Technoarete Transactions on Advances in Computer Applications (TTACA)
Vol-1, Issue-4, December 2022
e-ISSN: 2583-3472

Exploring the Potential of IoT for Smart Agriculture

Joey G. Fernando[1*], Arepalli Sathibabu[2]

[1] Central Luzon State University, Philippines.
[2] KARE, India.
*Corresponding Author Email: [1] jgfernando@clsu.edu.ph

Abstract

The study has depicted the overall impact of IoT technology in the agriculture field that strengthens the economic strength of the firming industry. Secondary data collection procedure and thematic data analysis process have been used in this study based on peer reviewed journals that increased the reliability and validity of this study. Role of IoT technologies in smart firming has been discussed over here along with advantages and disadvantages of the IoT technology. Security threats under IoT technology in the agriculture field also have been highlighted in this study to meet the goal of the study. Concept of IoT technology has referred the network exchanging procedure through different devices such as sensors, robotics and drones. Implication of automation process of IoT technology considering greenhouse innovation also has been focused over here. GREEN implication along with block chain technology and its impact on smart firming have been considered in this study to justify the study. Economic and environment sustainability also have been focused in this study to evaluate the significance of IoT technology in smart firming.

Keywords

Agriculture, IoT technology, smart firming.

INTRODUCTION

Continuous machine learning process has been influenced by the implication of IOT that has impacted the different operational fields such as smart agriculture application. Part of machine learning tools, robots, drones, remote sensors and computer imaging are helpful in monitoring fields, surveying for the continuation of the cultivation and mapping of the fields. Rational application of IOT technology in the firm management accelerates the money and time saving approaches of the agriculture field. Presumption of humidity, temperature and soil quality by utilizing the smart application of IOT helps the farmers to make an efficient irrigation and harvest forecast [1]. IOT is in fencing the predictive analytics to reach better harvesting decisions. Precision farming is the unique application of IOT in smart agriculture that increases the probability of sustainable agriculture prioritizing the reduction of carbon footprints. Continuous flow of supply chain considering the availability of raw materials stock by implication of the IOT technology based livestock monitoring facility. Smart green houses are another smart initiative of the rational firm management that ensures the availability and accessibility of the cultivated crops.

Controlling the climatic conditions is another advantage for agriculture to become smarter to leverage competitive advantage. Waste management, increasing productivity and assurance of resource availability also have been impacted by the smart implication of IOT in the agriculture field. Smart pest control and fertilizer management also have increased productivity considering the smart application of IOT in the agriculture field. GPS technology, aerial images and temperature sensors are the most influential innovations of IOT that save money, time and effort in agriculture yield [2]. Agriculture business became more profitable, safer and ecofriendly which enhanced the sustainability of the cultivation culture. Conductivity and pH balance maintaining is one of the vital roles of IOT in smart agriculture along with solar radiation evaluation and soil nutrient analysis that increased the rare crops cultivation. Economic progression of the nation is also to some extent driven by the implication of IOT in smart agriculture development.

METHODS AND MATERIALS

Research approach

Depending on the significance of the subject of the study, an inductive research approach has been selected to evaluate the impact of the IOT in smart agriculture. Inductive research approach has concluded the general outcomes retrieving from the specific draw line of a particular subject [3]. In this study, IOT and its impact on smart agriculture has helped to generate generalized conclusions to meet the goal of the study.

Research design

Cross sectional research design has been used in this study to meet the objectives of the study. Research design of cross sectional can be considered as the observational study design [4]. Cross sectional research design can compare many different variables at the same time as the variant component of IOT and its impact can be compared with the effect on the smart agriculture field.

Data collection procedure

Secondary data collection procedure has been chosen by the writer to collect data for this study. Peer reviewed journals are the source for collection of the data that make the study more reliable and authenticate. Time saving and budget friendly approach of secondary data collection enhances the quality of the study. Peer reviewed journals published before 2019 are excluded in this study to compact the study with

e-ISSN: 2583-3472

more authenticity.

Data analysis technique

On the basis of a secondary data collection method thematic data analysis has been done in this study. Themes have been developed in this study with the help of peer reviewed journals and realistic observation skills of the writer. Flexibility and independent approach of thematic data analysis enhanced the probability of meeting the goal of the study with proper informative justification.

RESULT

Concept of IOT

IoT stands for internet of things that connects and exchanges data with other devices and systems through the internet considering sensors, software's and other technologies relevant to the physical objectives. There are 4 types of IoT such as Cellular, Local and personal area networks, low power wide area networks and mesh networks. An enhanced communication network that integrates the communication technologies and positioning of objectives is the basic concept of internet of things [5]. IoT facilities can be categorized according to application of it such as consumer IoT and commercial IoT. Daily life utilization of IoT technologies includes home appliances, voice assistance; light fixtures can be defined as the consumer IoT and commercial IoT refers to the smart pacemakers, monitoring devices, GPS technologies in smart agriculture. The 5 layers of IoT are specifying the particular area for IoT application.

Perception layer, connectivity layer, edge layer, processing layer, application layer and business layer along with security layer are the best applicable layers of IoT technologies. Comprehensive solutions of IoT technologies have been considered the sensors, sensors of gateway networks, gateways, gateways of internet networks, data ingestion and processing of the information, establishing internet to user network [6]. Value added information based on IoT technologies also plays a vital role in various fields considering both aspects of commercial and consumer segments. Main principles of IoT have been developed depending on the three components of IoT that highlight the internet, things and connectivity. Pervasive connectivity has been established considering the networks with various wireless and wire line based technologies that set a standard and protocols. IoT things have prioritized the characteristics of it that focused on the application of advanced intelligence, instant action and ecosystem balancing. There are five stages of IoT that integrate connectivity. The stages are connectivity, real time monitoring, data analytics, automation and focusing on board intelligence.

Power constrained hardware sensors are used for acquiring data, then middleware has been used for processing the data with proper analyzing, after that transmission of the desired data has been utilized to visualize the final outcomes from the data are the gradual steps to apply the IoT technology for a specific purpose. IoT technology is also prioritizing the distribution of the database considering the management system of it. Data storage with predictive data analytics also has been integrated with the application of IoT technologies [7]. Infrastructure of IoT technologies consists of perception that includes the sensors, gadgets, and other devices that help to connect the networks between devices considering the application of IoT to interact with the physical objectives. Environmental use and better derivation of insights of the physical objectives are the prior concern of IoT technologies that help to compute and connect areas.

Internet of things solutions for smart firming

Transformation of the technologies has driven the agriculture field to add extra industrialized advantages that help the farmers to increase the livestock, growing crops considering the predictable efficiency. Implication of IoT technology in the field of agriculture has increased the market share up to 5.6 billion dollars in the global aspect, a big achievement in the smart farming industry [8]. Smart agriculture can be defined as the integrated application of IoT solutions in the agriculture field. Utilization of the IoT technology enhanced the scope for the farmers to collect the environment and machine matrix that improves the farmer's ability to make decisions in favour of farming crops. Adoption of IoT solution during Covid 19 has a significant impact on the CAGR that has grown by 9.9% in 2021 considering the disruption of supply chain and lack of workers.

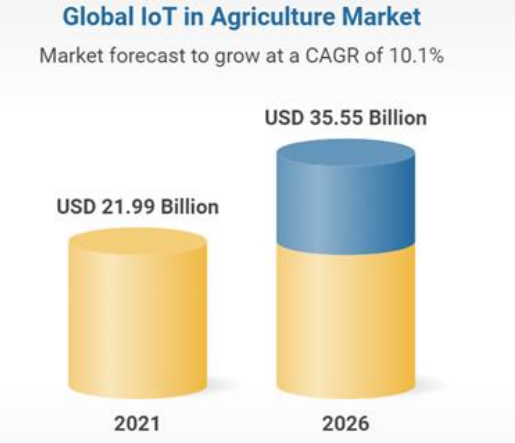

Figure 1: Implication of IoT technology in agriculture field

Global agriculture market size will reach 15.3billion dollars which is triple from 2016 that ensures the positive impact of IoT solutions in agriculture in a global aspect. Weather conditions, soil quality, crops growth considering the cattle's health has been collected by the smart agriculture sensors. Lowering the production risks is also a vital feature of IoT solutions in smart farming with the implication of controllable sensors and devices [9]. Cost effective approach of IoT solutions in smart agriculture also ensures the waste management by reducing waste products that have an ecological value in the agriculture field. Processed automation has enhanced the business efficiency of industrialized smart farming prioritizing the irrigation,

e-ISSN: 2583-3472

fertilizing and pest controls. Product quality and volumes of growing crops has been enhanced by the implication of IoT solutions in smart agriculture. Resource availability is also a prior concern of the IoT technology that ensures the continuous productivity of smart farming.

IoT solutions help to monitor the climate by collecting data from the environment to send it to the cloud for measuring and mapping the climatic condition to integrate precision farming. Innovation of the greenhouse using IoT technology enables the sensors to get accurate real time information considering the lighting, temperature, soil quality, humidity [10]. Automatically adjusting efficiency of the greenhouse automation systems meets the parameters of smart farming. Crop health also can be controlled by the advanced application of the IoT solutions that helps to prevent crop diseases or infestations which can harm yield. Collecting data regarding crop farming considering the weather situation, perception of leaf water potential and monitoring to provide a comfortable atmosphere for crop growing is one of the best initiatives of IoT solutions in smart agriculture.

Innovation of IoT technology agriculture drone helps to plant trees in deforested areas which is an advanced promising device for future integration of smart agriculture. Agriculture drones also known as UAVs that help to collect agriculture data through satellites to monitor crop health [11]. Decreasing the needs of human labour, agriculture drones efficiently plants trees, prevents pests and infections, agriculture spraying and crop monitoring. Crop performance also has been driven by the predictive analytics of IoT solutions for smart farming. End to end farm management systems also have been integrated with vehicle tracking, storage management and logistics facilities of IoT solutions that determine the prominent opportunities for smart farming. Smart farming solutions have been developed depending on the hardware, maintaining efficiency, mobility, infrastructure, connectivity, data collection frequency and data security in the agriculture field considering IoT solutions.

Benefits and disadvantages of IOT in agriculture

IoT beneficiary aspects have influential consequences in various fields in global platforms. Intelligent data collection process of IoT technology is one of the most impacting advantages that enhance the efficiency and productivity in different fields such as the smart agriculture industry. Waste reduction of IoT technology has an environmental benefit that helps to maintain the ecological balance. Processed automation also enforces innovation criteria in the industries such as greenhouse is one of the best examples of processed automation [12]. Animal monitoring is a unique feature of IoT technology that ensures ecological balance maintenance through the enhanced application of advanced technologies. Adding comprehensive advantage has increased the gr oath of the different industries considering the economical aspects of the g global platforms. Smart framing industry has reached an appreciable revenue collection considering the adoption of the IoT solution in the agriculture field.

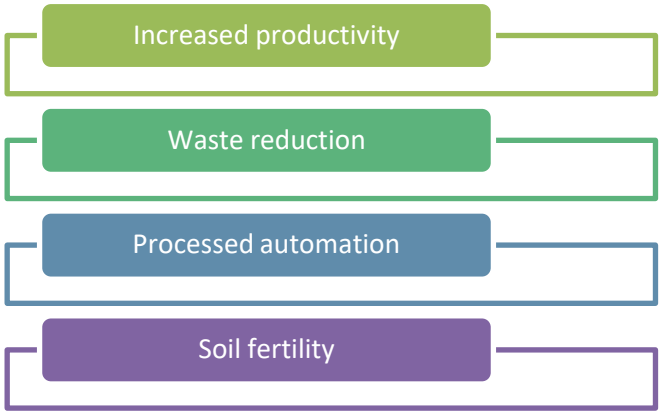

Figure 2: Benefits of IoT technology in smart agriculture

Lower cost of IoT solutions helps to access this technology easily and improve the efficiency along with qualitative productivity. Smart agriculture is benefited mostly with the implication of the IoT solutions to monitor crops and animals in farms even maintaining physical distance. On the other hand, lack of security of data is one of the major disadvantages of IoT solutions that enhance the risk of network attacks. Little control in measuring the security is the great default of IoT technology that has to be improvised including in securing the agriculture data. Initial adoption cost of IoT solution is high that creates obstacles for the implication of IoT solution in agriculture field [13]. Lack of information regarding all consecutive perspectives of the agriculture field has highlighted the cons of the IoT technology.

River pollution has been increased by the implication of the IoT technologies in the agriculture field. Radiation and chemical extraction has a bad impact on the environment through utilization of IoT solutions. Over use of IoT solutions to increase productivity can cause the decreasing soil fertility [14]. In the agriculture field soil fertility can be hampered by the application of IoT technology in framing. Over use of natural resources considering the IoT technology has a bad influence on the environment. Overall impact of IoT technology has explored the progression of different fields that ensure the economic benefits including smart framing.

A general survey on security threats in agricultural IOT and smart farming

Market size of agriculture has been significantly increased considering the implication of IoT technology in the agriculture field. However, the IoT has a cons aspect about smart farming that is lack of data security. Advanced cyber security can be considered as a high degree of protection for a network that prevents malware attacks, data misplacing, damaging programmes and unauthorized access [15]. Following the market trends new cyber threats are added in the agriculture field that includes ransom ware, endpoint attacks, phishing, third party attacks, supply chain attacks, artificial intelligence and machine learning driven attacks considering crypto jacking, cyber physical attacks, state sponsored attacks. IoT attacks have included the threats of

e-ISSN: 2583-3472

smart devices, connection attacks, and semi-autonomous vehicles risks.

Lack of designing network security protocols, cryptography solutions and device security creates several challenges in the agriculture field. Farmers have grown trust issues regarding the data security of agriculture hampers the implication of IoT technology in farming. Data integrity and data loss has been driven by the data security of agriculture that can affect the productivity of the crops. False measurements and commands can be a disaster for smart farming considering the technical and security fault of the data in IoT solutions that leads to the vulnerability of the data to create risk factors in smart farming [16]. Wireless networks are the low power connectivity networks that affect the environment including temperature, humidity, obstacles that turn to data loss and communication failure.

Malfunctions also can highlight the risk factors in farm lands that decrease the productivity of the lands. Data privacy is another major security issue in agriculture that can damage both the personal and financial terms of the farmers. Data stealing is the prior issue for smart farming as it can disrupt the supply chain management and agro business in the agriculture field [17]. Unethical data sale is also a vulnerable risk factor in agriculture considering the data security. Unattended foreign accessing confidential data through drone, cameras, and sensors to harm the farmers is another crucial security disadvantage of IoT solution in agriculture. In addition false data information can lead to dangerous health hazards in human considering the agro products overusing fertilizer and pesticides. Cybercrime has enhanced the device's accessibility to use personal information, confidential business information and government information along with delaying productivity in the agriculture field by disabling smart devices.

Multiple accessibilities of the smart devices considering transformation of heterogeneous data is creating a severe network point that helps the hackers to exploit it. Illegal launch of critical infrastructure of agriculture such as water and power supply has faced the devastating attack of cybercrime. Digitalization of the food industry including agriculture field explores the different network connection depending on various domains that makes the easy accessibility for cybercriminals [18]. Considering the negative consequences farmers believe in the physical approach of agriculture integration. Lack of knowledge about the IoT technology makes it difficult to maintain the security and privacy of data relevant to the cultivation yield for the farmers. Most of the cybercrimes in the agriculture field have been followed by the un-patched firmware and extended use of default passwords.

Implication of complex cryptographic algorithms has prioritized the limited computational resources of smart devices that enhance the probability of data loss and decrease the data security in IoT solutions. Communication protocols vulnerabilities in smart devices and low security of Wi-Fi protected access protocols has influenced the cybercrime. Vulnerable detection through the search engines considering detection of the internet scanning through smart devices also highlighting the exploitation of data security in the agriculture field impacting with IoT technology [19]. Lack of attention is the passive reason for security threats in smart agriculture including IoT solutions. Smart agriculture also takes initiatives to mitigate the challenges regarding security threats considering the internet of things technology. Investing a sufficient amount of budget has to be prioritized by the IoT providing companies to ensure cyber security. On the other hand, agriculture stakeholders have to focus on maintaining the data privacy and integration considering increasing the risk management abilities.

Implication of Block chain technology under IoT solutions in agriculture yield can improve the spacing capacity of data security including fault tolerance, trusted origin and accountability of data. Controlling access, third party risk removal, protection of illegal use of personal data along with preventing data loss in sharing network information also can be driven by the Block chain application of IoT solutions [20]. Smart agriculture field has to focus on privacy preserving solutions, data integrity solutions, authentication solutions, access control solutions, data confidentiality solutions and block chain based solutions. Based on these traditional and deep learning machines can be applied for enhancing cyber security in agriculture including support vector machines, K-nearest Neighbour, decision trees, Deep belief network, recurrent neural networks, self-organizing maps, natural language processing, deep neural networks and many other equipment.

DISCUSSION

The interpretation of the result has highlighted the impact of IoT in smart agriculture. Concept of IoT has been briefly described to analyze the key features of IoT along with characteristics of it to evaluate the scope that can be derived from IoT in the agriculture field. Connecting and exchanging data using different devices considering the internet can be defined as IoT or internet of things. Smart firming is focusing on increasing productivity, ensuring profit and IoT technology helps to enhance the implication of smart applications such as sensors, clones and drones to face challenges in the agriculture field. Supply chain and lack of skilled workers also can be controlled by the IoT implication in the agriculture segment. Statistics have highlighted that the firming industry has remarkably grown with the implication of smart application in smart agriculture.

Presumptions of weather condition, soil fertility, crops characteristics and cattle’s health have been impacted by smart firming prioritizing IoT technology. Irrigation, fertilization and pest controls also act in an integrated way to increase the productivity of agricultural production using IoT techniques. Decision making of framers becomes easy with the efficient effort of the internet of things. Innovation of IoT technology in smart firming brings a revolutionary change in the economic growth in the agriculture industry. Use of

e-ISSN: 2583-3472

robotics and drone technology under IoT technology are most useful data retrieving tools in smart firming that increase productivity in a cost effective way. Pros and cons both perspectives of IoT technology in smart firming have been considered in this study, despite the advantages of IoT technology, initial installation cost has a negative impact on smart agriculture.

Lack of security is another drawback effect of IoT technology in smart agriculture that restricted farmers to adopt this technology in farming business. Complexity of IoT decreases the probability of accessibility of this technology for farmers. On the other hand, the implication of intelligent technology in smart firming increased productivity along with profit that strengthened the economic background of the agriculture industry including different countries' financial background. Waste reduction feature of IoT technology also plays a vital role in maintaining ecological balance considering environmental sustainability. General overview of security threats in smart firming also has been discussed over here to evaluate overall impact of IoT technology implication in smart agriculture.

Unauthorized access, malware attacks, data misplacing are the influential threats for smart firming that can hamper the flow of productivity of agriculture crops along with damaging the execution process of smart firming considering wrong informative data. Modification in the IoT technology can ensure the security determination of data that helps to increase productivity. Implications of green technology along with block chain technology have also been depicted here to analyze the effectiveness of IoT technology in smart agriculture to maintain the sustainability in production of crops according to the demand of products. Cost effectiveness and time saving approach of IoT technology also have been highlighted in this study to meet the subject of the study with relevant informative justification.

CONCLUSION

The study has created perspectives of the impact of IoT solutions in the agriculture field to integrate the field with smart technology. The basic concepts of IoT have been depicted over here with the different device introduction and its operating field in agriculture. Secondary data collection method has been used for the data collection procedure based on the peer reviewed journals published after 2019. Use of peer reviewed journals makes the study more reliable and authenticate with a cost effective approach. Thematic data analysis has been selected in this study to explore the insights of the subject of the study. Commercial and consumer benefits of using internet of things has been discussed over here describing the tools utilization such as remote sensors, cameras, pacemakers, drones and other smart devices.

Advantages and disadvantages both are considered in this study to meet the goal of the study. Monitoring and precision farming, weather forecasting are the most influential impacts of the IoT solutions in agriculture that increase the productivity of the crops and help to grow the economy in a global aspect. Security threats also have been highlighted in this study that adds a comprehensive advantage to the study. Data loss along with hampering the security of data information regarding agriculture and its negative consequences on the agriculture field has been vastly described here. Evaluation of the reason for lack of security in the agriculture field has helped to generate strategies for mitigating the threats of security in smart farming. Overall discussion of IoT solutions in smart farming has highlighted the influential positive impact of the IoT solutions that integrated the environment and economic sustainability in the agriculture field considering the progression of the world economy.

REFERENCES

[1] Sivakumar, R., et al. "Internet of Things and Machine Learning Applications for Smart Precision Agriculture." *IoT Applications Computing; Singh, I., Gao, Z., Massarelli, C., Eds* (2021): 135-165.

[2] Raj, Meghna, et al. "A survey on the role of Internet of Things for adopting and promoting Agriculture 4.0." *Journal of Network and Computer Applications* 187 (2021): 103107.

[3] Walter, Dror, and Yotam Ophir. "News frame analysis: An inductive mixed-method computational approach." *Communication Methods and Measures* 13.4 (2019): 248-266.

[4] Van Tiggelen, Hanne, et al. "The prevalence and associated factors of skin tears in Belgian nursing homes: A cross-sectional observational study." Journal of tissue viability 28.2 (2019): 100-106.

[5] Islam, Nahina, et al. "A review of applications and communication technologies for internet of things (Iot) and unmanned aerial vehicle (uav) based sustainable smart farming." *Sustainability* 13.4 (2021): 1821.

[6] Lousado, José Paulo, and Sandra Antunes. "Monitoring and support for elderly people using LoRa communication technologies: IoT concepts and applications." *Future Internet* 12.11 (2020): 206.

[7] Suma, V. "Internet-of-Things (IoT) based Smart Agriculture in India-An Overview." *Journal of ISMAC* 3.01 (2021): 1-15.

[8] TeleSense. Impact of IoT in the Agriculture. *AppsforAgri.* 12 January. 2023. https://www.appsforagri.com/en/news/impact-of-iot-in-the-agriculture/

[9] Cheema, Sehrish Munawar, et al. "IoAT Enabled smart farming: Urdu language-based solution for low-literate farmers." *Agriculture* 12.8 (2022): 1277.

[10] Rokade, Ashay, et al. "Intelligent Data Analytics Framework for Precision Farming Using IoT and Regressor Machine Learning Algorithms." *Applied Sciences* 12.19 (2022): 9992.

[11] Nhamo, Luxon, et al. "Prospects of improving agricultural and water productivity through unmanned aerial vehicles." *Agriculture* 10.7 (2020): 256.

[12] Heikkilä, Marikka, Jouni Saarni, and Antti Saurama. "Innovation in Smart Ports: Future Directions of Digitalization in Container Ports." *Journal of Marine Science and Engineering* 10.12 (2022): 1925.

[13] Padyab, Ali, et al. "Adoption barriers of IoT in large scale pilots." *Information* 11.1 (2019): 23.

[14] Postolache, Stefan, et al. "IoT-Based Systems for Soil Nutrients Assessment in Horticulture." *Sensors* 23.1 (2022): 403.

e-ISSN: 2583-3472

[15] Hasan, Mohammad Kamrul, et al. "A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things." *IET Communications* 16.5 (2022): 421-432.
[16] Demestichas, Konstantinos, Nikolaos Peppes, and Theodoros Alexakis. "Survey on security threats in agricultural IoT and smart farming." *Sensors* 20.22 (2020): 6458.
[17] Bhat, Showkat Ahmad, et al. "Agriculture-Food Supply Chain Management Based on Blockchain and IoT: A Narrative on Enterprise Blockchain Interoperability." *Agriculture* 12.1 (2021): 40.
[18] Alahmadi, Adel N., et al. "Cyber-Security Threats and Side-Channel Attacks for Digital Agriculture." *Sensors* 22.9 (2022): 3520.
[19] Xenofontos, Christos, et al. "Consumer, commercial, and industrial iot (in) security: Attack taxonomy and case studies." *IEEE Internet of Things Journal* 9.1 (2021): 199-221.
[20] Hassan, Muneeb Ul, Mubashir Husain Rehmani, and Jinjun Chen. "Privacy preservation in blockchain based IoT systems: Integration issues, prospects, challenges, and future research directions." *Future Generation Computer Systems* 97 (2019): 512-529.