THE QUEST
ISSN 1908-3211 (Online) | ISSN 1908-322X (Print)
Journal of Multidisciplinary Research and Development

P-ISSN: 1908-322X and E-ISSN: 1908-3211
Vol.3 No.1 (2024)
Received: 04-20/ Revised: 06-20/ Accepted:06-30-2024
https://neust.journalintellect.com/quest

5G Internet of Things (IoT) And Its Impact to Agricultural Technology: Basis for Strategic Plan

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Abstract. This study explored the integration and impact of 5G-enabled Internet of Things (IoT) technology in agricultural practices in Hainan Province, China, through a quantitative descriptive approach. The study encompasses responses from the participants, including farm managers, agricultural technology experts, and farm owners. It delves into the demographic and professional profiles of these respondents, revealing a majority in the 35-44 age group, predominantly female, with a significant number holding college degrees or higher and mostly farm owners. The impact of 5G-enabled IoT on agricultural technology is generally perceived positively by respondents. The shared understanding of 5G's potential positive influence on agricultural productivity, compatibility with existing setups, and operational performance underscores the transformative capabilities of this technology. However, the study also identifies challenges, including concerns regarding cost effectiveness, accuracy, and risk/security, which pose significant hurdles to the widespread adoption of these technologies. The proposed strategic plan suggests targeted outreach, awareness programs, and the development of innovative financing models and cybersecurity measures to foster a conducive environment for the adoption of 5G IoT in agriculture. In conclusion, the study provides insights into the current perception and impact of 5G-enabled IoT in agriculture, coupled with actionable recommendations to navigate the challenges and maximize the technology's potential benefits. This comprehensive approach aims to support stakeholders in the agricultural sector in leveraging 5G IoT for enhanced productivity and sustainability.

Keywords: 5G-enabled IoT, Agricultural Technology, Stakeholder Profiles, Connectivity, Access, Technical Requirements

Introduction

In an era marked by technological advancements, the integration of Internet of Things (IoT) technologies revolutionized various sectors, with agriculture standing at the forefront of this transformative wave. The potential benefits, particularly in the form of

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improved decision-making tools, cost reduction, and heightened productivity, were increasingly recognized in the agricultural landscape (Nayak et al., 2020). Traditionally, agriculture was synonymous with manual labor and unpredictable outcomes. However, the infusion of IoT technologies, such as wireless sensor networks, RFID, and cloud computing, introduced a paradigm shift. This shift extended beyond mere automation, offering farmers intricate decision-support systems that harnessed data for optimized agricultural practices.This research explored the realm of 5G-enabled IoT in agriculture, investigating its impact on agricultural technology. The focal point was to elucidate the transformative potential of 5G-enabled IoT in shaping the future of agriculture and to develop a strategic plan that aligned with the evolving needs of the agricultural sector.Understanding the impact of 5G-enabled IoT in agriculture held profound significance. It not only propelled the agricultural sector towards greater technological resilience but also contributed to sustainable practices, informed decision-making, and the maximization of resources, thereby fostering economic growth.Despite the growing recognition of the potential benefits of 5G-enabled IoT in agriculture, there existed research gaps that demanded exploration. The nuanced understanding of the profile, technology integration, impact, and challenges formed the cornerstone of addressing these gaps, enhancing the rationale for the research.Thus, this study aimed to navigate through the intricacies of 5G-enabled IoT in agriculture, unraveling the current landscape, assessing its impact, and addressing the challenges that accompanied this technological transition. Through comprehensive analysis, the research aimed to provide valuable insights that would serve as the foundation for a strategic plan tailored to the dynamic needs of the agricultural technology landscape.

2.Methodology

The research utilized a quantitative descriptive design, which represented a structured and systematic approach to collecting and analyzing numerical data to describe, summarize, and understand various aspects of the integration of 5G-enabled IoT technology into agricultural practices in Hainan, China.

This quantitative descriptive design facilitated the research in providing a comprehensive and data-driven understanding of the then-current status and potential implications of 5G IoT adoption in Hainan's agriculture. It also yielded valuable insights for the development of a strategic plan tailored to the specific needs of the agricultural sector in Hainan, China.

2.1. Sampling Procedure

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The data gathering process was centered around the collection of numerical data and the subsequent application of statistical analysis to derive conclusions and draw inferences concerning a specific research problem or phenomenon. This process was meticulously structured and comprised several key steps.

Initially, it began with the establishment of clear research objectives and hypotheses, delineating the specific insights sought through quantitative analysis. Subsequently, measurement instruments, such as surveys or questionnaires, were meticulously developed to facilitate the collection of quantitative data, featuring structured questions and predefined response options.

The next crucial phase involved sampling, where the target population, in this case, encompassed farm managers, agricultural technology experts, and farm owners in Hainan, China. Through random sampling techniques, a representative subset of individuals from this population was selected, ensuring that the sample size was statistically robust for meaningful inferences. The data collection process involved the administration of surveys or questionnaires, which could be carried out electronically, via mail, or in person, contingent on the chosen method. It was imperative to maintain clarity and consistency in the questions to mitigate potential bias and standardize the process for minimal variation.

Upon data collection, a meticulous review ensued to verify accuracy, encompassing checks for completeness and precision, with special attention to identifying missing responses or outliers necessitating validation or correction. Subsequently, the collected quantitative data was diligently entered into a computer database or statistical software for analysis. This step included coding categorical responses with numerical values to facilitate quantitative analysis.

The core of the process resided in conducting statistical analysis, which involved the application of appropriate statistical methods and software.

The subsequent phase called for the interpretation of statistical findings to address the predefined research objectives and hypotheses. This entailed identifying significant patterns, relationships, or differences discerned within the data. Drawing conclusions and making inferences about the research problem followed, with an assessment of both practical and theoretical implications stemming from the analysis.

When presenting the findings, researchers were tasked with summarizing the quantitative research results in a clear and organized manner, making use of tables, charts, and graphs to visually represent key data points. The presentation was closely aligned with the initial research objectives and hypotheses.

2.2. Respondents

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In the context of the research on the integration of 5G-enabled IoT technology in agriculture in Hainan, China, the selection of respondents from three distinct groups—farm managers, agricultural technology experts, and farm owners—followed specific criteria to ensure inclusivity and relevance.

Table 1 *Distribution of the Respondents*

Respondents	Total number of Population	Total number of Sample
Farm Managers	25	24
Agriculture technology Experts	43	39
Farm Owners	150	109
Total	**218**	**172**

3 Results and Discussion

3.1Profile Description of the Respondents

3.1.1 Age. The majority of the respondents, 27.9%, fall within the 35-44 age range, suggesting a concentration of individuals with substantial professional experience in agriculture.

3.1.2 Sex. Female respondents constitute to 65.1% of the respondents, indicating a notable involvement of women in discussions about 5G IoT and agricultural technology.

3.1.3 Educational Background. The majority of respondents (57.0%) have completed college education, with significant representation of individuals holding master's (32.0%) and doctorate degrees (8.7%).

3.1.4 Position or Designation. Farm owners (22.1%), agricultural business owners (24.4%), and agribusiness entrepreneurs (16.9%) are prominently represented.

3.1.5Department or Unit. Agribusiness management (23.8%) and ownership/leadership (22.1%) are well-represented, indicating a strategic focus among respondents.

3.1.6 Years of Service. A balanced mix of experienced professionals (22.1%, 23.3%, and 15.1% for 6-10, 11-15, and 16-20 years, respectively) and those in the early stages of their careers (19.2% with 1-5 years) is evident.

3.2. Profile of 5G-Enabled IoT in Agricultural Technology

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3.2.1 Connectivity. Respondents generally agree on the positive impact of 5G networks on connectivity for IoT devices in agricultural technology, with an overall weighted mean of 3.07, falling under the category of "Agree."
3.2.2 Access. The overall weighted mean for access is 2.91, classified as "Agree," indicating a generally positive but varied outlook.
3.2.3 Technical Requirements (Infrastructure, others). With an overall weighted mean of 3.11, respondents generally agree on the importance of meeting technical requirements for successful implementation.
3.2.4 Resources Needed. The overall weighted mean for resources needed is 2.91, indicating general agreement among respondents regarding critical resources required for successful integration.
3.2.5 Innovation. The overall weighted mean for innovation is 3.16, indicating general agreement regarding the innovative potential of 5G IoT in agricultural applications.

3. Impact of 5G-Enabled IoT on Agricultural Technology
3.3.1 Productivity. The overall weighted mean for productivity is 2.74, indicating general agreement among respondents regarding the potential positive influence of 5G IoT on agricultural productivity.
3.3.2 Compatibility. The overall weighted mean for compatibility is 2.63, indicating a general agreement among respondents regarding the compatibility of 5G IoT with current agricultural setups.
3.3 Operational Performance. The overall weighted mean for operational performance is 2.72, indicating a general agreement among respondents regarding the potential positive impact of 5G on operational performance in agriculture.

3.4. Challenges of 5G-Enabled IoT in Agricultural Technology
3.4.1 Cost Effectiveness (Resource Optimization). The overall weighted mean for cost effectiveness is 2.97, highlighting that respondents identify this as a significant challenge in the widespread adoption of 5G agricultural IoT solutions.
3.4.2 Accuracy. The overall weighted mean for accuracy is 2.69, indicating that respondents perceive accuracy as a significant challenge in the implementation of 5G-enabled agricultural IoT solutions.
3.4.3 Risk and Security. The overall weighted mean for risk and security is 3.03, signifying that respondents view this as a significant challenge in the implementation of 5G-enabled agricultural IoT solutions.

3.5 Proposed Strategic Plan

The proposed strategic plan for integrating 5G-enabled IoT in agricultural technology covers five key focus areas. The plan targets inclusive engagement and communication, emphasizing initiatives such as targeted outreach, awareness programs, and tailored communication strategies.

Conclusions

The respondent profile highlights a diverse respondent in terms of age range and majority of them are female respondents indicating the importance of inclusive strategic planning tailored to diverse educational backgrounds and stakeholder roles within the agricultural sector.The profile of 5G-enabled IoT in agricultural technology reveals an overall positive perception among respondents. The agreement on the positive impact of 5G networks on connectivity, access to IoT data, meeting technical requirements, and the recognition of critical resources needed underscores the potential for a successful integration of 5G IoT in agriculture. The impact of 5G-enabled IoT on agricultural technology is generally perceived positively by respondents. The shared understanding of 5G's potential positive influence on agricultural productivity, compatibility with existing setups, and operational performance underscores the transformative capabilities of this technology. The challenges associated with the integration of 5G-enabled IoT in agricultural technology are evident, as highlighted by the respondents. Cost-effectiveness, accuracy, and risk/security emerge as significant concerns. The proposed strategic plan for 5G-enabled IoT integration in agricultural technology outlines focused objectives and strategies across five key areas.

Acknowledgements

The proponents would like to thank the Zongjie Technology (Hainan) Co., Ltd. of China and the Nueva Ecija University of Science and Technology of the Philippines for their valuable support.

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