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Original Paper

Smart Hydroponics Innovation: Blyink IoT Application for Sustainable Food Security

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Abstract
The rapid development of technology has a significant impact on various fields, one of which is technology in agriculture. The use of technology in agriculture, such as the Internet of Things (IoT), aims to make it easier for farmers to monitor, manage and carry out agricultural activities. The solution for farmers to utilize technology in monitoring agricultural land to get more effective and efficient harvests so that they can increase productivity and yields is by using IoT technology. The application of IoT technology in hydroponic farming systems can be done to determine the parts per million (ppm) content in water and water levels in real-time. The method used in this community service is socialization and training for farmers in Medalkrisna Village, as well as testing using the prototyping method connected to the Blynk application. This tool allows farmers to monitor parts per million of water and water levels online and makes it easier for farmers to monitor. The managerial implications of implementing Blyink's Internet of Things-based hydroponic system to improve food security include increasing the efficiency of resource management and optimizing agricultural production.

Keywords: Agriculture Technology, Hydroponic System, IoT

JEL Classification: Q16, Q18, Q13

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1. Introduction
Food security is an increasingly important issue in Indonesia, especially in rural areas. In recent years, challenges such as climate change, urbanization, and population growth have led to declining agricultural yields and threatened food availability (Chaireni et al. 2020; Hidayat 2023). Medalkrisna Village, located in Bojongmangu District, Bekasi Regency, has great potential for agricultural development. Based on BPS data in 2019, Medalkrisna Village is a village with the smallest number of farming families, namely 246 farming families (Bekasi Regency Central Statistics Agency 2019). This condition is because the local community still relies on traditional farming methods that are less efficient.

Therefore, there needs to be innovation in agricultural practices to increase productivity and ensure sustainable food availability. The prolonged dry season has had a significant impact on the lives of farmers in Medalkrisna Village, Bojongmangu District, Bekasi Regency, especially in terms of water availability for farming. The water sources that are usually used by the community to irrigate rice fields have dried up, causing the rice fields to no longer be productive. This condition has a major impact on the lives of farmers, the majority of whom are rice farmers; they have difficulty maintaining their agricultural activities, which ultimately results in a decrease in yields. When the dry season arrives, farmers switch to other livelihoods to meet their daily needs, and the potential of the existing land is neglected (Nurhidayah et al., 2023; Purwantari, 2023).

The hydroponic farming method uses water as the main medium to meet its nutritional needs. This method requires less water than plants grown in soil. Therefore, farming activities using the hydroponic method are suitable for areas with limited water sources (Setianingrum et al., 2020)(Aji et al. 2021). One of the plants that is popular among farmers and consumers because of its various advantages is pak choi as a plant that is relatively easy to grow, pak choi has a short life cycle so that it can be harvested in a relatively short time (Setianingrum et al., 2020)(Prasetyo, Nugroho, and Setyawan 2022). Pakcoy seeds are easy to obtain and affordable, making them an economical choice for cultivation, especially in limited conditions such as those experienced by the community (Alam et al. 2021; Rahmadhani, Widuri, and Dewanti 2020).

In terms of care, Pakcoy does not require special treatment and can grow well in a variety of environments, including in hydroponic systems. The use of hydroponics not only reduces costs associated with the use of land and fertilizers but also saves water, a very limited resource during the dry season. Pakcoy is an ideal plant to cultivate in drought situations. In addition, pakcoy has a lot of protein, vegetable fat, calories, carbohydrates, fiber, calcium, magnesium, sodium, phosphorus, iron, Vitamin A, Vitamin B, and Vitamin C, providing essential nutrients to support the health of pregnant women (Akbar et al. 2024). Regular consumption of pakcoy can help increase the nutritional intake of villagers while strengthening local food security. In an economic context, pak choy has good market potential, both for local needs and as an MSME product that can be sold to other regions (Aziz, Setyawati, and Al Kharits, 2023; Putra, Fadhliah, and Khoiriyah, 2024).

One innovative solution that can be implemented is an Internet of Things (IoT)-based hydroponic system. The Blyink Internet of Things (IoT)-based hydroponic system offers a modern approach to plant cultivation, especially pak choi, which is known as one of the green vegetables rich in nutrients. With this system, pak choi plants can be grown without using soil, thereby reducing the risk of soil diseases and utilizing space more efficiently. The process of growing pak choi through hydroponics allows farmers to strictly control the nutrients, water, and growing environment needed by plants, thereby increasing yields. Hydroponic technology enables soilless farming, thus overcoming the problem of limited land. With IoT integration, monitoring of plant conditions can be done in real time so that farmers can make more precise and efficient decisions. The application of this technology is expected to not only increase agricultural yields but also reduce dependence on limited resources, such as water and fertilizers (Doni and Rahman, 2020; Fuada et al., 2023; Sulistiyanto et al., 2023). According to Widodo (2020), IoT is a technology that allows surrounding objects to communicate with each other via an internet network, the concept of which is that objects can send data via the internet automatically without human intervention. IoT Blyink integrates various sensors that can monitor environmental conditions in real-time, such as temperature, humidity, pH, and nutrient levels in solutions. Data collected by these sensors can be accessed via a mobile application or online dashboard so that farmers can carry out the necessary monitoring and adjustments remotely (Afandi et al., 2023; Suryatini, Purnomo, and Harlanti, 2023). With the advancement of technology that continues to develop, IoT can be used in the agricultural sector. It has been proven that the IoT technology used is based on LoRa or long-range (Prasetyo et al. 2022; Sanubari, Indriyanto, and Pramono 2024).

Through this community service program, the introduction and implementation of hydroponic technology, for pakcoy cultivation is expected to be an effective and sustainable solution in

overcoming agricultural challenges in Medalkrisna Village, as well as improving economic welfare and public health. In addition, with the support of Blynk IoT technology, farmers can monitor plant conditions, such as water levels, in real-time, which allows for more efficient and effective plant management. This community service program is also expected to make a significant contribution to improving food security and the welfare of the Medalkrisna Village community. This effort is also in line with the government's program to increase agricultural productivity through the application of innovative and sustainable technology.

Based on previous research, the availability of valid data allows researchers to analyze variables objectively, especially in the context of the use of technology in the agricultural sector, which continues to grow (Nurhidayah et al., 2023; Purwantari, 2023). According to Prasetyo et al. (2022), the application of Internet of Things (IoT) technology in hydroponic systems can increase the efficiency of water and plant nutrient management, which is important in facing the challenges of climate change and resource constraints. Therefore, this study seeks to collect current and reliable data to understand further the impact of IoT technology in increasing agricultural productivity in areas with limited resources.

2. Method

The community development method applies the socialization and training method with several stages (Basri et al., 2023; Wekke, 2022). The stages of the implementation method must be carried out in a structured and continuous manner. starting with the preparation and planning stage, which includes a needs survey, equipment procurement, and the creation of tool designs, followed by socialization and training to the community to provide them with the knowledge and skills needed. Here are the stages of the implementation method:

1. **Preparation and Planning**. Survey and analysis of needs to understand the village's actual conditions, including water resources, available land, and the community's readiness and interest in hydroponic technology; procurement of IoT equipment such as solar panels, batteries, ESP8266, TDS sensors, and ultrasonic sensors; creation of IoT tools for monitoring PPM parameters and hydroponic water levels using the Blynk IoT application, which can be accessed in real-time.
2. **Socialization and Training**. Conducting counseling to the community regarding the concept of hydroponics, its benefits, and how technology can help them overcome the problem of water shortages. In addition, explaining the economic potential of cultivating pak choy and other hydroponic plants. Hydroponic technology training, namely providing direct training to the community on how to assemble and operate a hydroponic system, including how to plant pak choi and other plants in the system; IoT Blynk usage training, namely teaching farmers how to use the IoT Blynk application to monitor water levels and PPM in real-time, so they can intervene quickly if needed.
3. **Implementation of the Hydroponic System**. Installation of the hydroponic system, together with the community, the community service team consisting of students and lecturers from the Islamic University 45 will install a hydroponic system in strategic locations in the village, both in people's homes and on shared land. Planting and maintenance, namely planting pak choi seeds and other plants in the installed hydroponic system. During this phase, the team will provide guidance and assistance to the community in terms of plant maintenance, monitoring and evaluation, namely using IoT Blynk technology. The community will be trained to monitor plant conditions periodically. The community service team will conduct routine evaluations of plant growth, water use, and system effectiveness.

3. Results

The community service program began on August 14, 2024, to September 9, 2024, located in Medalkrisna Village, Bojongmangu District, Bekasi Regency. The implementation activities started from observation activities until the activities were completed. The activity entitled "Hydroponics Based on the Internet of Things (IoT) Blyink" was carried out in several main stages, which can be seen in the following Table 1:

Table 1. Time and Place of Implementation

NO	Activity	Execution time	Location
1	Observation	August 14, 2024	Medalkrisna Village
2	Program Planning	August 15, 2024	Unisma Bekasi
3	Preparation of tools and materials	August 19, 2024	
4	Tool Making	August 26, 2024	Medalkrisna Village
5	Socialization and IoT training	September 1, 2024	
6	Evaluation	September 9, 2024	

In order to improve food security in Medalkrisna Village, this community service activity carries the theme "Implementation of the Blyink Internet of Things (IoT) Based Hydroponic System." In implementing hydroponic technology integrated with IoT, the PPM team aims to provide innovative solutions for local farmers in optimizing vegetable production efficiently and sustainably. This system not only facilitates real-time monitoring of plant conditions but also increases public understanding of environmentally friendly modern agriculture. With the support of adequate training and facilities, including a detailed budget for community service activities, this activity can contribute significantly to strengthening food security and improving the village economy. The implementation costs that support the implementation of the community service program are listed in Table 2 below.

Table 2. Implementation Costs

No	Information	Quantity	Amount
1	TDS Sensor	1	200.000
2	ESP8266	1	50.000
3	Ultrasonic Sensor	1	20.000
4	Cable	1	30.000
5	Battery and solar cell	1	150.000
6	Acrylic	1	50.000
	Total		500.000

The implementation of this program began with an observation on August 14, 2024, in Medalkrisna Village, where the observation activity was carried out together with the head of the farmer group association (Gapoktan), as in Figure 1. The results of interviews during the observation revealed that in this village, there had never been any training on hydroponics or the use of technology in the agricultural sector. Therefore, the implementation of an IoT-based hydroponic system with the Blynk application has great potential to be developed and implemented in the village.

Figure 1. Observation with the head of Gapoktan

The next activity was to conduct socialization with farmer groups, which was carried out on August 24, 2024, and August 26, 2024, at the house of the head of Gapoktan and the house of Gapoktan RT 09 members. The socialization shown in Figure 2 explains the intent and purpose of what will be carried out.

Figure 2. Socialization and program delivery activities

Socialization activities were carried out by visiting the houses of farmer groups in Medalkrisna Village and informing them of the program that would be carried out, namely "Implementation of the Blynk Internet of Things (IoT) Based Hydroponic System to Increase Food in Medalkrisna Village."

Figure 3. Making the Blynk IoT tool

Figure 3 shows the activity of making an IoT tool for reading PPM levels and water levels. Another advantage of the IoT-based hydroponic system is the efficiency of water and nutrient use. In the hydroponic method, the water used can be recycled, thereby reducing waste and resource use. The nutrients provided are also more targeted because they are adjusted to the specific needs of the plant at each phase of its growth. This situation not only increases productivity but also produces vegetables of better quality. The application of the Blyink system in pak choy cultivation also makes it easier for farmers in the maintenance process. With the available data notifications and analysis, farmers can plan maintenance actions more effectively, such as fertilization or pest control. This effort helps reduce the use of pesticides and other chemicals, making the harvest healthier and more environmentally friendly. Thus, the Blyink IoT-based hydroponic system not only increases efficiency and productivity but also supports sustainable agricultural practices.

Figure 4. IoT Blynk-based hydroponic system training

Figure 4 shows the training activity "Implementation of the Blynk Internet of Things (IoT) Based Hydroponic System to Increase Food in Medalkrisna Village. The training was conducted on September 1, 2024, which took place at the house of the Gapoktan chairman. The participants who attended were 23 people consisting of mothers, fathers, and young people. The delivery of training materials by practicing directly with the participants. After the delivery of the training materials, a question-and-answer session was held regarding how to use and understand the materials that had been given.

Figure 5. Evaluation and Checking of Tools

Figure 5 is the documentation of the evaluation and checking of tools carried out on September 9, 2024, in the greenhouse and conducting interviews with the head of the farmer group regarding the use of tools and the obstacles faced.

4. Discussion and Benefits

The results of the training on the use of the IoT Blynk-based hydroponic system went well. The training aims to teach PKK mothers, youth, and Gapoktan members to make it easier to monitor PPM (parts per million) levels and water levels in the hydroponic system using the IoT Blynk application. The parameters used to achieve this success are the ability of participants to use the application and produce healthy and fresh plants with the help of monitoring using the Blynk application. The advantages provided in this training help increase efficiency in real-time and enable quick action, save water resources and control nutrient processing. PPM (parts per million) content and controlled water use can improve plant quality.

Table 3. Evaluation Questions

No	Question	Yes	No
1	Does the audience understand how to use the blank application?	70%	30%
2	Does the audience understand how to use the Blynk IoT tool?	70%	30%
3	Are there any parts of the explanation about Blynk IoT that need to be explained further?	80%	20%
4	Do you need any help with the use of the tool?	60%	40%

Table 3 shows the results of the evaluation of activities by asking questions to ensure that the delivery of the material that has been done is conveyed well. Most PKK mothers, youth and members of the farmer group understand how to use the IoT Blynk tool. However, in its implementation, this activity experienced several obstacles, including knowledge of IoT technology and field obstacles, such as limited internet networks.

Significant development opportunities exist in the future, such as increasing the scalability of this technology for further automation, integrating more sensors for deeper data analysis, and building ongoing training programs to improve community understanding and skills in using IoT technology. Overall, the IoT Blyink-based hydroponic system for pak choy plants promises an innovative solution to increase food security and provide economic benefits for farmers. Through this technology, farmers can adapt more easily to the challenges of modern agriculture and achieve optimal results.

Problem Discussion

This study identifies the main challenges in the use of traditional methods that are less efficient in agriculture, especially in areas with limited water, such as Medalkrisna Village and Bekasi Regency. These limitations result in decreased productivity, dependence on conventional agricultural methods, and risks to food security. In addition, the introduction of Internet of Things (IoT) technology based on the Blyink application in the hydroponic system provides an opportunity to optimize the process of monitoring and managing nutrients and plant environmental conditions, which are expected to be a solution to increasing agricultural productivity and food sustainability in the area.

The Nature of Problem Solving

This study aims to overcome resource limitations by implementing an IoT-based hydroponic method that allows farmers to monitor plant conditions in real time through the Blyink application. This implementation will help farmers monitor nutrient and water levels, which are important steps in optimizing resource use and increasing agricultural yields. This creates efficiency, increases control over production, and reduces the risk of crop failure caused by resource limitations.

Benefits of Research. The expected benefits of this research are to provide a basis for developing technology in sustainable agricultural practices. For farmers, especially in rural areas with limited resources, this research offers real solutions to address productivity and food security challenges. The implementation of this simple and applicable IoT technology also has the potential to be developed in other areas, thus providing sustainable economic, ecological, and social benefits for the community at large. Thus, this research is expected not only to increase agricultural yields using technology but also to have a positive impact on local and regional food security.

5. Conclusion

The implementation of the IoT-based hydroponic system training using Blynk technology has proven to be valuable for the community in Medalkrisna Village. This program has equipped local farmers with skills to monitor and manage their hydroponic crops more efficiently, enhancing crop quality and productivity. By learning to use IoT technology, participants can now make informed decisions on plant maintenance, water usage, and nutrient distribution, which contributes to sustainable agricultural practices. Furthermore, this initiative has fostered a sense of empowerment

in the community, showing that modern technology can be accessible and beneficial even in rural areas. For the broader community, this program provides a model of sustainable development that supports local food security and economic stability by enabling villagers to optimize their resources effectively.

Recommendations

The service teams that will continue this project are advised to explore further the technical aspects of IoT, especially related to the use of the Blynk application and the implementation of a more stable cellular network in the village. For further development, it is recommended to add sensors and actuators that allow the hydroponic system to not only monitor but also automatically control important factors such as water volume, nutrient distribution, and plant vitamin levels. In addition, the sustainability of this project will be more assured with the existence of advanced training programs and mentoring for the community, as well as collaboration with local internet service providers to overcome network constraints.

Limitations and Avenues for Future Community

Development

Several limitations emerged in the implementation of the Blyink IoT-based hydroponic system in Medalkrisna Village, such as the community's difficulty understanding this technology, the high initial and maintenance costs, and the limited environmental data collected. We overcome these, an intensive mentoring program is recommended, including the formation of study groups to support the operation and maintenance of the system. Further research is also needed to evaluate the long-term impact on farmer productivity and income and to involve more environmental variables to produce a more comprehensive analysis.

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