate technology	10	50.0	15
19	Poor support from ICT vendors	10	50.0	15
20	Unreliable fixed telephone	10	50.0	15
…	…	…	…	…
48	Changes in business environment	3	15.0	48
49	Previous bad experience	3	15.0	48
50	Perceived benefit	2	10.0	50
51	Fear of new technology amongst employees	1	5.0	51
52	Firm age	1	5.0	51

Table A4 Agreement frequency and proportion table for ICT barriers in service sector SMEs by respondents

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
1	Inadequate power supply	23	59.0	1
2	Cybercrime	22	56.4	2
3	Lack of policy and institutional framework	22	56.4	2
4	Lack of government support	22	56.4	2
5	Lack of education and training of employees	21	53.8	5
6	Unreliable basic fixed internet	21	53.8	5
7	Unreliable fixed broadband internet	21	53.8	5
8	Taxes and duties on ICT equipment and services	20	51.3	8
…	…	…	…	…
47	Fear of job loss	5	12.8	47
48	Lack of infrastructure	5	12.8	47
49	Technology change and evolution	4	10.3	49
50	Company size	4	10.3	49
51	Perceived benefits	3	7.7	51
52	Firm age	3	7.7	51

Table A5 Statistical significant results of the Mann-Whitney U-test on ICT barriers between activity sectors

ICT barriers	*Trade vs Manufacturing*	*Trade vs Service*	*Manufacturing vs Service*
High cost of access to fixed telephone	0.1330	0.9316	**0.0412** **
High cost of access to basic fixed internet	0.3770	0.2117	**0.0083** ***
High cost of access to fixed broadband internet	0.2900	0.2860	**0.0078** ***
High cost of access to basic mobile internet	0.7070	**0.0629** *	0.1195
High cost of access to mobile broadband internet	0.8570	**0.0629** *	**0.0447** **
Lack of customised ICT products for SMEs	**0.0410** **	0.7265	**0.0447** **
Perceived complexity	**0.0300** **	0.4788	**0.0507** *
Poor support from ICT vendors	**0.0630** *	0.1022	0.3438
Unreliable fixed broadband internet	0.4960	**0.0771** *	0.3196
Lack of infrastructure	0.1120	0.5307	**0.0062** ***
Technology change and evolution	**0.0930** *	0.6062	**0.0736** *
Lack of government support	**0.0040** ***	**0.0745** *	0.1759
Language barriers	**0.0990** *	0.5051	0.1753

Mann-Whitney U test significance – *$p < 0.1$; **$p < 0.5$; ***$p < 0.01$.

Table A6 Agreement frequency and proportion table for ICT barriers in micro enterprises by respondents

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
1	Inadequate power supply	15	68.2	1
2	Lack of policy and institutional framework	14	63.6	2
3	Unfavourable economic environment	13	59.1	3
4	Unreliable basic fixed internet	13	59.1	3
5	Unreliable fixed broadband internet	13	59.1	3
6	Language barriers	13	59.1	3
7	Financial constraints	13	59.1	3
8	Cybercrime	13	59.1	3
9	High cost of ICT equipments and implementation	12	54.5	9
10	Lack of government support	12	54.5	9
11	High cost of access to mobile telephone	11	50.0	11
12	High cost of access to fixed broadband internet	11	50.0	11
…	…	…	…	…
47	Fear of job loss	3	13.6	47
48	Previous bad experience	3	13.6	47
49	Perceived usefulness of the technology	2	9.1	49
50	Firm age	1	4.5	50
51	Perceived benefits	1	4.5	50
52	Type of business	1	4.5	50

Table A7 Agreement frequency and proportion table for ICT barriers in small enterprises by respondents

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
1	Unreliable basic fixed internet	28	65.1	1
2	Unreliable fixed broadband internet	28	65.1	1
3	Cybercrime	26	60.5	3
4	Inadequate power supply	25	58.1	4
5	Lack of government support	24	55.8	5
6	High cost of access to basic fixed internet	23	53.5	5
7	High cost of access to fixed broadband internet	23	53.5	5
8	High cost of access to mobile broadband internet	23	53.5	5
9	Lack of policy and institutional framework	22	51.2	9
10	Lack of education and training of employees	22	51.2	9
11	High cost of access to basic mobile internet	22	51.2	9
12	Lack of employees with required skills and knowledge	22	51.2	9

Table A7 Agreement frequency and proportion table for ICT barriers in small enterprises by respondents (continued)

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
13	Unreliable mobile broadband internet	22	51.2	9
…	…	…	…	…
48	Previous bad experience	6	14.0	48
49	Fear of job loss	6	14.0	48
50	Perceived benefits	6	14.0	50
51	Company size	5	11.6	51
52	Firm age	2	4.7	52

Table A8 Agreement frequency and proportion table for ICT barriers in medium enterprises by respondents

Count	*ICT barriers*	*Frequency*	*Proportion* (%)	*Rank*
1	Unreliable basic fixed internet	8	66.7	1
2	Unreliable fixed broadband internet	8	66.7	1
3	High cost of access to mobile telephone	6	50.0	3
4	High cost of access to basic fixed internet	6	50.0	3
5	High cost of access to fixed broadband internet	6	50.0	3
…	…	…	…	…
49	Firm age	1	8.3	49
50	Lack of maintenance of ICT equipment	1	8.3	49
51	Technology change and evolution	1	8.3	49
52	Changes in business environment	1	8.3	49

Table A9 Statistical significant results of the Mann-Whitney U-test on ICT barriers between business size

ICT barriers	*Micro vs Small*	*Micro vs Medium*	*Small vs Medium*
Lack of ICT literacy and familiarity	**0.0877***	0.7630	0.3898
Financial constraints	**0.0252****	**0.0310****	0.4432
Poor support from ICT vendors	0.5594	**0.0740***	0.1030
Cybercrime	0.8228	0.2310	**0.0997***
Unfavourable economic environment	**0.0130****	**0.0250****	0.6553
Lack of policy and institutional framework	0.1885	**0.0320****	0.2257
Language barriers	**0.0727***	0.1460	0.8607

Mann-Whitney U test significance – *$p < 0.1$; **$p < 0.5$; ***$p < 0.01$.