Design of Pond Water Quality Monitoring System Based on Internet of Things and Pond Fish Market in Real-Time to Support the Industrial Revolution 4.0

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Abstract. Pond cultivation is one of the contributors to foreign exchange and employment in Indonesia. The results of pond aquaculture production in Indonesia, according to statistical data in 2016, amounted to 3,012,467 tons, and the area of fish ponds in Indonesia in 2016 was 674,135 ha. The factors that lead to crop failure are illness, theft, poor water quality, and natural disasters such as floods. This research provides a solution called the Internet of Things Ponds (I-Tamb). I-Tamb applies the Internet of Things (IoT) technology to monitor water quality and the pond environment by installing several sensors. This study also aims to reduce crop failure and make it easier for farmers to market their crops. The cloud server receives sensor data in real-time. I-Tamb Apps produces information that can be used by farmer farmers as material for decision making. I-Tamb also facilitates the sale of crops in the form of a marketplace called the I-Tamb Marketplace. The output of this study is the design of an IoT-based pond water quality monitoring system on mobile and web applications.

1. Introduction

Ponds are an average artificial pond in the coastal area for aquaculture. Ponds are used to saving, grow and harvest results in a controlled environment [1]. Pond cultivation is one of the contributors to foreign exchange and employment in Indonesia. The results of pond aquaculture production in Indonesia, according to statistical data in 2016, amounted to 3,012,467 tons, and the area of fish ponds in Indonesia in 2016 was 674,135 ha. Activities to produce aquatic plants and animal species are called aquaculture. Field activities consist of Training, Knowledge, and Techniques for Breeding aquatic plants and several animal species. This activity has a significant interest in economic development and food production. Continuous monitoring of the physical, chemical and biological parameters of pond water helps not only to predict and control adverse aquaculture conditions but also to prevent environmental damage and the collapse of the production process. Monitoring physical and chemical variables such as oxygen, temperature, and pH in water is very important for adequate safety requirements and avoiding unwanted problems that can cause the collapse of the aquaculture system [2].

Water quality is the sum of all the physical, chemical, biological, and aesthetic characteristics of water that affect its use. Technology can be used to measure all the physical, chemical, biological, and aesthetic aspects of water. Any water characteristics in a production system that affect the survival, reproduction, growth, and production of aquaculture species, influence management decisions, cause environmental impacts or reduce product quality and safety can be considered as water quality variables [3].
Failure to harvest, which is often experienced by pond farmers, is one indication of the occurrence of water quality degradation [4]. Based on [5] the factors that lead to crop failure are illness, theft, poor water quality, and natural disasters such as floods [6]. The influence of the state of water is indeed significant because there are several influential water parameters such as water temperature, oxygen content, pH, and salinity [7]. This requires special attention to be able to increase production in each pond in several ways, one of them by paying attention to water quality. Poor water quality affects the slow growth of fish. In the aquaculture business, the availability of water and water quality is one of the factors that determine success in the fish farming business [8].

Internet of things (IoT) can optimize several tools such as media sensors, radio frequency identification (RFID), wireless sensor networks, and other smart objects that allow humans to interact with all equipment connected through the internet network easily [9]. IoT can help in many ways, such as monitoring water quality and environmental health [10].

The use of technology in aquaculture ponds provides breakthroughs to monitor and control pond water quality, such as by installing several sensors around the lake. The sensor gets the data then is processed into information about the pond water quality. With IoT technology that can be used by pond farmers, infrastructure support such as the internet, solar technology to support electricity energy-saving programs. Some sensors that can be used to measure pond water quality, such as Dissolved Oxygen (DO) [11] or also called dissolved oxygen, Potential Hydrogen (pH) [12], water temperature, soil temperature, salinity, CO2, ammonia, nitrite, nitrate, orthophosphate, plankton abundance, and soil texture [13].

2. The Design

This research has prospects to increase market demand, improve pond environmental control, reduce production costs, improve crop quality. I-Tamb was developed based on IoT, which uses a realtime database so that it can provide information about the state of water quality through several sensor nodes installed around the pond. Besides, I-Tamb has prospects for fishpond owners as well as the ease of getting information through mobile phones and websites.

![Figure 1. I-Tamb Framework](image-url)
Based on Figure 1, can be explained the workings of the I-Tamb Framework: the data obtained from sensors around the pond is sent to the cloud database, in real-time using WiFi. WiFi is chosen as the preferred communication technology. WiFi is an IEEE 802.11 standard for wireless local area networks (WLAN) [14]. The cloud database used is Firebase, a Google-owned multi-service cloud-computing solution for mobile and web developers. The service includes a real-time NoSQL database management system that enables fast queries execution. Each database is consolidated in a single JavaScript Object Notation (JSON) file, where tabular relations are used rather than traditional relational databases. This allowed highly-responsive data synchronization across system modules with latency in the range of milliseconds. Note that the use of Firebase does not ensure connection reliability, rather, real-time data transmission/retrieval is procured when a stable WiFi connection is available. Furthermore, these data produce information about water quality. Farm owners can access data through the smartphone as material for decision making. The website can also manage data. Marketplace applications can accommodate the marketing of ponds so that people can access the harvest directly. This marketplace application can make buying and selling transactions wherever they are. The series of industrial revolution 4.0 processes in this study is censorship collecting pond data and then generating data management through the I-Tamb application and accumulation of pond crop sales in the marketplace.

Synergy is carried out with the Software Development Life Cycle (SDLC) software development method and explains the problem through data retrieval from various predetermined sources. The research flow diagram, in terms of developing mobile and web applications, is illustrated in Figure 2:

![Figure 2. Research Flowchart](image)

2.1. Identification Phase

In this phase, the developer collects ideas that come from potential users or developers themselves. The idea is analyzed and described. Look for applications that are considered the same, then study, compare, and document the results of the comparison. The developer also determines the time needed to develop the application.
2.2. Design Phase
In this phase, the developer determines what platform to use. Furthermore, the developer specifies the release of the application as a free or paid version. Then, the developer defines the functions used as modules and prototypes. The developer plans the functionality and architecture requirements. The most important part of this design phase is that the developer creates a storyboard for user interface interactions. The developer carries out the coding process after the documentation results in the design phase are complete.

2.3. Development Phase
In this phase, the developer does the coding. The first coding is done in parallel and refers to the design documentation.

2.4. Prototype Phase
This stage analyses each functional prototype requirement; the prototype is tested and sent to prospective users for feedback. After feedback, the changes needed are back in the development phase. When the second prototype is ready, integrate with the prototype, then test it and send it back to the prospective user. This stage is the phase that iterates through prototyping and testing until the final prototype is ready.

2.5. Testing Phase
In this phase, it is one of the most critical aspects of each development life cycle model. This test is carried out on an emulator or simulator, followed by testing on a real device. The testing phase uses an actual method, usually done using several versions of the operating system and some android specifications. All test results need documentation.

2.6. Deployment Phase
This phase discusses the stages of deploying applications. Before researchers distribute applications to users, researchers need to prepare application release documents. The most important thing to do in this preparation process is [15]:

1. Gathering Materials and Resources
   Researchers prepare cryptographic keys, this key is a certificate owned by the developer. Next is to make sure the icons used to meet the suggested guidelines. The next process is the end-user license agreement (EULA), this process can help protect individual, organizational and intellectual property developers.

2. Configuring Applications for Release
   The researcher chooses the package name that is suitable for the application's lifetime, then turns off logging and debugging. Researchers clean the project directory; this process aims to facilitate the compilation process.

3. Building Application
   Researchers integrate with Android Studio to build APK files that are ready for release.

4. Test the Application
   Make sure the user interface elements have the right size, performance, and battery efficiency. The stages in testing are listed in [16].

5. Releasing Application
   After the application passes the application release preparation process, the researcher distributes the application by uploading the application that is ready for Google Playstore.

2.7. Maintenance Phase
This phase, the application has been uploaded to Google Playstore. After the user downloads the app, the user conducts a review of the app by rating and commenting on the application on Google Playstore. The results of the feedback are to make improvements and updates.

3. Conclusion And Future Work
The impact and benefits of this research are as follows:
1. Knowledge / Education
   Educating the public about the use of IoT in pond management.

2. Economy
   Increase the income of pond farmers and local government with the I-Tamb marketplace that makes it easy to market the farm's harvest that can be accessed directly by the public through a smartphone.

3. Technology
   I-Tamb produces data obtained through sensors mounted around the pond; this data can be processed with data mining techniques, so it supports for various business and management purposes.

4. Management
   It makes it easy to control and monitor pond aquaculture activities.

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