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Article

Technology adoption in audit of information systems: Ethiopian audit firms' perspective

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Abstract: Today's automation of the audit process increasingly relies on electronic auditing, especially computer-assisted audit techniques (CAATs), and has become a global necessity. Therefore, this study aims to explore the influence of technological, organizational, and environmental (TOE) factors on audit firms' adoption of CAATs in developing countries, focusing on Ethiopia. The research employed a quantitative approach and gathered 113 valid responses from certified external auditors in Ethiopian audit firms. The data was then analyzed through the Partial Least Squares Structural Equation Modeling (PLS-SEM) method. The findings show that relative advantage and compatibility are the significant technological attributes influencing CAAT adoption in Ethiopian audit firms. Besides, auditors' information technology (IT) competency was a significant organizational attribute influencing CAAT adoption. Environmental attributes such as the complexity of the client's accounting information system (AIS) and the professional body support significantly impact the adoption of CAATs. Additionally, the size of an audit firm reduces the impact of clients' AIS complexity on the adoption of CAATs in Ethiopian audit firms. The findings underscore the significance of CAAT adoption in audit firms and offer valuable insights for policymakers and standard setters in crafting legislation for the Ethiopian audit industry. This study represents the first scholarly effort to provide evidence of CAAT adoption in audit firms in developing countries like Ethiopia.

Keywords: CAATs adoption; electronic auditing; Ethiopian audit firms; external auditing; information system

1. Introduction

Technological advancement is currently believed to be one of the most critical issues, causing many challenges for the corporate world (Skousen and Wright, 2006). Currently, countless businesses are performing their operations using information technologies, and many misstatements and frauds occur daily from an organization's internal and external parties. Using the knowledge of information technology, different parties within or outside of a firm are making misstatements and fraud acts for the best of their interest (Kee et al., 2013). Here, auditors, especially external auditors, are expected to do extensive audit work to identify those potential misstatements and take corrective actions. However, before auditors engage in audits, it would be better to have good knowledge and expertise in using current auditing technologies (Mao et al., 2016), such as CAATs, to avoid "information asymmetry." Despite the significant advantages of using CAATs in audit engagements, their adoption by audit firms worldwide remains inadequate (Lia et al., 2018). Lia et al. (2018) note that most audit firms continue to rely on "rudimentary audit analytics

techniques (traditional auditing techniques)" to conduct their audit procedures.

Previous research on adopting CAATs for audit work has utilized the Technology-Organization-Environmental (TOE) framework across various countries. However, there has been limited exploration of CAAT adoption in information system auditing within the existing literature. Several research gaps have been identified: a scarcity of studies on the subject, limited coverage of geographical areas (regions and countries), methodological homogeneity, an overemphasis on specific theoretical frameworks, and a lack of studies addressing different audit perspectives (internal and external auditing). Furthermore, no empirical evidence indicates that Ethiopian audit firms currently use CAATs to support their audit procedures. Therefore, this study investigated the key factors influencing the adoption of CAATs by Ethiopian audit firms employing the TOE framework.

The study investigated the impact of various factors on CAAT adoption by developing seven hypotheses that propose a positive influence of technological factors (relative advantage and compatibility), organizational factors (auditor's IT competency and audit firm size), and environmental factors (clients' AIS complexity and support from professional bodies) on the adoption of CAATs in Ethiopian audit firms. Additionally, the study assessed the moderating effect of audit firm size on the relationship between clients' AIS complexity and CAAT adoption. In the present study, to test these hypotheses, primary data were gathered through a survey of qualified external auditors, such as Certified Public Accountants (CPA) or members of the Association of Chartered Certified Accountants (ACCA), who work in Ethiopian audit firms. The findings reveal that relative advantage and compatibility are significant technological factors influencing CAAT adoption. Moreover, auditors' IT competency, an organizational factor, was also found to significantly impact the adoption of CAATs in Ethiopian audit firms. Moreover, environmental attributes such as clients' AIS complexity and professional body support significantly impacted the adoption of CAATs.

The study's findings have theoretical and practical contributions to the field, such as contributing to the advancement of audit theory by shedding light on the evolving role of technology in audit processes, especially in developing economies (like Ethiopia) where technological adoption might differ from developed countries. Besides, it provides a unique contribution by offering the first insight into how implementing CAATs can increase audit efficiency and effectiveness in Ethiopia. Moreover, the insights from CAAT adoption can help Ethiopian regulatory agencies understand the norms and standards needed to integrate technology into audit procedures (it can improve regulatory compliance and audit quality). Furthermore, the study helps audit firms by demonstrating how effectively implementing CAATs may lead to a competitive advantage in the market. Finally, external auditors working in various audit firms are expected to profit from the study, particularly those who do audit tasks on computerized processes and systems through CAATs.

The study is organized and presented in five sections: literature review and research hypothesis development in the second section, the research method in the third section, the study results in the fourth section, the discussion in the fifth section, and the conclusion and future implications in the sixth section.

2. Literature review and research hypothesis development

In many countries, the widespread adoption of CAATs began in the 1990s when firms increasingly integrated information technology (IT) into their business operations (Debreceny et al., 2005). However, the responsibility for ensuring internal controls over IT-driven business transactions rests with auditors, who are expected to provide opinions on the internal control procedures of these firms (Marei and Iskandar, 2020). It is widely recognized that businesses rely on IT systems, enabling them to continuously offer customer-oriented, advanced, and value-added products and services by leveraging technology effectively. Many opportunities for advanced control, "risk management framework," and improved business efficiency have been created since the application of IT to the business process. However, new risks face businesses' internal control and auditing due to advancements in IT, for instance, operational process termination, illegal access, and software control failures. Auditors should know that the conventional technique of relying on internal control and minimizing or increasing the scope of substantive control is no longer their issue. In modern times, the widespread use of computer-associated audit procedures needs many countries' provisions of audit guidelines. Hence, auditors must obtain knowledge of internal control over information technology during the audit processes (Marei and Iskandar, 2020).

Compared to modern auditing techniques, manual auditing might be suitable for some kinds of auditing, mainly when the client is small and has small transactions during the audit period. Nevertheless, spreading this to some complex audit procedures might be immaterial. The demand for valuable computer auditing systems is critical since conventional auditing cannot instantly identify material misstatements, unlike computer systems (Chang et al., 2011).

There is no specific set of international standards exclusively for Computer-Assisted Audit Techniques (CAAT). Instead, various international standards and recommendations address the broader field of audit technology and data analytics, which includes CAATs (Daoud, 2023). These guidelines provide auditors with strategies for effectively incorporating technology into the audit process, focusing on CAATs. According to the AICPA (2008), existing audit standards advocate using CAATs to enhance the effectiveness and efficiency of audit procedures.

Most importantly, CAATs support auditors by spontaneously obtaining complete data and performing analyses. Hence, it will reduce audit costs and time. Some of the essential standards and principles applicable to CAATs include the "International Standards on Auditing (ISAs)," the "International Framework for Assurance Engagements (IFAE)," the "Information Systems Audit and Control Association (ISACA) Standards," and the "Institute of Internal Auditors (IIA) Standards" (Smidt et al., 2021).

Several studies on CAATs were conducted, considering various audit firms (from small to big 4) and audit experts (internal and external auditors). They evidenced a lack of adoption of CAATs, which means modern auditing techniques are still underutilized in many audit firms (Janvrin et al., 2008), and further research is needed to assess the adoption of CAATs. Therefore, this study aims to demonstrate and analyze the extent to which audit firms in Ethiopia use CAATs. As previously noted,

there is a lack of research on adopting CAATs for information system auditing in various countries, with only a few regions and countries being examined. Additionally, there has been a limited variety of research methodologies, an overreliance on specific theoretical frameworks, and insufficient exploration of different audit perspectives (both internal and external) (Widuri and Gautama, 2020). These factors highlight a significant research gap in this field. Literature.

Moreover, there is no empirical evidence that Ethiopian audit firms use CAATs to support their audit procedures. Thus, based on previous literature, the present study examined the factors that impact CAAT adoption by Ethiopian audit firms using the TOE framework. The technological, organizational, and environmental constructs are interdependent to provide insight into the determinants of technology adoption (Awuah et al., 2022). Adopting technologies like CAATs in organizations has an extended scope compared to personal user insights, and the organizational features and environmental aspects must be considered. In this study, the extended TOE framework was applied, and the elements and their relationships are represented in **Figure 1**.

2.1. Technological attributes

In the TOE framework, technological attributes specify the characteristics that can impact an organization's decision to adopt technology. In the literature (Hameed and Counsell, 2014; Sabherwal et al., 2006), many technological attributes were studied for their impact on technology adoption and usage. Most studies considered factors such as complexity, relative advantage, and compatibility since they have often been found to be significant in technology adoption (Thong, 1999). Hence, the two most significant factors (based on the literature frequency) have been included in the present study as technological attributes.

2.1.1. Relative advantage

According to Bertrand (2004), the relative advantage is the extent to which technological innovation is considered better than the notion that it supplants. It is an influential tool for gaining a maintainable relative advantage (Mao et al., 2016). Prior literature (Chandra and Kumar, 2018) highlights a direct association between the expected benefits of utilizing the technology (relative advantage) and its adoption. Hence, innovative technology adoption and practices commonly provide their users with a maintainable benefit (Chandra and Kumar, 2018). Audit firms must understand the advantages of utilizing CAATs in their audit process (Al-Hiyari et al., 2019) to distinguish themselves, simplify audit activities, and adopt innovative approaches to satisfy their stakeholders.

In addition, the outcome of Chandra and Kumar's (2018) investigation demonstrates that the relative advantage substantially affects adopting technology. In the context of CAAT adoption, Siew et al. (2020) found that relative advantage (a control variable) significantly positively affects the adoption of CAATs. Similarly, Daoud et al. (2021) and Rosli et al. (2013) also reported that relative advantage plays a substantial role in influencing the adoption of CAATs. However, Awuah et al. (2022) and Al-Okaily et al. (2022) argued that it has no significant impact on CAAT adoption. Therefore, as the audit firms start to understand the advantages of CAAT adoption, they will attain their relative advantage in the eyes of their stakeholders; they will

invest in such technology and will have consent to adopt CAATs. Ethiopian audit firms may use CAATs if they see them as more efficient and effective than conventional audit procedures.

Furthermore, suppose Ethiopian audit companies feel that using CAATs would result in cost benefits, such as lower personnel expenses, audit time, or improved resource allocation. In that case, they may be more willing to invest in this technology. However, it is critical to consider the initial expenditure for software, training, and infrastructure. Therefore, the study suggests that the perceived relative advantage of CAATs will encourage audit firms to incorporate them into their audit processes, leading to the following hypothesis:

H1. In Ethiopian audit firms, relative advantage positively affects the adoption of CAATs.

2.1.2. Compatibility

Based on Rogers (2003), construct compatibility is perceived as the extent to which technological innovation is considered in line with prospective adopters' prior practices, "value relevance," and desires. As demonstrated by Ghobakhloo et al. (2011) and Rogers (2003), an audit firm's perspective regarding adopting CAATs is the degree to which CAATs suit the audit firms' prevailing technology infrastructure, organizational philosophy, values, and workplace experience.

The previous empirical literature has portrayed diverse outcomes regarding technology adoption and compatibility. Some of them (Chiu et al., 2017; Daoud et al., 2021) have concluded that CAAT adoption is not affected by compatibility, and others revealed that compatibility negatively influences CAAT adoption (Siew et al., 2020). On the other hand, Awuah et al. (2022), Al-Okaily et al. (2022), and Rosli et al. (2013) found that compatibility significantly and positively impacts the adoption of CAATs. Martínez et al. (2014) highlighted that compatibility can hinder technology adoption. Despite this, many earlier studies (Tan et al., 2009; Zhu and Kraemer, 2005) have identified compatibility as a critical factor influencing CAAT adoption.

Integrating CAATs with current audit systems and procedures in Ethiopian audit firms might be challenging. Compatibility concerns, data transfer obstacles, and customization to meet unique organizational requirements may occur. The difficulty of integrating CAATs into the existing process might hinder acceptance efforts and raise installation costs. Ethiopian audit firms may also face obstacles due to the complexity and quality of the data they work with, change management, and risk and security considerations. Hence, it is expected that audit firms tend to ponder CAATs if it is in line with the firm's philosophy, existing values, and critical desires, and the hypothesis was developed as follows:

H2. In Ethiopian audit firms, compatibility positively affects the adoption of CAATs.

2.2. Organizational attributes

The organizational perspective is the second crucial component of the institutions' characteristics and resources within the TOE framework (Tornatzky and Fleischer, 1990). According to Siew et al. (2020), an auditor's IT competency is a defining characteristic of an audit firm's technology adoption constructs. However, in

the context of CAAT adoption within audit firms, as noted by Siew et al. (2020) and Kee et al. (2013), the number of external auditors in a firm was used as a proxy for the firm's size.

2.2.1. Auditor's competency in IT

Before any audit firm adopts the CAATs, external auditors must understand technical skills and their practice. Considering this, an auditor's competency in IT influences the adoption of CAATs (Axelsen et al., 2017; Janvrin et al., 2008). Additionally, Siew et al. (2020) highlight that CAATs require external auditors to possess adequate information technology skills to use these tools and interpret their results effectively. Axelsen et al. (2017) further assert that to explain the outcomes accurately, external auditors must be capable of understanding essential systems and recognizing overall computer controls. Moreover, Awuah et al. (2022), Al-Okaily et al. (2022), Sagar and Ramanathan (2022), and Siew et al. (2020) found that auditors' IT competency significantly and positively affects the adoption of CAATs. In Ethiopian audit firms, the compatibility of CAATs with auditors' skills, preferences, and procedures can significantly influence their adoption. User-friendly interfaces and intuitive features improve acceptance and shorten the learning curve for using CAATs. External auditors in audit firms need sufficient knowledge of technology-oriented audit techniques to execute their tasks. Therefore, an adequate degree of auditors' IT competency will make the adoption of CAATs more probable by audit firms, and this leads to formulating the hypothesis:

H3. In Ethiopian audit firms, the auditor's IT competency positively affects the adoption of CAATs.

2.2.2. Audit firm size

The prior empirical literature on information technology (Chiu et al., 2017; Pedrosa et al., 2020; Venkatesh and Bala, 2012) revealed that entity size is a precursor for technology adoption. Large organizations, compared to small ones, have more economies of scale (Lowe et al., 2017; Siew et al.,2020), enabling them to employ more workers and invest in innovative technology systems to simplify new technology adoption. According to Lestari et al. (2020) and Rosli et al. (2013), large audit firms may have more financial and human capacity to ensure that new technology is successfully deployed. Accordingly, audit firm size has been confirmed to be a significant organizational attribute for adopting technology (Al-Okaily et al., 2022; Chandra and Kumar, 2018; Daoud et al., 2021) since large firms have the potential to make more investments in innovative technologies.

In Ethiopia, the size of audit firms can impact CAAT adoption due to resource availability, operational scale, risk management needs, client expectations, market demands, training and skill development, and audit engagement complexity. As the path of the empirical literature, the present study suggested that firm size has a substantial impact on the adoption of CAATs in audit firms and formulated the following hypothesis:

H4. In Ethiopian audit firms, audit firm size positively affects the adoption of CAATs.

2.2.3. Moderation effect of audit firm size

As stated by Janvrin et al. (2008) and Lowe et al. (2017) in their study, large audit firms are likely to have clients with a complex accounting information system. These companies (clients) have a probability of selecting more prominent audit firms (Ismail et al., 2006) because of their ability to audit complex accounting information systems and provide a better quality of audit services (Davidson, 1993; Francis and Yu, 2009; Siew et al., 2020). In contrast, smaller audit firms might struggle to adopt new technologies (Curtis and Payne, 2008; Lowe et al., 2017; Rosli et al., 2013) for auditing clients with complex accounting information systems. Axelsen et al. (2017) suggest that it may not be cost-effective for these firms to invest heavily in information technologies for their clients. Additionally, Lowe et al. (2017) and Axelsen et al. (2017) noted that smaller audit firms place minimal importance on information systems audits and view the use of information technologies in audits as having limited significance.

Therefore, in smaller Ethiopian audit firms with limited information technology capabilities, the complexity of the client's AIS may have minimal impact on the adoption of CAATs (Axelsen et al., 2017). In contrast, for larger Ethiopian audit firms with more advanced IT capabilities, the complexity of the client's AIS could significantly influence the adoption of CAATs. Consequently, the hypothesis was formulated as follows:

H5. In Ethiopian audit firms, audit firm size moderates the effect of clients' AIS complexity on adopting CAATs.

2.3. Environmental attributes

In the TOE framework, the environmental component constitutes the firm's setting, comprising its market connections with the government and contestants (Chandra and Kumar, 2018; Oliveira and Martins, 2011; Tornatzky Fleischer, 1990). The present study considers two exceptional environmental attributes important to audit firms: clients' AIS complexity, competitive pressure, and professional body support.

2.3.1. Clients' AIS complexity

In the TOE framework, clients' AIS complexity refers to the level of intricacy in the accounting information systems of audit firm clients (Janvrin et al., 2008). This attribute encompasses the extent to which clients utilize computerized financial reporting systems (Ahmi and Kent, 2013) and the complexity and nature of the transactions managed by these systems within their organizations. Financial transactions are processed and kept electronically in computerized accounting information systems, improving "financial reporting quality" (Purnamasari et al., 2022). Furthermore, the industrial nature and clients' operational environment are other features of AIS complexity. For example, clients with large business operations in the banking industry may have complicated transactions that require improved and complex accounting information systems (Axelsen et al., 2017) to administer such business transactions. Prior empirical studies in developed countries (Al-Okaily et al., 2022; Ahmi and Kent, 2013; Siew et al., 2020) demonstrated that clients' IT complexity impacts the utilization of CAATs.

However, Daoud et al. (2021) argued in their study that this attribute has nothing to do with adopting CAATs. They contend that current CAATs are versatile and flexible enough to deal with various AIS difficulties. Audit firms may have access to CAATs with flexible functionality and customization possibilities, allowing them to efficiently manage a wide range of client requirements and AIS difficulties. As a result, differences in clients' AIS complexity may not impede CAAT implementation substantially. Nevertheless, in emerging countries like Ethiopia, higher utilization of CAATs could occur when the environments of clients' AIS complexity changes in the manner audit processes are executed (Axelsen et al., 2017; Janvrin et al., 2008) and involves robust control over substantive testing. Hence, the hypothesis was formulated as follows:

H6. In Ethiopian audit firms, the complexity of clients' AIS positively affects the adoption of CAATs.

2.3.2. Professional body support

In the present study, professional body support is considered the extent to which audit bodies inspire Ethiopian audit firms to adopt CAATs by providing standards, guidelines, and assistance. Professional auditing bodies regulate the external auditing profession, and some emerging nations consider regulators seriously when alerting audit firms about innovative technologies. According to Mahzen and Lymar (2009), the endorsements of professional bodies are one of the means that an auditor seeks to choose and use CAATs. Additionally, the professional audit body is critical in distributing information regarding innovative technological improvements to its members (Awuah et al., 2022; Siew et al., 2020) and giving guidance, practical training, and assistance in utilizing technology. Nevertheless, according to Al-Okaily et al. (2022), professional body support has no substantial effect on adopting CAATs.

Although most of the prior empirical literature using the TOE framework ignored this environmental attribute, the present study considered it as a significant factor that can impact CAAT adoption. In emerging nations like Ethiopia, technology development is recent, and professional body support is needed for CAAT adoption. Professional bodies may support Ethiopian audit firms by providing guidance and standards, offering training and education, advocating for technology adoption, promoting research and thought leadership, and ensuring regulatory compliance and assurance. If external auditors observed that the professional audit bodies encourage Ethiopian audit firms to adopt innovative audit technologies, this would raise their acceptance and adoption of CAATs. Thus, the present study suggested that the proper assistance from professional auditing bodies would upsurge the likelihood of CAAT adoption by audit firms, and the subsequent hypothesis was formulated as follows:

H7. In Ethiopian audit firms, professional body support positively affects the adoption of CAATs.

All hypothesises about the relationship between the dependent variables (in the TOE framework) and the dependent variable (CAAT adoption) are summarized and presented in **Figure 1**.

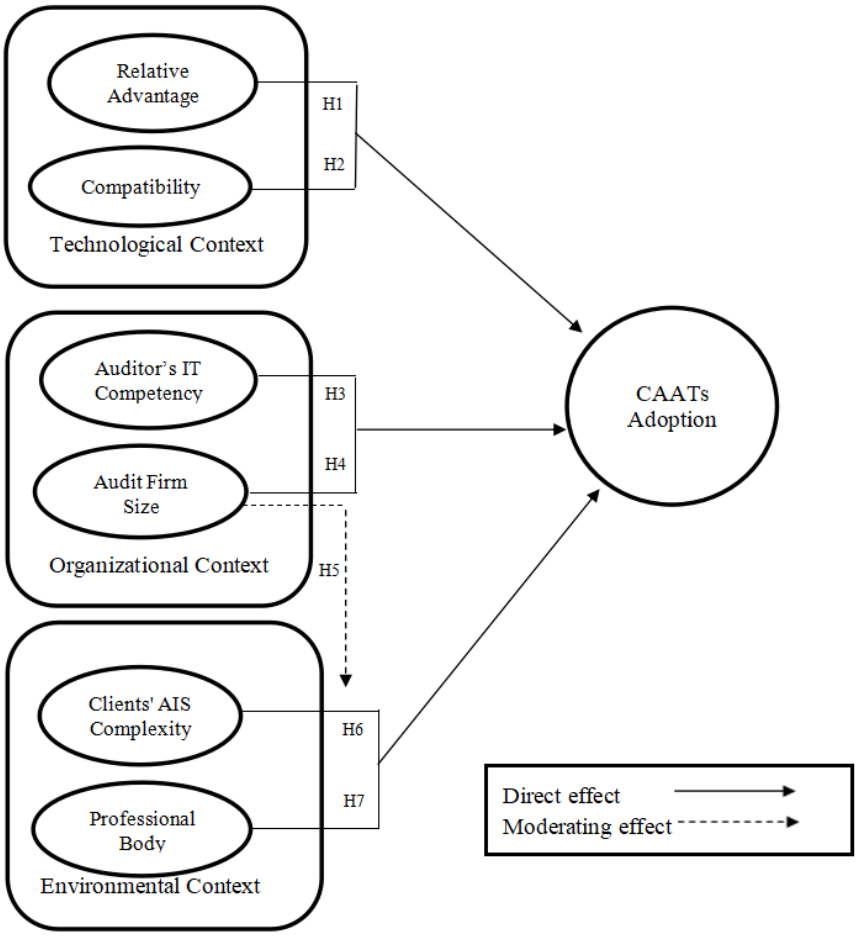

Figure 1. The research model using the TOE framework.

3. Research method

3.1. Sample and data collection

This study primarily utilized primary data collected through a survey of external auditors from Ethiopian audit firms. The data sources were qualified external auditors (CPA or ACCA), as they better understand theory and practice within their firms. According to the Accounting and Auditing Board of Ethiopia (AABE, 2022), 172 registered certified audit firms are in the country. Given the homogeneous population of qualified external auditors, the study determined the minimum sample size needed for PLS-SEM analysis using G*Power (version 3.1) software (Al-Okaily et al., 2022; Faul et al., 2009; Siew et al., 2020). The software was set with the following parameters (Al-Okaily et al., 2022; Siew et al., 2020): $f^2 = 0.15$ (medium effect size), significance level $\alpha = 0.05$, power = 0.95, and number of predictors = 6. The software indicated a minimum sample size of 89. Therefore, to ensure adequate coverage, a total of 200 questionnaires were distributed for the study.

A stratified sampling technique was employed to select respondents for the study. The sample was divided into two strata based on the operational location of the audit firms: those based in the capital (Addis Ababa) and those located outside the capital (in 11 regional states). Of the 172 registered certified audit firms, 148 operate in the capital, while 24 are based outside. Consequently, the strata were categorized as "in

the capital" and "outside the capital." The sample size was allocated according to the proportion of firms in each stratum, with 86% of the sample drawn from firms in the capital and 14% from firms outside the capital.

Strata 1 = (148/172) × 200 = 172 Strata 2 = (24/172) × 200 = 28

The questionnaires were distributed through an online survey method (using email). The researchers used external audit associations in the country to get responses from the respondents easily and promptly. A total of 113 valid questionnaires were collected and used for the analysis of this study. The total response rate was 56.5%, which is acceptable for studies on information technology at the institutional level. The responses were 101 from strata 1 (59%) and 12 from strata 2 (43%).

3.2. Measurement

The data was collected through a self-administered questionnaire, and it is a suitable instrument used in survey methods, especially to get a large amount of data (Kothari, 2004). In constructing the questionnaire and measuring the theoretical dimensions, the study adopted and used the validated and tested scales in the literature (Hair et al., 2019). Different measures were applied for the independent and dependent variables. The extent of CAAT usage in the audit firms was measured by the dependent variable and as applied by Braun and Davis (2011) and Siew et al. (2020). The adoption of popular CAAT applications such as Generalized Audit Software, Database SQL Search and Retrieval, Audit Automation Software, Test Data, Embedded Audit Modules, and Parallel Simulation Software were scaled from (1) "Never use at all" to (7) "Extensively used." Then, the average response score of all applications was considered to provide the overall score of the dependent variable (single-item variable) (See Appendix A).

In addition, to measure the items of the independent variables, the study used close-ended questions with a measurement of 7 points Likert scale (1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neutral, 5 = slightly agree, 6 = agree, 7 = strongly agree). A 7-point scale is selected because the probability of attaining the objective reality of people will be increased since a variety of options are provided. The items (see Appendix A) included each variable, and the scales were adopted from the previous studies in the literature (Al-Okaily et al., 2022; Ahmi and Kent, 2013; Janvrin et al., 2008; Kee et al., 2013; Siew et al., 2020; Thong, 1999; Venkatesh and Bala, 2012; Zhu and Kraemer, 2005).

3.3. Common method bias

The present study undertakes different ways to minimize common method biases, such as ensuring the anonymity of the respondents and collecting the data in two rolls. In addition, the items in the questionnaire were randomized to make the outcome variables and antecedents not easily guessed by the respondents. An exploratory factor analysis (unrotated solution) was also conducted to ensure no common method bias. Harman single-factor test statistics show that a single factor can explain about 46.62% of the total variance, indicating there is no standard method bias as it is less than 50% (Al-Qudah et al., 2021; Al-Okaily et al., 2022).

3.4. Data analysis

The present study used the PLS-SEM regression model to test the developed hypotheses and to validate measurements. It allows for estimating the relationships between variables without considering assumptions on the distribution of the data and with small sample sizes (Al-Okaily et al., 2022; Al-Qudah et al., 2021; Hair et al., 2019). Besides, considering previous empirical studies and the theoretical basis, PLS-SEM is a proper method for the present study since predicting the effect of independent variables on the dependent variable (exploratory) is the main aim of the present study, as the moderation effect (Pedrosa et al., 2020). The Amos 29 software was used to analyze and test the formulated hypothesis.

4. Study results

4.1. Descriptive statistics

The adoption of the popular and common CAAT applications was considered to determine the extent of CAAT adoption (CAT) as a variable. **Table 1** shows that the average overall score of CAAT use was 3.24, indicating that the use of technology by the external auditors is not satisfactory. It confirms the insights in the literature (Ahmi and Kent, 2013; Al-Okaily et al., 2022) that most external auditors in developing countries have low usage of audit technologies for their audit works. In addition, most participants agreed that Generalized Audit Software (with a high mean value) is the common CAAT application they utilize for their work. However, the low mean values for all CAAT applications indicate that each software is not utilized sufficiently.

Table 1. Descriptive statistics.

	Code	Mean	Std. Deviation	Skewness
Generalized Audit Software	GAS	3.94	1.915	0.090
Database SQL Search and Retrieval	DQL	3.57	1.856	0.350
Audit Automation Software	AUT	3.35	1.812	0.501
Parallel Simulation Software	PAS	3.32	1.858	0.577
Embedded Audit Modules	EAM	3.02	1.747	0.698
Test Data	TEA	3.24	1.838	0.615
Average response score of all applications	CAT	3.24	1.416	0.642

4.2. PLS-SEM model analysis

Initially, the cross-loadings of all items on their respective variable were measured and checked. Items that scored lower than the standard loading (Hair et al., 2019), which is 0.70, were omitted. The omitted items are 1 item (RAD) from relative advantage, three items (ACC, ACD, and ACE) from auditors' IT competency, 1 item (AXD) from client's AIS complexity, and 1 item (PSD) from professional body support (See **Table 1**). The criteria for discriminant validity established by Hair et al. (2017) were applied, and the measurement and structural models were analyzed accordingly.

4.2.1. Measurement model

The convergent validity of the items with their respective variables was calculated and is presented in **Table 2**. According to Hair et al. (2017), for the variables to be included in the models, the cross-loadings of all items, composite reliability (CR), and Cronbach's Alpha (CA) should exceed 0.7. Additionally, each variable's average variance extracted (AVE) value must exceed 0.5. Considering the criteria, all variables met the conditions for validity of convergent (See **Table 2**).

Table 2. Items loading, average variance extracted, composite reliability, and Cronbach's alpha.

Constructs	Items	Loading	AVE	CR	CA
CAT	Single item construct				
RA	RAA	0.992	0.971	0.990	0.989
	RAB	0.978			
	RAC	0.987			
	RAD*	0.573			
CM	CMA	0.987	0.975	0.991	0.992
	CMB	0.986			
	CMC	0.989			
AC	ACA	0.976	0.960	0.979	0.983
	ACB	0.984			
	ACC*	0.633			
	ACD*	0.513			
	ACE*	0.653			
AFS	Single item construct				
AX	AXA	0.982	0.968	0.991	0.990
	AXB	0.986			
	AXC	0.984			
	AXD*	0.566			
PS	PSA	0.984	0.970	0.989	0.989
	PSB	0.989			
	PSC	0.982			
	PSD*	0.356			
AFS × AX	AAA	0.995	0.986	0.995	0.971
	AAB	0.990			
	AAC	0.994			

Note: *The cross-loading is lower than 0.70.
CAT = CAATs adoption; RA = relative advantage; CM = compatibility; AC = auditors' IT competency; AFS = audit firm size; AX = Client's AIS Complexity; PS = professional body support; AFS × AX = moderating variable.

Besides, the separation of one variable from another was tested using discriminant validity. First, the Fornell-Larecker criterion test was used to see the variables' associations. As shown in **Table 3**, the square roots of AVE for all variables (on the main diagonal) are higher than the associations between the variables, indicating that all variables meet the standard for discriminant validity (Fornell and

Larcker, 1981; Hair et al., 2017). Second, the Heterotrait-Monotrait (HTMT) criterion test was used as an alternative discriminant validity assessment (Rahi et al., 2018). According to Henseler et al. (2015), there is no discriminant validity if HTMT values are close to 1, and a threshold of 0.85 is used for this purpose. As shown in **Table 4**, the HTMT values are lower than 0.85, indicating that the standard for discriminant validity is met.

Table 3. Fornell-Larecker test for discriminant validity.

	AFS	CAT	AFS × AX	PS	AX	AC	CM	RA
AFS	1.000							
CAT	0.706	1.000						
AFS × AX	0.578	0.587	0.993					
PS	0.731	0.560	0.359	0.985				
AX	0.737	0.576	0.381	0.438	0.984			
AC	0.788	0.659	0.438	0.539	0.641	0.980		
CM	0.706	0.550	0.313	0.590	0.387	0.438	0.988	
RA	0.690	0.571	0.318	0.433	0.539	0.691	0.433	0.986

Table 4. HTMT test for discriminant validity.

	AFS	CAT	AFS × AX	PS	AX	AC	CM	RA
AFS								
CAT	0.429							
AFS × AX	0.336	0.346						
PS	0.625	0.290	0.131					
AX	0.639	0.325	0.148	0.149				
AC	0.737	0.484	0.196	0.309	0.498			
CM	0.532	0.235	0.099	0.349	0.556	0.658		
RA	0.487	0.254	0.103	0.286	0.691	0.132	0.777	

4.2.2. Structural model

The statistical hypothesis test results for the structural model are summarized and presented in **Table 5**, **Figures 2** and **3**. The results show that the two technological constructs, which are relative advantage ($ß = 0.071$, $p < 0.10$) and compatibility ($ß = 0.910$, $p < 0.10$), have a significant impact on CAAT adoption (H1 and H2). Besides, the organizational construct, which is auditors' IT competency ($ß = -0.349$, $p < 0.05$), has a significant impact on CAAT adoption (H3). However, it has a negative impact, and audit firm size has an insignificant impact on CAAT adoption (H4). Moreover, the environmental constructs, which are clients' AIS complexity ($ß = -0.393$, $p < 0.01$) and professional body support ($ß = 0.783$, $p < 0.05$), have a significant impact on CAAT adoption (H6 and H7). However, the complexity of clients' AIS has a negative impact on CAAT adoption.

Table 5. Structural model assessment summary for direct and indirect effect model.

Relationship			Path coefficient	SE	CR.	P	Finding
RA	→	CAT	0.071	0.015	2.01	0.0712*	Significant
CM	→	CAT	0.910	0.024	1.93	0.095*	Significant
AC	→	CAT	−0.349	0.025	−2.807	0.037**	Significant
AX	→	CAT	−0.393	0.026	−3.028	0.004***	Significant
PS	→	CAT	0.783	0.023	2.961	0.026**	Significant
AFS	→	CAT	−0.137	2.383	−1.048	0.962	Insignificant
AFS × AX	→	CAT	0.297	0.785	0.553	0.581	Insignificant

Notes: *p-values < 0.10; **p-values < 0.05; ***p-values < 0.01.

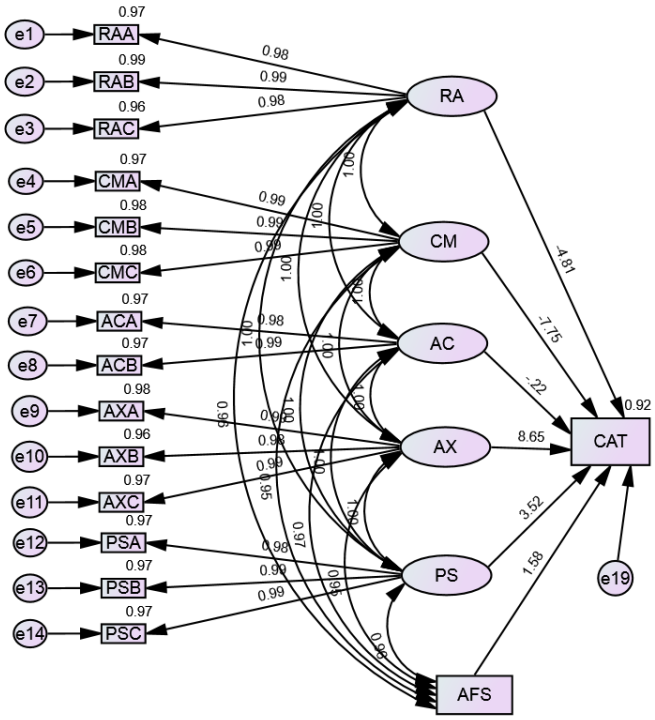

Figure 2. A structural model with significant findings: Without a moderator.

Considering the moderation effect, the interaction effect of audit firm size and clients' AIS complexity on the CAAT adoption was applied (See **Figure 3**). Following the recommendations of Hair et al. (2017), the statistical significance of the path coefficients was assessed using a bootstrap procedure with 5000 resamples. According to the criteria, an effect is considered significant if the *t*-value falls between 0.9993 and 4.466 (Hair et al., 2017). Hence, the present study found that the moderating effect of audit firm size* clients' AIS complexity (H5) was insignificant (*t*-value = 0.553). The result implies that AFS dampens the negative relationship between AX and CAT (see **Figure 4**).

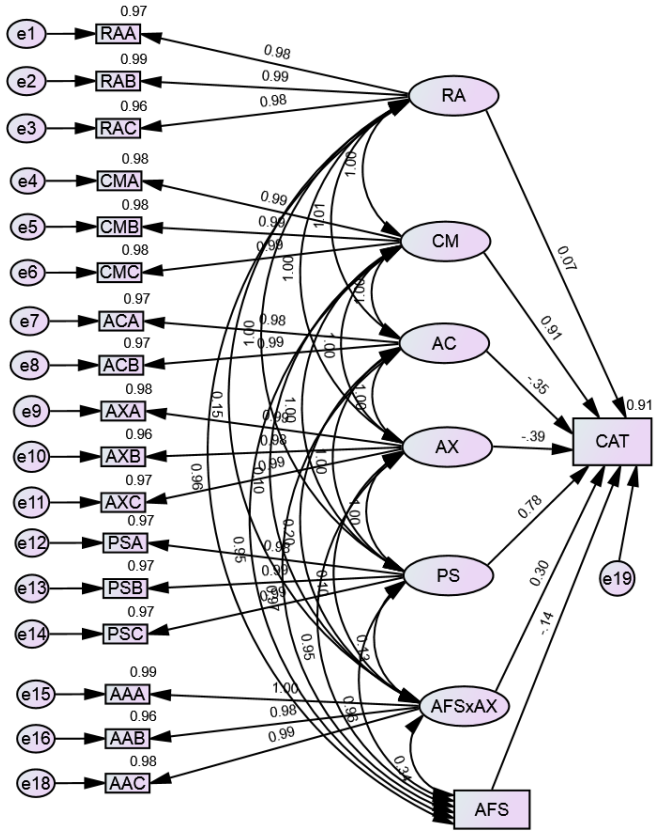

Figure 3. A structural model with significant findings: With moderator.

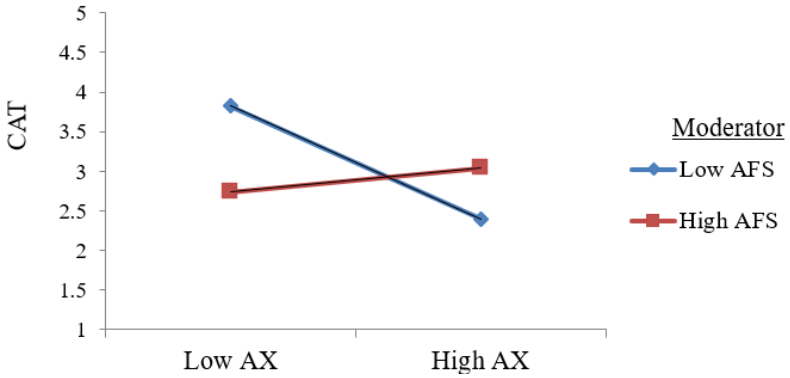

Figure 4. Interaction effect between audit firm size and clients' AIS complexity.

The variance explained by the variables in a model is expressed in R^2 values, and **Table 6** shows the R^2 values for each model. The values are considered weak, moderate, and substantial (0.25, 0.5, and 0.75, respectively) Hair et al. (2017). Hence, the R^2 in the direct model is considered substantial (see **Table 6**). It is a proper indicator for auditing and information technology adoption studies with PLS-SEM methods (Siew et al., 2020; Zhu and Kraemer, 2005). As shown in **Table 6**, the R^2 dampens from 0.92 to 0.91 when an indirect effect is added. Therefore, the effect of the interaction in this study has no substantial change on the model.

Table 6. R^2 Values and standardized root mean square residual (SRMR).

	Model			
	Direct effect	**Indirect effect**	**Saturated**	**Estimated**
R2	0.92	0.91		
SRMR			0.0247	0.0068

Lastly, the standardized root mean square residual (SRMR) was calculated (see **Table 6**), which indicates that the model is best fitted as the value is close to zero. Due to size dependency and sensitivity of mis specified models, it is challenging to put cut-off values for best fit (Hu and Bentler, 1998). Hooper et al. (2008) noted that a large sample size and many parameters result in a lower SRMR. The standard rule of thumb value specified by Hu and Bentler (1998) for a model to be acceptable is when the SRMR is lower than 0.05. Hence, the present study's SRMR value (0.0247) is acceptable.

5. Discussion

The issue of CAAT adoption was studied mainly in developed countries, and few studies have been made in developing countries (Samagaio and Diogo, 2022). However, the issue has not been addressed before in the Ethiopian context. Besides, the present study considered professional bodies' support as a significant environmental attribute that can impact CAAT adoption. Hence, it makes the study unique since most prior empirical literature using the TOE framework ignored this environmental attribute. Accordingly, technology development is recent in emerging nations like Ethiopia, and professional body support is needed for CAAT adoption. Moreover, little has been studied about the effect of interaction between the TOE framework's attributes (Lutfi and Alqudah, 2023). Therefore, this study aims to address the research gap by exploring the determinant factors within the TOE framework that influence CAAT adoption in Ethiopian audit firms.

The results of the present study confirm the relevance of various factors in the TOE framework within the context of Ethiopian firms. Specifically, two technological factors—relative advantage and compatibility—were identified as significant determinants of CAAT adoption in Ethiopian audit firms. Additionally, auditors' IT competency, an organizational factor, impacted CAAT adoption significantly. Furthermore, environmental attributes such as clients' AIS complexity and support from professional bodies also played a significant role in influencing CAAT adoption.

The results are discussed in the three contexts of the TOE framework. First, technological attributes, relative advantage, and compatibility play essential roles in adopting CAATs in Ethiopian audit firms (H1 and H2). The result confirms that as audit firms start to understand the advantages of CAAT adoption, they will attain their relative advantage in the eyes of their stakeholders; they will invest in such technology and will have consent to adopt CAATs. The finding implies that Ethiopian audit firms may use CAATs if they see them as more efficient and effective than conventional audit procedures. However, it is critical to consider the initial expenditure for software, training, and infrastructure. The positive impact of RA is consistent with prior studies investigated by Chandra and Kumar (2018), Siew et al. (2020), Daoud et al. (2021),

and Rosli et al. (2013). However, this is inconsistent with studies made by Awuah et al. (2022), Al-Okaily et al. (2022), and Maroufkhani et al. (2020), who revealed that RA does not affect the adoption of CAATs in different settings. The context of studies (country setting) could create inconsistent results with the literature.

Besides, CAAT's compatibility with the Ethiopian audit firm's work has a vital impact on its adoption. The impact is due to firms being anxious about how to audit technology tools relate to their prevailing procedures and practices. The result implies that the intention to use CAATs (then adoption) is more likely to occur when Ethiopian audit firms' beliefs, values, and IT experiences are congruent with CAATs. Contrary to prior literature (Al-Okaily et al., 2022; Ghobakhloo et al., 2011), this study highlights the distinctiveness of CAATs as an innovative advancement for audit firms. The findings reveal that technological contexts are crucial in driving the adoption of CAATs. This observation aligns with some earlier studies (Awuah et al., 2022; Al-Okaily et al., 2022; Kim et al., 2020; Rosli et al., 2013) that emphasize the importance of technological factors in motivating CAAT adoption. However, the findings are inconsistent with some studies (Chiu et al., 2017; Daoud et al., 2021), which concluded that CAAT adoption is not affected by compatibility, and others revealed that compatibility negatively influences CAAT adoption (Siew et al., 2020). This inconsistency could be due to the study's context (developing country).

Second, considering the organizational attributes, auditors' IT competency has an essential but negative impact on adopting CAATs in Ethiopian audit firms (H3). The results of the present study are inconsistent with studies in the literature (Abed, 2020; Janvrin et al., 2008) that state that effective CAAT adoption requires the auditor's IT competency. Besides, it contradicted the study of Siew et al. (2020), who demonstrate that CAATs demand external auditors to have sufficient information technology skills to use the tools and mainly describe the outcomes. Moreover, the result confronts with the study of Awuah et al. (2022), Sagar and Ramanathan (2022), Axelsen et al. (2017), and Al-Okaily et al. (2022) which concluded that auditor's competency in IT has a positive and significant influence on CAATs adoption. These inconsistent results and the negative relation may arise for several reasons, such as limited understanding of CAATs, fear of change, prevailing training needs, risk aversion behaviour, and resource constraints. Addressing these difficulties requires a deliberate effort to increase auditor IT knowledge, provide extensive CAAT training, and invest resources to support its installation and utilization.

Furthermore, developing a continuous learning culture in audit firms can assist reduce resistance to change and promote the successful implementation of CAATs. Moreover, the other organizational construct, audit firm size, is insignificant in determining CAAT adoption (H4). The result is inconsistent with some previous studies (Daoud et al., 2021; Pedrosa et al., 2020; Rosli et al., 2013; Siew et al., 2020; Venkatesh & Bala, 2012), which concludes that firm size is a precursor for technology adoption. Nevertheless, the study of Lefebvre et al. (2005) supported the result. The inconsistent results on the impact of audit firm size on CAAT adoption may arise from the measures of the construct (such as the number of clients and the number of auditors), the context's nature, and the adopted technology type.

Third, considering the environmental attributes, clients' AIS complexity and professional body support have an essential impact on adopting CAATs in Ethiopian

audit firms (H6 and H7). The nature of the client's industry, business environment, and activities are vital for the ease of use of technologies like CAATs. The implication is that audit firms may have clients with complex transactions requiring auditors to perform their tasks using advanced and complex CAATs. For example, clients with significant business operations in the banking industry may have complicated transactions that require improved and complex accounting information systems (Axelsen et al., 2017) to administer such business transactions. The results of the present study are consistent with previous empirical research from developed countries (Al-Okaily et al., 2022; Ahmi and Kent, 2013; Janvrin et al., 2008; Siew et al., 2020), which has shown that clients' IT complexity affects the use of CAATs. However, the direction of the impact is different as a negative relation was found. The negative impact may be raised from resource constraints, regulatory concerns, integration difficulties, and increased risk perception related to auditing complex AIS settings. Resolving these shortcomings requires organized efforts to devote suitable resources, create sound regulatory frameworks, and improve technological capabilities that enable the use of CAATs in the audit process. Furthermore, the findings of this study regarding the impact of professional bodies' support align with prior research (Mahzen and Lymar, 2009), which supports the idea that such support is a critical factor in an auditor's decision to select and use CAATs.

Additionally, the result supports that the professional audit body is critical in distributing information regarding innovative technological improvements to its members (Awuah et al., 2022; Siew et al., 2020) and giving guidance, practical training, and assistance in utilizing technology. Nevertheless, the result is contradicted by the study of Al-Okaily et al. (2022), who state that professional body support has no substantial effect on adopting CAATs. This inconsistency may arise from the nature of the context and the period (internal auditing in the public sector and the COVID-19 period).

Unlike the prior studies using the TOE framework, they ignored professional body support as an environmental attribute, and the present study considered it a significant factor that can impact CAAT adoption. In emerging nations like Ethiopia, technology development is recent, and professional body support is needed for CAAT adoption. The result of the study showed that it has a positive and significant impact on CAAT adoption. Besides, the moderating effect of audit firm size on the impact of the client's AIS complexity was found to be insignificant (H5). This result contrasts with previous studies that indicate larger audit firms are more likely to have clients with complex accounting information systems (Axelsen et al., 2017; Curtis and Payne, 2008; Janvrin et al., 2008; Lowe et al., 2017; Rosli et al., 2013; Siew et al., 2020). This discrepancy may arise from differences in research contexts, as prior studies were conducted in countries with Big-4 audit firms, while in Ethiopia, the audit firms are predominantly local and relatively homogenous in size.

6. Conclusions and future implications

In modern times, the widespread use of computer-associated audit procedures is influenced by many factors at individual and institutional levels. The present study found that institutional factors such as technological (relative advantages and

compatibility) and organizational (auditors' IT skills) factors significantly influence the adoption of computer-assisted audit tools (CAATs) in Ethiopian audit firms. While CAATs can improve audit quality, competitiveness, and efficiency, achieving these benefits requires careful planning, integration, and training. Furthermore, environmental factors (complexity of clients' AIS and support from professional bodies) significantly impact CAAT adoption. Hence, to enhance CAAT adoption, firms should invest in advanced training, address compatibility challenges, and educate clients on CAAT benefits. Professional bodies should also support this process to help firms implement technology-driven audit procedures effectively.

The present study offers both theoretical and practical implications. Theoretically, it contributes to auditing and accounting literature by showing that technological, organizational, and environmental factors significantly influence CAAT adoption in developing countries like Ethiopia. It highlights the evolving role of technology in audits, especially in regions where adoption differs from developed nations. These findings can guide future research on CAAT use in various contexts and further develop audit theory.

Practically, this study offers the first insight into how CAATs can enhance audit efficiency and effectiveness in Ethiopia. It shows that CAATs can streamline audit processes, improve resource allocation, and strengthen risk management. To leverage these benefits, audit firms should invest in robust IT infrastructure, provide targeted training for auditors, and establish clear guidelines for CAAT use. CAATs also give firms a competitive edge by offering advanced audit services, which can attract clients and open new business opportunities. Additionally, the study helps professional bodies (such as the Ethiopian Professional Auditors Association) develop training programs and assists regulatory agencies in setting standards for integrating technology into audit procedures.

The present study has limitations, including its focus on Ethiopian audit firms, which may affect the broader applicability of the findings. The sample size, while sufficient, may also limit the generalizability of the results. Future research should expand to include CAAT adoption in various-sized firms (local, national, Big 4) and across different industries (banking, trading, and manufacturing) with diverse accounting systems. Additionally, examining client firm characteristics like industry type and size could further elucidate factors influencing CAAT adoption.

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Appendix A

Table A1. Constructs and measurements used in the survey.

Constructs	Measurement	Foundation
CAATs Adoption (Single item variable)	It is calculated as the total average score of CAAT applications. The average score for a particular CAAT application is determined by the extent of audit tasks carried out using generalized audit software (i), database SQL search and retrieval (ii), audit automation/ electronic audit working papers software (iii), parallel simulation (iv), embedded audit modules (v), and test data (vi). The extent was scaled from 1 to 7 as (1) "never used at all" to (7) "extensively used."	Siew et al., 2020; Venkatesh and Bala, 2012); Al-Okaily et.al., 2022
Technological Context		
Relative Advantage (measured by 4 items)	1) CAATs will improve audit efficiency through reduced paperwork 2) CAATs will increase audit firms' productivity. 3) CAATs will reduce the error rates in the audit process. 4) CAATs will help reduce costs in auditing operations.	Venkatesh and Bala (2012); Siew et al., 2020; Al-Okaily et.al., 2022
Compatibility (measured by 3 items)	1) CAATTs are compatible with our firm's work procedures 2) CAATTs will fit in well with auditors' tasks in performing audits 3) CAATTs are compatible with our firm's current ways of doing an audit	Venkatesh and Bala (2012); Siew et al., 2020; Al-Okaily et.al., 2022
Organizational Context		
Auditor's IT Competency (measured by 5 items)	1) Our auditors are IT literate 2) Our auditors' understanding of CAATs is very good 3) Our firm has at least one auditor who is an expert in CAATs 4) Our employees know how to operate CAATs 5) Our employees have experience with CAATs	Thong (1999); Siew et al., 2020; Al-Okaily et al., 2022
Audit Firm Size (Single item variable)	Number of external auditors in the audit firm scaled from 1 to 7 (1–3, 4–6, 7–9, 10–12, 13–15, 16–18, and more than 18)	Kee et al. (2013). Zhu and Kraemer (2005); Siew et al., 2020
Environmental Context		
Client's AIS Complexity (measured by 4 items)	1) The majority of our clients have complex accounting systems 2) Most of our clients have highly computerized financial reporting systems 3) The majority of our clients have complex business environments 4) It is difficult to access audit evidence from clients' data manually	Ahmi and Kent (2013); Janvrin et al. (2008); Siew et al., 2020
Professional Body Support (measured by 4 items)	1) Professional accounting bodies support CAAT usage 2) Auditing standards that are set up by professional bodies support CAAT usage. 3) Professional accounting bodies highly recommend CAAT usage 4) Professional accounting bodies provide incentives to implement CAATs	Zhu and Kraemer (2005); Siew et al., 2020; Al-Okaily et al., 2022