

Technological Acceptance (TA) of the Internet of Things (IoT) in Tertiary Institutions in Nigeria

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Abstract - The study aimed to find out the readiness and the competence of academic staff in tertiary institutions to use the Internet of Things in instruction delivery process, as well as to identify the acceptance of students in tertiary institutions to use this technology in the teaching and learning process. A sample size of fifty (50) academic staff and sixty (60) students was used for the study. In the course of this study, the researcher used a self-made questionnaire. The statistical method used in data analysis in this research was the simple mean. A mean value of 2.50 and above on a scale of 5.00 was set as high enough to affirm a particular question in the questionnaire, whereas mean values of less than 2.50 was seen as not enough to affirm such question. The importance of this research lies in the fact that it afforded a background and firsthand information on acceptability and the nature of Internet of things (IoT) that can be implemented in tertiary institutions, in addition to providing decision makers responsible for the educational process with basic information related to the effectiveness of the use of modern technology in education, then developing the educational process in line with modern technologies, and the requirements of the modern era. This study came out with a set of results, the most important of which are that academic staff and students have positive motivations for using internet of things in educational process. The study further recommended that in addition to providing internet of things devices in academic institutions, regular training is a necessity to ensure a complete integration of modern technology in to the teaching and learning process in tertiary institutions.

Keywords: technological acceptance, Internet of Things, tertiary institution.

Introduction

Today's society is evolving from a type where the physical world and the information world are joined into a form where the physical world is subsume into the information network. This can be seen in the decrease of manual effort

exerted in monitoring the environment, gathering data and analyzing such data (Amadin, et al. 2017). Other everyday activities that involves smartness which technology promises to deliver through Internet of Things (IoT) include monitoring products movement, controlling devices in houses, allowing devices send information about their mechanical and physical states to the producers for faster maintenance, products publishing and updating information about their birth and their subsequent response to recent environmental needs.

In a research by Bamigboye & Ademola (2016), IoT is gaining wide awareness and acceptance in several fields specifically due to its practical relevance in everyday life improvement. IoT has found its utility in transportation, banking, environmental monitoring and forecasting, home and office appliances, agriculture, health, security and energy conservation. In another study by Global Standard Initiatives (2015), IoT is said to be network of physical devices, objects, buildings, vehicles and other items which are embedded with electronics, software, sensors and network connectivity which supports these objects to collect and exchange data. IoT on the other hand is the connection of physical things to the internet thereby creating channels to access remote sensor data and control the physical world from a distance (Kopetz, 2011).

With the development of the Internet and the emergence of the fifth generation networks, the applications of the Internet of Things (IoT) have emerged, which led to drastic changes in all institutions, including educational institutions, and a new form of services appeared, and Nigerian universities and colleges began under the funding of Tertiary institutions internal generated revenue (IGR) and the tertiary education trust fund (TetFund) of the National Universities Commissions (NUC), National commission for colleges of education (NCCE) and National Board for Technical Education (NBTE) the establishment of the directorate of information and communication Technology Centre (ICT).

In Cross River State College of Education, Akamkpa, the use of the Internet of Things for administration of the College was initiated with the aim of transforming it into a smart

tertiary institution and applying the idea of a smart building and classroom using cameras connected to the Internet to record activities within the campus and follow-up of students' reactions inside the classroom, and locate unused classrooms, and obtain a report on the extent of exploitation of the places, and college laboratories, however, this project was not nursed to fruition.

Internet of Things (IoT) is a new technology that has the potentials to enable academic staff to manage and control the teaching and learning process seamlessly in an easy and effective way, closely and remotely, and relies primarily on the scenario of interacting things across the internet to provide better services to educational systems, and smart classes based on the Internet of Educational Things cross from. The most prominent educational applications of this technology and the concept of smart classes means an intellectual environment equipped with advanced educational methods based on the latest technologies or smart things (Gul, et al, 2017).

In the works of Alandjani, et al,(2018), the smart object provides ease and comfort for class management, and helps provide a better educational environment, the Internet of Things can be considered a new way to manage classrooms using advanced tools, which help in facilitating tasks and removing barriers. The road ahead is still a difficult and long way for the Internet of Things initiative to achieve more transformations in educational institutions (Gul, et al, 2017). Gul, et al, (2017) listed some tools commonly used internet of things in the classroom to includes: Smart whiteboards, Tablets and Mobile devices, e-books, 3D Printers, Student ID Cards, Temperature Sensors, Security Cameras and Video, Room Temperature Sensors, Electric Lighting and Maintenance, Smart HVAC systems, Attendance Tracking Systems, Wireless door locks.

The Ministry of Education through Nigeria Communication commission (NCC) is currently working to keep pace with technological changes in this era, so the trend has begun towards employing some of these modern technologies in the educational process, the most prominent of which are: the experience of tablets, smart boards, and multi-touch panels, which have become an integral part of the classes study in some tertiary institutions, and it was initiated to prepare interactive digital content for the staff and students, so that the student can download the e-book from the official website of the institution and start the learning experience this category of book is not an ordinary electronic book, but rather an interactive book and a virtual lab. The students can click on the links to view the videos, drag and drop some symbols for conducting scientific experiments, and it also allows more than one student to interact with the content at the same time, thus, students can be partners in the virtual lab (Ali, 2019).

This is in addition to the presence of smart wearable devices such as Google glasses and smart contact lenses, which enable the student to view digital books as a direct broadcast in front of him/her. Virtual Reality (VR) can summarize hundreds of textbooks in a one-hour live experience, however, wearable devices are still an expensive option for some tertiary institutions, so virtual reality applications that require smartphones only appeared as the application of digital pedagogy which uses technology to integrate education and curricula with entertainment through games, pictures and 3D (Ali, 2019).

Although employment of The Internet of Things in education is still vague and unclear, many studies and research indicate that Internet of Things technologies have an important impact in the field of education, as many studies have indicated (Banica, 2017). In a study conducted by Pruet (2015), the study aimed at employing Internet of Things techniques to develop the educational process in primary schools in rural communities in northern Thailand. The results showed that IoT technologies helped provide a personal, rich and interactive learning environment, anytime and anywhere, and also made the learning process more active, through collaborative participation outside the classroom. While the study of (Mershad, 2018) indicated that the Internet of Things improves the management of the educational institution, provides the teacher with various teaching methods, and contributes to improving the process of explaining different concepts by linking the concept with virtual reality technology. In addition to, the study (Al-Aklabi, 2017) which presented one of the most important advantages and benefits of the Internet of Things, especially in the educational information environment, the study indicated that the student's behavior towards the Internet of things is determined by the student's view of this technology, the more they viewed it as easy and uncomplicated, the greater its demand for it and better results. The study also indicated that most students are concerned about espionage (spying), hacking and breaches of privacy. The results of the study (Al-Harbi, 2019) indicated that the Internet of Things facilitates the process of monitoring female students' attendance and monitoring absences, and is useful in determining the location of the student, whether in or outside the class.

Today, IoT is transforming every sector especially the agriculture industry, which enables farmers to contend with the enormous challenges they face, which has resulted in the growing interest in the potential of IoT technologies backing poverty alleviation and uplifting the living standards of the people (Kopetz, 2011). Despite the positive impact and enormous benefits that comes with these technologies, Nigeria still experience some problems in the effective and efficient adoption of these innovations.

Problem Statement

While developed countries have harnessed and adopted IoT innovations in academic institutions, developing countries are not yet fully adapted to its adoption. However, in Nigeria, the impact of IoT is felt in other sectors of the economy such as security, financial institutions and aviation, such impacts are not well felt in academic institutions except on rare cases like during the administration of Joint Admission and Matriculation Board (JAMB) examinations. This paper seeks to investigate the rationale for low acceptability and adoption of the internet of things in Nigeria academic institutions especially tertiary institutions.

The Concept of Internet of Things

Internet of things (IoT) is a term coined by Kevin Ashton in one of his presentations. The term describes a technology of the future based on the Internet and involves sharing of information (Miao et al., 2010). IoT is a revolution in the world of technology and it is now at the fore front in the world of computing and communication. Although developed countries have led the world in ICT use for over two decades, the past decade has seen unprecedented growth in ICT usage by developing countries. The latter now boast the fastest growth in ICT penetration and related productivity growth has surpassed that of developed and transition countries (Lu & Neng, 2010). IoT allows the communication between the things we see around us and does not include human-machine interaction.

Applications of IoT range from various fields from the obvious information technology to saving energy using smart grids (Lu & Neng, 2010). IoT can be considered as an extension of traditional Wireless Sensor Networks (WSN) that makes the object-to-object communication possible by use of Radio Frequency Identification (RFID) technology. RFID enables an object to identify other objects and has long been used as a replacement to barcode. Objects use this technology to identify other objects so that they can connect to each other. This technology also detects objects in real time and provides important information such as location and status (Castellani et al., 2010). IoT is enabled by a robust RFID system.

IoT uses sensors to link the physical and information worlds (Huansheng & Ziou, 2011). The sensors are used to collect data about the surroundings and the data can be analyzed according to different circumstances and factors to bridge the gap (Lu & Neng, 2010). IoT is a technology occurrence that is influencing the current context and will influence the future context. The idea of IoT relates to creating a network of objects that communicates with one another, via the internet, integrating embedded sensors, RFID, GPRS, computers, actuators, mobile phones etc. These objects have

unique addresses that enable them to address and verify their identities, as well as exchange and process information according to defined tasks and send reports to users (Agarwal & Karahanna, 2000).

IoT in Tertiary institutions

The Internet of Things (IoT) - which refers to the interconnectivity of internet-aware devices has transformed tertiary education. With e-learning platforms, teleconferencing, social media chat groups, educative gaming applications, radio frequency identification (RFID) and cloud computing technologies all yielding bigger, better data sets, educational institutions are gaining more visibility into their people and resources (El-Dahshan, 2019). Few educational institutions actively incorporate technology into learning, fewer reach out and connect to each other except for research projects. Massive adoption of technology in education is required so that the power of IoT can be realized and learning can become more authentic and relevant through engagement beyond the classroom (Osisanwo et al. 2016).

Educational authorities and institutions can no longer rely solely on their core competences and teacher knowledge. Instead, they must embrace and not prohibit the devices that learners bring into the classroom and allow students to use them as learning tools to capture intelligence faster and accelerate learning. The proliferation of mobile devices will also enable educational institutions to collect data to interpret a learner's behaviors and activities. Used intelligently, such data will result in personalized learning targeted to individual needs, learning styles, and aspirations. There are myriad uses for technology in education, but many are piecemeal and ad hoc with little informed thinking.

Internet of Things (IoT) has the potential to integrate technology with learning in many ways (Michelle et al, 2013). Higher education programs must ensure that the next generation of engineers understands how to design and build technological systems that reflect our altered expectations of openness and participation. In the area of computer science, the challenge is in developing new forms of scalable education that accommodate large numbers of students around the world, attract potential students with various interests, and deliver an innovative curriculum that reflects the radical changes in computing technology.

Four Pillars of IoT in Education

Brady A. (2014), highlighted four main pillars of IoT in education these includes people, process, data and things.

People: Today, most people connect to the Internet using multiple devices and social networks. It is not yet certain to

predict the channels people will use to connect to the Internet in the future, what is certain is that through such channels, people will be hyper connected. The education sector must comprehend how people connect to the Internet to increase their learning and apply their knowledge as a result. Time to mastery will be key knowledge gained today will be used tomorrow. Those learners who thrive will stay current and ahead of the pack. In the words of Adetoun & Kolawole (2010), there will also be those who know how to “learn, unlearn, and relearn.” Finding the right people with and from whom to learn will be crucial.

Process: Process plays an important role in how people, data, and things work together to deliver value in the connected world of IoT. With the correct process, connections become relevant and value is added because the right information is delivered to the right person, at the right time, in an appropriate way. Ensuring that young people have access to learning opportunities that meet their needs will make education more efficient, improve time to mastery, and motivate learners. Such opportunities will also increase student retention and the application of new knowledge, which is vital for future success in both work and society. Much value can be derived from feedback on a student’s performance. For example, a learner studying computer courses using IoT could observe his or her ranking in real time against all learners studying the same course without the use of IoT. The process could eliminate examinations used to measure and compare learners’ performance and achievement. The model of measurement could be accurate at any moment in time, providing ongoing, targeted, and personalized feedback on what a learner must do to improve his or her understanding and performance.

Data: As things connected to the Internet evolve, they will also become more intelligent, thereby providing more useful information. Rather than just report raw data, connected things will soon send higher-level information back to machines, computers, and people for further evaluation and quicker decision making. The implications of this in education are enormous. For example, as part of their studies, learners could tag physical objects, collect data about those objects, and then feed that information to other programs for analysis, improving the accuracy of their research. Learners could also access data from research initiatives, monitor programs on oceanography or climate change, or watch animals in their natural habitats through live webcams then collect data on their movements through sensors attached to the animals’ bodies. The authenticity of such data will have a huge impact on learners’ interests. Furthermore, collecting data remotely will also help people reduce their carbon footprints through fewer field trips. Research has shown that access to real-time

information and engagement with experts truly impacts learning.

Things: Things are physical items that can be connected to both the Internet and people via sensors. Sensors give things an identity by capturing data, sensors enable things to become context-aware, providing more practical information to help people and machines make relevant and valuable decisions. For example, smart sensors are being used today in bridges to monitor temperature, structural integrity, and traffic density in real time. In this way, students can learn physics using their portable devices to collect and observe the bridge at peak traffic times. Capabilities like these have huge implications for learning and the potential to help transform pedagogical practices.

Technology Acceptance Model (TAM)

TAM theory was developed by Fred Davis in 1989. The model is an information system (consisting, of the network of all information and communication technology channels used within an organization) theory based on theories in social psychology, such as the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB), the TAM has been validated as a powerful and parsimonious framework to explain users adoption of information technology (IT). According to TAM, usage of an information system is determined by user’s intention to use the system, which in turn is determined by users beliefs about the system. There are two kinds of salient beliefs involved: perceived usefulness (PU) and perceived ease of use (PEOU) of the system. The theory stated that, if a user perceives a specific technology as useful, he/she will believe in a positive use-performance relationship. Since effort is a finite resource, a user is likely to accept an application when he/she perceives it as easier to use than another. As a consequence, organizational technology with a high level of PU and PEOU is more likely to induce positive perceptions. The relation between PU and PEOU is that: PU mediates the effect of PEOU on attitude and intended use. In other words while PU has direct impacts on attitude and use, PEOU influences attitudes and use indirectly through PU. User acceptance is defined as the demonstrable willingness within a user group to employ information and communication technology for the tasks it is designed to support (Adetoun, & Kolawole, 2010).

In view of Internet of Things (IoTs) in education, TAM suggests that if users (Lecturers and students) formulate a positive attitude towards the technology when they perceived the technology to be useful and easy to use, then the technology will be adopted (Osisanwo, F. et al. 2016). Scholarly research on IoTs acceptance and usage in tertiary institutions suggested that TAM has emerged as one of the

most influential models in this stream of research. TAM gives deep understanding of importance of theoretical contribution towards IoTs integration and acceptance behaviour in tertiary institutions. TAM also revealed the factors that influence ones attitudes acceptability or otherwise of a particular technology to include: Perceived usefulness and Perceived ease-of-use. To this end, IoT when applied to tertiary education will stand the test of time going with the postulation of TAM adoption of IoT in tertiary education. Figure 1 below illustrates the various components of the technological acceptance model (TAM) as proposed by Davis F. (1989).

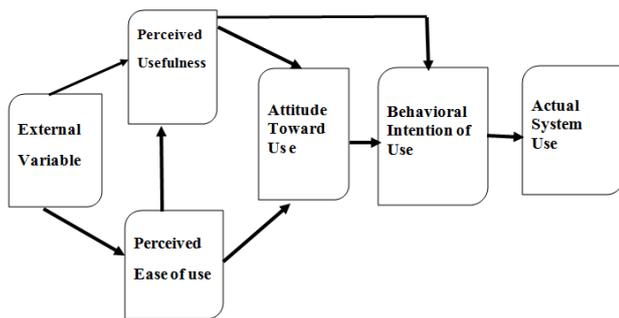


Figure 1: Illustration of the Technology Acceptance Model (Davis, F. 1989). (Redrawn by Author)

Methodology

The researcher was convinced that conducting a research of this nature at this modern age is imperative. So this study aimed to Identify the motivation of academic staff, and the extent of their qualification to use these innovative techniques in the educational process and assessing the problems that face them as a cornerstone in the entire educational system. The study also aimed to evaluate the extent of acceptance of students to use these technologies. The research problem was formulated in the following questions:

Research question 1:

What is the level of awareness of IoT among lecturers’ academic institutions?

Research question 2:

To what extend are academic staff qualified and ready to use IoT devices and technologies for teaching?

Research question 3:

What is the extent of acceptance of students to use the Internet of Things (IoT) in the learning process?

Sample: The study was conducted in two tertiary institutions in Cross River State: Cross River state college of Education, Akamkpa and Cross River State College of Health

Technology, Calabar. The sample size consists of fifty (50) academic staff and sixty (60) students. These institutions were used because of proximity and the ongoing strike by the Academic Staff Union of Universities (ASUU) as at the time of this research.

Data collection, and data collection tools: In this study, an academic staff questionnaire and a student questionnaire was prepared by the researcher. The questionnaires included demographic variables and five-point Likert scale elements on the use of the Internet of Things in academic institutions.

Data Analysis: The questionnaire for academic staff consists of ten (10) items, and the questionnaire for students consists of six (6) items. Response scores were distributed on these questionnaires according to the Likert five point scale measure as shown in the following table:

Table 1: Likert five point scale

Options	Completely Agreed	Agreed	Partly Agreed	Disagreed	Completely Disagreed
Scale	5	4	3	2	1

One hundred (100) research questionnaires were administered and collected. Using mean score of 2.5 and above as accepted and below 2.5 as rejected.

Results

The following tables show the response of individuals in the sample according to their choices.

Table 2: Assessment of the Level of awareness of IoT among academic staff

Item No.	Item	Mean	Level	Decision
1	I have a fair knowledge on the concepts of IoT	1.74	Very low	Rejected
2	The institution had organized training on the use of IoT for teaching	1.42	Very low	Rejected
3	IoT is a common paradigm on modern day instructional delivery	2.14	Low	Rejected
4	Apart from this institution, I have gotten some exposure on the usage of IoT, not necessarily on teaching	1.52	Very low	Rejected
5	IoT devices though pervasive in nature are easily noticed and identified.	2.23	Low	Rejected
6	The ubiquitous nature of IoT devices makes	2.44	Moderate	Rejected

it more appealing to be adapted and adopted in academic institutions			
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This research question examined the level of awareness of among academic staff on Internet of Things technologies. The research question was tested with responses to items 1, 2, 3, 4, 5 and 6 in the academic staff questionnaire. From table 2 above it was observed that item 2 and item 4 has the least mean value. This implies that apart from poor level of awareness on the academic staff on IoT, the institutional awareness on this technology is also poor. Thus, from the responses, it can be deduced that the level of IoT awareness is very low. In other words, they do not have ample knowledge on the usage of internet of things (IoT). Hence, ways on how to improve the awareness level should be adopted to enhance IoT acceptance for a better academic achievement and instruction delivery.

Table 3: Qualifications and readiness of academic staff for using IoT devices and technologies for teaching

Item No.	Item	Mean	Level	Decision
7	The in-service workshop organized by the institution aided me to utilize modern technology for instruction delivery effectively.	1.72	Low	Rejected
8	More training is needed in IoT to enable me use IoT technologies for instruction delivery.	4.34	Very high	Accepted
9	I have the competence to assist my colleagues who have no experience dealing with technologies.	1.96	Low	Rejected
10	I resort to technical support in the ICT unit when any technical failure ensues in the course of using electronic devices even if it appears simple.	4.79	Very high	Accepted

The results of the arithmetic mean for table 3 show that though academic staff lacks the basic requirements and qualifications for the usage of internet of things in instruction delivery, they exhibit high level of readiness in the usage of this technology in the instruction delivery process

Table 4: The extent of acceptance of students to use the Internet of Things (IoT) in the learning process

Item No.	Item	Mean	Level	Decision
1	ICT reduces my	4.50	Very	Accepted

	dependence on constant use of printed materials which improves my study.		high	
2	Receiving lectures through IoT is interesting and exciting.	4.00	Very high	Accepted
3	IoT delivers new synergies for collaborating, communication and cooperation among colleagues.	3.80	High	Accepted
4	IoT mitigates the stress associated with the conventional classroom to classroom movement of the traditional teaching and learning process.	3.75	High	Accepted
5	IoT provides an environment to display study materials in different format which has greatly enhanced learning among students.	3.22	Moderate	Accepted
6	The use of IoT provides and easy interaction between students and lecturers, this has greatly enhanced a more conducive environment for learning.	3.95	Very high	Accepted

The results of the students' questionnaire show that the arithmetic mean of all items ranges between (3.22 - 4.50). From this result, it can explain that sample students have high desire to use the Internet of Things in the educational process and keep pace with the digital age. Hence, there is a need for academic and students to be train on the usage of the internet of things in all educational institutions.

Discussion of Results

The results obtained from research question one (1) showed that majority of academic staff are not aware of the existence of IoT Innovations based on the response of the sample respondents. This is in agreement with a study conducted earlier by Csotos et al., (1998) as cited by Amadin et al., (2017) where academic staff are oblivious of the numerous kinds of technology provided for them. This poor awareness has created many misconceptions on the true value of this technology. However, Technology Awareness is very important for a technology. Knowledge provides the technology users with the ability to comprehend the need for a new technology and this would eventually promote compliance (Saad, 2010). The initial step towards instilling knowledge is to create awareness. Increased awareness of new

innovation initiative is essential to gain public acceptance and confidence (Noor et al., 2014). Thus, it is ideal to educate the users on what they are to expect from the new innovations, in order to increase their levels of use of the technology. In a research conducted by Yara (2009) and Davis (1989) it was postulated that the attitude of a user toward an innovation was a major factor in determining whether the user will actually use or reject the innovation. This present study revealed that the academic staff has good perception towards IoT innovations; as they indicated that such innovations would lead to better instruction delivery. They also advocated that IoT innovation will make it possible to execute certain activities in a more convenient manner. The results from research questions two and three indicates that majority of the academic staff lack the basic qualifications and experiences to use the internet of things in the classroom. On the part of the students the enthusiasm to use the internet of things for learning is quite high.

Conclusion

The evolving paradigm of the Internet of Things (IoT) is rapidly finding its path throughout our modern life, aiming to improve the quality of life by connecting several smart devices, applications, and technologies. Generally, the IoT would allow for the automation of everything around us. Though it is still relatively a new technology, its power will rise with increased acceptance which will culminate in more stakeholders' involvement and more contribution towards their success. This research review the concept of this technology, level of awareness, users' perception and possible impact of IoT in academic institutions.

Recommendations

Based on the findings of this study, the following recommendations were made:

- i. The use of the Internet of Things in academic institutions should be encouraged.
- ii. Regular training of academic staff and students on the use of internet of things should be given higher priority.
- iii. More funding should be channel towards Internet of Things projects in academic institutions.
- iv. Some students continuous assessment should be administer using the internet of things technology.

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