The Implementation of Rapid Application Development (RAD) Method at Aquaponics Cultivation Monitoring System

Z Zuriati[1], D Dulbari[2], Widyawati DK[1]

[1]Informatics Management, Politeknik Negeri Lampung,

Jl. Soekarno Hatta No.10, Rajabasa Raya, Rajabasa, Bandar Lampung, Lampung

[2] Food Crop Production, Politeknik Negeri Lampung,

Jl. Soekarno Hatta No.10, Rajabasa Raya, Rajabasa, Bandar Lampung, Lampung

*e-mail: zuriati_mi@polinela.ac.id

Abstract. Aquaponics is a cultivation method that combines plant cultivation and freshwater fish farming. Aquaponics can be applied to a limited land such as house yard, which is very suitable to be applied in urban areas with limited land. Aquaponics cultivation requires a controlled environment and more maintenance and care compared to other cultivation techniques such as hydroponics, since cultivators must maintain and take care for both plants and fish at the same time. To get the maximum yields, it is necessary to control the time, ambient temperature, humidity value, water level, pH, and water temperature. The existing aquaponics farming that are carried out by farmers or cultivators in general still uses a simple system through measuring the pH level of the water (using the pH meter equipment), water level, water temperature, and ambient temperature, so that farmers or cultivators need more time and manpower to maintain and take care of the plants and fish. Therefore, we need a solution in the form of a monitoring system that can monitor the environmental conditions of plants and fish continuously throughout the day. The monitoring system developed has the ability to monitor time, ambient temperature, humidity, water level, pH, and water temperature. The system was developed using the rapid application development (RAD) system development method. The RAD consists of four stages: requirements planning; system design; construction; and cutover. The test result using the black box testing method prove that the monitoring system can monitor time, ambient temperature, humidity, water level, pH, and water temperature.

1. Introduction

Urban farming is a term for aquaculture practises in urban areas that involve the entire food production system, including animal husbandry, freshwater aquaculture, and horticulture [1],[2]. Aquaponics can be applied to limited land for example in the yard so it is very suitable to be applied in urban areas that have limited land. The urban farming method is proven to be able to improve family food security [3], besides that urban farming can also increase the income of farmers [4], can reduce family food spending [5], and contribute to saving the environment related to the empowerment of organic waste [1]. One of the potential urban farming methods is aquaponics [6].

Aquaponics is a method that combines farming activities and freshwater fish cultivation [7], [8]. Aquaponics cultivation activities have been widely applied by cultivators by combining various types of plants and freshwater fish including: catfish, tilapia, koi with kale [9] , carp with lettuce and mustard greens [10], catfish with kangkong and mustard greens [11]. The aquaponics method has advantages including more production, less land use and nutrients, easy control of pests and diseases so that plants and fish are healthier because they are organic [2][7]. However, this aquaponics cultivation really requires a controlled environment, requires more maintenance and care compared to farming with soil or water media because you have to maintain and care for plants and fish at the same time.

To get maximum yields, it is necessary to control pH [5],[8],[12],[13][14], water temperature and environment [5][15], volume or water level [8],[13], and humidity [15]. In generally aquaponics farming carried out by the community still uses a simple system such as: monitoring the pH of the water using a pH meter equipment, monitoring the height or volume of water, temperature and humidity by measuring, so that farmers need more time and labour to monitor and take care of plants and fish.

For this reason, a solution is needed in the form of a system that can monitor the conditions of plants and fish automatically and continuously throughout the day and has the ability to monitor time, ambient temperature, humidity, water level, pH, and water temperature. The main objective of this research is the design of aquaponics cultivation monitoring system that can monitor time, ambient temperature, humidity, water level, pH, and water temperature. The date of time, ambient temperature, humidity, water level, pH, and water temperature were obtained from the database of microcontroller devices that have been installed on aquaponics cultivation land. The monitoring system was developed using the Rapid Application Development (RAD) method. RAD was chosen because it has several advantages including: the process of making applications based on prototype. The prototype is designed in stages and repeatedly, certain stages can be done repeatedly so that feedback is obtained as needed. Another advantage of the process of making a system using the RAD method is: it is relatively fast with fairly good results [16], involving the user in the design process, causing user needs to be met properly and automatically increasing user satisfaction as a system user [17]. RAD method has been applied to the development of various systems, including store monitoring systems [18], aquaponics monitoring [5], library systems [16], inventory system [19], website development for the PLN project [20].

2. Methods

The stages of developing a monitoring system using the rapid application development (RAD) method. The stages of RAD are presented in Figure 1 below:

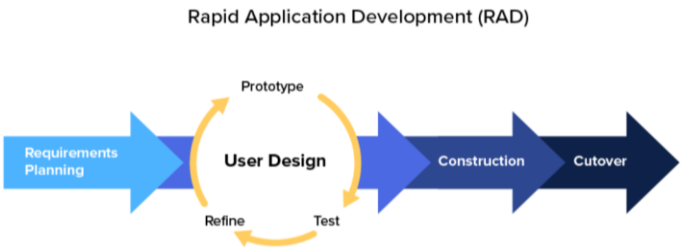

Figure 1. RAD Stages

2.1 Requirements Planning

At the requirements planning stage identification of system requirements is carried out in the form of formulating functional requirements and non-functional requirements for monitoring systems. In addition, the equipment requirements for system development are also formulated.

2.2 User Design

At this stage carry out the design process according to user needs and make improvements if there are still discrepancies at the requirements planning stage. This stage will produce a prototype monitoring system. The design carried out include: database design, flowchart, and use case design.

2.3 Construction

The construction stage is the stage of making a monitoring system program using the hypertext preprocessor (PHP) programming language.

2.4 Cutover

At the cutover stage the monitoring system is tested using the black box testing method.

3. Results and Discussion

3.1 Requirements Planning

In the requirements planning stage the result obtained are: mapping of user categories and determining the hardware and software requirements of the monitoring system. Here are the results obtained:

3.1.1. User Mapping

The monitoring system only has one (1) user. Users are farmers or aquaponics activists. User activity is able to view: time, ambient temperature value, humidity value, water level value, pH value, and water temperature value.

3.1.2 Hardware and Software Requirements

Tools and materials hardware and software requirements are presented in Table 1.

Tabel 1. Tools and materials hardware and software

Hardware	**Software**
Laptop	OS Window 7 to 10
Printer	Web browser
	XAMPP
	Framework CodeIgniter
	PhpMyAdmin
	MySQL

3.2. User Design

At the user design state what is done for is: formulating the workings of the monitoring system, designing database tables and designing use case diagrams for the monitoring system. The results obtained are follows:

3.2.1. How the Monitoring System Works

The monitoring system data comes from sensor data collected through the Arduino microcontroller device that has been installed on the aquaponics cultivation area. The microcontroller can capture and read data from installed sensors, including: RTC timer, ambient temperature sensor, humidity sensor, water level sensor, pH sensor and water temperature sensor. To make it easier for farmers or aquaponics activists to monitor the state of cultivated land, the data is displayed in the form of a monitoring system that can be accessed via a computer or smartphone. In the Table 2 example of sensor data that have been collected are presented.

Table 2. Example of a Data Monitoring System

Date	Time	Ambient temperature	Humidity	Water Level	pH	Water temperature
05/09/2022	21:19:36	30.64	77	11	6.78	28.44
05/09/2022	21:19:41	30.67	77	11	6.85	28.67
05/09/2022	21:19:47	30.54	77	11	6.71	28.44
05/09/2022	21:19:52	30.54	77	11	6.58	28.44
05/09/2022	21:19:57	30.50	77	11	6.68	28.44
05/09/2022	21:20:03	30.47	77	11	6.89	28.44
05/09/2022	21:20:08	30.44	77	11	6.85	28.44

Figure 2 presents a flowchart that describes how the monitoring system works.

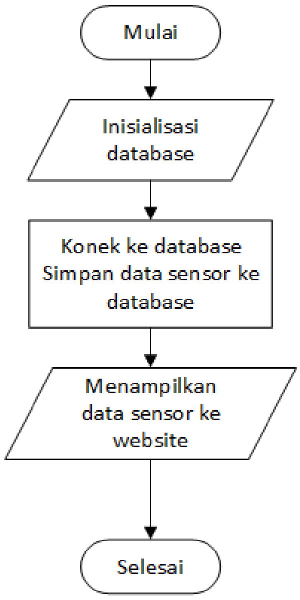

Figure 2. Flowchart of How the Monitoring System Works

Figure 2 shows how the monitoring system works. In the early stages when the monitoring system is turn on, the system will initialize the database. The database stores sensor data, which is obtained from a microcontroller device installed on aquaponics cultivation, including time or hour data, ambient temperature, humidity, water level, pH, and water temperature. Then the sensor data that has been stored in the database will be displayed on the monitoring system website. The monitoring system can be accessed via computer or smartphone device that is connected to the internet. The monitoring system will continue display sensor data as long as the device is powered on and connected to the internet.
`

3.2.2 Database Table Design

In Figure 3 the design of the monitoring system table is presented. It can be seen that the database table only consist of one (1) table containing the entities of time, ambient temperature, humidity, water level, pH, and water temperature.

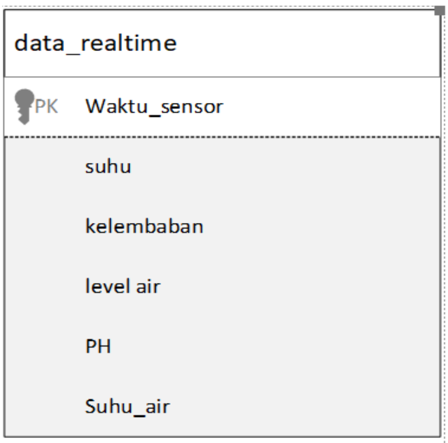

Figure 3. Monitoring System Database Tabel Design

3.2.3 Monitoring System Use Case Design

In Figure 4 the results of the monitoring system use case design are presented based on the sensor time recording. Users of the monitoring activities, such as: monitoring time, ambient temperature, humidity, water level, pH, and water temperature. The data of time, ambient temperature, humidity, water level, pH, and water temperature are obtained from sensor data that has been stored in the microcontroller device database.

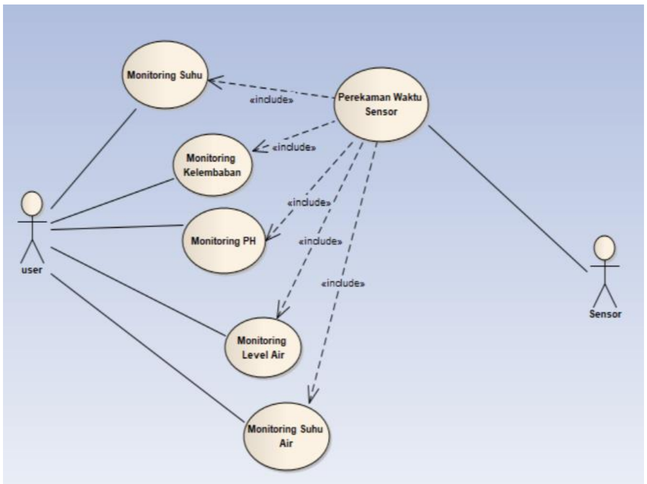

Figure 4. Use Case Monitoring System

3.3 *Construction*

In Figure 5 the results of the construction phase are presented in the form of an interface or dashboard for the aquaponics cultivation monitoring system. The dashboard displays the time, ambient temperature, humidity, water level, pH, and water temperature.

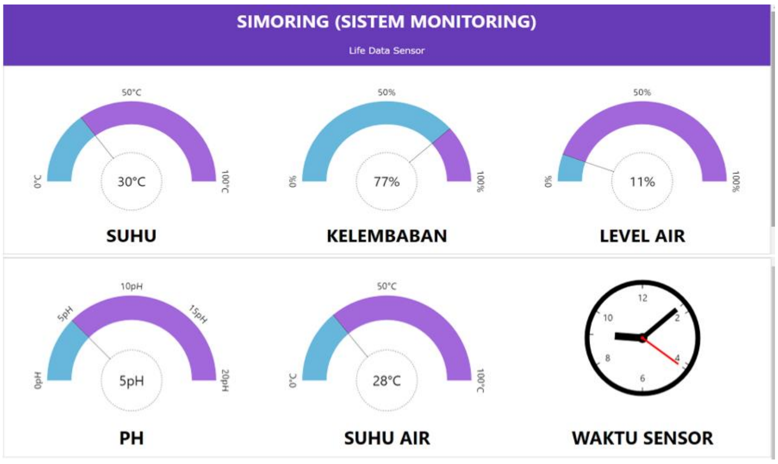

Figure 5. Monitoring System Dashboard

3.4 *Cutover*

At the cutover stage testing the monitoring system is carried out. Testing the plant monitoring system application is done by testing the application interface, using the black box testing method. In Table 3 a summary of the test scenarios for the black box testing method is presented.

Table 3. Testing Scenario

Scenario	Expected Result	Test Result	Conclusion
Display time	Can display time	Succeed	Valid
Display ambient temperature	Can display ambient temperature	Succeed	Valid
Display humidity	Can display humidity	Succeed	Valid
Display water level	Can display water level	Succeed	Valid
Display pH	Can display pH	Succeed	Valid
Display water temperature	Can display water temperature	Succeed	Valid

4. Conclusions

The application of the RAD method for the development of the monitoring system resulted in the following conclusions: Aquaponics cultivation monitoring system has been successfully developed using the RAD method. The monitoring system can display time, ambient temperature, humidity, water level, pH, and water temperature.

5. Acknowledgments

The author would like to thank the Lampung State Polytechnic, especially the Research and Community Service Unit (UPPM) which has provided funding through the DIPA 2022 Research and Community Service Grant.

6. References

[1] K. Wijaya, A. Y. Permana, S. Hidayat, and H. Wibowo, "Pemanfaatan Urban Farming Melalui Konsep Eco-Village Di Kampung Paralon Bojongsoang Kabupaten Bandung," *J. Arsit. ARCADE*, vol. 4, no. 1, p. 16, 2020.

[2] F. Septya, R. Rosnita, R. Yulida, and Y. Andriani, "Urban Farming Sebagai Upaya Ketahanan Pangan Keluarga Di Kelurahan Labuh Baru Timur Kota Pekanbaru," *RESWARA J. Pengabdi. Kpd. Masy.*, vol. 3, no. 1, pp. 105–114, 2022.

[3] F. M. Anggrayni, D. R. Andrias, and M. Adriani, "Ketahanan Pangan Dan Coping Strategy Rumah Tangga Urban Farming Pertanian Dan Perikanan Kota Surabaya," *Media Gizi Indones.*, vol. 10, no. 2, pp. 173–178, 2015.

[4] R. A. Nugroho, L. T. Pambudi, D. Chilmawati, and A. H. C. Haditomo, "Aplikasi Teknologi Aquaponic Pada Budidaya Ikan Air Tawar Untuk Optimalisasi Kapasitas Produksi," *SAINTEK Perikan. Indones. J. Fish. Sci. Technol.*, vol. 8, no. 1, pp. 46–51, 2012.

[5] D. Megawati, K. Masykuroh, and D. Kurnianto, "Rancang Bangun Sistem Monitoring PH dan Suhu Air pada Akuaponik Berbasis Internet of Thing (IoT)," *TELKA - Telekomun. Elektron. Komputasi dan Kontrol*, vol. 6, no. 2, pp. 124–137, 2020.

[6] S. Diver and L. Rinehart, "Aquaponics — Integration of Hydroponics with Aquaculture," *Water*, p. 28, 2010.

[7] B. R. L. Nelson, "Aquaponic Equipment, The Bio Filter," *Aquaponics J.*, vol. 1, no. 48, pp. 22–23, 2008.

[8] T. Y. Kyaw and A. K. Ng, "Smart Aquaponics System for Urban Farming," *Energy Procedia*, vol. 143, pp. 342–347, 2017.

[9] Z. Hasan, Y. Andriani, Y. Dhahiyat, A. Sahidin, and M. R. Rubiansyah, "Pertumbuhan tiga jenis ikan dan kangkung darat (Ipomoea reptans Poir) yang dipelihara dengan sistem akuaponik," *J. Iktiologi Indones.*, vol. 17, no. 2, p. 175, 2018.

[10] N. A. Maharani and P. N. Sari, “Penerapan Aquaponic Sebagai Teknologi Tepat Guna Pengolahan Limbah Cair Kolam Ikan di Dusun Kergan, Tirtomulyo, Kretek, Bantul, Yogyakarta,” *J. Pengabdi. Kpd. Masy. (Indonesian J. Community Engag.*, vol. 1, no. 2, p. 172, 2016.

[11] S. Nazlia, “PENGARUH TANAMAN BERBEDA PADA SISTEM AKUAPONIK TERHADAP TINGKAT KELANGSUNGAN HIDUP DAN PERTUMBUHAN BENIH IKAN LELE (Clarias sp),” *Acta Aquat. Aquat. Sci. J.*, vol. 5, no. 1, pp. 14–18, 2018.

[12] Y. Rahmanto, A. Rifaini, S. Samsugi, and S. D. Riskiono, “SISTEM MONITORING pH AIR PADA AQUAPONIK MENGGUNAKAN MIKROKONTROLER ARDUINO UNO,” *J. Teknol. dan Sist. Tertanam*, vol. 1, no. 1, p. 23, 2020.

[13] A. J. Kuswinta, I. G. P. W. Wedashwara W, and I. W. A. Arimbawa, “Implementasi IoT Cerdas Berbasis Inference Fuzzy Tsukamoto pada Pemantauan Kadar pH dan Ketinggian Air dalam Akuaponik,” *J. Comput. Sci. Informatics Eng.*, vol. 3, no. 1, pp. 65–74, 2019.

[14] A. K. Pasha, E. Mulyana, C. Hidayat, M. A. Ramdhani, O. T. Kurahman, and M. Adhipradana, “System Design of Controlling and Monitoring on Aquaponic Based on Internet of Things,” *Proceeding 2018 4th Int. Conf. Wirel. Telemat. ICWT 2018*, 2018.

[15] G. L. Tuapatel and A. Stephanus, “Rancang Bangun Sistem Akuaponik Berbasis Mikrokontroler Dan Android,” *J. Simetrik*, vol. 9, no. 2, p. 232, 2019.

[16] D. Hariyanto *et al.*, “Implementasi Metode Rapid Application Development Pada Sistem Informasi Perpustakaan,” *Jupiter*, vol. 13, no. 1, pp. 110–117, 2021.

[17] Agustinus Noertjahyana, “Studi Analisis Rapid Aplication Development Sebagai Salah Satu Alternatif Metode Pengembangan Perangkat Lunak,” *J. Inform.*, vol. 3, no. 2, pp. 64–68, 2002.

[18] Y. D. Wijaya, “Penerapan Metode Rapid Application Development (Rad) Dalam Pengembangan Sistem Informasi Data Toko,” *J. SITECH Sist. Inf. dan Teknol.*, vol. 3, no. 2, pp. 95–102, 2021.

[19] O. I. - AMIK BSI Bekasi and G. B. A. L. - AMIK BSI Bekasi, “Metode Rapid Application Development (RAD) pada Perancangan Website Inventory PT. SARANA ABADI MAKMUR BERSAMA (S.A.M.B) JAKARTA,” *Evolusi J. Sains dan Manaj.*, vol. 6, no. 2, pp. 12–18, 2018.

[20] C. Mandang, D. Wuisan, and J. Mandagi, “Penerapan Metode RAD dalam Merancang Aplikasi Web Proyek PLN UIP Sulbagut,” *Jointer - J. Informatics Eng.*, vol. 1, no. 02, pp. 49–53, 2020.