International Journal of Electronics and Communications System
Volume 3, Issue 2, 69-78.
ISSN: 2798-2610
http://ejournal.radenintan.ac.id/index.php/IJECS/index
DOI: 10.24042/ijecs.v3i2.19750

Design and Construction of an Automation Tool for Feeding Pokdakan Pesawaran Fish

Ricco Herdiyan Saputra
Institut Teknologi dan Bisnis Bakti Nusantara (IBN), Lampung, INDONESIA

Eko Hendrawan
Institut Teknologi dan Bisnis Bakti Nusantara (IBN), Lampung, INDONESIA

Article Info

Article history:

Received: September 28, 2023
Revised: November 2, 2023
Accepted: December 29, 2023

Keywords:

Automatic;
Fish;
Feed;
RAD;
Technology

Abstract

This study focuses on developing an automated feeding tool for fish farming in Pesawaran, a region known for its aquaculture potential. Aquaculture, crucial for global food needs, requires efficient and sustainable management, especially in feeding, a critical factor in fish growth and health. Traditional manual feeding methods are time-consuming and prone to errors, affecting fish productivity and growth. The research aimed to enhance feed management efficiency, minimize feeding errors, and improve the sustainability and productivity of fish farming in Pesawaran. The initial phase involved analyzing the needs of fish farmers, environmental factors, and fish species. The design of the automation tool emphasized ergonomics, reliability, and ease of use. The Rapid Application Development (RAD) method was employed, focusing on quick and iterative development. This method was applied at the Pokdakan Young Farmer RPL in Negeri Sakti Village, Gedong Tataan District, Pesawaran Regency, from July to November 2023. The application of RAD in designing the Pokdakan Pesawaran fish-feeding automation tool yielded positive outcomes. The fast, responsive development process, which actively involved users, led to a practical solution well-received by the fish farming community. This research demonstrates the value of RAD principles in providing practical, locally relevant solutions and guiding the development of adaptive, user-oriented aquaculture technology.

To cite this article: R. H. Saputra and E. Hendrawan, "Design and Construction of an Automation Tool for Feeding Pokdakan Pesawaran Fish," *Int. J. Electron. Commun. Syst.*, vol. 3, no. 2, pp. 69-78, 2023.

INTRODUCTION

Human population growth is rapid, so the increasing demand for food sources has encouraged increased attention to the aquaculture sector to meet animal protein needs [1]. Aquaculture has several terms, such as fish cultivation, and aquaculture. Fisheries cultivation is the activity of producing aquatic (water) biota (organisms) to gain profit [2]. In local terms, the aquaculture system is known as Karamba [3].

Aquaculture and fish cultivation have become increasingly crucial in fulfilling global food needs. In this context, efficient and sustainable management of fish farming activities becomes crucial. One of the main aspects of fish cultivation is feeding, which plays a central role in fish growth and health. Established aquaculture requires effective fish farm management to balance high yields with low farm effluent and consider changes in available water sources [4].

Artificial intelligence, IoT, and BlockChain technologies are widely explored in the present scenario to improve livestock sustainability [5], [6], [7]. An analysis of their chewing habits, eating patterns, and movement patterns, i.e., standing, moving, drinking, and feeding habits, indicate the amount of stress the animal is going through, which in turn helps in predicting the vulnerability to disease, weight gain, and production of the livestock [8]. These systems are limited by a lack of sensors that monitor the following process variables: temperature, dissolved oxygen, pH, turbidity, total ammonia

• **Corresponding author:**
Institut Teknologi dan Bisnis Bakti Nusantara (IBN), Lampung, INDONESIA. ✉ ekohendrawan85@gmail.com

nitrogen (TAN), tank water levels, and feeding [9].

Pesawaran Regency, known for its natural resource potential, has experienced significant development in the local economy in the aquaculture sector. However, fish cultivation is often faced with challenges in providing optimal feed. The manual feeding process is not only time-consuming but also prone to dosage and frequency errors, which can negatively impact fish growth and production efficiency. Adequate feeding increases the growth rate of cultivated species and reduces food waste and water pollution [10].

To overcome this problem, this research aims to design and build an automation tool for feeding fish in fish cultivation groups (Pokdakan) in Pesawaran Regency. This tool is expected to increase the efficiency of feed management, reduce the risk of feeding errors, and increase the productivity and sustainability of fish cultivation in the area [11].

In the initial stage, analysis of the needs of fish farmers, environmental characteristics, and types of fish cultivated will be the focus. Furthermore, automation tools will be designed considering ergonomics, reliability, and ease of use. Implementation of the tool prototype will involve field trials to ensure optimal performance and positive response from fish farmers [12], [13].

With the development of this feeding automation tool, it is hoped that it can positively contribute to increasing the productivity of fish cultivation in Pesawaran Regency and become a reference for other regions with similar needs in managing fish feed efficiently. This research can also be a basis for developing similar technology on a broader scale, supporting the sustainable growth of the aquaculture sector at national and international levels.

METHOD

According to Whitten & Bentley, Rapid Application Development (RAD) is a system development strategy emphasizing speed in development through user involvement in rapid, iterative, and incremental development of a series of system prototypes that can develop into a system. Specific ending or version [14]. The basic idea of Rapid Application Development (RAD) is as follows [15]: 1) To make users more effective in analyzing, designing, and building activities; 2) Organize system development to be more focused and involve more system owners, users, analysts, designers, and builders; 3) To accelerate system requirements analysis and design activities through an iterative development approach; 4) To reduce the time needed for users to see the work process of the system being developed; 5) The following is the cycle process of Rapid Application Development (RAD).

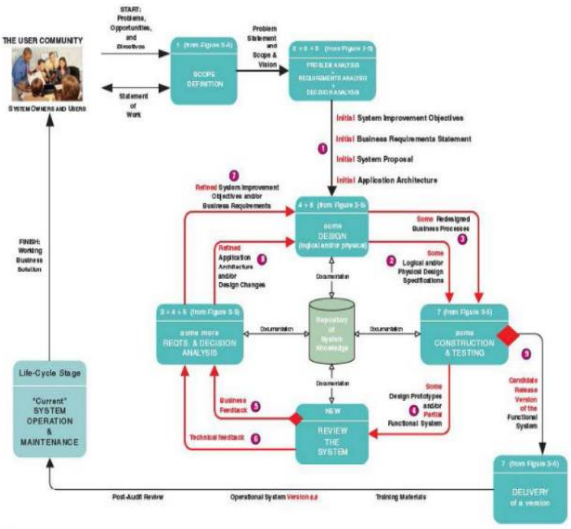

Figure 1. Rapid Application Development (RAD)

Whitten & Bentley explain the description of the rapid application development (RAD) process above as follows [14]: 1) The problem analysis, system requirements analysis, and decision analysis stages need to be accelerated and consolidated to reduce the time required for system and application development. RAD, which uses an iterative approach in the initial analysis process, can be completed within a few weeks; 2) The physical and logical design process is usually shortened and significantly accelerated. In each iteration cycle, only a few design specifications are considered. When several system models can be taken, they can be selected and emphasized to continue rapid development. Assumes errors can be discovered and resolved in the following iterative process; 3) It is rare, but there is some possibility that business processes need to be redesigned to represent application involvement in the system; 4) In each iteration cycle, several prototype designs and several functions of the system parts are built and tested. Later, the completed application will result from the final iteration process; 5) After

each prototype and functional system is developed and tested, users can try using it. User expectations for the prototype will become new system requirements and respond to the business process description; 6) Later, after each prototype and functional system is developed and tested, system analysts and designers will review it to get technical feedback and development direction for the following process; 7) Based on the responses obtained, the system analysts will identify the objectives or direction of justification for implementing the system or system requirements.

Based on the responses received, designers will identify the purpose or direction of design changes and justify the application architecture. Later, the system will be assessed as ready to be implemented [16], [17].

Advantages and Disadvantages of RAD

According to Whitten & Bentley, Rapid application development (RAD) provides several advantages in its use in building website prototypes but also has disadvantages that can cause losses. The following further explains the advantages and disadvantages of rapid application development [14].

Table 1. Advantages and Disadvantages of Rapid Application Development (RAD).

Advantages	Disadvantages
1. It is beneficial for projects where the system requirements to be developed are not completely precise or uncertain. 2. Encourage enthusiastic end-users to participate in the project. 3. The project has high visibility and support due to user involvement. 4. Software-based solutions are faster than business model-based solutions. 5. Errors and omissions can be identified more quickly in this prototype than in the system model. 6. Testing is necessary for a product, which is the basis of the prototype approach. 7. An iterative approach is more natural because change is an expected factor in the development process	1. Several issues say that RAD requires more energy, support, and 2. development, causing an increase in the costs required. 3. RAD can solve the wrong problem if the problem is ignored and shortened. 4. RAD-based prototypes can allow for less enthusiasm from analysts than others. 5. Sometimes, stakeholders see prototypes as a waste of energy and time. 6. Emphasizing the speed of project completion can harm product quality.

According to other experts, the RAD stage consists of planning, analysis, design, implementation, testing, and maintenance. The RAD method is more accessible to implement because development focuses on each development requirement at one time and requires less time [15]. According to R. Astuti, S. Sfenrianto et al. explained that James Martin created RAD, which is designed to provide faster development and quality results [18].

The RAD (Rapid Application Development) research method is a software development approach that emphasizes fast and iterative development. In the context of designing an automated tool for feeding Pokdakan fish in Pesawaran, the following is the RAD research method used:

Step 1: Preparation

Identify Needs: 1) Needs analysis to determine the main requirements for fish-feeding automation tools; 2) Interview related parties, including fish farmers in Pokdakan Pesawaran, to understand their needs and expectations for this automation tool.

Step 2: Planning

Team Formation: 1) Form a development team of technology experts, hardware designers, software designers, and fisheries experts; 2) Define the roles and responsibilities of each team member.

Preparation of Project Plan: 1) Determine a development schedule that includes iterative

stages; 2) Identify potential risks and plan mitigation strategies.

Step 3: Design
Initial Prototype Design: 1) Create a simple automation tool prototype to get users' initial feedback; 2) Focus on user interface and basic functionality; 3) Prototype Iteration: (a) Perform multiple iterations on prototypes based on user feedback; (b) Adjust the design based on emerging needs during development.

Step 4: Construction
System Development: 1) Implement hardware and software according to agreed designs; 2) Perform repeated testing throughout the construction process.

Step 5: Test
Functionality Test: 1) Conduct functional tests to ensure the automation tool can provide fish food effectively; 2) Identify and fix bugs or deficiencies found during testing.

Step 6: Implementation
Initial Implementation: 1) Implement automation tools in a test environment in Pokdakan Pesawaran; 2) Observe and record automation tool performance and user feedback.

Step 7: Evaluate
User Evaluation: 1) Carry out further evaluation by involving key users; 2) Gather further feedback to make necessary changes.

Step 8: Refinement
Optimizations and Improvements: 1) Make changes or improvements based on user feedback and evaluation results; 2) Iterate on specific steps if necessary.

Step 9: Deployment
Full Implementation: 1) Thoroughly implement automation tools in Pokdakan Pesawaran after ensuring good operational skills and user acceptance; 2) Provide training to fish farmers to ensure they can use automation tools effectively.

Step 10: Maintenance
Maintenance and Support: 1) Establish a routine maintenance and technical support plan for users; 2) Set up a problem reporting and repair handling system.

In applying this research method, several challenges are faced, including: 1) **High Initial Investment Costs**: (a) The main challenge is the high cost of purchasing and installing technology; (b) Lack of funds to adopt advanced technology such as automation systems can be a barrier; 2) **Environmental Complexity**: How do we deal with various environmental conditions in the Pokdakan Pesawaran area that might affect the performance of automation tools, such as weather and water conditions?; 3) **Limited Human Resources**: How do we overcome labor limitations that may occur in Pokdakan so that automation tools can be operated efficiently?; 4) **Integration with Existing Systems**: How do we integrate automation tools with existing systems in Pokdakan to ensure accurate data and information availability?; 5) **The researcher provided the following solution**: Raise funds through a joint financing scheme with support from the government or financial institutions and Encourage partnerships with non-profit organizations to provide financial resources; 6) **Weatherproof and Waterproof Design**: Ensure the design of automation equipment can withstand changing weather and water conditions by using materials and technology resistant to corrosion and moisture; 7) **Operator Training**: Organize training for Pokdakan operators to use and maintain automation tools. This can increase the efficiency of tool use and minimize the need for labor; 8) **Use of the RAPID Platform**: The Rapid Application Development (RAD) method is used to build automation tool control software. With RAD, software development can be done more quickly, allowing adaptation to evolving needs in the field; 9) **Regular Monitoring and Maintenance**: Incorporate sensors and monitoring systems that can provide real-time information about the condition of automation tools. This will facilitate the early detection of problems and necessary routine maintenance; 10) **Collaboration with Environmental Experts**: They involved environmental experts in development to ensure that automation tools could function optimally and were environmentally friendly.

The RAD method allows for rapid development and responsiveness to changing needs, making it suitable for projects with dynamic environments, such as the design of fish-feeding automation equipment in Pokdakan Pesawaran. By overcoming this challenge, it is hoped that the design and construction of fish-feeding automation equipment in Pokdakan Pesawaran can provide an effective and efficient solution for fish farmers.

RESULTS AND DISCUSSION

This feeding automation tool was implemented at the RPL Farmer Youth Pokdakan in Negeri Sakti Village, Gedong Tataan District, Pesawaran Regency, Lampung Province, Indonesia. This research was conducted for four months, namely July – November 2023.

Implementation of this Fish Feeding Automation Tool goes through several stages:

Step 1: Preparation

Identify Needs:

A needs analysis was carried out to determine the main requirements for a fish-feeding automation tool. The need for Pokdakan is a tool to provide feed automatically and on a schedule. Interview related parties, including fish farmers in Pokdakan Pesawaran, to understand their needs and expectations for this automation tool. The interview results were that this tool could reduce the intensity of the farmer's role in providing feed twice a day, every morning and evening.

The tools needed in designing this automation tool include: (1) Nodemcu ESP8266 Lua Wifi V3 4mb 32mbits Ch340 with Base Plate; (2) 40 Pcs Jumper Cable 20cm Female to Female Dupont Cable; (3) 40 Pcs Jumper Cable 20cm Male to Male Dupont Cable; (4) 40 Pcs Jumper Cable 20cm Male to Female Dupont Cable for Breadboard; (5) Bread Board Mini Breadboard 8.5x5.5 Cm Holes High-Quality Arduino; (6) 12 V 10 Ampere adapter; (7) Towerpro Servo Motor Mh996r Metal Gear Upgrade; (8) DC Jack Power Adapter; (9) Spots / Body Cables / Automotive Car Motorcycle Cables

Step 2: Planning

Team Formation:

Form a development team consisting of technology experts, hardware designers, software designers, and fisheries experts, along with a development schedule that includes iterative stages, which can be seen in the following table:

Table 2. Planning Team Formation

No.	Project Preparation Stages	Estimated Time (Week)	Responsibility
1	Preparation and Needs Analysis	2	Development Team
2	Team Formation and Project Plan	1	Project Manager
3	Initial Prototype Design	3	Software Designer
4	Prototype Iteration	2	Development Team
5	System Implementation	4	Hardware Expert
6	Functionality Test	3	Testing Team
7	Initial Implementation and Observations	2	Development Team
8	User Evaluation	2	Evaluation Team
9	Optimization and Enhancement	3	Development Team
10	Full Implementation and Training	2	Implementation Team
11	Maintenance and Support	On Going	Maintenance Team

Step 3: Design

Initial Prototype Design:

A simple prototype of an automation tool to get initial feedback from users. This tool is designed without a user interface and basic functionality—repeated iterations on the prototype using Arduino IDE software series 2.2.2.

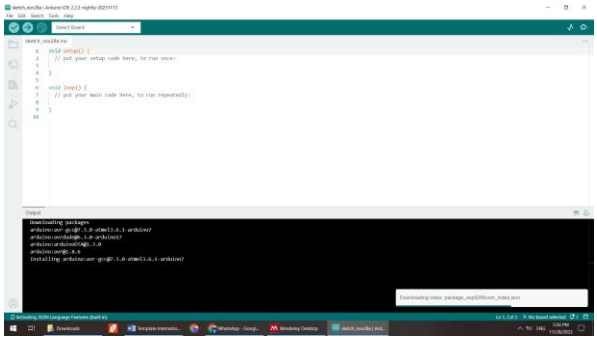

Figure 2. Initial Prototype Design

Step 4: Construction

System Development:

Implement hardware and software according to agreed designs. Repeated testing during construction is carried out with discussions and practice directly in front of the Pokdakan.

Figure 3. System Development

Step 5: Test

Functionality Test: 1) Conduct functional tests to ensure the automation tool can provide fish food effectively; 2) Identify and fix bugs or deficiencies found during testing; 3) At the testing stage, there were problems, such as the rotation of the tool not reaching 180^0

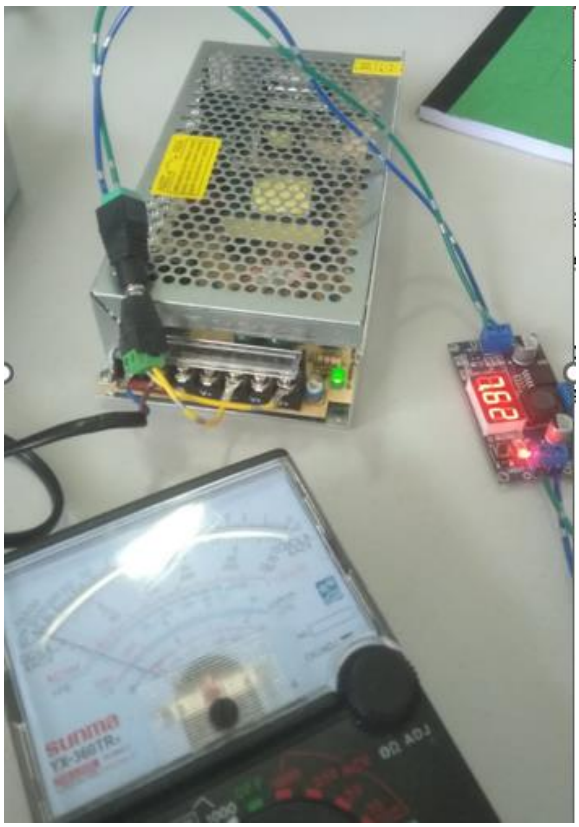

Figure 4. Functionality Test

Step 6: Implementation

Initial Implementation: 1) Implementation of automation tools in a test environment in Pokdakan Pesawaran; 2) Observation and Records of automation tool performance as well as user feedback; 3) At this stage, there is a delay problem that is too long.

Figure 5. Initial Implementation

Step 7: Evaluate

User Evaluation: 1) Further evaluation by involving key users; 2) Further feedback to make necessary changes; 3) At this evaluation stage, if there is a problem with fish food falling into the pond, we need to use a scale to give fish food according to the dose.

Figure 6. User Evaluation

Step 8: Refinement

Optimizations and Improvements: 1) Changes or improvements based on user feedback and evaluation results; 2) Iterate on specific steps as necessary.

Step 9: Deployment

Full Implementation:

Thoroughly implement automation tools in Pokdakan Pesawaran after ensuring good operational skills and user acceptance.

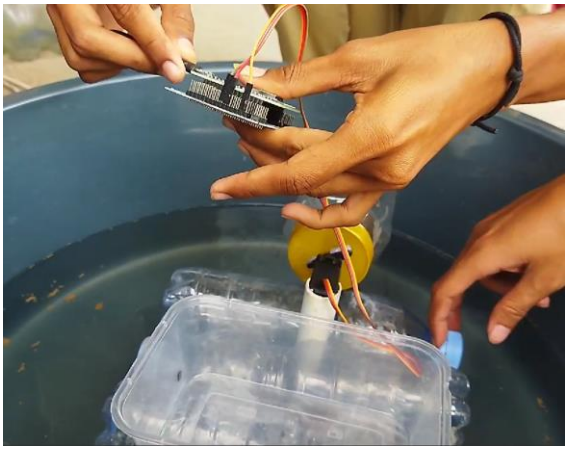

Figure 7. Full Implementation

User Training: Conduct training for fish farmers to ensure they can use automation tools effectively.

Step 10: Maintenance

Maintenance and Support: 1) Establish a routine maintenance and technical support plan for users; 2) Set up a problem reporting and repair handling system.

Table 3. Matrix Variables and Data

Matrix Variables and Data	Number of Percentage (%)	
	Before	After
increase in feed management efficiency	50%	85%
Percentage reduction in feeding errors	50%	80%
Observed productivity increases	50%	75%
Average	50%	80%

So, from the table above, we can see positive results from applying an automation tool for feeding using the RAD method in developing automation tools. This is proven in specific evaluation metrics and quantitative data to increase or increase 30% in aspects of feed management efficiency, the percentage reduction in feeding errors, or the increase in productivity observed.

Design of an automation tool for feeding Pokdakan fish in Pesawaran using the RAD method: 1) **Results of Automation Tool Development**. The application of the Rapid Application Development (RAD) method in developing automation tools for feeding Pokdakan fish in Pesawaran has resulted in significant progress. The iterative, prototype-focused development process allows the team to quickly respond to changing user needs [20]; 2) **Initial Prototype and Testing.** A prototype automation tool was successfully built using the RAD approach in the initial development phase. This prototype was then tested intensively involving fish farmers in Pesawaran. Feedback obtained from users plays a crucial role in defining more precise requirements and identifying necessary improvements [21]; 3) **Flexibility and Adaptability.** The RAD approach provides great flexibility in

accommodating changing requirements during development. The ability to quickly respond to user feedback allows customization of the design and function of automation tools, ensuring that the resulting solutions meet fish farmers' expectations and practical needs [22]; 3) **Performance of Automation Tools**. At the implementation stage, the automation tool demonstrated satisfactory performance during field trials. The accuracy of feed dosage and interface ease of use earned user praise. A development phase involving rapid iteration allows the team to address technical issues that may arise during testing effectively [23]; 4) **Economic Impact and Sustainability.** The implementation of automation tools has had a positive impact on the economic aspects of fish cultivation in Pesawaran. Although initial investment is required, long-term cost savings related to feed efficiency, time, and increased production can strengthen the sustainability of fish cultivation at the local level [24]; 5) **Challenges and Learning.** The RAD method development process has challenges, including maintaining consistency and prototype integration. However, these challenges provide continuous learning and improvement opportunities, supporting the iterative development philosophy underlying RAD [25], [26]; 6) **Implications for Other Technology Development.** The successful development of this automation tool provides the basis for developing similar technology in the context of fish farming in other areas. A RAD approach responsive to user needs can become a model for developing other technologies in the aquaculture sector.

CONCLUSION

Applying the RAD method to design automated tools for feeding Pokdakan fish in Pesawaran brought positive results. A development process that is fast, responsive, and actively involves users has resulted in a solution that is effective and well-adopted by the fish farming community. By involving RAD principles, this research provides practical solutions in a local context and guides the development of more adaptive and user-oriented aquaculture technology.

Potential Limitations and Challenges: 1) Initial Investment Costs: The first challenge faced was the high initial investment costs in designing and building automation equipment for feeding Pokdakan fish in Pesawaran. Many traditional fish farms may have limited budgets to adopt advanced technology; 2) Technical Support Needs: Implementation of automation tools requires technical expertise in operations and maintenance. Traditional fish farmers may not have sufficient knowledge or expertise to understand and operate these devices; 3) Potential Impact on Traditional Fish Farming Practices: Implementing automation technology could impact established traditional fish cultivation practices. These changes may cause resistance or disapproval from fish cultivation communities relying on traditional methods.

Technology Adaptability in the context of fish cultivation or other agricultural sectors: 1) Cost Efficiency Thinking: Technology developers should consider strategies to reduce initial investment costs. This could involve selecting more affordable materials, simpler designs, or smaller, more focused automation tool models; 2) Training and Technical Support: Training and technical assistance programs should be developed to address technical support needs. Technology developers can work with relevant parties to provide training to fish farmers, ensuring that they can independently manage and maintain the automated devices; 3) Gradual Integration: Solutions can be adapted by introducing technology in stages. Small steps integrated with traditional methods can help fish farmers adapt without significantly disrupting cultivation practices; 4) Flexible and Easy-to-Repair Design: Automation technology must be designed with flexibility and easy-to-repair in mind. This allows adaptability to different contexts of fish cultivation or

other agricultural sectors. Modular design can allow customization to suit local needs; 5) Collaborative Research and Participatory Approaches: Technology developers can work with fish cultivation communities and local experts to design solutions. A participatory approach can increase technology acceptance while ensuring local communities adapt the solutions created well.

Through this approach, it is hoped that the developed fish-feeding automation tool can be successfully implemented in other fish cultivation contexts or other agricultural sectors, minimizing negative impacts and increasing sustainability.

REFERENCES

[1] R. A. C. U. F. Ulcsen, R. Jakcs, and M. Gcmicrt, "The microtubule-binding repeats of tau protein assemble into fi1ament. s like those found in Alzheimer's disease," *FEBS LETTERS*, vol. 309, no. 2, pp. 199–202, 1992.

[2] E. Irza and Mulyadi, "Budi daya Perikanan," *Jurnal Budidaya Perikanan*, pp. 1–40, 2004.

[3] F. Firdaus, N. Shalihin, D. K. Anggreta, F. Yasin, and R. Tutri, "Improving the benefits of karamba into tourism activities: An effort to reduce the ecological impact of aquaculture in Maninjau Lake, Indonesia," *Geojournal of Tourism and Geosites*, vol. 26, no. 3, pp. 726–736, 2019, doi: 10.30892/gtg.26304-392.

[4] M. Kami, K. Kampus, and K. Lumpur, "Universiti Putra Malaysia Universiti Putra Malaysia," *Factors Influencing Continuance Intention Towards on-Demand Ridesharing Services*, no. M, pp. 2–3, 2013.

[5] M. A. Alam, A. Ahad, S. Zafar, and G. Tripathi, "A neoteric smart and sustainable farming environment incorporating blockchain-based artificial intelligence approach," *Cryptocurrencies and Blockchain Technology Applications*, pp. 197–213, 2020.

[6] B. I. Akhigbe, K. Munir, O. Akinade, L. Akanbi, and L. O. Oyedele, "IoT technologies for livestock management: a review of present status, opportunities, and future trends," *Big data and cognitive computing*, vol. 5, no. 1, p. 10, 2021.

[7] A. Gehlot, P. K. Malik, R. Singh, S. V. Akram, and T. Alsuwian, "Dairy 4.0: Intelligent Communication Ecosystem for the Cattle Animal Welfare with Blockchain and IoT Enabled Technologies," *Applied Sciences*, vol. 12, no. 14, p. 7316, 2022.

[8] A. Sharma, A. Jain, P. Gupta, and V. Chowdary, "Machine Learning Applications for Precision Agriculture: A Comprehensive Review," *IEEE Access*, vol. 9, pp. 4843–4873, 2021, doi: 10.1109/ACCESS.2020.3048415.

[9] G. M. Soto-Zarazúa, R. Peniche-Vera, E. Rico-García, M. Toledano-Ayala, R. Ocampo-Velázquez, and G. Herrera-Ruiz, "An automated recirculation aquaculture system based on fuzzy logic control for aquaculture production of tilapia (Oreochromis niloticus)," *Aquaculture International*, vol. 19, no. 4, pp. 797–808, 2011, doi: 10.1007/s10499-010-9397-5.

[10] F. D. Von Borstel Luna, E. De La Rosa Aguilar, J. S. Naranjo, and J. G. Jagüey, "Robotic system for automation of water quality monitoring and feeding in aquaculture shadehouse," *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, vol. 47, no. 7, pp. 1575–1589, 2017, doi: 10.1109/TSMC.2016.2635649.

[11] A. E. Multazam *et al.*, "Image Processing Technology for Motif Recognition Mandar Silk Fabric Android Based," in *Indonesian Journal of Artificial Intelligence and Data Mining (IJAIDM)*, 2021, pp. 117–126.

[12] L. Ode, M. Yasir, and M. Fujii, "Assessment of coral reef ecosystem status in the Pangkajene and Kepulauan Regency, Spermonde Archipelago, Indonesia using the rapid appraisal for fisheries and the analytic hierarchy process," *Marine Policy*, vol. 118, no. July 2019, p. 104028, 2020, doi: 10.1016/j.marpol.2020.104028.

[13] L. Yang *et al.*, "Computer vision models in intelligent aquaculture with emphasis on fish detection and behavior analysis: A review," *Archives of Computational Methods in Engineering*, vol. 28, pp. 2785–2816, 2021.

[14] L. D. Bentley and J. L. Whitten, *Systems analysis and design for the global*

enterprise, vol. 417. McGraw-Hill/Irwin New York, 2007.

[15] E. Hutabri, "Penerapan Metode Rapid Application Development (RAD) Dalam Perancangan Media Pembelajaran Multimedia," *Innovation in Research of Informatics (INNOVATICS)*, vol. 1, no. 2, 2019.

[16] S. Nižetić, P. Šolić, D. López-de-Ipiña González-de-Artaza, and L. Patrono, "Internet of Things (IoT): Opportunities, issues and challenges towards a smart and sustainable future," *Journal of Cleaner Production*, vol. 274, 2020, doi: 10.1016/j.jclepro.2020.122877.

[17] J. Reis, A. Weldon, P. Ito, W. Stites, M. Rhodes, and D. A. Davis, "Automated feeding systems for shrimp: Effects of feeding schedules and passive feedback feeding systems," *Aquaculture*, vol. 541, p. 736800, 2021.

[18] R. D. Astuti, S. Sfenrianto, M. Mustofa, D. Andriyani, and E. R. Kaburuan, "Development of 3D Solar System Application Using RAD Model for Elementary Schools," in *2018 International Conference on Orange Technologies (ICOT)*, IEEE, 2018, pp. 1–4.

[19] J. Dolbeault and G. Toscani, "Nonlinear diffusions: Extremal properties of Barenblatt profiles, best matching and delays," *Nonlinear Analysis, Theory, Methods and Applications*, vol. 138, no. 1, pp. 31–43, 2016, doi: 10.1016/j.na.2015.11.012.

[20] D. Coppola, C. Lauritano, F. P. Esposito, G. Riccio, C. Rizzo, and D. de Pascale, "Fish Waste: From Problem to Valuable Resource," *Marine Drugs*, vol. 19, no. 2, pp. 1–39, 2021, doi: 10.3390/MD19020116.

[21] Ogden Rob, "Fisheries forensics : The use of DNA tools for improving compliance, traceability and enforcement in the fishing industry," *Fish and Fisheries*, vol. 9, no. 4, pp. 462–472, 2008.

[22] A. D. M. Smith, E. J. Fulton, A. J. Hobday, D. C. Smith, and P. Shoulder, "Scientific tools to support the practical implementation of ecosystem-based fisheries management," *ICES Journal of Marine Science*, vol. 64, no. 4, pp. 633–639, 2007, doi: 10.1093/icesjms/fsm041.

[23] S. B. Phillips, V. P. Aneja, D. Kang, and S. P. Arya, "Modelling and analysis of the atmospheric nitrogen deposition in North Carolina," *International Journal of Global Environmental Issues*, vol. 6, no. 2–3, pp. 231–252, 2006, doi: 10.1016/j.ecolmodel.2005.03.026.

[24] K. Marzuki, M. I. Kholid, I. P. Hariyadi, and L. Z. A. Mardedi, "Automation of Open VSwitch-Based Virtual Network Configuration Using Ansible on Proxmox Virtual Environment," *International Journal of Electronics and Communications Systems*, vol. 3, no. 1, p. 11, 2023, doi: 10.24042/ijecs.v3i1.16524.

[25] R. Iskandar and M. E. K. Kesuma, "Designing a Real-Time-Based Optical Character Recognition to Detect ID Cards," *International Journal of Electronics and Communications Systems*, vol. 2, no. 1, pp. 23–29, 2022, doi: 10.24042/ijecs.v2i1.13108.

[26] M. Føre, M. O. Alver, K. Frank, and J. A. Alfredsen, "Advanced Technology in Aquaculture–Smart Feeding in Marine Fish Farms," in *Smart Livestock Nutrition*, Springer, 2023, pp. 227–268.