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Factors Influencing Internet of Things Adoption for E-Learning in Sub Sahara African Higher Institutions: A Systematic Review

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Abstract
Internet of Thing (IoT) adoption have been in the existence from developed and developing countries, still many industry face difficulty in identifying and adopting relevant IoT technologies including e-learning in higher education institutions. Despites the significant studies of IoT adoption for e-learning in higher institution in developing country, there has yet to be a systematic review of the studies related to factors influencing IoT adoption for e-learning in Sub-Sahara African country specifically Nigeria. Therefore, this study aim to investigate the factors influence IoT adoption for e-learning in Sub-Sahara African higher education institution. The study conducted systematic review using updated preferred reporting items for systematic review and meta-analysis protocol (PRISMA). Following this method, 26 articles from 2019 to 2024 were included in this review. The finding reveals that the number of articles related to IoT adoption in higher institution is increasing with the majority of the studied were conducted in Asian countries. The majority of studies are quantitative method with the (UTAUT) model. Four different important factors and variables of TOE and UTAUT conceptual model which include Technological: Compatibility, Perceive ease of use, Perceive usefulness, Security and Privacy, Organizational: Government Support, Financial Readiness, Training, Innovativeness, Environmental: Efficient Structure, Facilitating conditions and End-user: Performance expectancy, Effort expectancy, Social influence and Hedonic motivation. More conceptual model studies are required in IoT adoption, and more studies are required in the adoption of IoT for e-learning in developing countries
Keywords: *Internet of Things (IoT), E-Learning, higher education institutes (HEIs), influencing factors, adoption, Sub-sahara Africa.*

1. INTRODUCTION

Sub-Sahara Africa specifically Nigeria's higher education institutions system has not progressed as much as global benchmarks (Adewole, 2020). The average student-teacher ratio of 1:50 is significantly higher than the recommended ratio of 1:25 (Emmanuel, 2014). National assessments reveal that most students struggle to comprehend basic texts and perform division, highlighting poor learning outcomes (Stephania, Ahmed, & Jacob, 2022). There is a lack of infrastructure, with a need for over 72,000 classrooms to meet UN standards, and only 50% of schools equipped with basic water and sanitation facilities (Alexander et al., 2016). Teaching methods in Nigeria higher education institutions heavily emphasize rote learning over critical thinking (West, 2023). Nevertheless, Nigeria has the potential to overcome this stagnation by integrating 21st century

technologies, just like its advanced counterparts. The continuous advancement of technology has made it increasingly possible to integrate it into different facets of life. One area that could undergo substantial change due to technological progress is education, particularly with the advent of the Internet of Things.

The Internet of Things (IoT) involves a network of physical devices that have embedded electronics, software, sensors, and network connectivity, allowing them to collect and exchange data over the internet (Muhammad et.al, 2022). Introducing IoT applications to e-learning higher institutions system of Nigeria can turn stagnant classrooms into dynamic learning environments. This transformation can be achieved through the use of tools that support student-centered active learning, personalized e-learning, remote accessibility from underserved areas, data-driven optimization of administrative functions and infrastructure, and continuous adaptation of curricula to meet the demands of the digital era.

The potential advantages of integrating the Internet of Things to e-learning higher education system in Nigeria are not well understood due to a lack of research, which makes it difficult to attract attention from key decision-makers and stakeholders. While initial efforts suggest promise, there is limited information available on the specific benefits that the Internet of Things could offer in improving learning outcomes, accessibility, efficiency, and socioeconomic impact on a large scale (Onayinka et al., 2024). Therefore, in order to gain support from policymakers and all stakeholders (including students, staff, schools, and communities), it is crucial to widely communicate the benefits of incorporating the Internet of Things to Nigerian e-learning higher institutions. Research is necessary to emphasize the concrete progress of the Internet of Things in areas such as innovative teaching methods, expanding distance learning, data-driven management, and maintenance, with the aim of generating political drive and interest in allocating resources for the widespread integration of the Internet of Things to Nigeria's e-learning higher education system (Onayinka et al., 2024). To the best of the researcher's knowledge, there is a lack of research that promotes the integration of IoT adoption for e- learning in Sub-Sahara African country including Nigerian higher education institutions. Therefore, this research was developed with the aim of filling the research gap as well as exploring existing scenarios for their inclusion and implementation in Sub-Sahara Africa specifically Nigeria higher education through a systematic review literature from 2019 - 2024 to investigates the influencing factors for adoption and implementation. The results obtained will be useful for used by researchers or practitioners in higher education institutions in the future.

1.1 PROBLEM STATEMENT

From Internet of thing (IoT) literature, the gap were identified from literature (Madni et. al., 2022; Ali et al., 2023; Özgül and Ocak, 2023**;** Mitra et al., 2024**)** reveals that despite substantial strides in IoT utilization from industrialized nations such as the United States, the United Kingdom, Japan, China, Turkey, Australia serving as prime exemplars. Fewer studies considered leading developing nation such as Pakistan (Shaikh et al., 2019), Jordan (Altawalbeh et. al., 2023), Saudi Arabia (Alam, Benaida, 2020; Shaqrah and Almars, 2022; El-Haggar et al., 2023; Masadeh et al., 2023; Mashat et al., 2024), Indonesia (Lutfiyah et al., 2024; Maharani et al., 2024), Iraq (Hashim and Al-Sulami, 2020; Azeez 2022; Assim and Ali, 2023;), India (Sinha and Brar, 2024), Malaysia (Almetere et al., 2020; Madni et. al., 2022; Shah et al., 2024), Romania (Mircea et al., 2021). Only few studies focused on Sub-Sahara African nations such as South Africa (Ajigini, 2023). Findings from previous studies were based on data collected from western and developed countries and therefore might not be transferable or applicable to Sub-Sahara African countries including Nigerian society which characterized by a relatively weak economy and limited technological infrastructure **(**Adewole, 2020). Thus, this research intended to provide new findings, which reflect the perspectives of developing countries in Sub-Sahara Africa and might broaden the generalization of IoT Adoption literature. And also to find the influencing factors adoption of IoT for e-learning in higher institutions.

1.2 RESEARCH QUESTION

How to find the influencing factors of Internet of Things (IoT) Adoption for e-Learning in Sub-Sahara African Higher Institutions?

This paper is organized as follows: Section 4 Review of the related systematic review, section 5 details the methodology of the review, section 6 discusses the findings and limitations of the study. The study's conclusions are presented in the last part. Table 1 show the comparison of this study with the previous systematic reviews:

Author and year	Type of Organization	Time range	Adoption model
Sneesl et al., 2022	Higher Education Institutions	2016-2021	Limited to VAM constructs
Xue et al., 2024	Higher Education	2008-2022	Limited to UTAUT Construct
Batanero et al., 2023	Higher Education	2017-2021	Not specified
Kandil et al., 2023	Higher Education	2009-2021	Not specified
Elneel et al., 2023	Higher Education	2015-2022	Not specified
Chweya and Ibrahim, 2021	Higher Education	2008-2017	Not specified
Osman et al., 2023	Higher Institutions	Not specified	Not specified
This study	Sub-sahara African HEIs	2019-2024	Conceptual model

Table 1: Comparison of this study with previous systematic reviews

2. RELATED WORKS

In this section, we study the existing relevant systematic literature reviews and survey studies for the adoption of new technologies in education systems. Influencing factors regarding IoT adoption. Hence (Sneesl et al., 2022) conducted a systematic review to select relevant articles from the three reputable databases. It proposed a conceptual model for the adoption of the smart campus was derived through the lens of a value-based adoption model (VAM). The model's components used propagation, perceived fees, perceived trust, and perceived value. The studies investigate the Internet of Things and the difficulties that information institutions encounter while trying to take advantage of IoT technology (Osman et al., 2023). By looking over and evaluating the published work, they take a descriptive approach. They gathered information by examining data from literature and intellectual activity, evaluating it, and drawing the most significant findings from earlier studies. It showed that because of its many advantages, the majority of global and cutting-edge information institutions are quickly implementing internet of things technology. Despite the fact that (IoT) applications encounter several difficulties and problems, including inadequate internet networks, data theft, and privacy concerns. According to the report, sufficient infrastructure and support should be made available to encourage the use of Internet of Things technology.

It also identify the studies' country, participant profile, and methodology (Batanero et al., 2023) and ascertain the ways in which the Internet of Things (IoT) is now enhancing higher education. As demonstrated by the findings, one of the benefits of IoT is that it not only introduces ICT into the classroom but also increases student engagement, which raises the standard of instruction in higher education. The attitude of educators toward its implementation, however, as well as their degree of digital competency, presents some difficulties. (Kandil et al., 2023) examines and highlights the major aspects that influence the impact of the IoT on education and discloses the current state of academic research to manage higher education (HE) resources effectively and efficiently. They extensively assessed the various study approaches used to embrace IoT, summarizing the substance of the studies and highlighting the important aspects that may affect IoT adoption in HE by analyzing 95 publications; 35 were explored and analyzed. The literature review and analysis of academic articles indicated the parameters impacting the adoption of IoT technology in HEIs.

The adoption of IoT utilization in e-learning systems and ways to enhance it for effective use are the subjects of a thorough literature analysis (Elneel et al., 2023). The development of new technologies like the Internet of Things has a big impact on improving the performance of new systems and bringing about positive change. It was discovered that e-learning systems require such modern techniques as the Internet of Things to enable interconnection, increase reliability, and enhance the enjoyment of the educational process. IoT deployments at

educational institutions are examined by (Chweya and Ibrahim, 2021), along with their application areas, themes, models, and approaches, as well as the advantages. The focus of this study was on works published between 2008 and 2017. The results showed that one of the applications of IoT in education was the use of IoT to track and trace a student's attendance.

Several studies have suggested that establishing IoT-based learning environments can aid in developing a new paradigm for learning processes in HEIs, thereby improving learning and teaching processes. However, these efforts were isolated and incomplete, as the studies discovered were not investigated in a single study, particularly in developing countries including Sub-sahara Africa. HEIs is considered as a potential candidate for the implementation of IoT applications. The primary goal of this research is to provide a more comprehensive view of the factors influencing IoT adoption for e-learning in Sub-Sahara African higher institutions.

This study advances the existing body of research by offering a comprehensive and integrated perspective on the evolution of factors influencing IoT adoption in Sub-sahara African including Nigeria from 2019 to 2024. Unlike studies that narrowly focus on other developing countries, this research adopts a systematic literature review to find the influence factors of IoT adoption.

3. METHODOLOGY

In order to examine and expand on earlier research on IoT uptake in higher education, this study conducted a systematic review using data from the past six years. According to Page et al. (2020), a systematic review is a precise technique for methodically gathering, assessing, and synthesizing the available data on a certain research issue. However, it has been determined to conduct this systematic review because of its importance and usefulness in producing trustworthy knowledge based on the facts currently available in the field of research. Sampling in a systematic review does not depend on randomization to choose which studies to include in the analysis, in contrast to other study formats. In a review, studies that sufficiently address the study issue are found through a database search. Predetermined inclusion and exclusion criteria will be used to choose these studies. This sampling technique aims to ensure that the most rigorous and pertinent studies are included to address the research question of the review, but it does not guarantee a full representation of all studies carried out in the field. The literature search was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) declaration as research methodology in order to guarantee the quality of the review (Moher et al., 2014).

3.1 Study Selection and Eligibility Criteria

Articles were searched and selected from four scholarly literature databases:

1. IEEE Xplore.
2. Scopus.
3. Emerald and
4. Google Scholar.

(Factors OR Influence OR Impact) AND ("Internet of things" OR IoT) was the search query utilized, with a sole focus on conference proceedings, reviews, and journal articles as the best sources of the most recent, relevant scientific literature in the field of study. To make the results in each database accessible and quickly filterable, books, chapters, and reports have been removed. Additionally, all publications that examined the adoption of IoT or were devoted to the individual and organizational levels. To further reduce the possibility of selection bias, the eligibility requirements were applied to each article separately (see Table 2). In the end, this study's final list of publications contained a total of 26 articles. To gather the pertinent information needed to address the research issue, every chosen article was carefully studied. The combined data was then divided into groups, each of which represented a response to a different study topic. The PRISMA flow diagram for the systematic review and findings is shown in Figure 1.

S/N	Inclusion	Exclusion
1	Articles authored in English languages.	Articles authored in languages other than English.
2	Studied focuses the IoT from HEIs domain	Studied outside the IoT from HEIs domain
3	Studies focusing on the factors that influence adoption of internet of things in HEIs	Studies focusing on internet of things in HEIs in general without focusing on the factors that influence adoption
4	Articles that were released between 2019 and 2024	Previous publications from before 2019
5	Only conference papers and journals	White papers, books, book chapters, editorials, review papers, etc
6	Only the quantitative, full length, empirically verified articles from structured equation modeling.	Only pilot test, pre-test, technical models without structured equation modeling.

Table 2: Inclusion and Exclusion Criteria

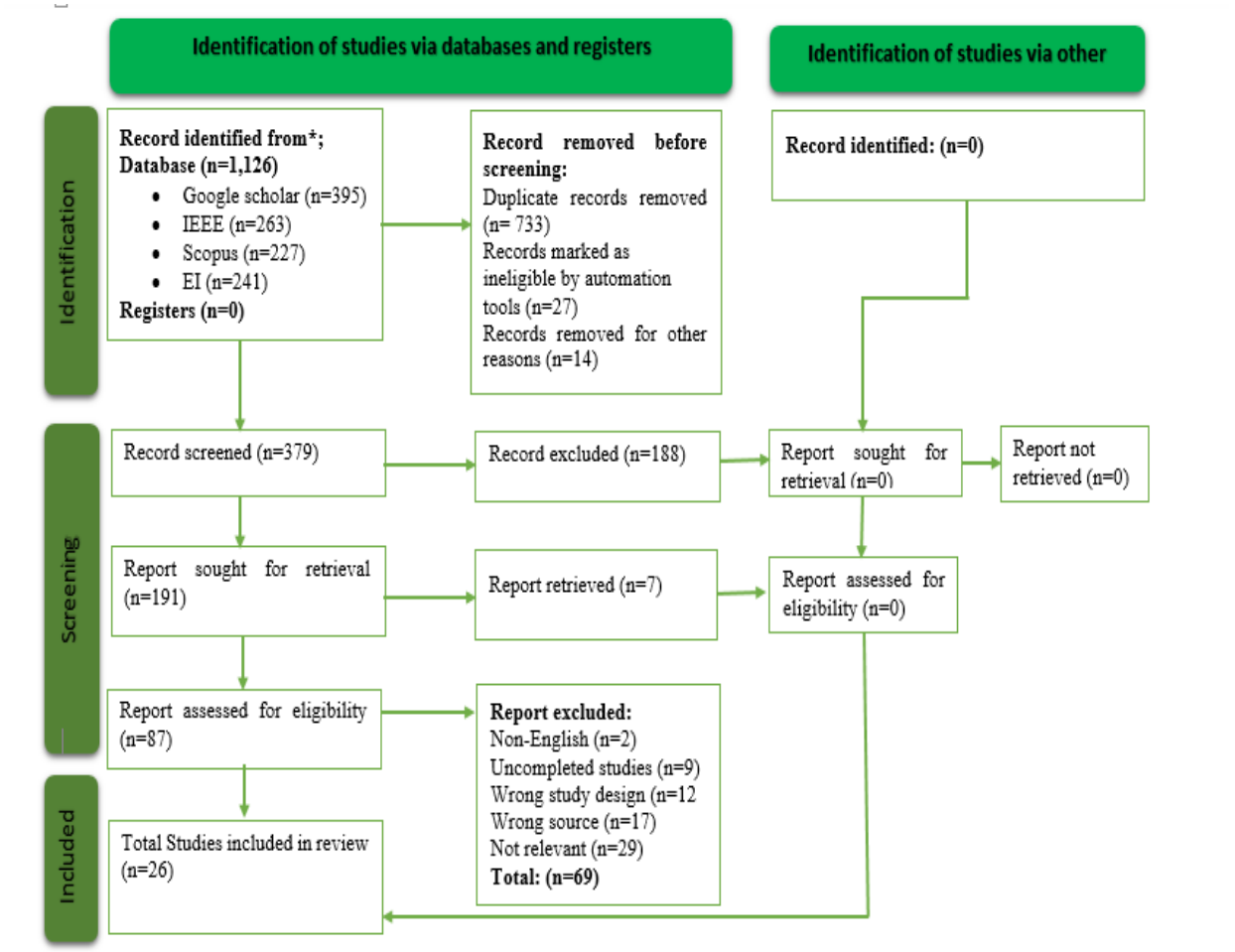

Figure 1: Study Selection process using PRISMA flow Diagram Page et al., 2020 (Authors own creation)

3.2 Publications by Year

A breakdown of the selected articles by year. Most of the articles were published in 2023, followed by 2024, 2022 and 2020, with the lowest number published in 2019 and 2021. Over the years, the number of articles investigating IoT adoption in e-learning HEIs has steadily increased (see figure 2).

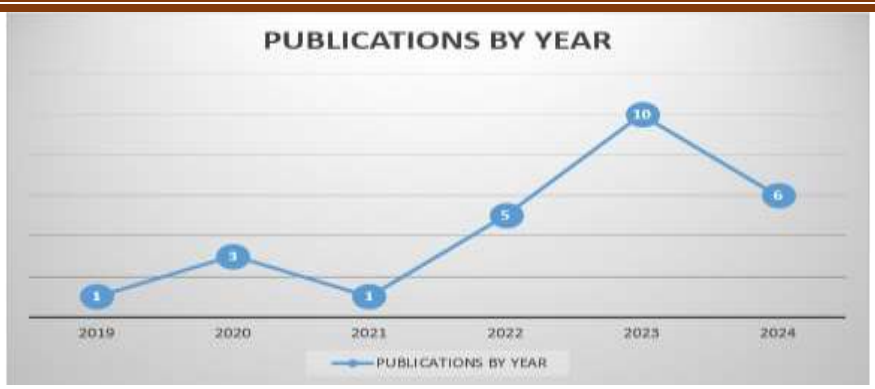

Figure 2: publication by year

3.3 Publications by Country

The research articles are categorized based on the countries level. It shows that based on country analysis, Iraq have the largest number of publications followed by Saudi Arabia then developing country is least (see in figure 3).

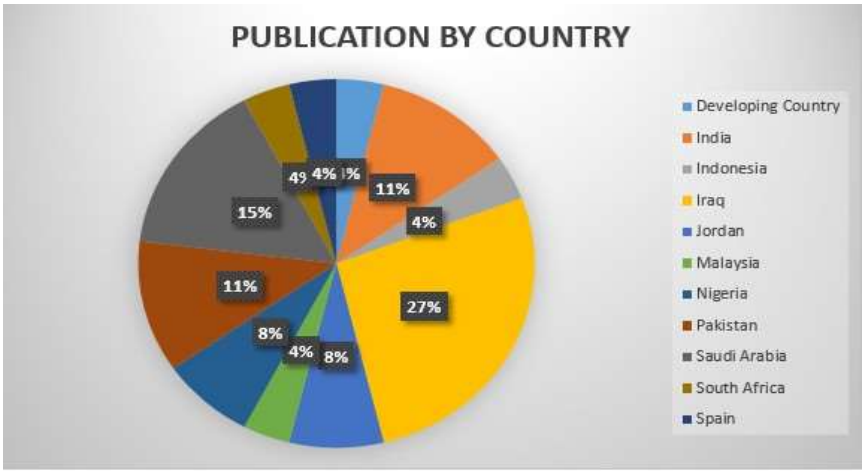

Figure 3: Publication by Country

5.4 Theoretical framework

Models that have been deployed by researchers to examine the adoption of IoT is shown in Figure 4. It shows that UTAUT is the highest deployed model followed by TAM. Other models include UTAUT2, TOE, TAM2, ISS, TAM and UTAUT, TAM and TRI, UTAUT2 and ISS, TAM, TPB, UTAUT2 and VAM model. The reviewed studies included 73% single model followed by 15% multiple models and 12% did not use any model.

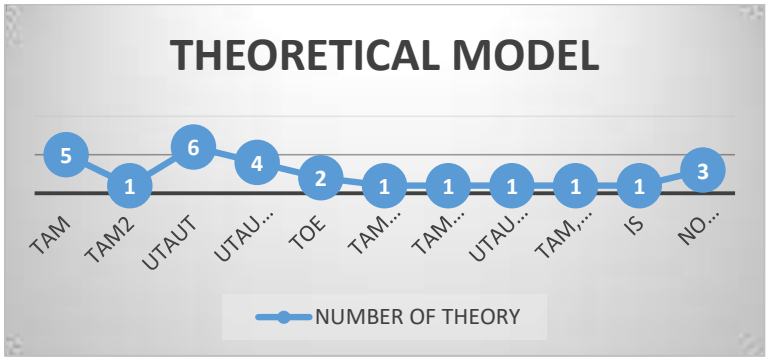

Figure 4: Publication by Theoretical model

3.4 Approach

The reviewed studies can be divided into six approaches. The quantitative studies accounted to 62% followed by the mixed method with 9%, the review articles with 8% are network analysis and review paper, while conceptual and analytical hierarchical process with 4%. Figure 5 shows the approach that has been used in previous studies.

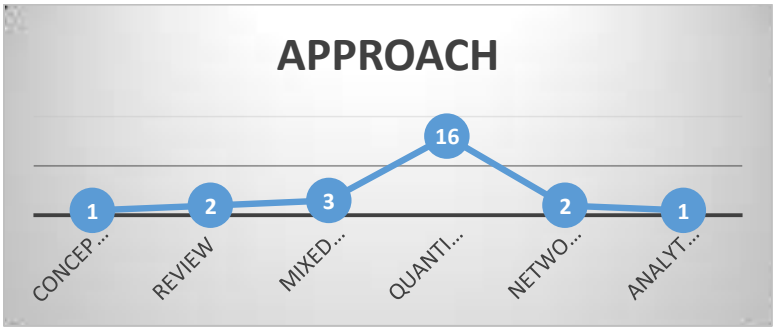

Figure 5: Publication by Approach

3.5 Categorization of E-Learning Influencing Factors of IoT Adoption in Sub Sahara African Higher Institutions

The answers to our research question, which is to determine the critical factors that influence IoT adoption for e-learning in Sub-Saharan African HEIs in Nigeria, are presented in this section. To begin, the data was taken from the earlier studies that were part of this research and organized into a single table. The methodology for identifying the factors was taken from the study (Qasem et al., 2019). As shown in Table 3, the table was designed with six columns: reference, theory, methodology, dependent variable, independent variable, and research findings. It was then divided into four columns: Factors, variables, frequency, and references, as indicated in Table 4. Finally, the variables were grouped and categorized based on the specific factors, in Table 5. In order to do this, the elements were identified using the following steps:

i. Every variable found in Table 3 was taken out and arranged into groups.
ii. Because several studies utilized the same variables under various names, the variables for each group were filtered to remove duplicates.
iii. Based on the shared traits of the variables in each category, the groupings were given factor names.

S/N	Author/Year	Model	Methodology	Research Findings
1.	Hashim and Al-Sulami, 2020	Conceptual model (UTAUT)	The stratified sampling Techniques	The results shows that social influence is the most important factor in relation to the behavioural intention (BI) to use IoT services follow by effort expectancy, Security and, performance expectancy. Facilitating conditions.
2.	Almetere, 2020	UTAUT model	Quantitative	Effort expectancy is the most significant factor to behavioural intention to use IoT adoption follow by facilitating conditions, Psychological capital, Performance expectancy, social Influence,
3.	Madni et al., 2022	TAM and UTAUT2 model	Quantitative and Qualitative methods	The results reveals the privacy (27%), infrastructure readiness (24%), financial constraints (24%), ease of use (20%), support of faculty (18%), interaction (15%), attitude (14%), and network and data security (14%), as the significant E-Learning influencing factors on IoT adoption in HEIs.
4.	Ali et al., 2023	TOE Model	An inferential methodology,	Financial obstacles, self-efficacy, interactive capability, online surveillance, automated attendance tracking, training programs, network and data safeguarding measures, and relevant tools significantly influence IoT adoption. While accessibility, internet quality, infrastructure preparedness, usability, privacy concerns, and faculty support insignificantly on the adoption IoT within HEIs.
5.	Ajigini, 2023	UTAUT model	Quantitative	Performance expectancy, social influence, and effort expectancy had a positive influence on behavioral intention to adopt IoT, with effort expectancy indicating the strongest significant impact. However, Facilitating conditions do not have any significant effect.
6.	Al_Wahshata et al., 2024	TOE Model	Quantitative	Attitude, behavior, financial preparedness, dependability, and training have a substantial impact on the adoption of the IOT. While class capacity, awareness, system resources, and course design had a minor influence on the adoption rates inside HEIs.
7.	Lutfiyah et al., 2024	Conceptual framework	A mixed-methods approach was employed	Security cameras and environmental sensors, have been implemented, there is still significant room for improvement. Key challenges include limited human resources and financial constraints. Stakeholder analysis identified the school committee, head of the boarding school, and technology procurement partners as crucial actors in driving IoT adoption
8.	Sinha and Brar, 2024	TAM Model	Quantitative research design	The result reveal that most of the students got familiar with IoT from browsing on the Web/Internet, social networking sites, research projects, conferences, workshops, webinars and faculty development programs, professional discussions, and meetings, as part of the curriculum. Respondents were in favor of implementing IoT in library services.
9.	Masadeh and El-Haggar, (2023)	Extended TAM model	Questionnaire method	The study investigate the issues affecting IoT adoption in higher education. Also, it creates trustworthy literature to guide decision-makers to adopt IoT to improve and facilitate the learning process and to increase the adoption of IoT technologies academic context.
10.	Alhasan et al., 2023	TAM and TRI models	A quantitative research design	Compatibility, discomfort, enjoyment, and self-efficacy are significant influence on both perceived ease of use

				(PEOU) and perceived usefulness (PU). While, innovativeness is significant effect on PEOU, and insecurity is significant impact on PU. The results also revealed that PU is significant influence on the students' behavioural intention to use.
11.	Shaikh et al., 2021	UTAUT2 model	Network analysis method	The method proposed in this study is network analysis method to observe users' actions in relation to several IoT applications in higher education. An in-depth analysis and consideration of key deliverables which have a major impact on the Internet of Things (IoT) adoption in Pakistani educational institutions of higher level, revealed that only a few applications are heavily used in comparison to all other applications
12.	Muhammad et al., 2023	UTAUT2 model	Quantitative	It found that accessible resources are scarce (46.0%), with smartphones being the only resource available to 98.0% of respondents. Even though the majority of respondents are mediocre users, they utilize IoT for all of their learning tasks, including teaching and research. In addition, 56.0% of respondents said they needed training to improve their IoT abilities
13.	Alzahrani, 2023	TAM model	Quantitative	Perceived ease of use affected both perceived usefulness and attitude toward adopting the IoT. However, perceived usefulness failed to affect attitude, and attitude does not influence behavioral intention to adopt IoT technology.
14.	Evwiekpaefe and Amrevuawho, 2023	UTAUT model	Quantitative	Performance Expectancy, Effort Expectancy, and Facilitating Condition positively influence Behavioral Intentions to use IoT technology, whereas Social Influence has no positive influence on Behavioral Intentions to use IoT technology for educational purposes in tertiary institutions in Kaduna state metropolis
15.	Sneesl et al., 2023	TAM model	Quantitative	Perceived usefulness in technology-specific factors, facilitating conditions, and propagation in organizational-specific factors, government support, social influence, and external pressure in environmental-specific factors, as well as privacy concerns, self-efficacy, satisfaction, and domain-specific knowledge in end-user-specific factors. Four hypotheses related to perceived ease of use, service collaboration, habit, and innovativeness were rejected. Notably, the study identifies propagation as the most significant predictor in the ANN analysis.
16.	Azeez, 2022	UTAUT model	Quantitative	Social influence is the most important factor regarding behavioral intention (BI) to use IoT services followed by expected effort, privacy and performance expectations. Facilitating conditions have an impact on the behavior of using IoT services
17.	**S**haqrah and Almars, 2022	UTAUT2 model	Quantitative	The results demonstrated in this study potentially assist the universities to understand the main determinists of using IoET applications acceptance and usage from students' perspectives to integrate the IoT concept in teaching and learning.
18.	Altawalbeh et al., 2023	TAM Model	Quantitative	The study's findings revealed important understanding of how students accept using digital tools or technology in education to process information for better decision-making and student support.
19.	Akazua et al., 2023	Nil	Quantitative	The findings revealed that the use of the internet of

				things in classrooms in tertiary institutions in Rivers State is influenced by the lack of ICT facilities, network connectivity, and knowledge of ICT. The incorporation of the internet of things in the classroom of tertiary institutions will enhance participation and concretize complex learning.
20.	Jarallah and Alyouzbaky, 2024	TAM model	A Quantitative approach	The result reveal that the perception of benefit is influenced by ease of use. In contrast, self-efficacy and facilitation conditions are unchanged and do not affect behavioral intention to adopt the Internet of Things.
21.	Romero-Rodríguez et al., 2020	UTAUT model	Quantitative	Performance expectancy, facilitating conditions, and attitude toward using technology were influential in behavioral intention to use IoT. While the intention for use was similar between men and women and with respect to age.
22.	Sneesl et al., 2022	TAM, TPB, UTAUT2, VAM	SLR	The study adapts perceived scalability, perceived replicability, perceived reliability, perceived privacy and security, perceived trust, the cost of deployment, usefulness, enjoyment, and technicality as adoption factors of sustainable smart campuses. This study offers practical and theoretical implications regarding the adoption and propagation of emerging smart campuses.
23.	Sneesl et al., 2022	NIL	Analytical Hierarchical Process (AHP)	The most significant contributing factors were government support, privacy concerns, social influence, facilitating conditions, and service collaboration, whereas the least significant contributing factors were enjoyment, availability, reliability, mobility, and compatibility..
24.	Arunkumar et al., 2024	NIL	SLR	It highlight the diverse information requirements of stakeholders involved in campus management. Facility managers, for instance, expressed a need for real-time data on building performance, including temperature, humidity, energy consumption, and occupancy levels. Such information enables proactive maintenance and optimization of building systems to ensure comfort, safety, and energy efficiency.
25.	Tyaga and Krishankumar, 2024	UTAUT 2 AND IS Success Model	fuzzy qualitative and comparative analysis (fsQCA)	The results of the study emphasize the importance of considering both individual and technological factors in e-learning adoption and provide evidence for the significance of integrating multiple theories in understanding the complex relationship between factors and learners' BI.
26.	Shaikh et al., 2019	UTAUT2	network analysis approach	It proposes the network analysis approach to observe the users' behavior towards different IoT applications usage in higher education. The consideration of key deliverables that have significant effect on the acceptance of Internet of Things (IoT) in higher education institutions of Pakistan and the in-depth analysis showed that few applications are being used heavily compared to all other applications. This study provides basis for developing countries, to increase wider acceptance and use of IoT technologies in higher education to provide benefits for both students' and faculty members.

The Table 3: The previous studies examining the IoT adoption factors in e-learning HEIs

FACTOR	VARIABLE	FREQUENCY	REFERENCE
Technological	Compatibility	4	Alhasan et al., 2023; Arunkumar et al., 2024; Shaikh et al., 2021; Sneesl et al., 2022;
	Perceive ease of use	8	Alhasan et al., 2023; Alzahrani, 2023; Altawalbeh et al., 2023; Jarallah and Alyouzbaky, 2024; Masadeh and El-Haggar, (2023); Sinha and Brar, 2024; Sneesl et al., 2023; **S**haqrah and Almars, 2022
	Perceive usefulness	9	Alhasan et al., 2023; Alzahrani, 2023; Altawalbeh et al., 2023; Lutfiyah et al., 2024; Sinha and Brar, 2024; Sneesl et al., 2022; Sneesl et al., 2023; **S**haqrah and Almars, 2022; Jarallah and Alyouzbaky, 2024
	Ease of Access	1	Madni et al., 2022
	Technical Support	6	Al_Wahshata et al., 2024; Ali et al., 2023; Madni et al., 2022; **S**haqrah and Almars, 2022; Sneesl et al., 2022; Sneesl et al., 2023
	Security	8	Ali et al., 2023; Alhasan et al., 2023; Arunkumar et al., 2024; Lutfiyah et al., 2024; Madni et al., 2022; Hashim and Al-Sulami, 2020; Shaikh et al., 2019; Sneesl et al., 2022
	Privacy	9	Arunkumar et al., 2024; Azeez, 2022; Madni et al., 2022; Sneesl et al., 2022; Sneesl et al., 2023 Al_Wahshata et al., 2024; Ali et al., 2023; Shaikh et al., 2019; Shaikh et al., 2021
	System resources	4	Al_Wahshata et al., 2024; Madni et al., 2022; Tyaga and Krishankumar, 2024; Sinha and Brar, 2024
	Internet Quality	2	Al_Wahshata et al., 2024; Tyaga and Krishankumar, 2024
	Reliability	3	Madni et al., 2022; Sneesl et al., 2022; Sneesl et al., 2022
	Awareness	1	Madni et al., 2022
	Multimedia installation	1	Madni et al., 2022
	Interoperability	1	Arunkumar et al., 2024.
	Enjoyment	3	Alhasan et al., 2023; Sneesl et al., 2022; Sneesl et al., 2022
	Virtual reality	1	Masadeh and El-Haggar, (2023)
	Relevance	1	Shaikh et al., 2021
	Scalability	2	Arunkumar et al., 2024; Sneesl et al., 2022
	Digital literacy	1	Tyaga and Krishankumar, 2024
	Optimism	2	Alhasan et al., 2023; Lutfiyah et al., 2024
	Discomfort	2	Alhasan et al., 2023; Lutfiyah et al., 2024
	Insecurity	2	Alhasan et al., 2023; Lutfiyah et al., 2024
	Government Support	2	Sneesl et al., 2022; Sneesl et al., 2023
	Financial Readiness	2	Al_Wahshata et al., 2024; Madni et al., 2022
	Infrastructure Readiness	2	Arunkumar et al., 2024; Madni et al., 2022
	User friendly	1	Madni et al., 2022
	Training	4	Ali et al., 2023; Al_Wahshata et al., 2024; Madni et al., 2022; Masadeh and El-Haggar, (2023)
	Course Design	2	Al_Wahshata et al., 2024; Madni et al., 2022
	Online exams/test/quiz	1	Madni et al., 2022

Organizational	Online monitoring	1	Madni et al., 2022
	Auto attendance	1	Madni et al., 2022
	Innovativeness	8	**S**haqrah and Almars, 2022; Sneesl et al., 2023; Muhammad et al., 2023; Alhasan et al., 202;3 Masadeh and El-Haggar, (2023); Lutfiyah et al., 2024;
	Facilitating conditions	12	Sneesl et al., 2023; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Shaikh et al., 2021; Hashim and Al-Sulami, 2020; Almetere, 2020; Ajigini, 2023; Shaikh et al., 2019; Sneesl et al., 2022; Romero-Rodríguez et al., 2020; Jarallah and Alyouzbaky, 2024; **S**haqrah and Almars, 2022.
	Service collaboration	2	Sneesl et al., 2022; Sneesl et al., 2023
	Regulatory Compliance	1	Arunkumar et al., 2024
Environmental	Tools	2	Ali et al., 2023; Madni et al., 2022
	Efficient Structure	2	Al_Wahshata et al., 2024; Madni et al., 2022
	Class Capacity	2	Al_Wahshata et al., 2024; Madni et al., 2022
	External pressure	1	Sneesl et al., 2023
	Progress	1	Madni et al., 2022
	Social influence	11	Shaikh et al., 2019; Tyaga and Krishankumar, 2024; Romero-Rodríguez et al., 2020; **S**haqrah and Almars, 2022; Azeez, 2022; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Ajigini, 2023; Almetere, 2020; Hashim and Al-Sulami, 2020; Shaikh et al., 2021
End-User	Trust	5	Azeez, 2022, Muhammad et al., 2023, Shaikh et al., 2021, Sneesl et al., 2022
	Self-Efficacy	6	Ali et al., 2023; Jarallah and Alyouzbaky, 2024 Sneesl et al., 2023 Alzahrani, 2023 Alhasan et al., 2023; Madni et al., 2022
	Interactivity	1	Masadeh and El-Haggar, (2023)
	Computer anxiety	2	Madni et al., 2022; Tyaga and Krishankumar, 2024
	Skills	2	Tyaga and Krishankumar, 2024, Madni et al., 2022
	Feedback	2	Madni et al., 2022, Muhammad et al., 2023
	Competency	1	Sinha and Brar, 2024
	Motivation	2	Madni et al., 2022
	Mobility	1	Madni et al., 2022
	Availability	2	Sneesl et al., 2022, Masadeh and El-Haggar, (2023)
	Attitude toward Usage	6	Sinha and Brar, 2024; Romero-Rodríguez et al., 2020; Altawalbeh et al., 2023; Alzahrani, 2023; Al_Wahshata et al., 2024; Madni et al., 2022
	Behavioural Intention	5	**S**haqrah and Almars, 2022; Azeez, 2022; Muhammad et al., 2023; Shaikh et al., 2021; Almetere, 2020
	Actual system use	1	Sinha and Brar, 2024
	Habit	1	Sinha and Brar, 2024
	Satisfaction	1	Sneesl et al., 2023
	Digital literacy	1	Sneesl et al., 2023
	Hedonic motivation	4	Tyaga and Krishankumar, 2024; Shaikh et al., 2019; Muhammad et al., 2023; Shaikh et al., 2021

	Performance expectancy	11	Shaikh et al., 2019; Tyaga and Krishankumar, 2024; Romero-Rodríguez et al., 2020; **S**haqrah and Almars, 2022; Azeez, 2022; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Ajigini, 2023; Almetere, 2020; Hashim and Al-Sulami, 2020; Shaikh et al., 2021
	Effort expectancy	11	Shaikh et al., 2019; Tyaga and Krishankumar, 2024; Romero-Rodríguez et al., 2020; **S**haqrah and Almars, 2022; Azeez, 2022; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Ajigini, 2023; Almetere, 2020; Hashim and Al-Sulami, 2020; Shaikh et al., 2021
	Knowledge sharing	3	Masadeh and El-Haggar, (2023); Akazua et al., 2023 Sneesl et al., 2023
	Price value	2	Shaikh et al., 2021, Muhammad et al., 2023
	Cost of development	1	Sneesl et al., 2022
	Psychological capital	1	Almetere, 2020

Table 4: Summary of the previous studies on the Factors influence IoT adoption in e-learning HEIs

FACTOR	VARIABLE	REFERENCE
Technological	Compatibility	Alhasan et al., 2023; Arunkumar et al., 2024; Shaikh et al., 2021; Sneesl et al., 2022;
	Perceive ease of use	Alhasan et al., 2023; Alzahrani, 2023; Altawalbeh et al., 2023; Jarallah and Alyouzbaky, 2024; Masadeh and El-Haggar, (2023); Sinha and Brar, 2024; Sneesl et al., 2023; **S**haqrah and Almars, 2022
	Perceive usefulness	Alhasan et al., 2023; Alzahrani, 2023; Altawalbeh et al., 2023; Lutfiyah et al., 2024; Sinha and Brar, 2024; Sneesl et al., 2022; Sneesl et al., 2023; **S**haqrah and Almars, 2022; Jarallah and Alyouzbaky, 2024
	Security	Ali et al., 2023; Alhasan et al., 2023; Arunkumar et al., 2024; Lutfiyah et al., 2024; Madni et al., 2022; Hashim and Al-Sulami, 2020; Shaikh et al., 2019; Sneesl et al., 2022
	Privacy	Arunkumar et al., 2024; Azeez, 2022; Madni et al., 2022; Sneesl et al., 2022; Sneesl et al., 2023 Al_Wahshata et al., 2024; Ali et al., 2023; Shaikh et al., 2019; Shaikh et al., 2021
Organizational	Government Support	Sneesl et al., 2022; Sneesl et al., 2023
	Financial Readiness	Al_Wahshata et al., 2024; Madni et al., 2022
	Training	Ali et al., 2023; Al_Wahshata et al., 2024; Madni et al., 2022; Masadeh and El-Haggar, (2023)
	Innovativeness	**S**haqrah and Almars, 2022; Sneesl et al., 2023; Muhammad et al., 2023; Alhasan et al., 202;3 Masadeh and El-Haggar, (2023); Lutfiyah et al., 2024;

Environmental	Efficient Structure	Al_Wahshata et al., 2024; Madni et al., 2022
	Facilitating conditions	Sneesl et al., 2023; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Shaikh et al., 2021; Hashim and Al-Sulami, 2020; Almetere, 2020; Ajigini, 2023; Shaikh et al., 2019; Sneesl et al., 2022; Romero-Rodríguez et al., 2020; Jarallah and Alyouzbaky, 2024; **S**haqrah and Almars, 2022.
End-User	Performance expectancy	Shaikh et al., 2019; Tyaga and Krishankumar, 2024; Romero-Rodríguez et al., 2020; **S**haqrah and Almars, 2022; Azeez, 2022; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Ajigini, 2023; Almetere, 2020; Hashim and Al-Sulami, 2020; Shaikh et al., 2021
	Effort expectancy	Shaikh et al., 2019; Tyaga and Krishankumar, 2024; Romero-Rodríguez et al., 2020; **S**haqrah and Almars, 2022; Azeez, 2022; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Ajigini, 2023; Almetere, 2020; Hashim and Al-Sulami, 2020; Shaikh et al., 2021
	Social influence	Shaikh et al., 2019; Tyaga and Krishankumar, 2024; Romero-Rodríguez et al., 2020; **S**haqrah and Almars, 2022; Azeez, 2022; Evwiekpaefe and Amrevuawho, 2023; Muhammad et al., 2023; Ajigini, 2023; Almetere, 2020; Hashim and Al-Sulami, 2020; Shaikh et al., 2021
	Hedonic motivation	Tyaga and Krishankumar, 2024; Shaikh et al., 2019; Muhammad et al., 2023; Shaikh et al., 2021

Table 5: Factors influence IoT adoption in e-learning HEIs of the current study

According to Table 5, from the SLR, the factors can be categorized into four main factors that influence IoT adoption for e-learning in Sub-sahara African HEIs: Technological, Organizational, Environmental, and End user factors. However, the results revealed that several studies had examined UTAUT, TAM, TOE, TAM and UTAUT, TAM and TRI factors as important factors for IoT adoption in HEIs in developing countries with little consideration paid to factors influence IoT adoption for e-learning in Sub-Sahara African Countries. In order to determine the elements that have a major impact on IoT adoption and improve its efficacy, these factors need to be investigated further. As a result, these elements can be distinguished and gradually enhanced to increase the effectiveness of IoT adoption.

4. DISCUSSIONS

This study aimed to provide an insight of IoT adoption studies for e-learning in Sub-Sahara African country including Nigeria and evaluate the current research situation. This review could assist researchers in determining the key elements that affect IoT adoption for e-learning in HEIs as well as the theoretical models that direct and support IoT adoption studies. The study's conclusions can serve as a roadmap for real-world application, giving managers pertinent knowledge to encourage and assist IoT applications both before and throughout the adoption stage, guaranteeing the deployment of IoT solutions. To guarantee the accuracy and objectivity of the search procedure, the study used the systematic review technique. After presenting a broad data analysis of the 26 papers that were chosen, the research issues were discussed. The inquiry served as a guide for further research based on the current body of knowledge.

A general data analysis of the selected 26 studies was presented, then the research questions were addressed. The question provided a roadmap to the existing research for future research. The publishing trend generally indicates a growing interest in IoT implementation in HEIs. Only 18 prior studies have been found, though, suggesting that IoT adoption is still in its infancy and that further study is needed. In order to determine the key elements impaction IoT adoption, the study also looked into theoretical models. Determining these elements can improve the adoption of IoT technology by giving decision-makers a clearer picture of its advantages and

disadvantages. Four crucial elements were found in the earlier research. Therefore, the results indicated that researchers have focused on TAM, UTAUT, TOE, TAM2, UTAUT2, TAM and UTAUT, TAM and TRI as the main factors that influence IoT adoption. Although Incorporating UTAUT and TOE factors significantly affect the technical efficiency and success of IoT adoption, researchers have paid little attention to them. The absence of practical applications in HEIs, the immaturity of current research on IoT uptake, and the early attempts to implement widely used models could all be contributing factors. At every stage of adoption planning, implementing, and using—researchers must concentrate on these elements and ascertain how they affect IoT uptake. The anticipated benefits of these elements will raise the degree of IoT adoption.

The study's limitations include the following: the literature review was limited to four electronic databases, focusing only on academic articles and conferences; future research could include more databases and include books, chapters, and industrial reports to broaden the body of knowledge; the review period was time-limited and included specific keywords; future research could extend the period and add more search keyword combinations; and, finally, the findings were based on data analysis.

5. CONCLUSION AND RECOMMENDATIONS

The study aim to investigate factors influencing IoT adoption for e-learning in Sub-Sahara African higher institution. The study conducted systematic review using preferred reporting items for systematic review and meta-analysis protocol (PRISMA) on the previous research conducted over a six-year period. The study is restricted keyword, timeframe and search parameters. To increase the results, it advised that future researchers perform additional literature in reviews in some various developing countries. The finding reveals that the number of articles related to IoT adoption in higher institution is increasing with the majority of the studied were conducted in Asian countries. The majority of studied are quantitative with the (UTAUT) model. Four different important factors and variables of TOE and UTAUT conceptual model which include Technological: Compatibility, Perceive ease of use, Perceive usefulness, Security and Privacy, Organizational: Government Support, Financial Readiness, Training, Innovativeness, Environmental: Efficient Structure, Facilitating conditions and End-user: Performance expectancy, Effort expectancy, Social influence and Hedonic motivation. More conceptual model studies are required in IoT adoption, and more studies are required in the adoption of IoT for e-learning in developing countries.

Mixed method study are required for Sub-Sahara African higher institution since the literature is yet in emerging state. The future studies are required to develop a conceptual model to identify the factors and variables influencing adoption of IoT for e-learning in Sub-Sahara African higher institution, and figure out which factors are more significant in IoT adoption for e-learning in Sub-Sahara African higher institution.

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