Finding the Productivity of Implementing IoT in Malawi and improve the usage of IoT devices to enhance nation Building: A survey

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Abstract

The Internet of Things (IoT) is a contemporary technology in today's world by grabbing the industries, home and, research consideration with a firm stride. According to the research, the average number of IoT devices per household will be 50 million in this era. The evolution of IoT will make the existing household devices to be hoary and now it's a good time to create IoT devices to be affordable for daily use by the survivors across the world. This research is to find out the productivity of implementing IoT and to avoid disturbing existing network architecture and the software Define Network (SDN) in the underdeveloped country like Malawi and the usage of IoT devices in every household, offices and in agriculture to enhance the development of Country.

Keywords: IoT, household devices, Malawi, automation, smart agriculture

1. Introduction

The Internet of Things (IoT) is a contemporary technology in today's world by grabbing the industries, home and, research consideration with a firm stride. This research is to find out the productivity of implementing IoT and to avoid disturbing existing network architecture and the software Define Network (SDN) in the underdeveloped country like Malawi and the usage of IoT devices in every household, offices and in agriculture to enhance the development of Country. Malawi, landlocked country in south-eastern Africa.

Most of Malawi's population engages in cash-crop and subsistence agriculture. The backbone of the Malawi economy is agriculture, since the mid-1960s the government has sought to strengthen the agricultural sector by encouraging integrated land use, higher crop yields, and irrigation schemes. Lake Malawi is the fifth largest fresh water lake in the world and it provides enough water to the irrigation mechanism also Shire River is the largest river in Malawi and it provides sufficient support to the irrigation mechanism.

1.1 IoT

IoT devices are physical objects with the ability to connect and exchange data with other devices over the internet [3]. IoT devices can range from small household things to advanced industrial tools. A light that can be operated using a smartphone application is an IoT device. Some larger objects such as jet engine have many smaller IoT devices for collecting and transmitting data to make sure it is operating efficiently. IoT extends internet connectivity beyond standard devices like desktop, smartphones etc, to any range of non-internet enabled devices and everyday objects.

The term Internet of Things or 'IoT' was first formed by Kevin Ashton in 1999. At the beginning of 21st century, the term Internet of Things started to give global momentum. Elevators, airplanes and missile systems are some examples of early machines that connected to IoT in life changing ways.

1.1.1 IoT Components

a) Smart Devices and Sensors

Sensors continuously collect data from the environment and transmit the information to the next layer, latest techniques in the semiconductor technology is capable of producing micro smart sensor for various applications, and common sensors are:

- Light Intensity Detector

- Pressure Sensor

- Moisture Sensor [9]

- Proximity detector

- RFID Tags

b) Gateway

IoT has the ability of bidirectional data transfer between different network and protocols, it performs pre-processing of collected data from thousands of sensors before transmitting it to the next stage. It offers certain level of Security

c) Cloud

Cloud is basically a set of servers connected to internet, once the data has been collected and it reaches the cloud then the data need to be processed. It acts as a brain of IoT device and it handles the data, stores it and make decisions to make or break the deal just under milliseconds. With their accurate computing power, storage capabilities, network options clouds make information effectively for consumers. Fog computing or Edge Computing is also preferred when needed for high storage.

d) Analytics

Data is analysed here with the help of various algo99rithms like Machine Learning.

e) User Interface

User end application where user can monitor or control the data

1.1.2 Classification of IoT devices

IoT classified into three categories:

1. Consumer IoT

   Devices are smart TVs, smart speakers, toys, wearable's and smart appliances.
2. Enterprise IoT

   Edge devices are smart locks, thermostats, lighting and smart security
3. Industrial IoT

   Devices are designed to be used in factories or other industrial environments.

a) Malawi

Malawi is a landlocked country in eastern Africa. It occupies a thin, twisting strip of land along the East African Rift Valley and is endowed with stunning hills and huge lakes [2]. Lake Nyasa, also known as Lake Malawi in Malawi, covers more than one-fifth of the

country's total area. The majority of Malawians work in cash crops and subsistence agriculture. Malawi, on the other hand, is rapidly urbanizing, with urbanization occurring at a rate significantly faster than the African or worldwide averages.

Agriculture is the backbone of the Malawian economy, employing more than four-fifths of the working population and accounting for roughly one-third of GDP and the great bulk of export earnings in the 2000s. The most important is tobacco.

b) SDN

Software-defined networking (SDN) has been touted as one of the most promising solutions for future Internet [1]. SDN is characterized by its two distinguished features, including decoupling the control plane from the data plane and providing programmability for network application development. As a result, SDN is positioned to provide more efficient configuration, better performance, and higher flexibility to accommodate innovative network designs.

c) Agriculture

Tobacco, sugar, tea, and cotton are the most important agricultural products of Malawi, accounting for a large amount of the country's export revenue [4]. Tobacco, the country's most important export, is grown mostly in the central plateau on big estates and by smallholders throughout the country. With the rise of anti-smoking initiatives, farmers have been urged to diversify and become less reliant on tobacco. Corn (maize) is the main food crop and is typically grown with beans, peas, and peanuts (groundnuts) by almost all smallholders throughout the country [6]. Cassava (manioc), bananas, lentils, sweet potatoes, and rice are also important food crops, and poultry, cattle, pigs, sheep, and goats are raised.

Beginning in the early 1970s, the government funded the development of several large timber and pulpwood plantations with the goal of making the country self-sufficient in construction grades of timber; pine and eucalyptus were also extensively planted in the northern Viphya Mountains to supply a large pulp and paper project in the region. The rate at which woody areas are disappearing in Malawi is cause for significant concern. More than half of Malawi's wooded area was depleted between the early 1970s and the early 1990s, and while the rate of deforestation moderately dropped in the following decade, it remained exceptionally high by relative standards. The use of wood as fuel is a major contributor to the country's forest decline. In rural areas, wood has traditionally been utilized as a cooking fuel,

and as the population rises, more of it is consumed; in urban areas, charcoal is the primary source of energy, putting further strain on woodlands. The tobacco industry's dominance has resulted in more forest deforestation, as trees have been constantly destroyed for timber for the construction of sheds to dry or cure the crop, as well as to power the curing process itself. Because to the International Monetary Fund (IMF) and World Bank-mandated reductions in casual labor and civil service employment, forest reserves no longer have employees to protect them against misuse.
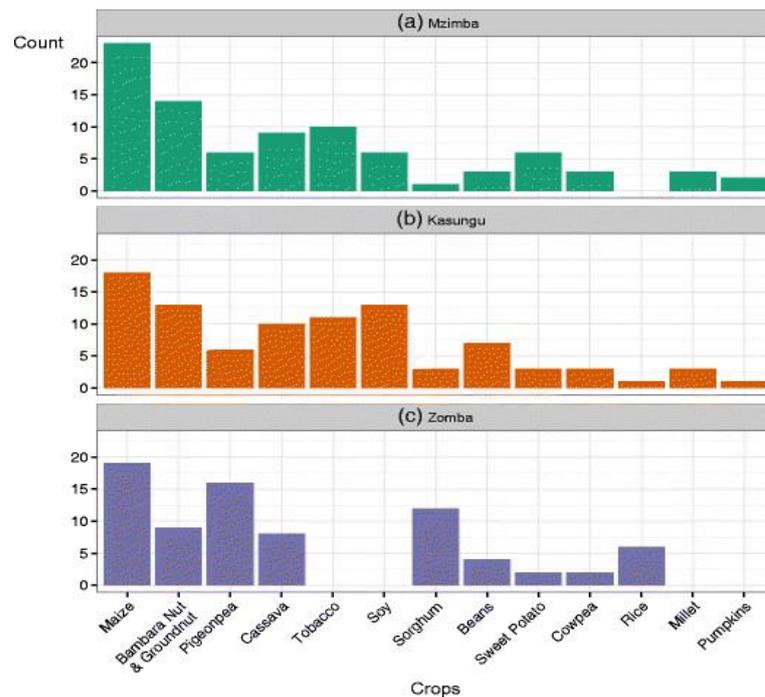

Figure 1. Histogram of crops that farmers in the Malawian Districts of (a) Mzimba (green), (b) Kasungu (orange), and (c) Zomba (purple) growing in 2013 to 2014

d) Economy of Malawi

Malawi's economy is primarily agricultural, with 80 percent of the people residing in rural areas [7]. The landlocked country in south central Africa is one among the world's least developed. Agriculture accounted for over one-third of GDP and approximately 80% of export revenue in 2017. Malawi's economy is based primarily on agriculture, with major exports including tobacco, tea, sugar, cotton, rice, groundnuts, textiles, and garments. Tobacco, tea, and cane sugar account for more than 70% of total export revenues. Tobacco is the most important export earner, accounting for more than 60% of total foreign exchange profits. Macadamia nuts, handicrafts, chilies, rubber, lumber, paprika, and beans are also exported. Agriculture is important for economic development, and the IoT smart farmer

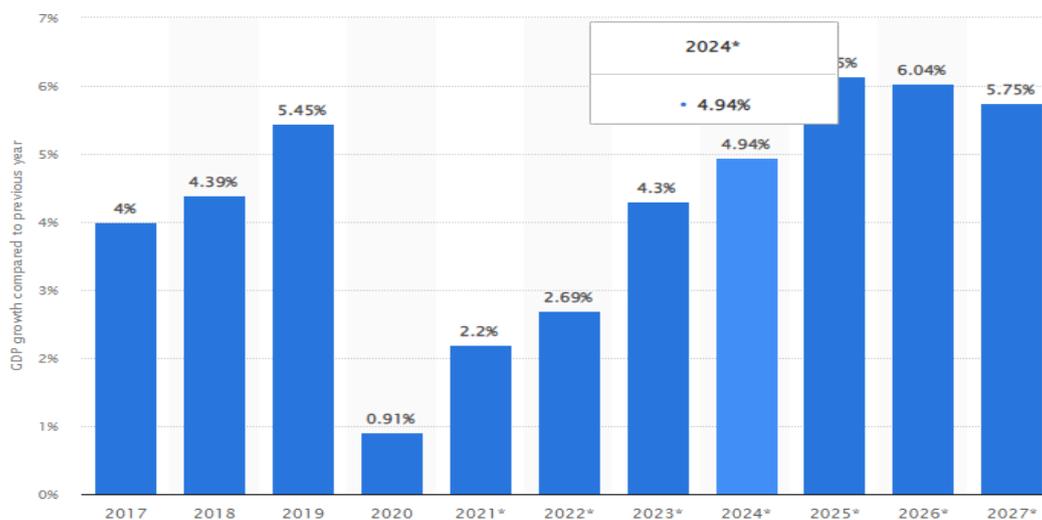application developed by MUBAS will have a significant influence by utilizing the Irrigation Mechanism.

Figure 2. Malawi: Growth rate of real gross domestic product (GDP) from 2017-2027

2. Implementation of IoT in Malawi

2.1 UNICEF TNM – Introduced free information on Internet using IoGT

After a successful partnership on U-Report, UNICEF Malawi and Telekom Networks Malawi PLC (TNM) have now revealed the Internet of Good Things (IoGT). IoGT aspires to generate positive change by delivering free education and health information. Every TNM user has free access to IoGT through their TNM.org application and can read about maternal health, hygiene, and emergency information such as Cholera, drought, or flooding. People that connect to IoGT can access localized, up-to-date, and high-quality material from their mobile devices at any time.

2.2 IoT Smart Farmer App – Developed by MUBAS student in 2018

Madalitso Mnduwira, a second-year Bachelor of Science in Information Technology student, and his brother Cliff have won the annual Information Communication Technology Association of Malawi (ICTAM) innovation award for the best Internet of Things (IoT) Smart Farmer application in the category of Smart Agriculture.

2.3 IoT Healthcare Programmes

Telecom26 has a strong presence and is connecting IoT Healthcare programs being implemented by Big Pharma customers, Healthcare diagnostic partners, and non-

governmental organizations. Malawi is a landlocked country in southern eastern Africa known as "The Warm Heart of Africa" because to its kind people. It is bounded on the west by Zambia, on the north and northeast by Tanzania, and on the east, south, and southwest by Mozambique. Telecom26's IoT SIM cards were created with the explicit objective of increasing connection in remote places with inconsistent coverage. Our IoT SIM cards allow devices to automatically access and switch between several networks both within and beyond borders, eliminating the need to be concerned about a single MNO's coverage.

2.4 IoT Automation Company in Lilongwe Malawi

Lilongwe Company that started communication integration in the early 1990 **[8]**. After focusing on international satellite networks for some years, focus has now shifted to IoT under our new name, IoT Automation. IoT has a strong focus on water sensors and controls, particularly agriculture, automatic weather stations, including lightning detection, supply chain platforms, private or public blockchain, system monitoring (solar projects, smart metering, input supplies, etc), carbon reduction projects, such as improved cook-stoves, that also require software support for monitoring and auditing, hybrid software services with the ability to manage all these solutions

Table 1. Literature Table for IoT in Malawi

Name of Entity	Programme	Implementation
UNICEF TNM	IoGT	Yes
IoT Smart Farmer App	ICTAM	Not Yet
Telecom26	IoT Healthcare Programme	Yes
IoT Automation Company	House Appliances	Yes

2.5 IoT in Irrigation

Figure 3. Drip Irrigation

Drip irrigation applies water slowly to the soil ideally at the same rate with crop consumption. Spray irrigation applies water under pressure and it sprinkles / spray in the surface [10].

Figure 4. Sprinkler / Spray Irrigation
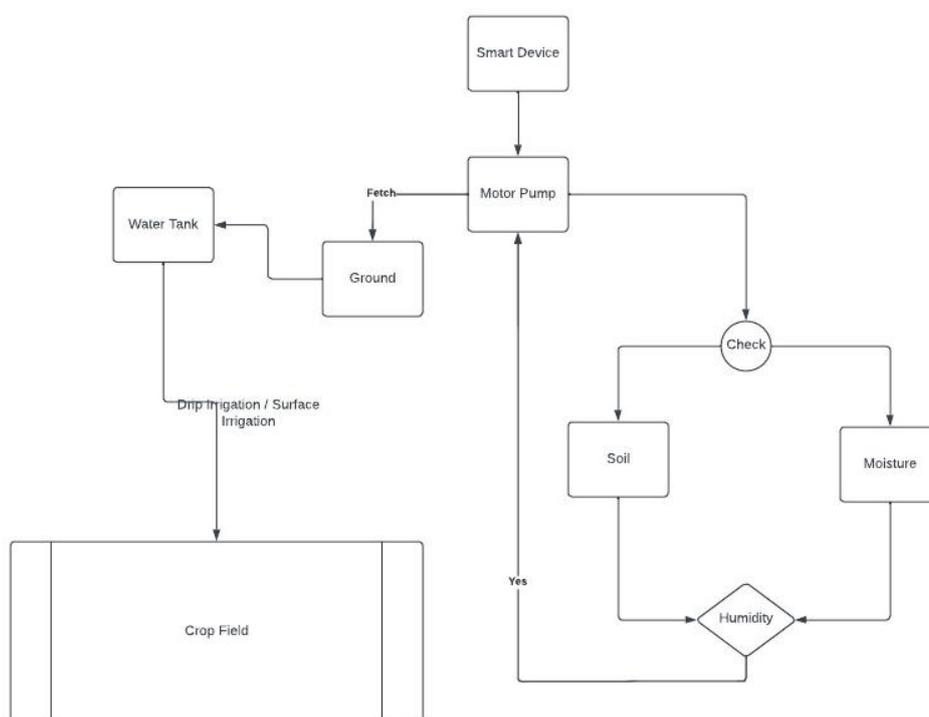
2.6 Architecture

Figure 5. IoT Architecture

Figure 5 shows the architecture of IoT system works in drip or surface irrigation to automate the system. Systems works as an intelligent Irrigation system, smart device is connected to the motor pump to check the soil quality and moisture in the environment, once the humidity level is more than 40% then the system will starts and regulates the water for Irrigation. Human communication is necessary to initiate the system at first place of

implementation, Length and width of the field need to be entered in the smart device app, then the number of pipes in the field to be entered in the system. Once the infrastructure is done, then the system will work on its own without any human intervention. Level / Litre of water will be determined by the software based on the humidity level, system will check the humidity once in 12 hours and if there is a need in between, then human can intervene. Moisture sensor is used to sense the moisture and soil.

3. Results and Discussion

Drip Irrigation and Spray irrigation are suitable in Agriculture due to its effectiveness and less maintenance. The performance of a bucket drip irrigation system (BDI) powered by treadle pump was evaluated on tomato and intercropped maize/bean crops, between 2005 and 2007 in Malawi **[5]**. Tomato was more valuable with BDI, compared to maize and beans. It can be concluded that BDI, powered by a treadle pump, saves labour and time and it provides uniform irrigation for crop production. Therefore, tomato is recommended for use with this system, compared to maize and bean. Similarly, with this system any corp which can grow at a level of 40% humidity can be grown in this system.

4. Conclusion

An intelligent irrigation system is a way to deal with all of the issues in a conventional approach. This method regulates the water by sensing the soil quality and moisture and providing adequate moisture needed using motor pumps. The IoT technique here transfers the data to a network with little human communication. Study reveals that the productivity of IoT devices in Malawi is not available and the IoT devices are imported and implemented by various organizations and the programming languages are used to create IoT enabled application. To develop the nation Malawi, export of goods are depend upon Agriculture and its production, to improve the production in Agriculture, IoT devices are recommended to use in Irrigation to enhance the growth of Republic of Malawi.

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