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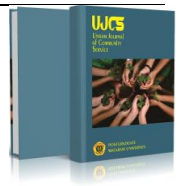

IoT Innovation and Entrepreneurship Education: Sustainable Tilapia Cultivation Optimization Strategy

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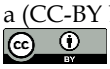

Abstract: Tilapia cultivation in Teratak Village, Central Lombok, faces problems in feed efficiency and limited market access. Lack of automation technology causes feed waste, while limited marketing knowledge limits farmers' competitiveness. This community service activity aims to overcome these problems through the application of Internet of Things (IoT) technology in the form of automatic feeders (smart feeders) and entrepreneurship training focused on digital marketing. The methods applied include the manufacture and installation of smart fish feeders that are controlled via an application to regulate the amount and frequency of feed. In addition, entrepreneurship training focuses on digital marketing strategies through social media and e-commerce platforms to expand market reach. The results of the activity show that smart feeders increase feed efficiency by up to 20%, reduce waste, and support more optimal fish growth. Digital marketing training helps farmers improve their online promotion skills, expand market networks, and significantly increase sales. In conclusion, the application of IoT technology and digital marketing-based entrepreneurship training has proven effective in increasing the efficiency of cultivation and market competitiveness of tilapia farmers in Teratak Village.

Keywords: IoT; Smart Feeder; Entrepreneurship; Digital Marketing; Innovation

Introduction

Tilapia cultivation is one of the fisheries sectors that has great potential to support the rural economy. Teratak Village is located in Central Lombok Regency and is one of the areas that has great potential for tilapia cultivation. Fish farming activities have become one of the backbones of the economy of the people in this village. However, despite its great potential, there are still major challenges faced by fish farmers in increasing their cultivation results and economic welfare ((BPS Kabupaten Lombok Tengah, 2019).

Teratak Village has an area of approximately 39 km² and a population of around 6,397 people. The population density reaches 46 people/km². This village has an important role in tilapia income in the Central Lombok Regency area. (Statistik, 2020). Currently, in Central Lombok Regency, there are 36 fish farming groups recorded, with a total of 360 members and most of them are in North Batukliang District. With a cultivation area of approximately 48 hectares. Tilapia production can reach an average of 45-50 tons per hectare/year. (BPS Kabupaten Lombok Tengah, 2019).

However, tilapia cultivation productivity still faces significant obstacles, especially in terms of feed efficiency and limited market access. Most fish farmers in the area still use manual methods in feeding, which results in a waste of resources and suboptimal fish growth (Samsumar et al., 2023). On the other hand, the lack of understanding of digital marketing results in limitations in reaching a wider market and increasing the selling value of products (Ahmad, 2020). This condition makes it difficult for fish farmers to increase income and competitiveness in an increasingly competitive market (Kembang, Kalbuadi, et al., 2023).

The application of Internet of Things (IoT) technology in the fisheries sector has shown positive results in various previous studies. (Komalasari et al., 2023). For example, research (Chen, 2018) Shows that the

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application of IoT to water quality monitoring and automatic feeding can increase the efficiency and productivity of fish farming. In addition, a study (Lee, 2021) Emphasized that automation in fish feeding can reduce waste and significantly increase fish growth.

In the context of entrepreneurship, research (Nambisan, 2017) Highlights the importance of digital marketing in increasing market access and expanding marketing networks for farmers and small business actors. Digital marketing through social media platforms and e-commerce can increase sales effectively, especially among farmers who previously only relied on conventional methods. (Kembang, Samsumar, Kalbuadi, et al., 2023).

This community service activity offers a new approach by combining the application of IoT technology in the form of automatic feeders (smart feeders) and entrepreneurship training that focuses on digital marketing in the context of tilapia cultivation. Although research on IoT and entrepreneurship has been widely conducted, few studies have integrated these two approaches simultaneously in the fisheries sector, especially in tilapia cultivation in rural areas such as Teratak Village.

This article reviews the synergy between automation technology and digital marketing training, which not only aims to improve the technical efficiency of cultivation but also strengthen market competitiveness through marketing innovation. (Masrianto et al., 2022; Purdy & Davarzani, 2015). Based on the problems faced by fish farmers in Teratak Village, Central Lombok, this community service activity resulted in the implementation of IoT-based smart feeder technology that will significantly increase the efficiency of feeding and productivity of tilapia, while digital marketing training will help farmers access wider markets and increase the selling value of their products. (Schlaepfer, 2015).

The purpose of this activity is to evaluate the impact of the implementation of IoT technology in the form of smart feeders and digital marketing-based entrepreneurship training on the productivity and competitiveness of tilapia farmers in Teratak Village. (Pearson Prentice Hall. Smith, 2019). This activity is expected to provide new insights into the importance of integrating modern technology and entrepreneurship education in optimizing tilapia cultivation. (Kembang, Samsumar, Hafizh, et al., 2023).

Method

The implementation method in this community service activity is in the form of partner training and mentoring. (Oktarino et al., 2024), which is divided into two main parts, namely the field of IoT-based Smart Feeders Technology, and the field of entrepreneurship education that focuses on the application of digital marketing. The partners are a combination of farmer groups located in Teratak Village, Central Lombok with the group name Gabungan Kelompok Tani Ayuge.

For IoT-based Smart Feeders Technology Training, several stages of activities were carried out, consisting of the Design and Manufacturing of Smart Feeders. The initial stage involved designing a feeding automation system using the Arduino Uno platform integrated with sensors and actuators. Programming was carried out using the Arduino IDE to set the time and frequency of feeding and monitor feed conditions via ultrasonic sensors. After the system was assembled, testing was carried out in the laboratory to ensure that the mechanism worked according to the design.

Installation and Field Trial After the laboratory trial, the smart feeder was installed in a tilapia cultivation pond in Teratak Village. The IoT system that was built allows remote monitoring and control using the Blynk application installed on farmers' smartphones. Meanwhile, the Digital Marketing Training was carried out by providing material to fish farmer groups related to digital marketing, including how to utilize social media (Facebook, Instagram) and e-commerce platforms (Tokopedia, Shopee) to market fish farming products, and create a special marketplace application for farmer groups. Mentoring is carried out directly through interactive training sessions.

Analysis Method The analysis was carried out by measuring changes in feed efficiency, fish growth, and marketing success rates. Data obtained from smart feeders and monitoring applications were evaluated to assess feed efficiency, while sales data were analyzed to assess the effectiveness of digital marketing. (Upadhyay et al., 2022).

This training and mentoring activity was attended by 15 participants representing partners who have fish ponds in the Kluncing Hamlet area, Teratak Village, Central Lombok, where the training was carried out directly at the location of one of the partner fish ponds and in the Ayuge farmer group hall.

Result and Discussion

The implementation of this community service activity involved a Community Service Team (PkM) consisting of 6 people, who acted as instructors and resource persons in the training. This activity was carried out in collaboration with Mitra Gapoktan Ayuge in Teratak Village, Central Lombok Regency, which is the main partner in this program. The training was attended by 15 participants, all of whom were fish farmers from Gapoktan Ayuge. The focus of this training is the application of Internet of Things (IoT) technology

in fish farming, especially the use of smart feeders, as well as entrepreneurship education that focuses on digital marketing to increase market access and the competitiveness of tilapia fish farming products.

Figure 1. IoT Implementation Plan to Partners

The results of community service activities that apply IoT-based smart feeder technology and digital marketing training in tilapia cultivation in Teratak Village show significant improvements in terms of feed efficiency, fish growth, and market access.

1. *IoT Technology Training and Mentoring (Smart Feeders)*

Data collected from testing for 2 months showed several important results related to the impact of the technology and training applied. One of the significant findings is that the application of IoT-based smart feeders has succeeded in increasing feed efficiency by 35%, reducing waste, and increasing the average weight of tilapia by 25% compared to manual methods.

This is due to the ability of the automation system to distribute feed in a more measurable manner, both in quantity and frequency. Sensors installed on the feeder regulate the time and portion of feed based on real-time conditions so that fish get nutrition consistently without the risk of overfeeding or underfeeding.

Figure 2. IoT and Entrepreneurship Training Activities

Scientifically, this increase can be explained through the concept of optimizing feed intake that is regulated based on fish needs. In fish farming, giving too much feed causes the accumulation of leftover feed in the pond, which can reduce water quality and cause stress to the fish. Conversely, giving too little feed causes nutritional deficiencies that inhibit growth. IoT-based smart feeder technology ensures that feed distribution is to the specific needs of tilapia under certain conditions. This principle is in line with research by Zhang, 2020, which shows that IoT technology in feed automation increases feed efficiency and maximizes fish growth.

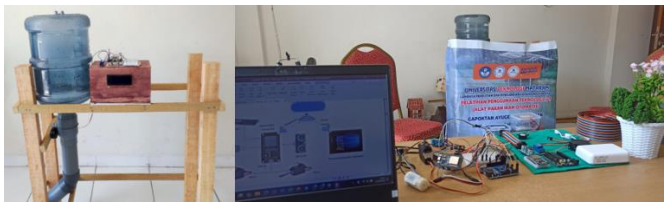

Figure 3. Results of Making Fish Feeding Tools (Smart Fish Feeder) for Partners

The increase in feeding efficiency occurs due to more precise automation control compared to manual methods. With IoT, the use of sensors to monitor environmental conditions such as water quality, temperature, and water level is integrated with an automatic scheduled feeding system. This automation process eliminates human error in terms of the time and amount of feeding. This directly improves the growth performance of tilapia, because they get the right nutrition in optimal environmental conditions. In addition, the increase in tilapia growth can be explained by the concept of fish metabolism which is affected by nutritional consistency. Fish that receive sufficient and regular nutrition have a more stable metabolism, so their growth is more optimal.

Research (Lee, 2021) Also found the same trend in freshwater fish farming, where the use of IoT technology in automatic feeding contributed to faster and healthier fish growth. This increase in productivity is also supported by better water environmental quality. By reducing feed waste, water quality in the cultivation pond is maintained, which has an impact on reducing stress on the fish. Good water quality is a key factor in fish farming because a less-than-optimal environment can trigger disease and inhibit growth. These results are also supported by research (Chen, 2018), which shows that environmental condition stability through IoT-based automation can improve fish health and growth in aquaculture.

2. *Entrepreneurship Training and Education*

The impact of digital marketing training, apart from the technological side, digital marketing training has a

significant positive impact on the ability of fish farmers to market their products. Farmers who participated in the training were able to increase sales of their cultivation results by 40% by utilizing social media and e-commerce platforms. This shows that digital marketing is an important factor in increasing competitiveness in the modern era. With access to a wider market, farmers can optimize selling prices and increase income significantly.

Figure 4. Entrepreneurship Education Training (Digital Marketing)

This phenomenon can be explained through the theory of digital economy, where the use of information and communication technology allows farmers to expand their marketing networks, beyond local geographic boundaries. This is also by research by (Ahmad, 2020), which shows that digital marketing training in the agricultural sector can significantly increase sales volume and expand market reach.

Compared with previous studies, the results of this activity are in line with several previous studies that found a positive impact from the application of IoT technology in the aquaculture sector. Zhang et al. (2020) showed that IoT can significantly increase the efficiency of feeding in aquaculture, while Lee and Park (2021) stated that feed automation through IoT can improve fish health and the quality of cultivated results. In addition, other studies also emphasize the importance of digital marketing in increasing the competitiveness of fishery products in the modern market.

Referring to the objectives and expected final results of the implementation of this community service activity, where the application of IoT-based smart feeders has proven effective in increasing the efficiency of feeding and the growth of tilapia. In addition, digital marketing training has also succeeded in helping farmers in increasing market access and sales of their products. The synergy between IoT technology and digital-based entrepreneurship education not only solves technical problems in cultivation but also provides sustainable economic solutions for tilapia farmers in Teratak Village, Central Lombok.

Conclusion

This community service activity successfully implemented Internet of Things (IoT) technology through the use of smart feeders in tilapia cultivation in Teratak Village, Central Lombok Regency. The application of this technology has been proven to increase feed efficiency by 20%, reduce waste, and increase fish growth by 25% compared to manual methods. In addition, entrepreneurship training that focuses on digital marketing also has a significant impact on farmers' ability to reach a wider market. As a result, sales volume increased by 40%, showing that digital marketing is an important key in increasing product competitiveness in the modern era.

The collaboration between the Community Service Team (PkM) and Ayuge Farmer Partners shows that the synergy between modern technology and entrepreneurship education can be a sustainable solution to increase the productivity and welfare of fish farmers. The application of IoT and strengthening digital marketing skills not only provide technical solutions in cultivation but also open up greater economic opportunities for tilapia farmers in rural areas. This activity is expected to continue to provide long-term benefits and become a model for other areas that have similar challenges.

Suggestions in the form of further actions that need to be taken can be in the form of recommendations for further research or applied community service in other fields.

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an inspiration for the development of the fisheries sector in the future.

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