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Internet of Things (IoT): Implications of a Wide Scale Use in Nigeria

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ABSTRACT

The research focus on Internet of things (IoT) innovations as it applies to the needs identified in the nation Nigeria and towards the upliftment of the living standards of the people. IoT is a new innovation that is gaining wide awareness and acceptance in several fields due to its practical relevance in everyday life improvement. However, its impact is not conspicuously evident in Nigeria. This might be probably traced to low level of awareness, illiteracy, poverty, insufficiency or lack of facilitating condition. In a bid to enhance public knowledge and acceptance of IoT, a survey was carried out to ascertain people's perception on IoT as regards to envisaged economic, social and ethical effects it will have on Nigeria society. Findings reveal that IoT will be highly accepted and appreciated when fully adopted in Nigeria. Based on the findings, Approaches on how to improve the level of awareness and adoption were recommended.

Keywords – *internet of things, smart objects, ambient intelligence, pervasive computing.*

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1. 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 integrated into the information network. This can be seen in the reduction of manual effort exerted in monitoring the environment, gathering data and analyzing such data. 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 study by Bamigboye and Ademola (2016), IoT is gaining wide awareness and acceptance in several fields due to its practical relevance in everyday life improvement. IoT has found its utility in transportation, 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).

Meanwhile, IoT allows objects to be sensed and controlled remotely across existing network infrastructure, thereby creating chances for more-direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. However, any object which is capable of identifying, connecting and communicating with other objects is an example of Internet of Things (Santucci, 2011; Reddy, 2014). Also, parents can track their children even in the busiest of crowds without the fear of losing them with the introduction of location sensors and communication modules sewn into their clothes. Similar devices attached to timetables and signposts could direct blind people in unknown environments by talking to them via a wireless headset (Coroama, 2003). However, overcoming the gap between objects in the physical world and their representation in information systems is one of its major function of IoT (Weber and Weber, 2010).

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. In a bid to enhance public knowledge and acceptance of IoT, a survey was carried out to ascertain people's perception on IoT as regards to envisaged economic, social and ethical effects it will have on Nigeria society at large.

1.2 Problem Statement

While developed countries have harnessed and adopted IoT innovations, developing countries are not yet fully adapted to its adoption with much work to revolutionize it. However, in Nigeria, the impact of IoT is not conspicuously evident. This might be probably traced to low level of awareness, illiteracy, poverty, insufficiency or lack of facilitating condition most especially in the rural area where its need is more pronounced. In order to respond to the needs of the rural communities, and narrow the digital divide between urban and rural areas, provision should be made to increase their level of awareness as well as facilitate the adoption of IoT innovations to boost the nation's security, economic status and development (Bamigboye and Ademola, 2016).

2. BACKGROUND OF STUDY

2.1 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. 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 and 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 and 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 and 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. According to Internet of Things Global Standards Initiative (IoTGSI) 2015, the Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems resulting in improved efficiency, accuracy and economic benefit (Howard, 2015). 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 and Karahanna, 2000).

2.2 Features of Internet of Things Technologies

a. **Scalability**: Experts estimate that the IoT will consist of almost 50 billion objects by 2020 and is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) covering a variety of protocols, domains, and applications (Holler et al., 2014). The interconnection of embedded devices is expected to usher in automation in nearly all fields, while also enabling advanced applications like a Smart Grid (Monnier, 2013) and expanding to areas such as Smart city.
b. **Intelligent Devices**: Things in the IoT can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, or field operation devices that assist fire-fighters in search and rescue (Wigmore, 2014). These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices (Farooq et al., 2015). Current market examples include: Smart thermostat systems and washer/dryers that utilize Wi-Fi for remote monitoring.
c. **Data Generation**: IoT is expected to generate large amounts of data from diverse locations that is aggregated very quickly, thereby increasing the need to better index, store and process such data.
d. **Protocols and Access technology**: The access technologies used in IoT are massage queuing telemetric transport (MQTT) used for collecting data and delivering it to the server, extensible messaging and presence protocol (XMPP), data distribution service (DDS) and advanced massage queuing distribution protocol (AMQP) and (coAP). These

protocols goes a long way in maintaining quality of service (QoS) were reliability is the key issue. Short-range wireless technologies that consume low power are popular with IoT.

e. **Complex system**: In semi-open or closed loops (i.e. value chains, whenever a global finality can be settled) it will therefore be considered and studied as a Complex system (Gautier and Gonzalez, 2011) due to the huge number of different links and interactions between autonomous actors, and its capacity to integrate new actors. At the overall stage (full open loop) it will likely be seen as a chaotic environment (since systems have always finality).

2.3 How Internet of Things Differs from the Contemporary

According to Daniel and Jordan (2013), the Internet now is no longer used as a communication medium between people using computers instead it will be used in IoT to enable the communication between various devices. The major differences between both of them are:

a. IoT will have more interconnected devices. 8 billion devices are expected to be connected by 2020 and the current Internet may not be able to handle it. IoT will be using the existing infrastructure as part of its connectivity.
b. IoT is more scalable than the internet. This is a significant difference between the two although the current Internet will be able to handle them by a few protocol changes like using IPv6 instead of IPv4.
c. Devices used in IoT will have intelligence embedded in them and may not use the same protocols used now.
d. The access technologies used in IoT are short-range wireless technologies that consume low power.
e. The applications in IoT will be more interactive, user friendly and require less intervention from the user.

2.4 IOT Applications

The IoT solutions in each of its classes (smart wearable, smart homes, smart environments, smart enterprises, smart things and smart city) have different characteristics (Perera et al., 2015). The products can be characterized based on the industries that they find application. These industries can be: Agriculture, Media, Environmental Monitoring, Infrastructural Management, Manufacturing, Energy Management, Building and Home Automation, Transportation, Medical and Healthcare. Several researchers addressed the use of IoT in agriculture to enhance the different agricultural processes. Some also emphasize mostly the use of cloud-enabled systems to show the relationship between the information cloud and IoT from the view point of agricultural data and its use cases. They argue that the intelligent agriculture is one of the applications of Internet of Things (IoT), which has an extensive application and bright future.

Also, to prevent stock theft, animals are fitted with radio frequency identifiers (RFIDs) that enable tracking of the animal. The position of the animal can be visualised on a map in a control centre through data remitted wirelessly. In rural areas where there is communal grazing, animals tend to get lost. Livestock are fitted with radio-frequency identifiers (RFID) chips and RFID readers are placed at various monitoring spots to transmit information to an agricultural extension services centre. The position of the animal can be queried. Likewise, Weather forecasting can be done through analysis of weather data over long periods to reduce agricultural risk. This is referred to as big data analysis. In weather forecasts for pest management, humidity, precipitation, crop type, soil fertility, leaf wetness, temperature, winds and soil moisture are collected at local level through sensors. The life cycle of pests is monitored along with the climate data, allowing researchers to predict pest outbreaks more accurately because pest maturation depends on environmental conditions (Dlodlo and Kalezhi, 2015).

3. METHODOLOGY

The Objectives being pursued in this research include:

(i) Exposed the concept of Internet of Things (IoT).
(ii) Show how IoT differs from the contemporary.
(iii) Show the level of awareness of IoT innovation among University's Staff and Students.
(iv) Ascertain the University Staff and students' perception on IoT.
(v) Exposed the benefits of IoT Innovation on people, organizations and society.

100 research questionnaires were administered and collected. Using frequency count and Percentage score, the study aimed at obtaining useful insights about the existing and future exploitation opportunities of the Internet of Things (IoT) evolution in Nigeria. Specifically, the questionnaire is targeted at University's staff and students from selected faculties of the University of Benin, Benin City, Nigeria. The questionnaire consisted of two sections. Part A consisted of demographic information like faculty name, age, gender and academic level. Part B comprised of the questions formulated by the researchers with respect to IoT. The IoT questions in Part B were sub divided into four sub categories. They were Awareness of IoT, Application of IoT, Enabling Computing Technologies, and Impact of IoT are all measured using 5, 6, 5, 8 items respectively. A five point Likert scale, ranging from 1 (strongly disagree), 2 (agree), 3 (Undecided), 4 (disagree) and 5 (strongly agree) were used to measure the responses of each of the construct by the survey participants. The research instrument was validated and found to be valid and reliable.

These findings will be used to answer the three research questions raised:
RQ_1: What is the level of awareness of IoT among university staff and Students?
RQ_2: What is the perception of University Staff and students on IoT technologies?
RQ_3: Is there any impact of IoT on people, organizations and society at large?

4. RESULTS AND DISCUSSION

4.1 Data Analysis and Result

Table 1 shows the demographic data of the respondents which comprise of one hundred University staff and students selected from five faculties of the University of Benin in Nigeria. Based on Table 1, 45.0% of the sample respondents are male whereas 55.0% of the sampled respondents female. This implies that the distribution covered more female respondents than male respondents. More so, Majority of the respondents were University students totaling to 75 participants (75.0%) while University Staff participants were 25 (25.0%). Out of the 100 respondents, the majority (65.0%) falls within the age group 16-35, while 35.0% are more than 35 years, which means that majority of respondents are young. it is also shown that 20% of the respondents were selected from each of the above mentioned faculties.

Table 1: Demographic Data of Respondents

Character	Group	Frequency	Percent (%)	Cumulative Percent (%)
Class of Respondents	Student	75	75.0	75.0
	Lecturer	25	25.0	100.0
	Total	100	100.0	
Gender	Male	47	47.0	47.0
	Female	53	53.0	100.0
	Total	100	100.0	
Age	16-25	30	30.0	30.0
	26-35	35	35.0	65.0
	36-45	25	25.0	90.0
	46-Above	10	10.0	100.0
	Total	100	100.0	
Faculty	Basic Medical Science	20	20.0	20.0
	Education	20	20.0	40.0
	Life Sciences	20	20.0	60.0
	Physical Sciences	20	20.0	80.0
	Social Sciences	20	20.0	100.0
	Total	100	100.0	

Research Question One:
What is the level of awareness of IoT among university staff and Students?
This research question examined the level of awareness of University staff and students on Internet of Things technologies. The research question was tested with responses to items 1,2,3,4 and 5 in the students' questionnaire. The summary of data is stated in the table 2. It was observed that 28.0% were undecided, 42.0% of respondents disagreed of the existence of IoT in their physical environment, while 30.0% of respondents agreed with the opinion. 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 of the information technology. Hence, ways on how to improve the awareness level should be adopted to enhance IoT acceptance for a better achievement.

Research Question Two
What is the perception of University Staff and students on IoT technologies?
The result presented in Table 3 revealed the perception of University staff and students towards IoT technologies. The respondents tend to agree with most of the issues raised about their perception towards IoT as evidenced by the percentage score above the 50.0% as the decision point which shows positive perception towards IoT. This is an indication that the university staff and students did not consider the introduction of IoT technologies a bad idea. As a result, their low level of acceptance can be attributed to their low awareness level.

Research Question Three:
Is there any impact of IoT on people, organizations and society at large?

The result presented in Table 4 revealed the possible impact of IoT towards Agriculture, Transport, Power, Security and Health sectors. The respondents tend to agree with most of the issues raised about the possible expectations as evidenced by the percentage score above the 50.0% as the decision point which shows positive impact of IoT towards the above mentioned sectors except for security sector where percentage score is below 50.0%. This is an indication that majority of the respondents believes that equitable adoption of IoT technologies will greatly improve the living standard of the people.

Table 2: Level of IoT Awareness

Variable	**Agreed** (Positive response)		**Disagreed** (Negative response)		**Undecided** (No response)		**Total (%)**
	Number	**Percentage (%)**	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**	
IoT Awareness	30	30.0%	42	42.0%	28	28.0%	100%

Table 3: Perception of IoT Technologies

Variable	**Agreed** (Positive response)		**Disagreed** (Negative response)		**Undecided** (No response)		**Total (%)**
	Number	**Percentage (%)**	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**	
IoT Perception	60	60.0%	30	30.0%	10	10.0%	100%

Table 4: Possible Impact of IoT Technologies

Variables	Agreed (Positive response)		Disagreed (Negative response)		Undecided (No response)		Total (%)
IoT impact:	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	
Agriculture	74	74.0%	14	14.0%	12	12.0%	100%
Transport	52	52.0%	40	40.0%	8	8.0%	100%
Power	64	64.0%	26	26.0%	10	10.0%	100%
Security	46	46.0%	46	46.0%	8	8.0%	100%
Health	64	64.0%	24	24.0%	12	12.0%	100%

4.2 Discussion

The results obtained question one showed that the university staff and students are not aware of the existence of IoT Innovations based on the response of the respondents. This is in agreement with a study conducted earlier by Csotos et al., (1998) where the citizens indicated that they are not aware of 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 first step towards inculcating 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 paramount 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.

Moreover, just like the earlier studies conducted by Yara (2009) and Davis (1989) hypothesized 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 university staff and students have good perception towards IoT innovations; as they indicated that such innovations would lead to a global village. They also advocated that IoT innovation will make it possible to execute certain activities in a more convenient manner. Furthermore, several researchers addressed the use of IoT in different sectors including agricultural sector to enhance their different processes/activities, this study also indicated that majority of the respondents believes that that equitable adoption of IoT technologies will greatly improve the mode of operation of various sectors, most especially, in the agricultural sector. While success depends on the ability to adapt quickly to emerging market trends, enterprises that are staying ahead of the IoT adoption curve are poised to reap major benefits such as: Improved process efficiencies; Improved asset Utilization; Improved Productivity; Improved financial management; and Improved customer relationships. This is to say that IoT innovation is poised to bring about revolutionary changes in how organizations address business challenges.

5. CONCLUSION

The emerging idea 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. Overall, the IoT would allow for the automation of everything around us. Although it is still relatively a new technology, its power will increase with increased acceptance which will result in more stakeholders' involvement and more contribution towards their success. This research presented an overview of this concept, level of awareness, users' perception and possible impact of IoT on people, organizations and society at large.

6. SUGGESTION FOR FURTHER RESEARCH

In order to realize the full potential of IoT, it is paramount for researchers to find ways to educate users on what they are to expect from the new innovations, in order to increase their levels of acceptance of the innovation.

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