Review Article

Application of IoT-based Technology in Vaname Shrimp Cultivation: A Systematic Literature

ABSTRACT

Vaname shrimp is one type of shrimp that the people of Indonesia widely cultivate. However, there are several problems in the failure of vaname shrimp production, including poor water quality during the maintenance period, especially in ponds. Based on the selection of inclusion and exclusion criteria and quality assessment, it was found that the use of technology in cultivation activities will help streamline time, energy, and human resources so that decision-making can be made faster. The technology used is limited to water quality monitoring, disease monitoring, and EMS. The methods used to create IoT-based technology are hardware devices, software tools, function tests, and user tests. The smaller the error value, the more accurate the data obtained.

Keywords: IoT, Technology, Shrimp

1. INTRODUCTION

Indonesia is a maritime country. Based on data obtained from the Ministry of Maritime Affairs and Fisheries that 25.74% of Indonesia's territory is land, 41.61% is an ocean, and 32.65% is the Exclusive Economic Zone (EEZ) (Rahmantya, 2018). Based on these data, it can be concluded that the State of Indonesia has a larger water area than its land area, so from this fact, Indonesia has enormous potential in terms of fishery productivity. Aquaculture is a set of activities, knowledge, and techniques used to grow aquatic organisms. Aquaculture is very important for Indonesia's economic development and food production. Although aquaculture has great potential and consistently increases, in reality, it has many risks, and many farmers experience crop failure (Saragih, 2015). This is due to the lack of understanding possessed by cultivators, and also, the cultivation method used is still using conventional methods (Madhavireddy, 2018). Starting from observing fish habits and then identifying the effect of environmental changes on the physiological conditions of cultured fish through the expression of their appetite using an automatic self-feeding system (Pratiwy, 2017). Some studies that have used technology in aquaculture such as self-feeding system were done using Nile tilapia gave good results indicated by the growth of fish weight gain was significantly higher ($P < 0.05$) in males than that in females in both groups experiment (Pratiwy, 2017). Another study in shrimp about design and development of an automatic feeder for Penaeus vannamei have been done by Rekha (2017). Along with the development of the era, technology began to develop using IoT to make it easier to monitor, collect, transmit and access data over a network without using the help of computers and humans.

Shrimp is one of the aquaculture commodities in Indonesia, which has the highest level of risk compared to other commodities (Utojo, 2008). Shrimp commodity is sensitive to changes in water quality, so it requires stable water quality conditions to survive. Water quality in shrimp farming must be maintained so that it is always in good condition. Water quality parameters that need to be considered in shrimp farming include the content of dissolved oxygen (DO), hydrogen potential (pH), turbidity, temperature, and water level (Atmomarsono, 2014). These water quality parameters must continue to be maintained at their respective standard values that have been determined so that the shrimp continues to grow and avoid disease so that the shrimp will survive longer until harvest time arrives (Supono, 2017).

Vaname shrimp is one type of shrimp that the people of Indonesia widely cultivate. This shrimp comes from the West Pacific Coast of Latin America, first introduced in 1970 in Tahiti, entered the Asian continent in 1978-1979, and was introduced commercially in Indonesia in 2001. Vaname shrimp is a raised shrimp which is officially designated as one of the leading commodities of aquaculture by the minister of DKP (Ministry of Marine Affairs and Fisheries) in 2001 (Lin, 2015). There are several problems in the failure of vaname shrimp production, including poor water quality during the maintenance period, especially in ponds. High stocking and feeding a lot can reduce water quality conditions. This is due to the accumulation of organic matter because shrimp retain feed protein around 16.3-40.87 %, and the rest is disposed of in the form of excretion of feed residues and feces. Therefore, management and monitoring of water quality during the rearing process are necessary (Faruq, 2019).

The above problems can be minimized by the collaboration of all fields in the midst of this 4.0 revolution, especially Computer Information Technology (ICT) with the specialization of Fisheries. The use of technology in cultivation activities is needed so that data, especially water quality, can be obtained by farmers in real-time. This is because the Internet of Things (IoT) is a technology that allows us to connect machines, equipment, and other physical objects with network sensors and actuators to acquire data and manage their performance, thus enabling devices to collaborate and even act on information—independently obtained (Anwar, 2020). The Internet of Things (IOT) is a future innovation for all smart devices to connect people remotely. Agricultural systems use various sensor nodes to check water parameters. Wireless sensor A network (WSN) consists of a large number of sensor nodes used in the monitoring area to collect, send and process information. Water-rich in phytoplankton and zooplankton, natural food for shrimp that boosts shrimp immunity and enables better survival (Rosaline, 2019).

The use of technology in cultivation activities will help streamline time, energy, and human resources to make decision-making faster. However, there are still many applications of technology during cultivation activities such as monitoring water quality and feeding that are done manually, namely by way of cultivators monitoring ponds directly. The quality of water and feed is one of the crucial factors in the life and growth of vaname shrimp seeds. Water quality affects shrimp ponds: water temperature, salinity, water pH, dissolved oxygen, and alkalinity. At the same time, nutrition and the right amount of feed will reduce the accumulation of excess feed and shrimp feces. However, there are several obstacles in monitoring water quality and feeding, one of which is distance constraints because the location of the pond is far from settlements, so monitoring is carried out intensely every day. Therefore, technological assistance is needed to facilitate cultivators in cultivation activities.

The technology-based fisheries literature has made significant progress in improving our understanding of how technology works in aquaculture. In this paper, the author conducts a systematic literature review to find out the extent to which technology is applied in shrimp farming. This paper is structured as follows: Section 2 presents the materials and methods followed for the systematic review. Section 3 presents the results and analysis of the journals reviewed and the conclusions in Section 4.

2. RESEARCH METHODS

The research method used is modified from Triandini (2019) and Ebrahimi (2021). The object of this research is the application of IoT-based technology in vaname shrimp cultivation. Cultivators can consider the adoption of IoT-based technology to make it easier for vaname shrimp cultivation activities.

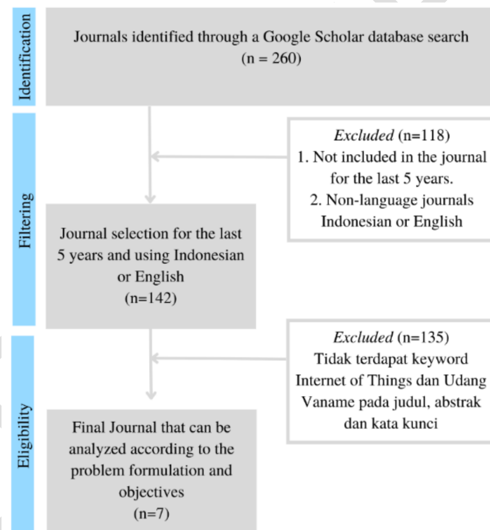

Figure 1. Literature Selection Procedure

The method in this study consisted of the planning stage, which was the initial stage of doing SLR, then the conducting stage, namely the implementation stage of the SLR, and the reporting stage, which was the stage of writing SLR into a report.

1. Research Question

At this stage, questions are determined according to the research topic. The following is a research question in this study:

a. RQ1: What IoT-based technology is used in vaname shrimp farming?
b. RQ2: What devices are used to apply IoT-based technology in vaname shrimp farming?

c. RQ3: How accurate is the application of IoT-based technology in vaname shrimp farming?

2. Search Process

The search process is a search stage to find sources that match the research question. In this study, the authors used secondary research data obtained from journal sources or articles at the site address https://scholar.google.co.id/.

3. Inclusion and Exclusion Criteria

At this stage, the criteria are determined from the data found, whether the data is suitable for use as a data source for research or not. The following are the criteria for data to be said to be worthy of being a research data source, namely:

a. The data obtained has a period from 2016 to 2021.
b. The data used is in Indonesian or English

4. Quality Assessment

At this stage, the data that has been found will be evaluated based on the following questions:

a. QA1: Is the journal paper published in the 2016-2021 timeframe?
b. QA2: Does the journal paper discuss IoT-based technology in vaname shrimp farming
c. QA3: Does the journal paper write the output of the application of IoT-based technology in vaname shrimp farming

And each paper will be given a value based on the questions above.

a. Yes: for journal papers that match the questions in the quality assessment.
b. No: for journal papers that do not match the questions in the quality assessment.

5. Data Collection

At this stage, the data needed in the research is collected for further analysis. The following are the steps for data collection:

a. Visit the site https://scholar.google.co.id/
b. Enter the keyword "IoT-based technology in vaname shrimp farming."
c. In "Custom range," enter 2016 in the first box and 2021 in the second box. This indicates that the selected journal paper range is from 2016-2021.

6. Data Analysis

The data that has been collected in the previous stage will be analyzed at this stage. The results that have been analyzed will answer all the research questions that have been previously determined.

3. RESULT AND DISCUSSION

3.1. Selection Results Inclusion and Exclusion Criteria

I found 260 journals on the Google Scholar platform based on the journal search results. Furthermore, based on the selection based on some inclusion and exclusion criteria, seven journal papers were obtained that were in accordance with the criteria, namely journal papers published in the 2016-2021 period and having discussions related to "Internet of Things" and "Vaname Shrimp Cultivation." The information obtained is then grouped by year of publication (Figure 2).

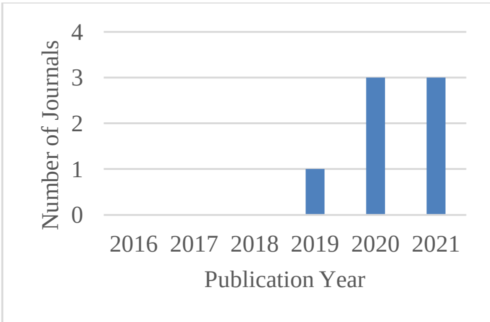

Figure 2. Number of Journals by Year of Publication

Based on the results obtained, it can be seen that the growth trend of publications related to IoT-based technology in Vaname Shrimp cultivation will increase in 2020. One of the earliest studies started from Mina Kamal SMEs, which experienced production failure due to WFD (White Feces Disease) disease, which was then developed technology to assist the process of controlling the water quality of vaname shrimp culture in Lamongan by Febrianti (2019). The number of journals published in recent years shows that IoT applied to vaname shrimp culture is still a topic of discussion for researchers.

In addition, when viewed grouped by journal type, as shown in Table 1, most of the research was carried out by researchers in the IT field. This indicates that the role of researchers in the fisheries and marine fields is still lacking in producing or assisting the process of applying technology to vaname shrimp farming activities.

Table 1. Grouping by Publisher's Journal

No	Journal Type	Year	Total
1	Jurnal Pekommas	2020	1
2	Journal of Innovation and Applied Technology	2019	1
3	Jurnal Infotronik	2020	1
4	Jurnal Infra	2021	1
5	Journal of Computer Science and Informatics Engineering	2021	1
6	Jurnal Informatika	2021	1
7	Jurnal Teknik Informatika dan Sistem Informasi	2020	1

3.2. Quality Assessment Results

The following are the quality assessment results, which are written in tabular form, which can be seen in Table 2. A journal is said to be appropriate if it fulfills that there is sufficient information and is following the predetermined Quality Assessment, and vice versa.

Table 2. Quality Assessment Results

No	Writer	Title	Year	QA 1	QA 2	QA 3	Result
1	Indo Intan, Nurlina, Fitriaty Pangerang, Agung Mulyawan	Sistem Monitoring Sirkulasi Air pada Budidaya Udang Vanam	2020	Yes	Yes	Yes	Accepted

		e berbasis Internet of Thing (*Water Circulation Monitoring System for Vaname Shrimp Cultivation based on Internet of Thing*)					
2	Annurfitri Febrianti, Anis Miftachurrochmah, Ammar Waliyudin Jannah, Yudi Muliawan, Albin Adyaksa Sabil	Water Quality Controller for Cultivation of Vannamei Shrimp (Litopenaeus vannamei) in Wedoro Village, Glagah District, Lamongan Regency	2019	Yes	Yes	No	Accepted
3	Saeful Anwar, Abdurrohman	Pemanfaatan Teknologi Internet Of	2020	Yes	Yes	No	Accepted

		Things untuk Monitoring Tambak Udang Vaname Berbasis Smartphone Android Menggunakan Nodemcu Wemos D1 Mini (*Utilization of Internet Of Things Technology for Monitoring Vaname Shrimp Farms Based on Android Smartphones Using Nodemcu Wemos D1 Mini*)					
4	Kevin Alexander Harianto, Rudy Adipranata, Leo Willyanto Santoso	Penerapan IoT dan Sistem	2021	Yes	Yes	Yes	Accepted

		Pakar untuk Memonitoring Kualitas Air dan Mendiagnosa Penyakit pada Tambak Udang Vaname (*Application of IoT and Expert Systems to Monitor Water Quality and Diagnose Diseases in Vaname Shrimp Farms*)					
5	Muhamad Wisnu Alfiansyah, I Gede Putu Wirarama Wedashwara, Ahmad Zafrullah Mardiansyah	Implementasi IoT Untuk EWS Menggunakan Metode DES Model Holt Pada Tambak Udang Vaname	2021	Yes	Yes	Yes	Accepted

		(*IoT Implementation for EWS Using Holt Model DES Method on Vaname Shrimp Farm*)					
6	Harry Pratama Ramadhan, Condro Kartiko, Agi Prasetiadi	Monitoring Kualitas Air Tambak Udang Dengan Metode Data Logging dan Algoritma KNN Berbasis Internet Of Things (*Monitoring the Water Quality of Shrimp Ponds Using the Data Logging Method and the Internet Of*	2021	Yes	Yes	Yes	Accepted

		Things-Based KNN Algorithm)					
7	Harry Pratama Ramadhan, Condro Kartiko, Agi Prasetiadi	Monitoring Kualitas Air Tambak Udang Menggunakan Metode Data Logging (*Monitoring of Shrimp Pond Water Quality Using the Data Logging Method*)	2020	Yes	Yes	Yes	Accepted

4. Data Analysis

This stage will answer questions from the Research Question (RQ) and discuss the results of the method and the outputs that appear from the selected journal.

4.1. Result of RQ1: IoT Based Technology Used

Based on Research Question 1 or RQ1 regarding IoT-based technology used in vaname shrimp cultivation, a paper category is generated based on the name of the technology being studied. The results shown in table 3 show that currently, many researchers prefer to research IoT-based technology for water quality management of vaname shrimp culture.

Table 3. IoT Based Technology

No	IoT Based Technology	Research Paper	Total
1	Water Quality Management	2, 3, 6, 7	4
2	Disease Management	1, 4	2
3	Early Warning System	5	1

- **Water Quality Management**

Maintaining water quality is an important factor in a healthy aquaculture environment. Its main objectives are: water temperature, pH, dissolved oxygen (DO), salinity, turbidity, ammonia nitrogen, chemical oxygen demand (COD), biochemical oxygen demand (BOD), the parameters that strongly associated to the incubation environment of aquaculture (Gudapati, 2018).

According to Wibisono (2019), three variables significantly affect Vaname Shrimp cultivation because they impact water quality, including temperature, pH, and salinity. Temperature significantly affects the growth of shrimp culture. If there is an extreme increase in temperature, it will result in the death of shrimp. Shrimp fry can grow well in warm water, but the older the shrimp, the lower the optimum temperature. The suitable temperature for the growth of vaname shrimp is 22-30 ^{o}C, while the shrimp is stressed when exposed to temperatures of 15-22 ^{o}C and 22-30 ^{o}C. pH serves as a chemical and biological indicator in aquatic metabolism. If the pH is low, the dissolved oxygen content is low. This can decrease oxygen consumption, reduce appetite, increase activity, and vice versa. Shrimp culture works well in water with a pH of 6.5-9.0 and an optimal range of pH 7.5-8.7. Salinity (salt content) is the environmental change from standard salinity medium (30 ppt) to low salinity stage. The decrease in salinity resulted in lower growth and survival of shrimp.

Manually controlling water quality can give less accurate results or solely on feeling. The utilization of information and communication technology is an alternative solution that adapts current technology to minimize the power of farmers in managing shrimp farming. Maintaining water quality will be a factor for shrimp growth rapidly with a low mortality rate.

Several studies on the design of water quality monitoring have been developed, such as incorporating microcontroller and IoT technology carried out by Intan (2020) to produce real-time, objective information and display the circulation process when water quality changes from normal conditions in the Vaname Shrimp cultivation prototype. Another thing was done by Anwar (2020), who used a microcontroller and sensors (pH and temperature) and ultrasonic sensors to measure the water level and displayed it on Telegram Messenger. There is also the use of data loggers and IoT connected to the internet to send all water quality monitoring data to a Google database service called Firebase, which can be accessed through an android-based monitoring application (Ramadhan, 2020; Ramadhan, 2021).

Some of the advantages of using IoT for water quality management include improving the water quality management are reducing the operational cost of the shrimp aquaculture by using an automatic aeration system (Wiranto, 2015). Also, it helps farmers maintain the water quality precisely to produce high-quality shrimp crops toward the precision aquaculture concepts by using PFF (Precision Fish Farming) (Komarudin, 2021).

- **Disease Management**

Various types of diseases occur in shrimp. Farmers report black gill disease, white muscle disease, shrimp moss, weed breeding, fungal diseases, protozoan-related diseases, and bacterial diseases. Disease outbreaks on a farm contribute to fluctuations in market value and pose a significant threat to the economic viability of the farm. In shrimp farming, disease control and control require maintaining environmental conditions through good aquaculture practices (Uddin, 2020). Shrimp death due to disease is something that farmers avoid. This is caused by several factors, one of which is water quality. This is because if the water quality in aquaculture ponds is not maintained, it can significantly disrupt the activity of the biota in the pond. One of them is stressing the shrimp, which can cause a decrease in shrimp appetite, which results in a large amount of residual organic waste that can damage the ecosystem in aquaculture ponds and cause shrimp to be susceptible to diseases that cause shrimp to die. If the shrimp have been affected by the disease, no cure can 100% cure the disease in the shrimp affected because the treatment for shrimp is not the same as for humans. In most scenarios, if the shrimp has been exposed to the disease, it means it is too late. Therefore it is important to maintain water quality in the culture pond because this is one way that can be used to control the growth of shrimp (Alexander, 2021).

Several studies on the design of water quality monitoring have been developed, such as an IoT-based water quality controller that is operated through an application on a smartphone or web, which results in an increase in SR (Survival Rate) from 63% to 71% with a stocking density of 100 fish/m2 and WFD (White) disease. Feces Disease) which is starting to be resolved with an indicator of a reduced number of white feces floating on the pool water's surface (Febrianti, 2019). Another thing that Alexander (2021) did was not only monitor water quality, but the researchers also succeeded in creating a system that can simplify the process of diagnosing diseases in shrimp with 100% accuracy.

- **Early Warning System**

Research on the Early Warning System (EWS) is still rarely done. EMS is useful for predicting (forecasting) the following data where the data collection pattern is time series. Several methods are used in forecasting data in time series, such as Single Exponential Smoothing, Double Exponential Smoothing, Autoregressive Integrated Moving Average (ARIMA) (Bidangan, 2016). As in Alfiansyah's research (2021), research on EMS requires a lot of data as much as 163 data and consists of several stages of a study that will produce forecast data with a low MAPE (Mean Absolute Percentage Error) value (temperature 9.08% and pH 0.82%).

4.2. Result of RQ2: Method Used

Based on Research Question 2 or RQ2 about the method used to create IoT-based technology in Vaname Shrimp cultivation, the results are paper categories based on the research stage procedures, namely hardware devices, software tool function tests, and user tests. The results seen in table 4 show that all of these studies passed the stages of designing hardware, software, and testing tools, but not all journals showed the results of testing tools on users (cultivators).

Table 4. Device Used

No	Device Used	Research Papers	Total
1	Hardware Device Design	1, 2, 3, 4, 5, 6, 7	7
2	Software Device Design	1, 2, 3, 4, 5, 6, 7	7
3	Function Test Tool	1, 2, 3, 4, 5, 6, 7	7
4	Test Tool Functions on Users	2, 4	2

The method or procedure commonly used is based on the literature above, namely the overall system design, which consists of hardware design, software design, tool function test, and tool function test to the user. Hardware design is by preparing the components used, such as ethernet, Arduino Uno, NodeMCU ESP8266, access point, mini ups, step down, relay, black box, jumper cable, small cable, breadboard, laptop, smartphone, and water quality sensor. The water quality sensors used include a salinity sensor, a DS18b20 temperature sensor to measure temperature, a SEN0161 pH sensor to measure pH, an Ultrasonic Sensor HC-SR04 to measure water levels, a light sensor (light dependent resistor), and a DHT sensor to sense temperature and humidity objects, which has an analog voltage output. After that, it is arranged into a series, and coding is carried out so that all components can work according to the inputted commands. In the coding process, initialization of the setpoint is entered for the water quality variable, including the control action when it is outside the setpoint value. The process is valid if there is no error notification in the coding or compiler.

Software design usually consists of making applications, web, and databases. The software needs include Windows 10 Pro, Visual Code, Arduino IDE, Flutter SDK, Firebase, Heroku, Python, and Android Q. Software design can be described using use cases and entity-relationship diagrams, which show that the interaction between actors is admin and user. In the use case diagram, the admin can manage the microcontroller's data. The user requests access to the admin, logs in to see the water quality value in real-time and according to the sampling time: hours, days to months. While in research that uses data logger software, namely NodeMCU ESP8266, which gets a voltage to activate the sensor, calculations, and calibrations are carried out according to functions in the C programming language on the Arduino Uno. Furthermore, the data is sent to Firebase in real-time as long as the data logger is still connected to the internet. Firebase's real-time database is used because it is quite easy to use.

To find out whether the tool is functioning correctly and integrated according to the programmed command, it is necessary to test the device's function. This can be done by applying it to ponds or ponds, both on a laboratory scale and aquaculture scale, seeing the accuracy of the data obtained or whether the sensor can be read in the application. The lower the error value, the better. Notifications or outputs received by users (cultivators) are very diverse. Some use the Telegram application, MS IP PRO, KKN programs, and application prototypes.

And the last one is testing the tool against the user. This is done to determine whether this IoT-based technology is easy enough to use and facilitates vaname shrimp farming activities. Application testing is carried out by the user or users using the black box method. Application testing is the final test of the vaname shrimp pond monitoring system. In Febrianty's research (2019), after socializing, implementing, and installing applications on smartphones owned by farmers in Wedoro Village, the benefits of data presented in seconds, handling can be done directly, measurements do not require coming to the cultivation location, reduced SR and disease. Decreased WFD. Meanwhile, in Alexander's (2021) research, an assessment was carried out regarding user interface appearance, ease of use of the application, and accuracy in diagnosing vaname shrimp diseases.

4.3. Result of RQ3: Technology Accuracy

Based on Research Question 3 or RQ3 about the accuracy of the tools used in vaname shrimp culture, the results are journaled categories based on the presentation of errors obtained from research results. The smaller the error value, the better. The results shown in Table 5 show the value of the accuracy of the tools from each journal.

Table 5. Technology Application Accuracy

No	Tools	Error (%)	Research Papers	Total
1	Temperature Sensor	2.19	1	1
		0.53	3	1
		0.64	4	1
		9.09	5	1
2	pH Sensor	1.1	1	1
		0.20	3	1
		0.32	4	1

		0.83	5	1
		1.55	1	1
3	Salinity			
		2.36	4	1
4	Ultrasonic Sensor	0.8	3	1

Based on the results of the Table 5, the best accuracy values for temperature, pH and ultrasonic sensors are in study Anwar (2020), while salinity sensors are in study Intan (2020).

5. CONCLUSION

IoT-based technology in vaname shrimp farming activities is for water quality monitoring, disease monitoring, and EMS can be beneficial for farmers. This is because the time required is more effective and efficient, handling and decision-making are faster, and data sources are more centralized. It's just a few things that need to be considered, namely the use of more complete and appropriate sensors for more accurate measurements, a stable internet connection, and the need for application testing on cultivators directly to determine accuracy and ease of use.

bacteria. With biofloc there are some improves in different aspects during culture like higher growth rates, increased survival, improved water quality, reduced amount of water used and decrease in diseases. Thus, role of microorganisms is important in biofloc system; therefore, it is necessary to carry out more studies related to identification of microbes that can be present in biofloc systems.

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