ENGAGEMENT
Jurnal Pengabdian kepada Masyarakat
Volume 07, Number 02, November, 2023, pp. 409-423

Efforts to Improve the Welfare of Ornamental Fish Farmers in Kalipaten Village Through the Implementation of LoRaWAN-Based IoT Technology

William Widjaja[1*], Theresia Herlina Rochadiani[2], Handri Santoso[3], Ninuk Yasmarini[4], Sherensia Putri Angeliani[5], Gabriel Alexander[6]
Universitas Pradita
william.widjaja@pradita.ac.id, theresia.herlina@pradita.ac.id, handri.santoso@pradita.ac.id, ninuk.yasmarini@student.pradita.ac.id, sherensia.putri@student.pradita.ac.id, gabriel.alexander@student.pradita.ac.id

Article History:
Received: Aug 11th 2023
Revised: Oct 22nd 2023
Accepted: Nov 30th 2023

Keywords:
Income Statement
IoT Technology
LoRaWAN
MSEMs
Product Quality

Abstract: *The ornamental fish business is currently one of the popular businesses in the community. The relatively fast reproduction cycle, around 0.5 – 1.5 months, with a relatively high selling price, makes this ornamental fish business much in demand by the public. The maximum utilization of technology will help MSMEs in increasing their income. This service activity aims to build a LoRaWAN-based IoT system for ornamental fish farming along with a mobile-based ornamental fish monitoring application to help manage ornamental fish livestock, which ultimately has an impact on improving the quality of ornamental fish and the income of CV Home Aquafish partners. The method used is implementing, mentoring, and measuring the effectiveness of the LoRaWAN device in improving the quality of ornamental fish and the income of CV Home Aquafish partners. As a result, LoRaWAN can effectively help minimize mortality in ornamental fish seedlings so that the quality of the fish is maintained. The income of CV Home Aquafish's ornamental fish nursery partners in Kalipaten Village, Gading Serpong, Tangerang also increases.*

Introduction

MSMEs (Micro, Small, and Medium Enterprises) in Indonesia are an essential foundation in supporting the economic ecosystem, contributing as much as 60% to the national gross domestic product and 97% to the absorption of workers affected by the current Covid-19 pandemic. Of all business actors in Indonesia, 99% come from the MSME sector, meaning that MSMEs in Indonesia have a significant influence on economic change in Indonesia. Of course, this is driven by technological advances that continue to evolve following changes from time to time. The development of technology today creates a lot of new ideas and creativity in supporting a changing world. Technology has a positive influence on many aspects, one of which is in the business world, from the

production process, seeking consumer preferences, minimizing the risk of loss, to managing management in a business. Utilization of information technology and several applications that digital companies have provided to offer products and sell them in the hope of increasing revenue continuously. When entrepreneurs can use technology appropriately, it will positively affect MSME income, which means increased income. The research results conducted by Hasanah, Kholifah, and Alamsyah explain that information technology positively influences the income earned by MSMEs. If information technology is utilized optimally, the MSME income obtained will be assessed to increase.[1]

The ornamental fish business is currently one of the popular businesses in the community. The relatively fast reproduction cycle, around 0.5 – 1.5 months, with a relatively high selling price, makes this ornamental fish business much in demand by the public. Based on trade map data, Indonesia is ranked fourth after Japan, Singapore, and Spain as an exporter of ornamental fish worldwide from 2016-2019(2). Referring to 2018 data, Indonesia is in third position globally as an exporter of seawater ornamental fish and fifth in the world for exports of freshwater ornamental fish. The Coordinating Minister for Maritime Affairs and Investment Luhut Binsar Pandjaitan said the export value of Indonesian ornamental fish in 2017 was US$ 27.6 million, an increase of US$ 3 million from 2016, US$ 24.6 million. The world of ornamental fish business is related to the blue economy, an economic system in which the principles of sustainable natural resource management form the basis of and are supported by an efficient and clean production system for society's present and future welfare without damaging the environment. The blue economy relies on marine resources linked to asset preservation and survival management. Closely related to this, this research aims to develop the fishing industry following the concept of the blue economy, which starts with existing MSMEs. In the MSME business, financial reports can be recorded using Standard Micro, Small, and Medium Entity Financial Accounting. This EMKM SAK was prepared to encourage and facilitate the need to prepare MSME financial reports.

Janrosl (2018) said that due to the inability to fulfill the accounting requirements set by SAK ETAP, MSMEs could use SAK EMKM to facilitate the preparation of their financial reports independently.[2] Financial reports are essential for a business, for

[1] Riyan Latifahul Hasanah, Desiana Nur Kholifah, and Doni Purnama Alamsyah, "Pengaruh Modal, Tingkat Pendidikan Dan Teknologi Terhadap Pendapatan Umkm Di Kabupaten Purbalingga," *Kinerja* 17, no. 2 (2020): 305–313.Marini Marini, Linawati Linawati, and Rezi E Putra, "Peran Fintech Terhadap Inklusi Keuangan Pada UMKM Tangerang Selatan," *Keberlanjutan Jurnal Manajemen Dan Jurnal Akuntansi* (2020); Mochamad Mas'ud, "Pemanfaatan Teknologi Sistem Informasi Untuk Meningkatkan Penjualan Hasil Produk UMKM Logam Di Kota Pasuruan," *Engagement : Jurnal Pengabdian Kepada Masyarakat* 1, no. 2 SE-Articles (2017), http://engagement.fkdp.or.id/index.php/engagement/article/view/14; Loviga D Pratama et al., "Pendampingan Umkm Berbasis Digital Marketing Untuk Meningkatkan Keunggulan Kompetitif Produk Di Desa Sumberbulu," *Jurnal Abdi Insani* (2022).

[2] Viola Syukrina E Janrosl, "Analisis Persepsi Pelaku Umkm Dan Sosialisasi Sak Emkm Terhadap Diberlakukannya Laporan Keuangan Yang Berbasis SAK," *Jurnal Akuntansi Keuangan Dan Bisnis* 11, no. 2 (2018): 97–105.

example, to find out the development of the business from period to period, to assist business needs such as tax matters, and to apply for credit to banks as an additional capital injection for business operations. In their research, Santiago and Estiningrum stated that many MSME business actors already understand the importance of financial reports. However, only some business actors know about it because of their limited educational background.[3] The income statement is one of the important financial reports to be used as evaluation material for the financial department. The income statement is one of the important financial reports to be used as evaluation material for the financial department. In their research, Tricia and Apriwenni stated that the income statement (income statement) role measures company performance with income and expenses earned and issued by the company in its transactions each period. The income statement can also be the basis for decision-making. This makes the income statement important for every business actor, without exception for MSMEs.[4]

The object of this community service (CS) activity is the MSME Home Aquafish, established on February 5, 2014, in Gading Serpong. MSME has been running the ornamental fish business for seven years and has 25 ponds. As explained in the research by Kumar and Haniffa[5], they argue that water temperature affects improving product quality. Product quality is one of the factors that must be maximized in a company to achieve consumer desires or expectations. Product quality is the ability to operate its functions, including the dimensions of product quality itself, Kotler and Armstrong.[6] To achieve maximum product quality, several dimensions are measured in the quality of the product itself. In contrast, the dimensions of product quality measurement are performance, durability, conformance to specifications, features, reliability, aesthetics, perceived quality, and serviceability.[7]

---

[3] Mohammad David Santiago and Sri Dwi Estiningrum, "Persepsi Dan Pemahaman Pelaku Usaha Terhadap Pentingnya Laporan Keuangan Pada UMKM," *Ekuitas: Jurnal Pendidikan Ekonomi* 9, no. 1 (2021): 199–205.

[4] Jessica Tricia and Prima Apriwenni, "Pengaruh Ukuran Perusahaan, Laba/Rugi Perusahaan, Kompleksitas Operasi Perusahaan, Dan Reputasi Kapterhadap Audit Delay Pada Perusahaanpertambangan," *Jurnal Akuntansi Bisnis* 10, no. 1 (2018). See Risa Septiani and Eni Wuryani, "Pengaruh Literasi Keuangan Dan Inklusi Keuangan Terhadap Kinerja Umkm Di Sidoarjo," *E-Jurnal Manajemen Universitas Udayana* (2020); Ainna Amalia FN and Lilis Rahmawati, "Pendampingan Manajemen Keuangan Melalui Program Literasi Keuangan Kepada Komunitas Usaha Mikro Kecil Dan Menengah (UMKM) Yang Terjerat Rentenir Di Kabupaten Nganjuk," *Engagement : Jurnal Pengabdian Kepada Masyarakat* 3, no. 1 SE-Articles (2019), http://engagement.fkdp.or.id/index.php/engagement/article/view/55; Jilma Dewi Ayu Ningtyas, M Si, and P Pusmanu, "Penyusunan Laporan Keuangan Umkm Berdasarkan Standar Akuntansi Keuangan Entitas Mikro, Kecil Dan Menengah (Sak-Emkm)(Study Kasus Di Umkm Bintang Malam Pekalongan)," *Riset & Jurnal Akuntansi* 2, no. 1 (2017): 11–17; Pristiana Widyastuti, "Pencatatan Laporan Keuangan Berbasis Standar Akuntansi Keuangan Entitas Tanpa Akuntabilitas (SAK ETAP) Pada Usaha Mikro Kecil Menengah (UMKM) Di Bidang Jasa," *Journal For Business And Entrepreneurship* 1, no. 1 (2017).

[5] Ajaz Ali Bhat et al., "Molecular Characterization of Eight Indian Snakehead Species (Pisces: Perciformes Channidae) Using RAPD Markers," *Molecular Biology Reports* 39, no. 4 (2012): 4267–4273.

[6] Philip Kotler and Gary Armstrong, "Prinsip-Prinsip Pemasaran" (Jilid, 2008).

[7] Nurus Safa'atillah, "Analisis Pengaruh Faktor Kelengkapan Produk, Kualitas Produk Dan Citra

Ornamental fish cultivated include Oscar, Flowerhorn, Man fish, Peacock bass, Koi, Goldfish, and Discus. This MSME serves to sell ornamental fish seeds for large parties and units. Cultivated ornamental fish is marketed through resellers and e-commerce such as Tokopedia and Shopee. This service only focuses on two ornamental fish seeds: Oscar and flower horn. Inappropriate water PH control in the application of livestock fish farming at CV Home Aquafish harms the cultivation process without maximum technological assistance, causing crop failure. So far, pH measurements have been carried out only once weekly for the 25 ponds owned. A technology known as IoT (Internet of Things) technology can be connected in communication to exchange information. This technology can help control and monitor fish farming automatically because it connects machines and devices that provide more significant benefits. IoT technology aims to simplify processes in several fields so that the system can be more efficient in improving living standards. A modulation that applies FM modulation, namely Long Rage or LoRa, is used to create a stable frequency point. Lora has the expertise as a technology to cover large distances of hundreds of square kilometers, vulnerable to environmental influences and location constraints. LoRaWAN is a Low Power Wide Area Network (LPWAN) technology. LoRaWAN also uses a star-on-star topology to save battery power and reach a broader range of communications. LoRaWAN also has high extensibility.

Method

This CS activity was located in the Gading Serpong, Kalipaten Village, RT 001/004 No31, Pakulonan Barat, Kelapa Dua District, Tangerang, Banten. The partner in this CS activity is the MSME Home Aquafish, established on February 5, 2014. The CS activity team conducts periodic surveys to directly observe business conditions regarding income and the quality of ornamental fish cultivated before the CS activity. The method used in this activity consists of 5 stages.

First, identify and compile an income statement pre-IoT implementation. Activities are carried out by conducting surveys to research locations to obtain supporting data in making pre-IoT implementation income statements.

They were second, designing and building a LoRaWAN-based IoT and mobile-based monitoring system. This activity is carried out by installing an IoT system in an ornamental fish pond and a mobile application installed on a partner's smartphone so that it can be used to monitor the ornamental fish cultivation process.

Third, training and assistance in using monitoring systems for fish farmers. In this activity, partners are explained in tutorials on how to operate to use IoT systems and mobile applications without assistance.

Produk Terhadap Loyalitas Konsumen Basmalah Market Karanggeneng," *ILTIZAM Journal of Shariah Economics Research* 3, no. 1 (2019): 1–23.

Fourth, compile and analyze profit/loss financial reports after IoT implementation. This activity is carried out by compiling profit/loss reports based on the results of the IoT post-implementation survey.

The fifth is the stage of measuring and evaluating the effectiveness of IoT on product quality based on the perceptions of breeders. This activity is carried out by providing statements filled out via Google forms by farmers regarding the results of IoT post-implementation on aspects of the effectiveness of IoT use on product quality.

Result

Product Quality Evaluation After LoRaWAN-Based IoT Technology Implementation

Before installing the technology in the ornamental fish breeding pond at CV Home Aquafish, we conducted a pre-survey to find out the location and situation at the research site regarding the quality of ornamental fish products and cost-efficiency before installing the technology.

Figure 1. Survey

After carrying out the pre-survey, the next step was directly installing LoRaWAN-based IoT technology in the Flowerhorn and Oscar ornamental fish nursery ponds.

Figure 2. Implementation

Pre-survey & Post-Survey of the implementation of LoRaWAN-based IoT technology on the aspect of product quality through the application of LoRaWAN-based IoT technology, researchers analyze the aspects of cost efficiency in managing ornamental fish farming by making profit/loss reports and product quality with the dimensions of performance, durability, compliance with specifications, aesthetic serviceability and perceived quality through the perceptions of breeders on Flowerhorn and Oscar ornamental fish. Based on the research results, the pre-survey and post-survey analysis of product quality were obtained in the table below.

Table 2. Performance Dimensions on Flowerhorn

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Breeding flower horns are active and agile	4	S	5	SS
Breeding flower horns can be cultivated again because they produce quality seeds	3	N	4	S
AVERAGE	3,5	S	4,5	SS

Table 2 shows that in the dimensions of average performance after using LoRaWAN-based IoT technology, there is a change of 1.0 points. Before using LoRaWAN-based IoT technology, the average performance of Flowerhorn fish was 3.5 and increased to 4.5 after using LoRaWAN. With the scale of the increase occurring, breeders strongly agree that there is an increase in the quality of Flowerhorn ornamental fish products in the performance dimension through LoRaWAN-based IoT technology.

Table 3. Endurance on Flowerhorn

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Flowerhorn is not easy to get sick in adapting to water quality	4	S	5	SS
Flowerhorn withstands extreme weather	4	S	5	SS
AVERAGE	4	S	5	SS

Based on table 3 shows that there is an increase of 1.0 points in the endurance dimension after the use of LoRaWAN-based IoT technology. With an increase in the dimensions of endurance, partners strongly agree that technology helps to increase the resistance of Flowerhorn ornamental fish and can minimize mortality in Flowerhorn fish seeds.

Table 4. Conformity With Specifications on Flowerhorn

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Flowerhorn has a price that is comparable to the quality provided	5	SS	5	SS
The quality of the flower horn produced is excellent	4	S	5	SS
AVERAGE	4,5	SS	5	SS

In Table 4, it can be seen that the effect is 0.5 points after implementing LoRaWAN-based IoT technology. The partners strongly agree through this increase that the price is comparable to the quality, and the seeds produced from flower horn fish are excellent.

Table 5. Serviceability on Flowerhorn

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Flowerhorn can be sold via E-commerce	4	S	5	SS
Flowerhorn for sale has a warranty period	3	N	3	N
AVERAGE	3,5	S	4	S

Table 5 shows that Flowerhorn sold through e-commerce has increased compared to before the implementation of LoRaWAN-based IoT technology because by using this technology, partners can control the PH of the water so that crop failure of Flowerhorn fish seeds has decreased and can be sold, including to e-commerce more.

Table 6. Perceived Quality on Flowerhorn

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Flowerhorn is varied, unique, and interesting	5	SS	5	SS
Breeding flower horns have exciting colors and pattern patterns	4	S	5	SS
Flowerhorn has a perfect shape	5	SS	5	SS
Bred flower horns have a clear, bold color	4	S	5	SS
AVERAGE	4,5	SS	5	SS

Table 6 shows that the average aesthetic dimension has increased by 0.5 points. This improvement makes some of the quality in the aesthetic aspects of the Flowerhorn fish better, and the partners strongly agree that the colors and pattern patterns produced are more attractive and firm.

Table 7. Perceived Quality on Flowerhorn

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Breeding Flowerhorn seeds are of the same quality	4	S	5	SS
Flowerhorn quality provides maximum benefits	5	SS	5	SS
AVERAGE	4,5	SS	5	SS

It can be seen from Table 7 that the perceived quality of the good Flowerhorn fish has increased to very good after the use of LoRaWAN-based IoT technology. Flowerhorn seedlings raised after using technology became healthier and died. Therefore, the average perceived quality increases by 0.5 points, touching 5.

Tabel 8. Performance on Oscar

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Breeding Oscars are active and agile	4	S	5	SS
Farmed Oscars can be re-cultivated because they produce quality seeds	4	S	5	SS
AVERAGE	4	S	5	SS

Based on Table 8, it can be seen that the average performance dimension after the use of LoRaWAN-based IoT technology has increased by 1.0 points. With the scale increase that occurs through the help of LoRaWAN-based IoT technology, partners strongly agree that the Oscar ornamental fish seeds produced are of high quality and have become more active and agile.

Table 9. Endurance on Oscar

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Oscar is not easy to get sick in adapting to water quality	4	S	5	SS
Oscar is resistant to extreme weather	4	S	5	SS
AVERAGE	4	S	5	SS

Table 9 shows an increase of 1.0 in the endurance dimension after implementing LoRaWAN-based IoT technology. With an increase in the dimensions of endurance, the partners strongly agree that technology helps to increase the resistance of Oscar ornamental fish, so they do not get sick quickly in adapting to water quality, are resistant to extreme weather, and can minimize mortality in Oscar fish seedlings.

Table 10. Conformity With Specifications on Oscar

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Oscar has a price that is comparable to the quality provided	5	SS	5	SS
The quality of the resulting Oscar is excellent	4	S	5	SS
AVERAGE	4,5	SS	5	SS

In Table 10, it can be seen that the effect is 0.5 points after the use of LoRaWAN-based IoT technology. With this increase, the partners strongly agree that the price is comparable to the quality, and the seeds produced from Oscar fish are excellent.

Table 11. Serviceability on Oscar

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Oscars can be sold via E-commerce	4	S	5	SS
Oscars sold have a warranty period	3	N	3	N
AVERAGE	3,5	S	4	S

Table 11 shows that Oscar ornamental fish sold through e-commerce increased after implementing LoRaWAN-based IoT technology because by using this technology, partners can control the PH of the water so that they can minimize crop failure in Oscar fish seeds and can maximize sales, including e-commerce more many.

Table 12. Aesthetic on Oscar

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Oscars are varied, unique, and interesting	5	SS	5	SS
Breeding Oscars have exciting colors and pattern patterns	4	S	5	SS
Breed Oscars are bold and vivid in color	4	S	5	SS
AVERAGE	4,5	SS	5	SS

Table 12 shows that the average aesthetic dimension has increased by 0.5 points. This improvement improves some of the qualities in the aesthetic aspects of the Oscar ornamental fish. The partners strongly agree that the resulting colors and pattern motifs are more attractive, and the resulting seeds have more vivid and bold colors.

Table 13. Perceived Quality of Oscar

ITEM	PRE		POST	
	SCALE	CAT.	SCALE	CAT.
Farmed Oscar seeds are of the same quality	4	S	5	SS
Oscar quality provides maximum benefit	4	S	5	SS

RATA-RATA	4	S	5	SS

Based on table 13 shows that the perceived quality of good Oscar fish has increased to very good after the implementation of LoRaWAN-based IoT technology. Flowerhorn seedlings raised after using technology became healthier and died. Therefore, the average perceived quality increases by 0.5 points.

Performance Evaluation of Profit/Loss Reports after the implementation of LoRaWAN-based IoT technology

Through technology implementation, researchers analyze partners' income changes through profit/loss reports before and after the installation of IoT LoRaWAN technology in ornamental fish seed ponds. Below is attached the income obtained from the sale of Flowerhorn and Oscar fish, along with the costs incurred for the ornamental fish breeding process before using this technology.

Through the installation of LoRaWAN-based IoT technology in Flowerhorn and Oscar ornamental fish breeding ponds, ornamental fish nurseries which previously often experienced crop failures were reduced to just under ten ornamental fish seeds that died, which initially reached hundreds, with this phenomenon helping partners increase their income because of products that produced more. It can be seen from the attached profit/loss report results of partners that their sales have increased by 15% after the implementation of LoRaWAN-based IoT technology.

CV Home Aquafish
Income Statement - (Before LoRaWAN)
For the month ended

Sales		29.000.000
Less: Variable expense		
COGS	1.697.000	
MOH	1.000.000	
		2.697.000
Contribution Margin		26.303.000
Less: Fixed Expense		
Common Fixed Expense		4.600.000
Net Income		**21.703.000**

CV Home Aquafish
Income Statement - (After LoRaWAN)
For the month ended

Sales		33.250.000
Less: Variable expense		
COGS	1.959.500	
MOH	1.200.000	
		3.159.500
Contribution Margin		30.090.500
Less: Fixed Expense		
Common Fixed Expense		4.600.000
Net Income		**25.490.500**

Discussion

Efforts to improve the welfare of ornamental fish farmers are essential for sustainability and ethical practices in the industry. Stevens et al. (2017) discuss the potential application of lessons from aquaculture to improve ornamental fish welfare.[8] This is supported by Brandão et al.,[9] who highlighted the negative impacts of certain practices on fish behavior and welfare. Furthermore, Anjur et al. emphasized the importance of biosecurity measures to address disease issues in the ornamental fish industry, in line with the need to improve welfare.[10]

Geurden et al. provided insights into the positive impact of early plant-based feeding on fish acceptance and future utilization, which could be a potential strategy to improve ornamental fish welfare.[11] In addition, Boldt et al. highlighted the regulatory burden on ornamental fish farmers, indicating the need for supportive policies to improve welfare.[12]

Mulyati et al. MULYATI et al. present a strategic approach to the development of ornamental fish farming, emphasizing environmental protection and market orientation, which can contribute to the improvement of fish welfare and the industry as a whole.[13] Furthermore, Honorato et al. suggested the use of fruit residues as feed ingredients for ornamental fish to improve health and reduce production costs, in line with the goal of improving welfare.[14]

Jones et al. highlighted the growing interest in improving ornamental fish welfare, indicating an increased focus on this area.[15] In addition, Dhanasiri et al. demonstrated the potential of applying nitrifying bacteria to improve fish welfare during transportation, offering an innovative approach to improve welfare.[16]

The effort made by the Assistance Team is to provide one alternative to improve the welfare of fish farmers through LoRaWAN-Based IoT Technology, among others:

1. Increase in product quality.

   The quality of ornamental fish products can be seen from several aspects, one of which is fish health. Healthy ornamental fish have normal physical characteristics, no defects, and are actively moving. Stable pond water conditions are one of the factors that affect the health of

[8] Chloe Stevens et al., "Stress and Welfare in Ornamental Fishes: What Can Be Learned From Aquaculture?," *Journal of Fish Biology* (2017).

[9] Manuela L Brandão et al., "Understanding Behaviour to Improve the Welfare of an Ornamental Fish," *Journal of Fish Biology* (2021).

[10] Norashikin Anjur et al., "An Update on the Ornamental Fish Industry in Malaysia: Aeromonas Hydrophila-Associated Disease and Its Treatment Control," *Veterinary World* (2021).

[11] Inge Geurden et al., "The Positive Impact of the Early-Feeding of a Plant-Based Diet on Its Future Acceptance and Utilisation in Rainbow Trout," *Plos One* (2013).

[12] Noah C Boldt et al., "A Regulatory Cost Assessment of Ornamental Aquaculture Farms in Florida," *Journal of the World Aquaculture Society* (2022).

[13] S U R MULYATI et al., "The Prospects of Business Development in Ornamental Fish in Southeast Sulawesi, Indonesia," *Biodiversitas Journal of Biological Diversity* (2023).

[14] Claucia A Honorato et al., "Fruit Residues as Diet Ingredients for Symphysodon Discus: Nutrient Digestibility," *Semina Ciências Agrárias* (2022).

[15] Megan Jones et al., "How Should We Monitor Welfare in the Ornamental Fish Trade?," *Reviews in Aquaculture* (2021).

[16] Anusha K S Dhanasiri et al., "Novel Application of Nitrifying Bacterial Consortia to Ease Ammonia Toxicity in Ornamental Fish Transport Units: Trials With Zebrafish," *Journal of Applied Microbiology* (2011).

ornamental fish. Water temperatures that are too high or low can cause stress in fish, making them more susceptible to disease. Inappropriate water pH can also interfere with fish metabolism.

By using LoRaWAN-based IoT technology, CV Home Aquafish MSME partners can monitor the temperature and pH of the pond water in real-time. This allows partners to take appropriate action in case of inappropriate changes in water conditions. For example, if the water temperature is too high, partners can add cold water to the pond. If the water pH is too low, partners can add chemicals to increase the water pH.

The improvement in the quality of ornamental fish products produced by CV Home Aquafish MSME partners can be seen from the decrease in the mortality rate of ornamental fish seeds. A low mortality rate of ornamental fish seeds indicates that the ornamental fish are healthy and can survive in their environment.

2. Cost efficiency

LoRaWAN-based IoT technology can also help CV Home Aquafish MSME partners to improve cost efficiency. One of them is by reducing labor costs. By using the IoT system, partners do not need to regularly check the condition of the pond water. Partners only need to monitor the data sent by the IoT system periodically.

In addition, IoT technology can also help partners to save on raw material costs. By monitoring the condition of the pond water in real-time, partners can know when the right time to add raw materials, such as fertilizers or medicines. This can prevent excess or shortage of raw materials, which can lead to waste.

Conclusion

This community service activity went very well, with the cooperation of all parties involved. Through the help of LoRaWAN-based IoT technology, partners feel that there is an improvement in product quality and cost efficiency. This technology helps CV Home Aquafish's ornamental fish MSME partners maintain a stable temperature and water PH in ornamental fish ponds, which impacts more satisfactory nursery results. Through the help of this technology, partners can minimize the death rate of ornamental fish seeds, commonly called crop failure. The large number of ornamental fish produced and assessed to have increased certainly positively affected partners' income because the amount produced has increased. It can be concluded that this LoRaWAN-based IoT technology has a positive influence on CV Home Aquafish MSME partners in the ornamental fish breeding process.

Acknowledgement

We thank the Indonesian Ministry of Education and Culture for the grant entrusted to the Pradita University community service team and the support from the university leaders and the head of the Pradita University Research and Community Service. We also want to thank our partner, CV Home Aquafish, who have provided the opportunity to collaborate on this activity in

advancing the MSME for ornamental fish farming.

References

Anjur, Norashikin, Siti F Sabran, Hassan M Daud, and Norasikin Othman. "An Update on the Ornamental Fish Industry in Malaysia: Aeromonas Hydrophila-Associated Disease and Its Treatment Control." *Veterinary World* (2021).

Bhat, Ajaz Ali, M A Haniffa, P R Divya, A Gopalakrishnan, M James Milton, Raj Kumar, and Bilal Ahmad Paray. "Molecular Characterization of Eight Indian Snakehead Species (Pisces: Perciformes Channidae) Using RAPD Markers." *Molecular Biology Reports* 39, no. 4 (2012): 4267–4273.

Boldt, Noah C, Carole R Engle, Jonathan v. Senten, Eric J Cassiano, and Matthew A DiMaggio. "A Regulatory Cost Assessment of Ornamental Aquaculture Farms in Florida." *Journal of the World Aquaculture Society* (2022).

Brandão, Manuela L, Felipe Dorigão-Guimarães, Marcela C Bolognesi, Ana Carolina dos Santos Gauy, André V S Pereira, Lethicia Vian, Thaís B Carvalho, and Eliane Gonçalves-de-Freitas. "Understanding Behaviour to Improve the Welfare of an Ornamental Fish." *Journal of Fish Biology* (2021).

Dhanasiri, Anusha K S, Viswanath Kiron, Jorge M Fernandes, Øivind Bergh, and Mark D Powell. "Novel Application of Nitrifying Bacterial Consortia to Ease Ammonia Toxicity in Ornamental Fish Transport Units: Trials With Zebrafish." *Journal of Applied Microbiology* (2011).

FN, Ainna Amalia, and Lilis Rahmawati. "Pendampingan Manajemen Keuangan Melalui Program Literasi Keuangan Kepada Komunitas Usaha Mikro Kecil Dan Menengah (UMKM) Yang Terjerat Rentenir Di Kabupaten Nganjuk." *Engagement : Jurnal Pengabdian Kepada Masyarakat* 3, no. 1 SE-Articles (2019). http://engagement.fkdp.or.id/index.php/engagement/article/view/55.

Geurden, Inge, Peter Borchert, M Balasubramanian, J W Schrama, Mathilde Dupont-Nivet, Edwige Quillet, Sadasivam Kaushik, Stéphane Panserat, and Françoise Médale. "The Positive Impact of the Early-Feeding of a Plant-Based Diet on Its Future Acceptance and Utilisation in Rainbow Trout." *Plos One* (2013).

Hasanah, Riyan Latifahul, Desiana Nur Kholifah, and Doni Purnama Alamsyah. "Pengaruh Modal, Tingkat Pendidikan Dan Teknologi Terhadap Pendapatan Umkm Di Kabupaten Purbalingga." *Kinerja* 17, no. 2 (2020): 305–313.

Honorato, Claucia A, Rudã F B Santos, Ângelo Raphael Alexandre da Silva, Higo A Abe, Larissa S Dorce, D Araújo, and Rodrigo Y Fujimoto. "Fruit Residues as Diet Ingredients for Symphysodon Discus: Nutrient Digestibility." *Semina Ciências Agrárias* (2022).

Janrosl, Viola Syukrina E. "Analisis Persepsi Pelaku Umkm Dan Sosialisasi Sak Emkm Terhadap Diberlakukannya Laporan Keuangan Yang Berbasis SAK." *Jurnal Akuntansi Keuangan Dan Bisnis* 11, no. 2 (2018): 97–105.

Jones, Megan, Mhairi E Alexander, Donna Snellgrove, Peter Smith, Sam Bramhall, Peter

Carey, Fiona L Henriquez, Iain McLellan, and Katherine A Sloman. "How Should We Monitor Welfare in the Ornamental Fish Trade?" *Reviews in Aquaculture* (2021).

Kotler, Philip, and Gary Armstrong. "Prinsip-Prinsip Pemasaran." Jilid, 2008.

Marini, Marini, Linawati Linawati, and Rezi E Putra. "Peran Fintech Terhadap Inklusi Keuangan Pada UMKM Tangerang Selatan." *Keberlanjutan Jurnal Manajemen Dan Jurnal Akuntansi* (2020).

Mas'ud, Mochamad. "Pemanfaatan Teknologi Sistem Informasi Untuk Meningkatkan Penjualan Hasil Produk UMKM Logam Di Kota Pasuruan." *Engagement : Jurnal Pengabdian Kepada Masyarakat* 1, no. 2 SE-Articles (2017). http://engagement.fkdp.or.id/index.php/engagement/article/view/14.

MULYATI, S U R, TOMMY HERDIANTO, ACHMAD SUHERMANTO, and Achmad Sofian. "The Prospects of Business Development in Ornamental Fish in Southeast Sulawesi, Indonesia." *Biodiversitas Journal of Biological Diversity* (2023).

Ningtyas, Jilma Dewi Ayu, M Si, and P Pusmanu. "Penyusunan Laporan Keuangan Umkm Berdasarkan Standar Akuntansi Keuangan Entitas Mikro, Kecil Dan Menengah (Sak-Emkm)(Study Kasus Di Umkm Bintang Malam Pekalongan)." *Riset & Jurnal Akuntansi* 2, no. 1 (2017): 11–17.

Pratama, Loviga D, Anisa Y Putri, Novi A Yulia, and Wahyu Lestari. "Pendampingan Umkm Berbasis Digital Marketing Untuk Meningkatkan Keunggulan Kompetitif Produk Di Desa Sumberbulu." *Jurnal Abdi Insani* (2022).

Safa'atillah, Nurus. "Analisis Pengaruh Faktor Kelengkapan Produk, Kualitas Produk Dan Citra Produk Terhadap Loyalitas Konsumen Basmalah Market Karanggeneng." *ILTIZAM Journal of Shariah Economics Research* 3, no. 1 (2019): 1–23.

Santiago, Mohammad David, and Sri Dwi Estiningrum. "Persepsi Dan Pemahaman Pelaku Usaha Terhadap Pentingnya Laporan Keuangan Pada UMKM." *Ekuitas: Jurnal Pendidikan Ekonomi* 9, no. 1 (2021): 199–205.

Septiani, Risa, and Eni Wuryani. "Pengaruh Literasi Keuangan Dan Inklusi Keuangan Terhadap Kinerja Umkm Di Sidoarjo." *E-Jurnal Manajemen Universitas Udayana* (2020).

Stevens, Chloe, Darren P Croft, Gregory C Paull, and Charles R Tyler. "Stress and Welfare in Ornamental Fishes: What Can Be Learned From Aquaculture?" *Journal of Fish Biology* (2017).

Tricia, Jessica, and Prima Apriwenni. "Pengaruh Ukuran Perusahaan, Laba/Rugi Perusahaan, Kompleksitas Operasi Perusahaan, Dan Reputasi Kapterhadap Audit Delay Pada Perusahaanpertambangan." *Jurnal Akuntansi Bisnis* 10, no. 1 (2018).

Widyastuti, Pristiana. "Pencatatan Laporan Keuangan Berbasis Standar Akuntansi Keuangan Entitas Tanpa Akuntabilitas (SAK ETAP) Pada Usaha Mikro Kecil Menengah (UMKM) Di Bidang Jasa." *Journal For Business And Entrepreneurship* 1, no. 1 (2017).