Internet of Things: The Present Status, Future Impacts and Challenges in Nigerian Agriculture

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Abstract. The present study considered the current state of internet of things in Nigeria, future prospects and challenges to the usage of the technology in Nigerian Agriculture. In Nigeria, IoT has been used to dispense feed and water to chicks, virtual fences for monitoring farmlands and forest trees, cashless sales and purchases of farm produce and input, monitoring and management of staff performances on the farm and e-wallet for input, loan and information accessibility on agricultural issues. However, there is room for improvement in the area of security for the animals (animal tracking), weather forecasting and real-time soil monitoring, livestock and crop health surveillance. Challenges faced in the usage of IoT in Nigeria are inadequate/lack of capital, skilled manpower, facilities. In conclusion, IoT has great potentials to move Nigerian agriculture to an enviable position.

Keywords: IoT, Nigerian agriculture, prospects of IoT, status of IoT

1   Introduction

Internet of Things (IoT) is a recent technology that is gaining widespread 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 [Bamigboye and Ademola, 2016]. In Nigeria, agriculture serves as one of the main resources for income generation for individuals, private and public organisations. However, agriculture in Nigeria as an enterprise and food security outlets for her populace is still backward in the use of IoT. Internet of Things has the potential to improve, enhance and absolutely change the face of Nigerian agriculture to a world-class standard.

Internet of Things (IoT) is the network of physical objects, devices, vehicles, buildings and other items which are embedded with electronics, software, sensors and network connectivity which enables these objects to collect and exchange data [GSI, 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, and resulting in improved efficiency, accuracy and economic benefit. IoT is any object which is capable of identifying, connecting and communicating with other objects [Santucci, 2011] [LOPEZ Research Series, 2013] [Reddy, 2014].

Agriculture is a profit-driven oriented business; hence, factors that influence the profitability of a farm are of great paramount and interest to the farmer. IoT can be made relevant if it can address the general needs of a locality, be made available and affordable, easy to use and packaged in the local/indigenous languages. With intensification of crop/ livestock production systems and increased market demand of animal based products, the importance of information is growing in many developing countries [Morton and Matthewman, 1996]. Hence, there is need for continual exchange of information and data, decoding and interpretation as well as actions taken to achieve desired success.

[Sasidhar and Sharma, 2006] have emphasised that the use of Information and Communication Technology (ICT) has potential to change the economy of livestock, agriculture, and rural artisans in India. [Tiwari *et al,* 2010] argued that the livestock sector should come up with need based, location specific and local language contents in the form of computer software and other electronic material in regards to livestock disease control, dairy herd management, livestock production and for marketing of livestock and livestock produce. ICT based information delivery to livestock sector can significantly improve the quality of decision-making in livestock farming system. In this process of structural change and potential growth in high value products [Gulati *et al,* 2007], ICT based livestock advisory services for knowledge dissemination to the farming communities for better and informed decision-making at the farm level, have become essential.

Nigeria has witnessed a great deal of set-back due to corruption at all levels in every sector; agriculture inclusive. IoT in form of E-wallet was employed to address agricultural inputs and services corruption. Most times, subsidized inputs do not get to the practicing farmers but are rather lost in transit to the rich and influential few that repack and sell at exorbitant prices.

2 Present status of Internet of Things in Nigerian Agriculture

In Nigeria, the Internet of Things is just becoming popular in all facets of life. However, its usage in agriculture is still backward. Mostly, IoT usage in agriculture is believed to be only profitable to large-scale farmers. But very few farmers in Nigeria practiced large-scale farming. Hence, most farmers have not seen the need for its usage on their farms.

2.1 Mobile feed and water dispensing system

Feeding of poultry birds is a major task that is time-consuming and labour-demanding. Its efficiency also can determine the profitability of a poultry farm. In Nigeria, feed

dispensing methods working based on IoT were developed by researchers. In [Arulogun *et al*, 2010] a mobile intelligent poultry feed dispensing system was developed. The system was able to move, detect and avoid obstructions and dispense solid feed to poultry birds. However, [Olaniyi *et al*, 2014] designed a mobile intelligent poultry feed and water dispensing system; using fuzzy logic control technique.

This unit was responsible for dispensing solid feed to the poultry birds. It comprises of a solid feed trough, a 12V DC motor connected to a conveyor and a feeder. The solid feed trough is expected to be filled with the appropriate solid feed to be administered to the birds. A feed sensing unit which comprises of a light dependent resistor checks the feed level and in turn determines if there is a need to dispense the feed or not. The microcontroller will then send a signal through the PID controller to the DC motor which will enable it to rotate. The rotation of the DC motor will in turn rotate the conveyor which will result in the dispensing of the solid feed to the feeder. The poultry birds feed from the feeder after feed is dispensed to the feeder for the pre-defined time determined by the microcontroller. A relay circuit is connected between the microcontroller and the DC motor so as to enable proper functionality of the system [Olaniyi *et al*, 2016].

2.2 Virtual fences

The use of virtual fences to monitor the perimeters of large farmlands and plantations is of tremendous advantage. The most obvious is in terms of cost savings when compared to building high brick fences and employing security personnel to patrol the entire perimeter. With virtual fences, relatively cheap modules can be installed and the entire perimeter monitored remotely [Ajayi and Olaifa, 2016].

The Nigerian Satellite Company Limited, has successfully designed, implemented, tested and deployed an RFID-based Staff Attendance and Access Control System (RFID-SAACS). RFID-SAACS is a vital tool for staff management, administration, and monitoring that impacts staff's attitude to work, as time theft by staff is completely eliminated. The logged data can also serve as a means of staff monthly appraisal, while an additional utilisation of the RFID-SAACS system includes integration into the payroll system to facilitate precise salary computation and payment based upon vetting of employees' overall performance [N.C.S.L., 2015]. This is used in some automated farms in Nigeria.

Also, the use of point-of-sale (PoS) terminals for the purchase of farm produce to achieve cashless transactions is now common in Nigeria. A PoS terminal is an electronic device that is used for verifying and processing credit/debit card transactions, which transmits data over a standard telephone line or an Internet connection. The Nigeria Interbank Settlement Services (NIBSS) had observed in its recent report that PoS is the most popular non-cash payment channel, preferred among the non-cash payment options by 93.6 % of merchants and 35.8 % of consumer usage. It described the usage of card and PoS as fair, with an average of three to four out of every 10 customers requesting to pay for transactions by card/PoS [Adeoye, 2015]. Electronic payment through PoS terminals has risen by 191 % to N241 billion in 2014 [Komolafe, 2014].

Furthermore, as part of an ambitious strategy to transform agriculture, the Growth Enhancement Support (GES) initiative, introduced in 2012, farmers' cellphones as electronic wallets – distributing vouchers amounting to a 50% subsidy for purchase of fertilizer. Ministry officials say the phones could eventually be used for multiple purposes, from communicating weather and climate information to accessing market data. Experiences in other African countries showed that such uses can deliver higher prices to farmers. Records also show that 1.2 million farmers received their subsidized fertilizer and seeds through cellphone vouchers in 2013, resulting in the addition of 8.1 million metric tons to Nigeria's domestic food supply. As a result, Nigeria reduced its food imports by over 40 % by 2013, moving the country closer to self-sufficiency in agriculture [Hultman, 2015].

3   Future prospects of IoT in Nigerian agriculture

Effective tracking of nomadic cattle-grazing and movements enabled by smart tracking devices would greatly minimize the number of community clashes between nomadic herdsmen and the settled rural farming communities. This would go a long way to help settle the persisting conflict and communal disputes, tensions, which most often degenerate into communal wars between the people [Ume and Haruna, 2018]. Indiscriminate killings and destruction of properties in the recent time by Fulani cattle herders can be tracked and curbed. Animal theft can be drastically reduced to the minimum.

Since rural communities are sparsely populated, transportation of farm products can be a problem. IoT technologies can empower the transporters by providing them with information of farmers who require transport. Therefore transporters do not need to wait until they have a full truck load of farm products to start off, they can leave any time provided they are aware that there are farmers waiting for transport ahead [Bamigboye and Ademola, 2016].

Furthermore, farm workers can receive real-time notifications from farm machinery equipped with wireless sensors as issues arise. The ability to perform preventative maintenance and repair issues immediately could lead to tremendous cost savings in decreasing down time and protecting valuable assets [Farrell, 2015]. The health of farm animals such as cattle or chicken can be monitored to detect potential signs of disease. This can be linked to a central system which can trigger relevant advice to be sent to farmers, and contribute towards analytics that can be used to identify any outbreaks or trends [Farrell, 2015].

Through the use of Near-Field Communications (NFC), the farmers and buyers can benefit from paperless transactions and this helps minimize on theft and fraud. Similarly this is beneficial to rural farmers who have no access to banks within a reasonable distance to deposit cash from purchases or withdraw cash to buy farming inputs. The use of livestock or crop smart health cards which store information related to affected livestock or crops can be beneficial to both the veterinary or agriculture officer and the farmers in Nigeria. This can lead to efficient and effective diagnosis and prescription of medicine since the officer has access to all the historic information of the affected livestock or crop. If satellite transmission is made available in the deep rural area, this

has the potential to create jobs for local businesses who could offer low-cost solutions, access and wireless network services cheaper to the communities. Satellite transmission can also enable farmers in rural areas obtain information on markets for their products and prices, government services that they can access, and their rights. The system can also connect to government departments and local and international markets. With the introduction of the mobile internet and low-cost sensors, farmers could interact directly with consumers and cutting off middlemen who usually exploit them. This is beneficial to farmers because they can make better profits on their products [Haas *et al*, 2011].

4   Challenges of IoT in Nigerian agriculture

Inadequate skill manpower
The biggest challenge faced in the usage of IoT solutions in Nigeria is inadequate skilled manpower. Most farmers are found in the rural areas and are mostly unskilled and uninformed in terms of IoT. Adult literacy should be intensified to bring to lime-light the usage and usefulness of IoT to rural farmers in Nigeria. Also, training of farm-ers' children to integrate the household into IoT application usage will further enhance continuity

Inadequate facilities
Internet of Things requires a lot of equipment; software and hardware for proper func-tioning. Without power supply, continual usage of IoT is impaired. However, in the rural area where agriculture is most pronounced and prominent in Nigeria, constant supply of electricity is not guaranteed. Hence, efforts should be made towards the pro-vision of stable and constant power supply. This may be generated from solar, biogas or water which can be obtained even at the rural level.

Insufficient start-up capital
The initial cost of setting up an IoT compliant farm can prove to be a barrier to many small-scale farmers. The cost of importing some of the existing IoT-sensors is still rel-atively high. Inadequate/lack of access to source of internet has created a great setback for farmers to afford IoT. However, the cost of purchasing mobile data for continuous monitoring and storage either to cloud or remote centres for analysis is also expensive. However, in recent times, Nigerian Communications commission (NCC) is making ef-forts to improve data rates and supply in Nigeria. The Government also should support the farmers to make internet available even in the remote villages where they are mostly found.

Meager sponsorships from corporate organizations
Most support goes to entertainment- music and comedy rather than education, agricul-tural research and innovation in Nigeria.

6

Lack of collaboration among tech hubs

At present in Nigeria, technology hubs operate solo. As a result of this, innovations developed in one technology hub rarely diffuse to the rest of the country. This is slowing down innovation adoption and circulation in Nigeria. Co-operation and unity should be encouraged among tech hubs.

5   Conclusion

Internet of Things in Nigeria is still at the formative stage. However, future prospects were identified. Nevertheless, the sustainability of IoT in the country is being faced with some challenges.

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