Modelling Students' Satisfaction with Computer-Based Assessment (CBA) Environments in Higher Education: The Roles of CBA Center Service Satisfaction and Perceived Trust

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Abstract: It has been extensively researched how satisfied students are with the vast majority of goods and services offered by educational institutions of higher learning. However, there appears to be a paucity of research on students' satisfaction with the facilities and services of computer-based assessment (CBA) centers in higher education institutions, especially when the centers are equipped and staffed by third-party vendors. The CBA centers are public and private examination centers in developing countries that administer computer-based tests for higher education and other external organizations. Although satisfaction with the services and facilities is essential, it has been asserted that having the feeling of trust when using the CBA is even more critical to the students. Trust is essential for the success of any technological advancement, especially in the field of education. Any educational technology that lacks the stakeholders' trust, regardless of how effective it may be, is doomed to fail to be adopted on a large scale. However, limited studies have investigated how students' trust in the CBA affects their satisfaction. Therefore, this study aims to model and analyze the roles of CBA center service satisfaction and perceived trust in the CBA in attaining overall satisfaction by exploring their roles in influencing student satisfaction. A research framework based on the updated information system success model (ISSM) is validated using a survey incorporating system quality, service quality, question content, the cost-effectiveness of CBA services, CBA center service satisfaction, and perceived trust. A total of 459 survey responses collected from three higher education institutions in Nigeria were analyzed using structural equation modelling. As a result, the findings confirmed that students' satisfaction with services at the CBA centers is a mediator between service quality, system quality, and overall satisfaction with CBA. The correlation between CBA centre service satisfaction and overall CBA satisfaction was also found to be the strongest, indicating that student satisfaction with the services and facilities at the CBA centre is crucial. CBA center managers and institutions can utilize the findings from this study to successfully implement the CBA. In enhancing students' CBA satisfaction, higher education institutions should consider focusing on the necessary steps towards improving the conditions of the CBA centers in terms of infrastructure and services rendered. Meanwhile, to increase student satisfaction besides enhancing the system and service quality and cost-effectiveness, institutions should seriously consider promoting the CBA to the students by highlighting the personal impact of the CBA in terms of trust by improving the quality and features of the CBA.

Keywords: Computer-based assessment, CBA center, CBA trust, CBA satisfaction, CBA quality factors

1. Introduction

Globally, education has been transformed by information systems (IS) and information and communication technologies (ICT). Today's computer technologies and other multimedia elements facilitate teaching and learning in various settings. As a result of this trend, electronic assessment systems (e-assessment), also known as CBT (computer-based testing) and CBA (computer-based assessments), have grown in popularity (Fagbola, Adigun and Oke, 2013). With the increased adoption of CBA in higher education, particularly during the Covid-19 pandemic, students' satisfaction is a crucial goal. The quality of the services and facilities provided at the CBA centers is expected to help achieve it. In this context, students' satisfaction is a crucial demonstration of a successful CBA implementation (Vairamuthu and Anouncia, 2016). Several studies have successfully established a correlation between perceived quality factors (system quality, information quality, and service quality) and student satisfaction with educational technologies (Mohammadi, 2015; Ramayah and Lee, 2012; Almarashdeh, 2016).

Assessment is one of the educational activities for which trust is essential, especially when the assessment is administered online and is high stakes. Consequently, trust is considered one of the assessment principles (Liu, Chen and Lu, 2015). According to Liu, Chen and Lu (2015), perceived trust in the context of summative CBA is the extent to which the CBA is perceived to be trustworthy. If students lack faith in the CBA system, this will compromise their eligibility to take the examination ((Liu, Chen and Lu, 2015). Essentially, Ivanova et al. (2018) recognized that trust in CBA could be called at various levels: trust in the institution (Is the institution trustworthy?); trust in the e-authentication tools (Do the tools do what they claim to do?); trust in the

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deployment of the tools (Are the tools used transparently or covertly?); trust in the use of the collected data (Will the data be used as agreed and intended?); and trust in the outcomes (Will cheating students be identified?). Accordingly, students' satisfaction and participation in computer-based examinations will be influenced by their perceptions of its trustworthiness.

Nevertheless, whether quality factors and trust in the CBA explain students' satisfaction with CBA in higher education is still not empirically clear (Vairamuthu and Anouncia, 2016; Dobre, 2015; Bahati et al., 2019; Binsaif Alhassan, and Singh, 2021). Hence, this issue requires further research. The CBA system is another type of e-learning (Lin, 2019), and its critical role in the e-learning process has not received proper attention in empirical e-learning research compared to massive open online courses (MOOCs) and computer-supported collaborative learning (CSCL) (Osang, 2014). Therefore, four specific research gaps are identified along this line of research.

First, user satisfaction is a significant component of IS success (DeLone and McLean, 1992). Several studies have described the effect of CBA quality factors on students' satisfaction with higher education. For instance, Vairamuthu and Anouncia's (2016) study shows how usability factors affect users' satisfaction with CBA in higher education. Dobre (2015) is concerned with the impact of the system's navigation, interface, interaction, and assessment, while the quality of formative CBA feedback in influencing CBA satisfaction was studied by Bahati et al. (2019). Binsaif, Alhassan and Singh (2021) examined students' performance perceptions of CBA satisfaction. A close look at the studies highlighted above shows that these previous studies were not based on theory, and CBA satisfaction has not been explored in a theory-based approach. Consequently, CBA satisfaction based on quality factors has not been theoretically established so far (Osang, 2014). Second, all the factors considered in the previous studies were based on system/technical qualities. However, none included service quality because all the CBAs examined in the studies were run and managed by the institutions concerned. Though, in some developing countries, some higher education institutions' CBA services and facilities are run and operated by trusted third parties (Fluck, Adebayo and Abdulhamid, 2017; Umar and Wilson, 2019; Adebayo, Abdulhamid and Fluck, 2013), hence, determining the quality of the services provided by the vendors is of paramount importance (Vairamuthu and Anouncia, 2016). Third, students' satisfaction with the services offered by the CBA vendors needs to be assessed to ascertain the level of service quality provided (Vairamuthu and Anouncia, 2016). Students' service satisfaction is a short-term attitude resulting from the cognitive evaluation of the services offered and facilities provided (Weerasinghe, Lalitha and Fernando, 2017), while overall satisfaction is "the IS end-user's overall affective and cognitive evaluation of the pleasurable level of consumption-related fulfilment experienced with the IS." (Au, Ngai and Cheng, 2002). Prior literature suggested that IS's quality factors impact service satisfaction. In other studies, service satisfaction has influenced users' overall satisfaction (Mihanović, Batinić and Pavičić, 2016; Wang, So and Sparks, 2017; Eiamkanchanalai and Assarut, 2018). However, the mediating role of service satisfaction between perceived quality factors of CBA and overall satisfaction has not been explored in an integrated way so far. Thus, the specific mechanism through which the perceived quality factors of CBA affect overall CBA satisfaction has not been established yet. Fourth, trust is believed to be a fundamental prerequisite for the success of any educational technology, particularly in the higher education context (Edwards et al., 2018), because a student who trusts an institution's services expects satisfaction concerning the institutions that are likely to be confirmed (Kim et al., 2011). Hence, many studies have investigated the impact of perceived trust on user satisfaction and the successful implementation of educational technologies within the higher education context (Edwards et al., 2018; Nikou and Economides, 2017; Ivanova et al., 2018; Liu, Chen and Lu, 2015; Ismail, Celebi and Nadiri, 2019; Alkraiji and Ameen, 2021). Despite the increased popularity of CBA among higher education institutions, evaluating students' trust and satisfaction with the system was not fully undertaken.

In covering the gaps mentioned above, the study contributes to previous literature. First, the study extends the limited research on understanding CBA quality factors and their impact on satisfaction. Our study is one of the first to consider quality factors as essential antecedents of CBA satisfaction through a theoretical approach. Second, no previous research has empirically explored the effects of service quality on CBA satisfaction in higher education to the best of our knowledge and through searches in peer-reviewed databases. However, research has shown that service quality can increase users' satisfaction with educational technologies (Almarashdeh, 2016; Masrek and Gaskin, 2016; Al-Fraihat, Joy and Sinclair, 2020). Based on the reviewed literature, previous studies in higher education have not incorporated the identified mediator to explain the impact of perceived CBA quality factors and the effect of trust on CBA satisfaction. Consequently, there is still a limited understanding of the different routes that link the variables in this context.

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Thus, the overall objective of this study is to explore and empirically test quality factors' influence on how well they predict how satisfied students will be with their CBA. This was followed by testing a mediator to comprehend better the connection between the CBA centers' facilities and services and their overall satisfaction and examining the role of perceived trust in CBA in influencing satisfaction. Therefore, this study seeks to answer the question, "How does the quality of the services and facilities provided at the CBA centers affect student satisfaction, and what impact does student's perceived trust in CBA have on the overall satisfaction with the CBA at higher education institutions of developing countries?".

This research provides some practical contributions. It offers insight to CBA center managers who wish to enhance the students' service satisfaction, which is a crucial factor in overall satisfaction. The findings indicated that CBA center managers should focus on quality factors to increase overall satisfaction. The organization of this paper is as follows. The first section lays out the background and identifies research gaps. Section 2 provides the theoretical background of the Delone and Mclean model used in this study and the description of the proposed research model. Sections 3 and 4 elaborate on the methods and results of the study, while sections 5 and 6 consist of the research's discussion, conclusion, implications, and limitations.

2. Literature Review

2.1 Theoretical Background

This study was conceived under the updated information system success model (ISSM) (Delone and McLean, 2003), which links system quality, service quality, and information quality to overall user satisfaction and system use/intention, which in turn influences net benefits. Information quality, system quality, and service quality refer to features of both the system and the provider. This model is also flexible because other factors represented as the organizational and individual impact can be combined to make the model more adequate for describing various technologies. Figure 1 illustrates the model.

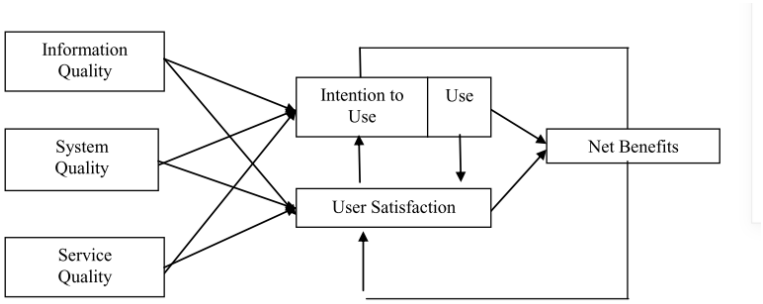

Figure 1: Delone and McLean Information System Success Model (Delone and McLean, 2003)

This study incorporates the Delone and McLean (2003) system success model with quality features relevant to CBA system. There is a need to distinguish the student's satisfaction with the CBA services provided at the CBA center from students' satisfaction with the overall student CBA usage experience (Wang, So and Sparks, 2017). Additionally, studies such as Ramayah, Nejati and Shafaei (2015), Cheng (2012), and Shin (2015) have replaced Delone and McLean's (2003) information quality variable with content in a content-oriented system (such as e-learning and web blogs). While previous research has validated the importance of cost-effectiveness and content as CBA quality requirements (Economides and Roupas, 2007). Nonetheless, little is known about how cost-effectiveness and content affect students' CBA satisfaction. In addition to quality factors, some studies extended the Delone and McLean (2003) with variables relevant to their research area. Hussein and Hilmi (2021) extended it with convenience in an e-learning study, and Al-Adwan et al. (2022) introduced self-regulated learning to the model in e-learning research, while Sharma and Sharma (2019) included trust in their model in a mobile banking study. Hence, this study extended the DeLone and McLean (2003) model with the construct of perceived trust in CBA.

2.1.1 System quality

A sound quality system quickly identifies functional IS groupings and navigational options through resources supplied by the IS (Cheng, 2012). Previous studies point to various criteria for determining system quality when assessing a system, including speed, time, accuracy, stability, functionality, and accessibility (Hamilton and Chervany, 1981; Bailey and Pearson, 1983). During the Covid-19 pandemic, internet connection and assessment

platform challenges were obstacles to CBA's success in Jordan. Also, login issues can delay starting the CBA, as previously proven by the study of Elsalem *et al.* (2020).

2.1.2 Service quality

Even though trusted third parties (TTP) in developing countries provide some CBA services and facilities, there are still delivery obstacles. There may be power outages, interruptions, untrained examination personnel, and poorly managed examination centers (Fluck, Adebayo and Abdulhamid, 2017; Sanni and Mohammad, 2015). Service quality examines the support or assistance provided by the service provider (Delone and McLean, 2003) or information system services, such as training and helpdesk services (Mohammadi, 2015). In light of this, the entire CBA center supports employees, and the institution's support staff is categorized as a service.

2.1.3 Questions' content

A CBA's question content and presentation are issues and obstacles higher education students cope with (Fluck, Adebayo and Abdulhamid, 2017; Sanni and Mohammad, 2015). Multiple studies have found that educational IS content (such as e-learning, e-training, and MOOCs) influences user satisfaction (Mohammadi, 2015; Seta et al., 2018; Hassanzadeh, Kanaani and Elahi, 2012; Kim et al., 2015). However, empirical research examining the influence of question content on CBA satisfaction is scarce. The CBA questions' content focuses on quantity and quality (Economides, 2005). In addition, students of the CBA examination anticipate that the items on the questions will be accurate, trustworthy, directly relevant, accurate, and reliable (Economides, 2005). Additional recommendations demonstrate that question format and presentation affect test quality (Kuikka, Kitola and Laakso, 2014). Figure 2 depicts a sample dummy CBA question for a college admission examination in Nigeria.

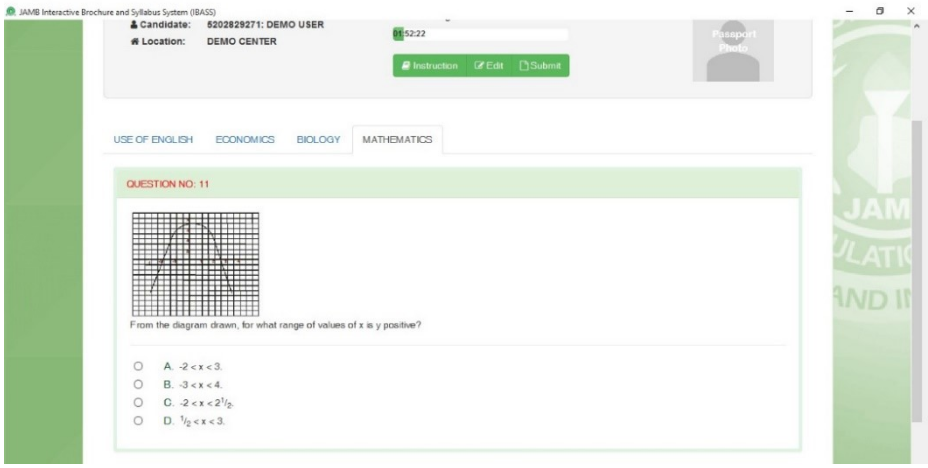

Figure 2: Sampled Higher education entrance Dummy CBA question in Nigeria. (JAMB, 2019)

2.1.4 CBA services cost-effectiveness

Cost-effective teaching and learning approaches are required to expand student numbers (Loewenberger and Bull, 2016). The cost-effectiveness of the CBA system is related to student-achieved satisfaction concerning the fees and costs of the CBA services (Economides, 2005). In other words, CBA services' cost-effectiveness is the students achieved satisfaction with using the CBA vs the fees the student pays (Economides and Roupas, 2007). Every student should be aware of all costs and fees for any CBA service (Economides, 2005). For instance, students of CBA in some Nigerian higher education institutions usually pay for some pre-examination or post-examination services or purchase scratch cards from the institutions before or after the exam (Economides and Roupas, 2007). CBA studies are lacking in exploring students' evaluation of the cost-effectiveness of CBA services.

2.1.5 CBA center service satisfaction

According to some studies, CBA centers in developing nations are unpleasant due to persistent network, power supply, and computer system failures (Adepoju, 2016). For instance, Elsalem et al. (2020) reported that most higher education institutions implemented on-campus CBA in response to the Coronavirus outbreak in Jordan, and students faced similar negative experiences when taking the on-campus CBA. Also, according to Salah, Ramadan and Ahmed (2021), a stress-free environment is required to encourage CBA adoption. Consequently, even though third parties provide certain CBA services and facilities, it is essential to evaluate student

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satisfaction with the services offered by these vendors. Consequently, computer-based assessment centers are validated to ensure students' positive experiences (Nwankwo, Nwosu and Oputa, 2016). Figure 3 depicts a typical CBA center in Nigerian higher education institution.

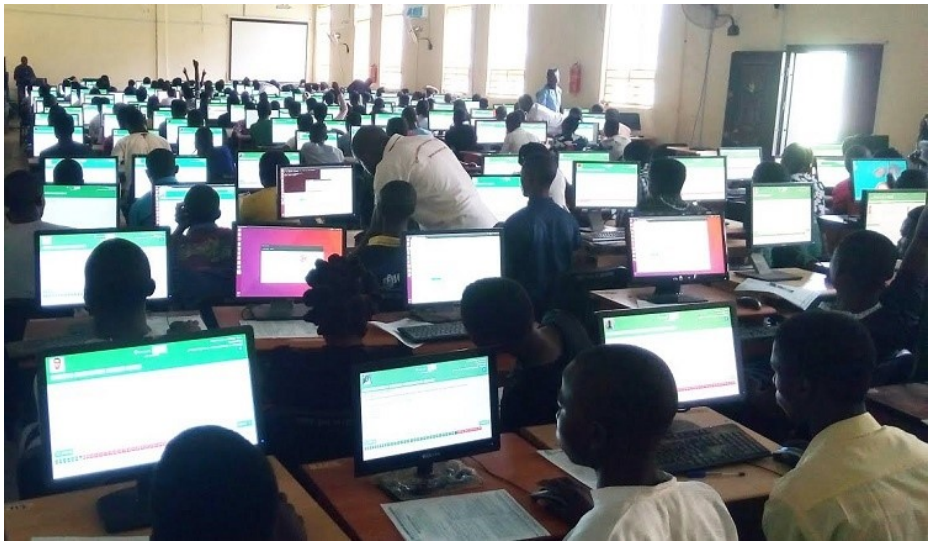

Figure 3: A typical higher education institution CBA center in Nigeria. (*Premium Times*, 2017).

2.1.6 Overall satisfaction with CBA

According to previous research, "user satisfaction" and "overall user satisfaction" are frequently used interchangeably (Ibrahim, 2016). Overall satisfaction is "the IS user's affective and cognitive assessment of the level of consumption-related fulfillment achieved with the IS" (Au, Ngai and Cheng, 2002). Overall user satisfaction comprises both the systems and services provided (Petter, DeLone and McLean, 2008). Based on the reviewed literature, few studies investigated students' satisfaction with CBA. For example, Vairamuthu and Anouncia (2016) investigated the effect of usability issues on academic institution students' satisfaction with an online assessment. Dobre (2015) used the Intelligent Tutoring System to collect data on CBA satisfaction for a study conducted in Romania. Similarly, Bahati et al. (2019) surveyed the University of Rwanda students' involvement and the impact of feedback quality on formative CBA satisfaction.

2.1.7 Perceived trust with CBA

CBA uses technology to support online assessments of students' knowledge and skills. However, challenging problems must be addressed, such as trustworthiness among students and teachers in higher education settings (Ivanova *et al.*, 2018). In their contribution, Nikou and Economides (2017) define perceived trust in a CBA system as the student's perceptions of its reliability and trustworthiness. Perceived trust in CBA may depend on the reliability of the user authentication process, the ability to cheat prevention, the security of the information processing, and the perceived reliability of the evaluation outcome (Liu, Chen and Lu, 2015). The importance of trust in the satisfaction of users in some electronic-mediated environments was studied by several researchers like Shirazi et al. (2021) (e-commerce), Meng and Berger (2021) (organization), Giao, Vuong, and Quan (2020) (online shopping), and Romeike, Nienaber and Schewe (2016) (virtual teams) and all established significant correlations between trust and users' satisfaction.

2.2 Research Model and Hypotheses Development

This study identified system quality, service quality, question content, the cost-effectiveness of CBA services, and trust as the primary determinants of CBA satisfaction. The relationship between service and system quality is mediated by CBA center service satisfaction. Prior study indicates that quality factors influence user satisfaction with information systems (Delone and McLean, 2003). This study examined the relationship between CBA center service satisfaction, quality factors, and overall satisfaction. Figure 4 shows the conceptual research model.

2.2.1 System quality and CBA center service satisfaction

With the widespread adoption of information technologies, new quality issues have emerged. There appear to be few studies on students' satisfaction with computer-based testing facilities. The relationship between system quality and service satisfaction is empirically supported (Shin, 2015; AlzabI et al., 2016; Noh and Chang, 2020).

Therefore, this study proposes:
H1: CBA system quality positively influences students' satisfaction with the CBA center services.

2.2.2 Service quality and CBA center service satisfaction

The cognitive evaluation of service quality emphasizes service efficiency and efficacy. The correlation between service quality and user satisfaction with services was established by (Wang, So and Sparks, 2017; Lee and Wu, 2011; Alzabi et al., 2016). Due to the positive impact of assessment service quality on students, the following hypothesis is presented:
H2: Service quality of CBA will positively influence students' CBA center service satisfaction.

2.2.3 CBA center service satisfaction and overall satisfaction

The impact of service satisfaction on overall user satisfaction with IS cannot be denied, as many studies have established (Mihanović, Batinić and Pavičić,, 2016; Wang, So and Sparks, 2017; Eiamkanchanalai and Assarut, 2018). Previous studies have found that service satisfaction positively affects overall satisfaction (Mihanović, Batinić and Pavičić,, 2016; Wang, So and Sparks, 2017). These studies demonstrated a correlation between service satisfaction and overall satisfaction. Those who are satisfied with the service provided at CBA centers may also be satisfied with their CBA usage experience. Consequently, this study proposed:
H3: Students' satisfaction with the CBA center's services will positively influence overall satisfaction.

2.2.4 System quality and overall satisfaction

User satisfaction is related to system quality (Delone and McLean, 2003; Fang, Chiu and Wang, 2011; Ramayah and Lee, 2012; Al-Mamary et al., 2015; Bello and Abdullah, 2021). The system's overall quality predicts an IS user's level of satisfaction. Therefore, it is hypothesized in this study that:
H4: CBA system quality positively influences overall satisfaction with the CBA.

2.2.5 Service quality and overall satisfaction

Several studies have proven a strong relationship between service quality and user satisfaction (Almarashdeh, 2016; Mohammadi, 2015). According to their findings, the quality of e-learning services has a significant and positive effect on learner satisfaction. The following hypothesis is developed to examine the impact of service quality on overall CBA satisfaction:
H5: CBA service quality positively influences the student's overall satisfaction.

2.2.6 Questions' content and overall satisfaction

Hassanzadeh, Kanaani and Elahi (2012) and Mohammadi (2015) investigated the correlation between the content of an e-learning system and learner satisfaction and discovered statistically significant correlations. Equivalently, CBA research should investigate the connection between CBA question content and student satisfaction. Hence,
H6: CBA question content positively influences overall satisfaction with the CBA system.

2.2.7 CBA services cost-effectiveness and overall satisfaction

Researchers analyzed the relationship between service cost-effectiveness and user satisfaction and found statistically significant correlations (Kumbhar, 2011; Atmojo et al., 2020). The cost-effectiveness and satisfaction of CBA services are understudied. It is necessary to examine these relationships to ensure a connection between the cost-effectiveness of CBA services and user satisfaction within the context of CBA. Therefore, the following hypothesis is proposed:
H7: CBA services cost-effectiveness positively influences overall satisfaction with the CBA system.

2.2.8 Perceived trust and CBA satisfaction

A student who trusts an institution's services expects satisfaction concerning the institution that is likely to be confirmed (Kim et al., 2011). Despite the increased popularity of student information systems (SIS) among universities, evaluating students' trust and satisfaction with the system was not fully undertaken. Hence, Ismail,

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Celebi and Nadiri, (2019) sampled 634 students from a Cyprus university to examine their trust and satisfaction with the SIS. The findings from SEM analysis indicated a significant influence of trust on students' satisfaction with SIS based. Young citizens' loyalty to e-government services was investigated by Alkraiji and Ameen (2021). The study's key findings indicated a significant impact of trust in the system on students' satisfaction and loyalty to the services provided by the e-government services.

Contrary to many assumptions, trust was found not to influence satisfaction with services in an electronically mediated environment (EME) of how consumers and firms interact. Dai et al. (2015) conducted a study with 415 consumers and found that consumers' trust does not influence their satisfaction in EME. Therefore, the relationship between trust and overall satisfaction with CBA is with this proposed to be tested. Hence,
H8: Perceived trust in the CBA positively influences students' CBA satisfaction.

2.2.9 The Mediating Role of CBA center service satisfaction

System and service quality are necessary conditions for satisfaction with information system services (Shin, 2015; (Wang, So and Sparks, 2017). It has also been proposed that system and service qualities directly affect information system satisfaction (Alzabi et al., 2016; Noh and Chang, 2020; Wang, So and Sparks, 2017; Subrahmanyam, 2017). Researchers also discovered a correlation between satisfaction with information system services and overall user satisfaction (Wang, So and Sparks, 2017; Eiamkanchanalai and Assarut, 2018). From an empirical standpoint, it is assumed that there is a relationship between system quality, service quality, and overall satisfaction via the service satisfaction effect. However, the indirect effects of CBA quality factors on overall CBA satisfaction have not yet been studied in the literature. Therefore, this study proposes:
H9: Students' satisfaction with the services provided at the CBA center mediates the relationship between system quality and overall CBA satisfaction.

H10: Students' satisfaction with the services provided at the CBA center mediates the relationship between service quality and overall CBA satisfaction.

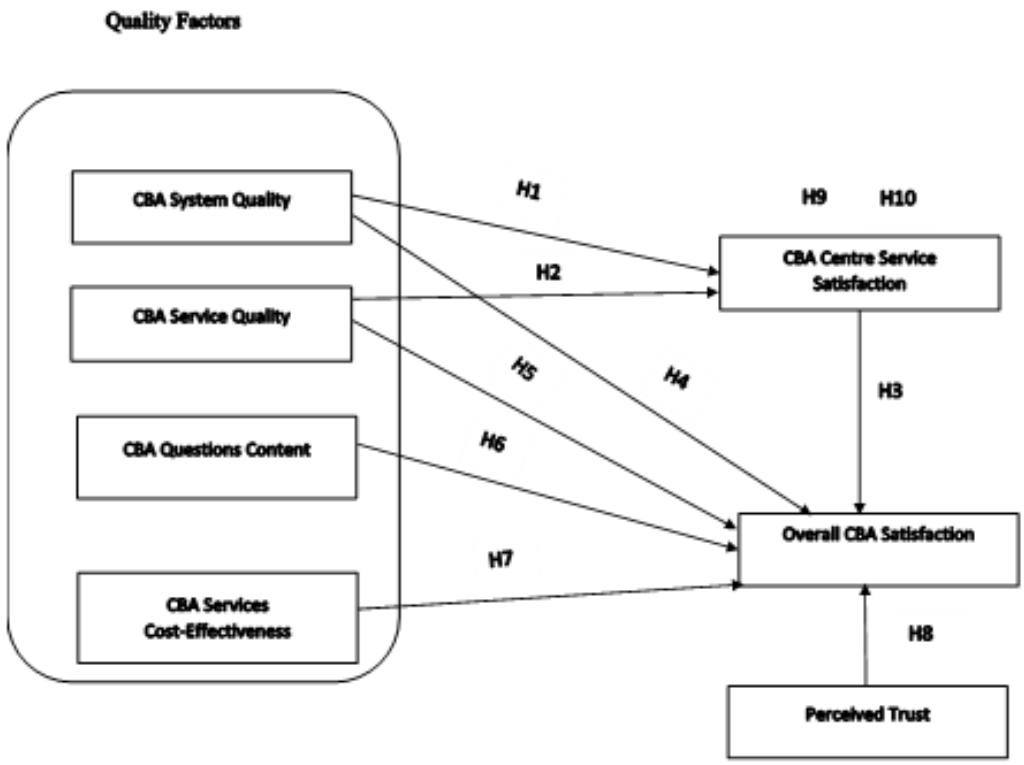

Figure 4: Students' CBA Satisfaction Model

3. Methodology

3.1 Instrument development

A research questionnaire was developed using previously employed, tested, and validated instruments. The questionnaire consisted of thirty questions organized into two sections. The first section requested demographic data and contained seven questions (see Table 1). The second section examined CBA quality, students' satisfaction with CBA center services, overall satisfaction, and perceived trust (see Appendix for more information about the items).

A five-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree, and 5 = strongly agree) was used to evaluate independent variables, whereas a seven-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = neutral; 5 = somewhat agree; 6 = agree, and 7 = strongly agree) was used to evaluate all items related to mediating and dependent variables. The Likert scales were employed as a procedural technique to reduce common method bias (CMB) (Podsakoff, MacKenzie and Podsakoff, 2012). Three items of the CBA services cost-effectiveness construct are adapted from Kim, Yoon and Han (2016), whereas three items of the question content variable are adopted from Nikou and Economides (2017). Five system quality measures and six service quality measures are adopted from Holsapple and Lee-Post (2006). In addition, three CBA center service satisfaction items and three overall CBA satisfaction items are adapted from Xu and Du (2018). The perceived trust measurement items are from Liu, Chen and Lu (2015). The research team interviewed three experts and conducted a pilot test with 100 students. Based on the test results, the questionnaire was modified to ensure the item meanings were not lost and no misunderstandings occurred.

3.2 Study Participants

This study sample consists of 459 undergraduate students from three public higher education institutions (a university, polytechnic, and college of education) in Kano state, North-West Nigeria. The three higher institutions selected for this study served as CBA centers for the annual matriculation computer-based examinations conducted by the Joint admission and matriculation board (JAMB). All the undergraduate students of these institutions have been admitted based on their participation in this examination. Male students outnumbered female students in this study, as shown in Table 1 (Male = 267; Female = 192). Regarding the type of institution of the students, the number of universities, polytechnics, and colleges of education students was 188, 162, and 109, respectively.

Table 1: Demography of the participants

Demographics	Items	Number	Percentage (%)
Gender	Male	267	58.2
	Female	192	41.8
Institution	University	188	41.0
	Polytechnic	162	35.3
	College of Education	109	23.7
Course	Science	342	74.5
	Art	97	21.1
	Others	20	4.4

3.3 Data Collection and Analysis

The data collection was conducted with the help of two trained research assistants. Six hundred questionnaires were administered at the selected institutions. Participation in this study was voluntary, and convenience sampling was adopted among current students enrolled in the academic year 2020/21 who were admitted via the CBA entrance matriculation examination as the minimum CBA experience. Lin and Lai (2019) and Okocha, Toluwani and Owolabi (2017) have typically employed non-probabilistic (convenience) sampling in CBA studies. To overcome the disadvantages of convenient sampling, students from various disciplines, including science, art, and others, were considered. The G*Power software (https://download.cnet.com/G-Power/3000-2054_4-10647044.html) was utilized to calculate the minimum sample size for the survey (Hair *et al.*, 2019). A minimum sample size of 146 was required for a power of 0.95. Four hundred fifty-nine valid records were obtained after data filtering and cleaning. Multivariate data analysis revealed that the scale data appeared to have a non-normal distribution; therefore, the data set was suitable for Partial Least Square Structural Equation Modelling (PLS-SEM) analysis (Hair et al., 2017).

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The hypothesized relationships were investigated using the technique of structural equation modelling (SEM) because of its statistical approach, which includes latent variable relations. SmartPLS 3.0 was utilized to evaluate and analyze the research model.

4. Results

The results of the hypotheses testing are obtained as follows: First, we assess the model's reliability and validity. Once the measurement model has been established, the subsequent step entails examining its paths and identifying model construct relationships.

4.1 Measurement Model Evaluation

The measurement model was evaluated using two types of validity: convergent validity and discriminant validity.

4.1.1 Convergent Validity

Fornell and Larcker (1981) proposed three criteria for assessing the convergent validity of reflective constructs. It is as follows: In particular: 1) indicator loadings must be statistically significant and greater than 0.70; 2) internal consistency (composite reliability/ Cronbach's Alpha) must be greater than 0.70; 3) the average variance extracted (AVE) for each construct must be greater than 0.50. However, indicator loadings between 0.5 and 0.7 are acceptable if the composite reliability (CR) and extracted average variance (AVE) values exceed the previously mentioned thresholds (Hair et al., 2017). These metrics are detailed in Table 2.

Table 2: Reliability and Validity Measurements

Construct	Items	Loadings	CR	AVE
CBA Services Cost-Effectiveness	CEF1	0.785	0.816	0.599
	CEF2	0.862		
	CEF3	0.661		
Overall CBA Satisfaction	OVER_SAT1	0.871	0.885	0.719
	OVER_SAT2	0.850		
	OVER_SAT3	0.822		
Perceived Trust	PTE1	0.790	0.841	0.571
	PTE2	0.833		
	PTE3	0.660		
	PTE5	0.729		
CBA Question Content	QCQ1	0.822	0.845	0.645
	QCQ2	0.817		
	QCQ3	0.769		
CBT Centre Service Satisfaction	SERV_SAT1	0.866	0.900	0.749
	SERV_SAT2	0.841		
	SERV_SAT3	0.890		
CBA Service Quality	SRQ1	0.819	0.894	0.628
	SRQ2	0.843		
	SRQ3	0.796		
	SRQ4	0.772		
	SRQ5	0.727		
CBA System Quality	SYQ1	0.792	0.883	0.557
	SYQ2	0.815		
	SYQ3	0.745		
	SYQ4	0.715		
	SYQ5	0.659		
	SYQ6	0.743		

NOTE: CR= Composite Reliability; AVE= Average Variance Extracted.

As shown in Table 2, all three conditions for convergent validity are met (Hair et al., 2017).

4.1.2 Discriminant Validity

To determine discriminant validity, Fornell and Larcker (1981) proposed that the square root of each construct's AVE should be greater than its highest correlation with any other construct. The square root of the AVE is expressed diagonally in Table 3. Compared to all other model constructs, the AVE value for each construct was greater than its correlation coefficient. In addition, Henseler, Ringle and Sarstedt (2015) recommended substituting the Heterotrait-Monotrait correlation ratio (HTMT) for measuring discriminant validity. The HTMT is calculated by dividing the average correlations between items across constructs by the geometric mean of the average correlations between items within the same construct. There are discriminant validity issues when HTMT values are increased. Therefore, Henseler, Ringle and Sarstedt (2015) proposed 0.90 as the cut-off value. As shown in Tables 3 and 4, the discriminant validity of the data is satisfactory.

Table 3: The Fornell-Larcker Discriminant validity correlation matrix

	SERV_SAT	QCQ	SRQ	CEF	SYQ	OVER_SAT	PTE
Construct							
SERV_SAT	**0.866**						
QCQ	0.462	**0.803**					
SRQ	0.536	0.624	**0.792**				
CEF	0.291	0.420	0.381	**0.774**			
SYQ	0.574	0.650	0.664	0.424	**0.747**		
OVER_SAT	0.674	0.476	0.511	0.373	0.647	**0.848**	
PTE	0.572	0.533	0.599	0.369	0.607	0.564	**0.756**

NOTE: SERV_SAT = CBA Centre Service Satisfaction; CEF= CBA services Cost-effectiveness. OVER_SAT= Overall CBA Satisfaction; QCQ = Question Content; SRQ= CBA Service Quality; SYQ= CBA System Quality; PTE=Perceived Trust

Table 4: The HTMT correlation matrix

	SERV_SAT	QCQ	SRQ	CEF	SYQ	OVER_SAT	PTE
Construct							
SERV_SAT							
QCQ	0.594						
SRQ	0.633	0.794					
CEF	0.370	0.590	0.491				
SYQ	0.675	0.830	0.787	0.548			
OVER_SAT	0.818	0.618	0.618	0.488	0.781		
PTE	0.718	0.716	0.745	0.509	0.769	0.720	

NOTE: SERV_SAT = CBA Centre Service Satisfaction; CEF= CBA services Cost-effectiveness. OVER_SAT= Overall CBA Satisfaction; QCQ = Question Content; SRQ= CBA Service Quality; SYQ= CBA System Quality; PTE= Perceived Trust.

4.1.3 Common method variance (CMV)

Kock (2015) proposed a comprehensive test for detecting common method variance in data using a model that passes standard convergent and discriminant validity tests via confirmatory factor analysis. Therefore, a comprehensive collinearity test was conducted to determine the PLS-common SEM method variance (CMV) (Kock, 2015). Collinearity Statistics (VIF) values should be less than 3.30 (Kock, 2015; Hair et al., 2017). As shown in Table 5, the VIF values for all factors were less than the 3.3 thresholds, indicating the absence of method bias in the model. Furthermore, Harman's single-factor test was employed to measure the common method bias problem using SPSS software (version 25), following the approach of previous studies to analyze CMV (Gu, Xu and Sun, 2021). The result from Harman's single-factor test conveyed that the single-factor contribution was 37.21 percent, which is less than 50 percent suggesting that CMV did not affect the results of this study (Verma, Chaurasia and Bhattacharyya, 2020).

Table 5: Collinearity (VIF) Statistics

	CBA Centre Service Satisfaction	Overall CBA Satisfaction
CBA Centre Service Satisfaction		1.736
CBA Question Content		2.045
CBA Service Quality	1.788	2.239
CBA Services Cost-Effectiveness		1.296
CBA System Quality	1.788	2.484

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	CBA Centre Service Satisfaction	Overall CBA Satisfaction
Overall CBA Satisfaction		
Perceived Trust		1.979

4.2 Structural Model Evaluation

The structural model investigated the direct and indirect relationships of the proposed variables. The path coefficients (β) were computed to determine the magnitude of the inter-variable effects. The significance level of the path was determined using 5000 samples using a bootstrapping procedure (Hair et al., 2017). The evaluation results of the study's hypotheses are summarised in Table 6 and Figure 5. The results of the hypotheses testing validate the influence of system quality (SYQ) on CBA center service satisfaction (SERV_SAT) and overall CBA satisfaction (OVER_SAT) (H1 and H4). Also, the findings revealed a correlation between CBA service quality (SRQ) and CBA center service satisfaction (SERV_SAT) (H2). There is a statistically significant correlation between center service satisfaction (SERV_SAT) and overall satisfaction (OVER_SAT) (H3). Although the cost-effectiveness of CBA services (CEF) was found to have a positive direct effect on overall satisfaction with the CBA system (OVER_SAT) (H7), the results do not support the direct impact of CBA service quality (SRQ) and CBA question content (QCQ) on overall satisfaction with the CBA system (OVERALL_SAT) (H5 and H6). On the relationship between perceived trust (PTE) in CBA and overall satisfaction (H8), the result indicated a statistically significant influence of trust on students' overall satisfaction.

Table 6 also indicates that the effect of CBA service quality (SRQ) on overall CBA satisfaction (OVER_SAT) via CBA center service satisfaction (SERV_SAT) is significant (H9). Therefore, the results demonstrate that service satisfaction at CBA centers (SERV_SAT) acts as a mediator between service quality (SRQ) and overall satisfaction with CBA (OVER_SAT). In addition, the results confirm the significant indirect effect of System Quality (SYQ) on overall satisfaction (OVER_SAT) via CBA center service satisfaction (SERV_SAT) (H10), thereby validating the mediating role of CBA center service satisfaction (SERV_SAT) too.

Table 6: Results of the Structural Model Analysis (Hypotheses Testing)

Hypothesis	Relationship	Beta value	Std. Error	t-value	P-value	Decision	R^2	f^2	Q^2
H1	SYQ-> SERV_SAT	0.390	0.062	6.247	0.000	Supported	0.373	0.135	0.274
H2	SRQ -> SERV_SAT	0.278	0.066	4.239	0.000	Supported		0.069	
H3	SERV_SAT -> OVER_SAT	0.412	0.054	7.664	0.000	Supported	0.570	0.227	0.402
H4	SYQ -> OVER_SAT	0.324	0.064	5.029	0.000	Supported		0.098	
H5	SRQ -> OVER_SAT	-0.022	0.056	0.388	0.349	Not Supported		0.000	
H6	QCQ-> OVER_SAT	-0.010	0.047	0.219	0.413	Not Supported		0.000	
H7	CEF -> OVER_SAT	0.084	0.045	1.866	0.031	Supported		0.013	
H8	PTE -> OVER_SAT	0.119	0.049	2.442	0.007	Supported		0.017	
H9	SRQ -> SERV_SAT-> OVER_SAT	0.114	0.028	4.156	0.000	Supported			
H10	SYQ-> SERV_SAT-> OVER_SAT	0.160	0.034	4.763	0.000	Supported			

Note: $p<0.05$ (one-tailed for direct effect, and two-tailed for specific indirect effect).

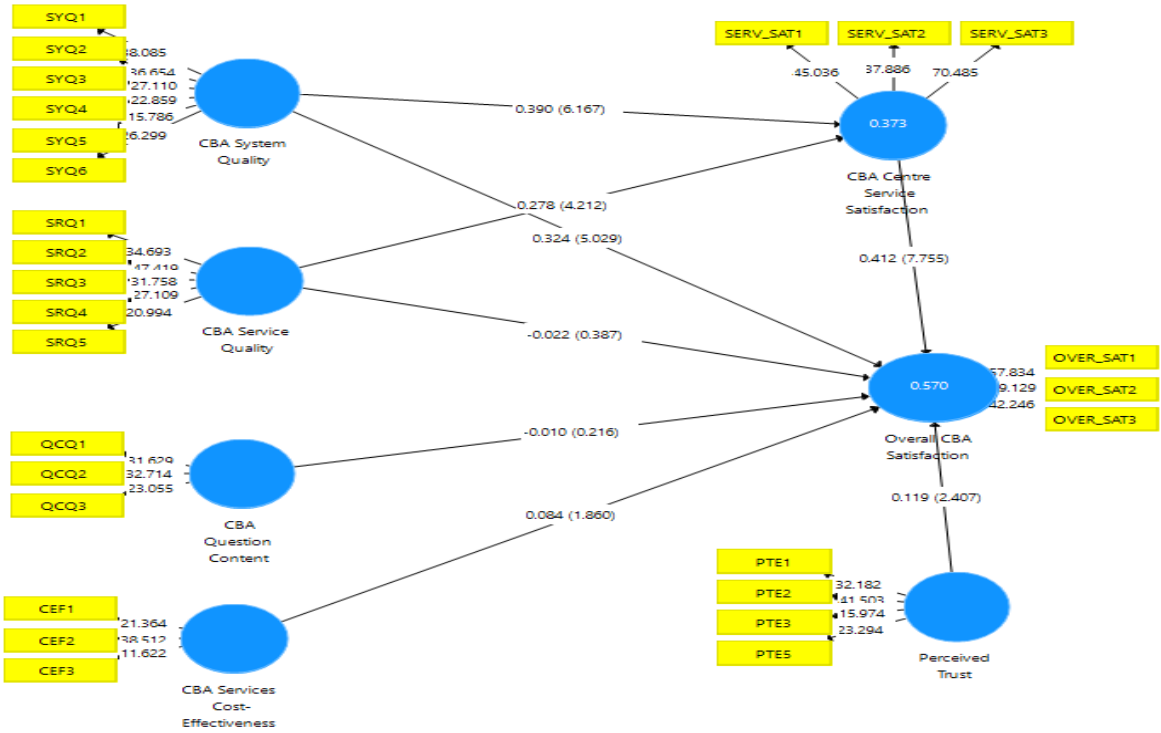

Figure 5: Results of evaluation of the structural model with R^2 values

R-square value (R^2) and Stone-Q^2 Geisser's were used to validate the structural model in this study. Stone-Q^2 Geisser's is a method for determining predictive relevance that does not consider the magnitude of the value of R^2. Values of Q^2 greater than zero indicate the existence of predictive relevance between the independent and dependent constructs (Hair *et al.*, 2019). About R^2, the results show a strong fit of the model, as Cohen (1988) suggested, where R^2 values of .02, .13, and .26 are considered weak, medium, and strong, respectively. In addition, each independent construct's impact on its corresponding dependent construct represents the effect size (f^2). Kenny (2016) also suggested using 0.005, 0.01, and 0.025 as a small, medium, and large effect sizes.

5. Discussion

CBA center service satisfaction had a significant impact on CBA overall satisfaction. Wang, So and Sparks (2017) and Hoyer, Herrmann and Huber (2002) found a correlation between service satisfaction and overall individual satisfaction with the specialized experience. This association is strongest according to the model's conclusion that student satisfaction with CBA center services is crucial. It is possible that during the CBA, students will pay more attention to the quality of services provided, particularly the technical assistance provided by CBA center employees. Consequently, a center must provide onsite student support. In addition, the study discovered a positive correlation between CBA system quality and CBA center satisfaction. This result is consistent with the findings of Shin (2015), Alzabi et al. (2016), Noh and Chang (2020), and Kim et al. (2015), who discovered that system quality influences user satisfaction. In addition, the study revealed that student satisfaction with CBA center services is proportional to the center's service quality. This study demonstrates that student satisfaction with the services affects their satisfaction with the service providers.

In line with Delone and McLean (2003), Al-Mamary et al. (2015), and Seta et al. (2018)., this study demonstrates a direct relationship between CBA system quality and overall CBA satisfaction. As a result, the system's overall satisfaction is determined by its usability, ability to meet students' needs, interaction flexibility, speed and security, and other features and functions. Consistent with previous research by Seta et al. (2018), the results revealed no direct correlation between CBA service quality and students' overall satisfaction with the CBA experience. In conclusion, higher education institutions must establish a helpdesk and provide online services and explanations to assist future exam takers with the CBA. In addition, the SEM analysis revealed that the content of the CBA questions did not affect the student's overall satisfaction. This study confirms the findings of Ramayah, Ahmad and Hong (2012), who demonstrated that the content of e-training has no impact on user

satisfaction. The following explanations have been offered: The student profiles offer a plausible explanation for this. According to their profiles, the students' backgrounds are diverse, and their interpretations of the material may vary. The cost-effectiveness of CBA services had a significant impact on overall satisfaction. This result demonstrated that different CBA center fees led to a stronger correlation between the cost-effectiveness of CBA services and overall CBA satisfaction (Kumbhar, 2011).

One of the primary objectives of this study is to determine how student satisfaction with CBA center services affects the relationship between the system, service quality, and overall satisfaction with the CBA system. Improving system quality indirectly increases CBA satisfaction by enhancing the quality of services provided at CBA centers. Consequently, service quality indirectly influences overall satisfaction via CBA center service satisfaction, whereas its direct effect is negligible. Thus, as service quality improves, so does CBA center satisfaction, increasing overall satisfaction. In addition, the results revealed a significant indirect effect of system quality on CBA satisfaction and the mediating role of CBA center service satisfaction. System quality had a significant direct effect on CBA satisfaction, as opposed to an indirect effect. Thus, CBA center service satisfaction mediates the relationship between system quality and overall CBA satisfaction.

This study demonstrated that users' evaluations of overall satisfaction is influenced by their assessment of the various examination phases. The direct effect results from the established structural model, also indicate that hypothesis H10 is supported. In addition to information, system, and service quality, trust also positively influences student satisfaction. CBA satisfaction is determined by CBA center service satisfaction, which complements system quality, the cost-effectiveness of CBA services, perceived trust, and indirect service quality. As a result, our understanding of how students achieve satisfaction has increased.

6. Conclusion, Implications, and Limitations

This study investigated the effect of CBA center service satisfaction on the relationship between CBA quality factors (such as system quality and service quality) and overall CBA satisfaction. Prior research has examined the relationship between quality factors and CBA satisfaction. As far as we know, the role of CBA center service satisfaction as a mediator has not yet been examined. Few studies have compared quality factors' direct and indirect effects on overall satisfaction with CBA. Consequently, the mediating role of CBA center services satisfaction is a significant theoretical contribution to the study. CBA system quality has a more significant direct impact on overall satisfaction than CBA center service quality. The link between CBA center service satisfaction and the indirect effect of CBA service quality on overall CBA satisfaction makes the indirect impact of CBA service quality on overall CBA satisfaction stronger and more significant. The theoretical finding highlights the significance of quality factors' direct and indirect effects on overall satisfaction. In addition, this research was conducted in Nigeria, a developing nation that has been largely overlooked, especially in terms of CBA center service satisfaction. Thirdly, previous CBA researchers overlooked the effect of the cost-effectiveness of CBA services on overall satisfaction; therefore, this study made a second theoretical contribution by exploring this relationship. Fourthly, in CBA satisfaction studies, there is little concern about the effect of perceived CBA trust on students' satisfaction which this study theoretically contributed.

These results suggested some practical implications. The quality of the CBA system, directly and indirectly, influenced the overall satisfaction with the CBA. For the development of a successful computer-based assessment, satisfaction is crucial. Additionally, more resources must be invested in system quality, particularly in the hardware and infrastructure, and fees/charges must be standardized and subsidized. Also indicated by the CBA center service satisfaction mediator study, there were greater direct impacts of certain quality components (such as system quality) and greater indirect effects of certain quality aspects (e.g., service quality). This finding suggests that managers of CBA centers should focus on quality factors to increase overall satisfaction and that CBA center satisfaction influences other relationship dynamics. The study's findings highlighted the importance of CBA center satisfaction to overall CBA satisfaction. CBA centers should maximize student satisfaction by enhancing the environment and services required for CBA exercises to succeed.

In this context, the study is novel because it examines the relationship between overall satisfaction with CBA services and several quality aspects. Still, the research has its limits. This study began by looking at the effects of various qualities (for example, system quality and service quality), while other facets may be investigated in the future (e.g., support system quality, invigilator quality, and student quality). This study found that the relationship between CBA and CBA utilization is mediated by school CBA center satisfaction. Future studies

should be conducted across regions and educational institutions to generalize the findings. In order to avoid causation concerns, the CMB test was utilized in this study.

Nonetheless, future development of the hypothesized links will be aided by the model's application in various locations and contexts. Due to the study's non-probability sampling method, the generalizability of the findings should be approached with caution. In order to provide a longitudinal approach to CBA satisfaction research, future studies must evaluate the direct and indirect relationships across time. This approach mitigates the limitations of a cross-sectional design and the risk of self-selection bias (Podsakoff, MacKenzie and Podsakoff, 2012). Future researchers must conduct additional qualitative research to discover the causes of these unsupported relationships.

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Appendix: Questionnaire items

Questions	
	CBA services cost-effectiveness
CEF1	I find the overall prices of the CBA services inexpensive.
CEF2	The CBA services deserve the current price.
CEF3	I find the CBA services cost-effective.
	Overall CBA satisfaction
OVER_SAT1	Overall, taking the CBA make me feel very satisfied.
OVER_SAT2	Overall, taking the CBA make me feel very pleased.
OVER_SAT3	Overall, taking the CBA make me very delighted.
	Question content
QCQ1	The CBA's questions were clear and understandable.
QCQ2	The CBA's questions were relevant to the courses' syllabus.
QCQ3	The CBA's questions were useful for my course
	CBA centre service satisfaction
SERV_SAT1	I feel satisfied with the services provided by the school's CBA centre staff.
SERV_SAT2	I feel contented with the services provided by the school's CBA centre staff.
SERV_SAT3	I like the services provided by the school's CBA centre staff.
	Service quality
SRQ1	The CBA centre service staff promptly attend to our request.
SRQ2	The CBA centre service staff responds to our needs timely and satisfactorily.
SRQ3	The CBA centre service staff understands the specific needs of the students.
SRQ4	The CBA centre service staff know their work very well.
SRQ5	The CBA centre service staff are available and cooperative when facing an error with the CBA system.
	System quality

SYQ1	The CBA system is easy to use.
SYQ2	The CBA system is user-friendly.
SYQ3	The CBA system is stable.
SYQ4	The CBA system protects my information from unauthorized access by logging in only with my account and password account and password account and password
SYQ5	The CBA system runs very fast.
SYQ6	The CBA system responds quickly to my request.
	Perceived Trust
PTE1	I think that the CBA is reliable in identifying students' identities.
PTE2	I feel that the strategies used to prevent cheating behaviors in the CBA are trustworthy.
PTE3	I think that assessment of learning outcomes through the CBA is fair.
PTE5	Overall, I think that the CBA is trustworthy.

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