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STUDY OF BACKYARD SCALE AQUACULTURE MODEL BASED ON IoT IN SMART VILLAGE AREA IN BULUKUMBA REGENCY SOUTH SULAWESI

Ahmad Munir, Kurniati and Juni Astuti
[1,2]Faculty of Post Graduate Hasanuddin University
[3]UCM Makassar
[1]amunir@unhas.ac.id

ABSTRACT

Smart economy is one of the pillars of smart village development. One of the obstacles faced in its achievement is the absence of a technical and economic feasibility study that can be used as a development reference. The purpose of this research is to design the function and design of an IoT-based aquaculture model, conduct technical and economic studies of aquaculture models in smart village areas and create detailed spatial plan scenarios by introducing backyard-scale aquaculture in smart village areas. The analysis used in this study is a quantitative descriptive analysis using a sample location of Bulukumba Regency South Sulawesi. Technical feasibility analysis was carried out by studying the geographical suitability and availability of back yards. Data acquisition and IoT systems are made by cunducting functional design and then technical design. Economic feasibility was carried out by analyzing Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit-Cost Ratio (B/C Ratio) analysis on IoT-based aquaculture models that have been obtained in the early stages. From this study, it was found that the suitability of the geographical position for the development of backyard-scale aquaculture based on IoT in the smart village area is: Ujung Loe, Bontobahari, Bontotiro, Herlang and Kajang. This sub-district has a geographical position located in a coastal area with an altitude from sea level ranging from 26-100 meters, an average temperature of 27.2 C-29.5 C. A suitable salinity sensor is a Conductivity/TDS/Salt Level Sensor, with a DC voltage of 3.3V/5V with stainless steel electrodes. A suitable temperature sensor is the DS18B20 with a range of -55C to +125C (-67F to +257F). Measurement of water depth is carried out by applying ultra sonic HC-SR04, using a 5V DC power supply. The implementation of IoT uses Arduino for data conversion, data control and data integration into the cloud network. Economic feasibility analysis shows that the NPV value is IDR 291,532,703,-, the IRR value is 57% and the B/C Ratio value is in the range of 2.7-2.8. Total revenue obtained from the development of backyard scale aquaculture model based on IoT in smart village area in bulukumba regency is IDR 229,478,400,000,-.

1. INTRODUCTION

Currently, the Ministry of Villages and Transmigration is proposing smart village development in several regions in Indonesia. In 2022, the Ministry will develop 3000 smart villages, and one of them is the development of smart villages in Bulukumba Regency, South Sulawesi. There are 6 pillars of smart villages that have been developed, namely: smart government, smart community, smart economy, smart environment, smart mobility and smart life. The achievement of smart economy is one of the focuses of discussion in this article. Various obstacles faced in achieving the smart economy are the absence of technical and economic feasibility studies related to alternatives of business that can be developed in the smart village area. Bulukumba, which is mostly located in the southern region of the island of Sulawesi, is a coastal area that has the potential for aquaculture development, especially the development of Vannamei shrimp culture. On the other hand, in the smart village area, information and communication technology infrastructure is available. There are 83.218 villages that have been reached by internet-based cellular network services (Kemendes, 2022). The existence of this technology has the potential to support agricultural and fishery production, its implementation can be realized by applying IoT in the production process. Total revenue obtained from model development of backyard scale aquaculture model based on iot in smart village area in bulukumba regency is

The purpose of this research is to design an IoT-based aquaculture model, conducting technical and economic studies of aquaculture models in the smart village area in Bulukumba district and create spatial plan by introducing backyard-scale aquaculture in smart village areas.

2. LITERATURE REVIEW

The urgency of developing smart villages is the existence of digital transformation as a national development plan for 2020-2024, which provides pointers on strategic priority projects in the RPJMN (National Mid-Term Development Plan) for 2020-2024, namely: 1) the acceleration of national priority programs, namely developing digital villages and tourism villages; 2) Achievement of the 6 Pillars of Smart Villages and Sustainable Development Goals (SDGs). The link between smart villages and the achievement of the SDGs, where villages contribute 74% to the achievement of the national SDGs; 3) the impact on the community, namely: more inclusive connectivity and internet access, access to basic smart village services, community empowerment based on local village innovations, improving the welfare of rural communities and improving the quality of the use of village funds (Nurdin, 2022).

Empowerment of natural resources and artificial resources is urgently to be implemented inorder to accelerate the achievement. One of the potential natural resources available is the coastline that stretches on the southern coast of the island of Sulawesi, providing a conducive condition for the development of aquaculture. The potential artificial resources that are available in the Smart Village area are cellular networks, the distribution of cellular network coverage in Indonesia is as follows: The number of villages covered by 2G, 3G and 4G network services is 76428, 67006 and 9113 villages respectively (Kemkominfo, 2020 and the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration, 2022).

The application of appropriate technology in smart village areas is an agenda of programmed activities, the aim of which is to improve the quality of the environment and the quality of people's lives, the use of technology to improve quality and productivity in the production and processing of agricultural products, on farm and off farm (Nurdin, 2022).

Technical Feasibility Analysis

One species of shrimp that is cultivated in aquaculture in Indonesia is Vannamei Shrimp (Penaeus vannamei). The original habitat of this shrimp is from the Pacific Northwest coast of the United States, namely Hawaii (Indah Purnamasari et al., 2017). This shrimp species entered in Indonesia in 2001 based on the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia. No. 41 of 2001. In 2004, Vannamei shrimp production has reached 1,116,000 tons (Sari Agri, 2020). This shrimp species is one of the commodities that can be developed in the Smart Village area in Bulukumba which will be discussed in research.

Data Acquisition and Internet of Think

Currently, there are various types of sensors that can be easily connected to a serial interface (embedded system) to produce output in digital form that can be processed directly by a microcontroller. Some of these systems apply a serial interface (serial interface) (Pallab Chatterjee, 2013). The salinity, temperature and proximity sensors used in this study already have an analog to digital conversion module so that they provide digital output, thus they can be connected directly to the microcontroller. The sensor specifications used for the development of IoT-based backyard aquaculture in the smart village area and several sub-districts in Bulukumba Regency are as follows:

Sensor Specifications

The sensor specifications used in the development of IOT-based backyard aquaculture in the smart village area and several sub-districts in Bulukumba Regency are as follows:

Tabel 1: Specification of the sensors for backyard scale aquaculture model based on iot in smart village area in Bulukumba regency south sulawesi

Parameters	Specifications
Salinity Sensor	
Type	Conductivity Sensor / Salinity / TDS
Voltage	DC 3,3V/5V
Electrode	stainless steel
Output	Analog ADC
Dimension	In pipe 18 cm x dia 1/2 inch
Compatibility	Arduino and all types of microcontrollers, AVR, ARM, PIC
Temperature Sensor	
Length of Cable	1m
Size of Stainless steel sheath:	6*50mm
Power supply range	3.0V to 5.5V
Operating temperature range	-55C to +125C (-67F to +257F)
Storage temperature range	55C to +125C (-67F to +257F)
Accuracy	over the range of -10C to +85C: 0.5C.
Output leads	Red (VCC)
Black (GND)	Blue (DATA)
water resistance	Waterproof
Water Depth Sensors	
Power Supply	5V DC
Current in standby mode	< 2mA
Current consumption when detection	15 mA
Detection angle width	15 Detection distance: accurate to 1 meter, can detect (but lacks precision) up to a distance of 4 meters, 3 mm resolution (calculation of sound propagation factor and MCU speed at 16 MHz)
Dimensions	45 x 20 x 15 mm

The display of the sensor images in the IoT-based backyard aquaculture development in the smart village area and several sub-districts in Bulukumba Regency is as follows:

(1a) (1b) (1c)

Figure 1: Salinity (1a), temperature (1b), and ultrasonic sensors (1c) in IoT-based backyard aquaculture development in smart village areas and several sub-districts in Bulukumba Regency.

Economic Feasibility Analysis

NVP (Net Present Value) and Internal Rate of Return (IRR) and B/C Ratio can be indicators of the feasibility of a project (Darkiman Ruminta, 2020). (NVP (Net Present Value) is the difference between the present value and the value at a certain time. The NVP value is a guide to investigate the feasibility of a business in the future. The NVP value can be calculated using the following equation.

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+r)^n} - \sum_{n=0}^{n} \frac{C_t}{(1+r)^t} \quad 1$$

where:

Bt = Present Value of benefit

Ct = Present Value of cost

t = The time of cash flow

n = the total time of the project

r = discount rate

Internal Rate of Return (IRR) is the level of efficiency or an indicator to estimate the profitability of a business unit. The IRR application can also be used to calculate the interest rate on an investment. IRR can be calculated by the following equation:

$$IRR = i' + \frac{NPV'}{NPV' - NPV''}(i'' - i') \quad 2$$

Where,

IRR = Internal Rate of Return

NPV'= value of NPV (positif)

NPV''= value of NPV (negatif)

i' = highest discount rate

i'' = lower discount rate

B/C Ratio

Benefit cost ratio is used to know the comparison between operating income with total costs (John Darwis and Yosua Damas Sadewo, 2021). The value of the B/C Ratio is one indicator to assess the feasibility of a business. The formula for calculating the B/C Ratio is as follows:.

$$\frac{B}{C} ratio = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}} \quad 3$$

Where,

B/C ratio= benefit/cost ratio

Bt = total income in period t

Ct = total cost in period t

r = discount rate

n = number of years

t = time

3. METHODOLOGY

The analysis used in this study is a quantitative descriptive analysis using a sample location of Ara' village, Bulukumba Regency. This study presents the results of the technical and economic feasibility analysis of developing an IoT-based back yard aquaculture model in the smart village area. Data collection stages are (1) observation (2) in-depth interviews (deep interviews), (3) literature search, (4) making prototypes. The research was carried out in Ara' Village, and several sub-districts in Bulukumba Regency, are one of the Smart Village areas in Bulukumba Regency, South Sulawesi. It was conducted during July-September 2022.

Secondary data for the technical feasibility study was collected from the literature study and secondary data for the economic study was collected from the Bulukumba Regency Bappeda Office and the Bulukumba Village Office. The primary data for the technical study was collected from a direct survey in Bulukumba Regency. Spatial data was taken from the Bulukumba Regency Bappeda Office.

Data Analysis

The technical feasibility analysis consists of the feasibility of geographical position, average temperature, and functional design of data acquisition system development, and engineering of data acquisition system development and telemonitoring system scheme. Economic feasibility based on technical feasibility, functional analysis and engineering. The technical feasibility analysis carried out is, financial analysis, depreciation analysis, book value analysis at the beginning and end of the year, variable cost analysis, cash flow analysis, Net Present Value (NPV) analysis, Internal Rate of Return (IRR) analysis, B/C analysis Ratios, spatial scenario analysis and revenue estimation. The research flow chart is as follows:

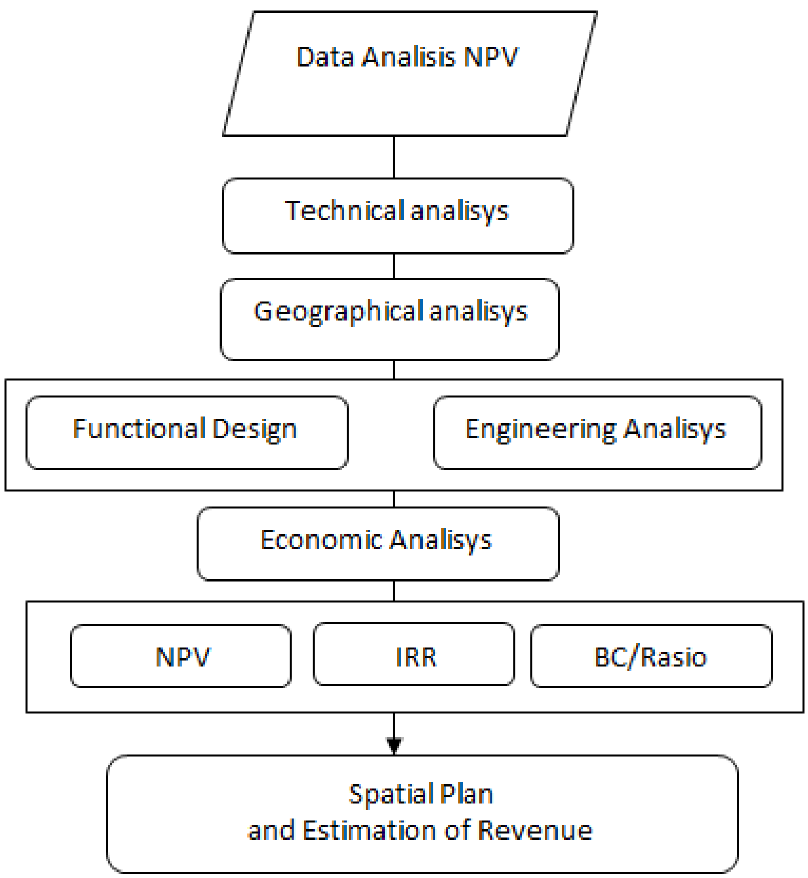

Figure 2: Flowchart of research implementation

4. RESULTS AND DISCUSSION

Technical Feasibility Analysis

Vannamei Shrimp (Litopenaeus vannamei) is a shrimp that is widely cultivated in aquaculture. There are several advantages of growing this shrimp, namely faster growth, resistance to disease and a higher survival rate than other shrimp. The original habitat of this shrimp is coastal waters with a salinity of 15-25 ppt. This situation is very suitable to be cultivated in coastal areas in Bulukumba Regency and other areas in Indonesia.

Geographical Position Suitability

Vannamei shrimp culture in ponds requires the availability of sufficient seawater to maintain salinity conditions (15-25 ppt) according to the shrimp habitat. From the survey results, it was found that the geographical position of the sub-districts that are suitable for the development of IoT-based backyard aquaculture in the smart village area and several sub-districts in Bulukumba Regency are as follows:

Tabel 2. The suitability of the geographical position for the development of IOT-based backyard aquaculture in the smart village area and several sub-districts in Bulukumba Regency

Sub District	**Mean above sea level (m) (m.a.s.l)**
Ujung Loe	26
Bontobahari	26
Bontotiro	100
Herlang	80
Kajang	80
Average	**62,4**

Source: Bulukumba in Figures, 2022 and Field Survey

The sub-district has a geographical position which is located in the southern coastal area of Sulawesi Island, so that it can facilitate water supply during cultivation activities carried out through direct pumping from the sea. Vannamei Shrimp tolerance to temperature changes is quite large (eurythermal). The temperature conditions at the IOT-based backyard aquaculture development location in the smart village area and several sub-districts in Bulukumba Regency are as follows:

Tebel 3: Average temperature at the location for the development of aquaculture in the smart village area and several sub-districts in Bulukumba Regency

Sub District	**Average Temperature (C)**
January	27.2
Pebruary	27.5
March	27.8
April	28.5
May	29.4
June	28.8
July	28.3
Agust	29.5
September	29.4
October	29.0
Nopember	28.3
December	27.7
Average	**28.45**

Source: Bulukumba in Figures, 2022 and Field Survey

From the results, show that temperature fluctuations throughout the year are between 27.2 C and 29.5 C. This situation provides a conducive climate for the growth of Vannamei shrimp.

Analog to Digital Data Acquisition Development Concept

Salinity Measurement Telemonitoring Scheme Wei Xu et al. (2019) said that measuring salinity is important for monitoring water quality, including in aquaculture activities. In the study of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district, applying the working principle of the salinity measurement sensor is the measurement of ions in the water. The presence of the number of ions is directly proportional to the ability to conduct electricity from the water.

The higher the ion concentration, the higher the electrical conductivity of the water, on the contrary, the lower the ion concentration, the lower the electrical conductivity of the water. Electrical conductivity is measured by electrodes. The flow chart of the measurement system is as follows:

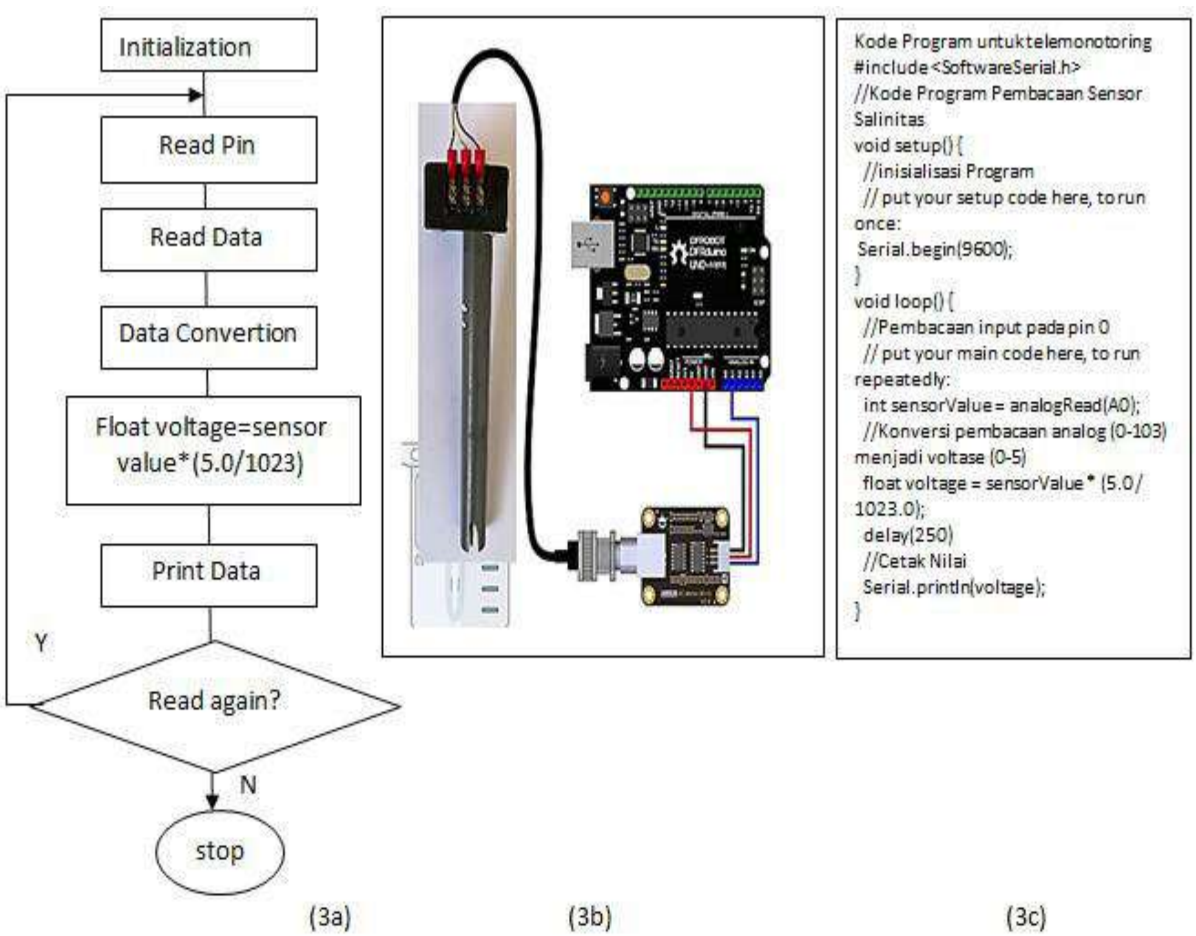

Figure 3: Flow chart of data acquisition algorithm (3a), scheme (3b) and computer code (3c) of the salinity data acquisition system

Temperature Measurement Telemonitoring Scheme

The temperature sensor works on the principle of a sensor that can detect temperature and cause changes in resistance properties (electrical conductivity). According to the measurement method, it can be divided into two categories: contact type and non-contact type. According to the characteristics of the sensor material and electronic components, it can be divided into two types: heat resistance and thermocouple. The measurement system algorithm is as follows:

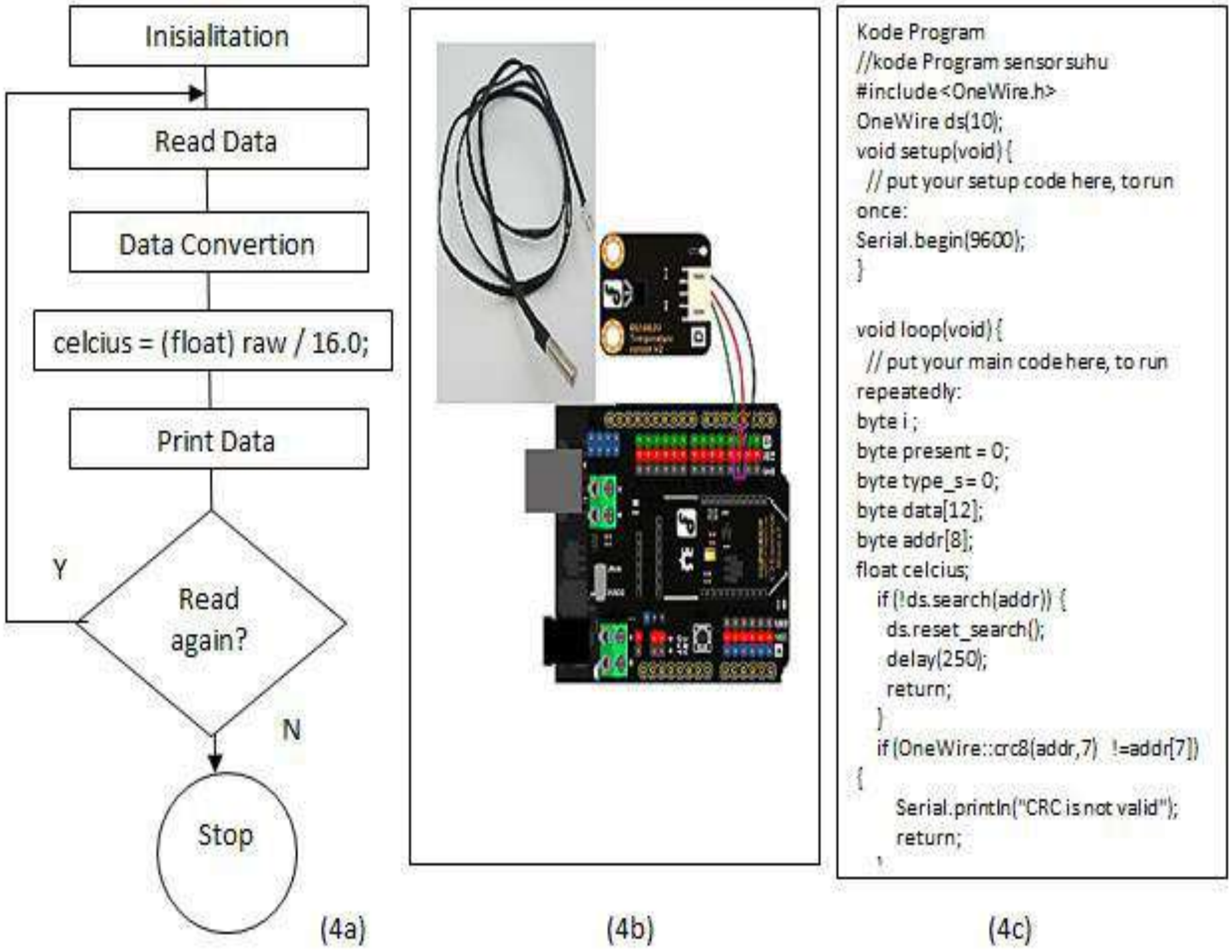

Figure 4: Flow chart of data acquisition algorithm (4a), scheme (4b) and computer code (3c) of the temperature data acquisition system

Resistance sensing occurs when the metal (sensor) is exposed to temperature which results in a change in its resistance properties, the resistance value. Each metal has different resistance properties when exposed to every degree of temperature change, the resistance value can be used as an output signal which is then converted to digital on the Arduino microcontroller.

Analog data into digital temperature is processed in the microcontroller. Wujut Harianto et. al. (2020), has implemented a temperature sensor to monitor environmental temperature using DHT11 with control using Arduino Uno R3. However, in this study using DS18BS20 which is connected to Arduino Mega, with control via program code that includes the OneWire.h sub-program is shown in Figure 4.

Water Level Measurement Telemonitoring Scheme

Detection of water depth is carried out using ultrasonic working principles, namely working based on the reflection of waves from an object in this study is the water level in the maintenance pond. The ultrasonic sensor consists of a transmitter and a receiver. The working mechanism of the sensor is as follows.

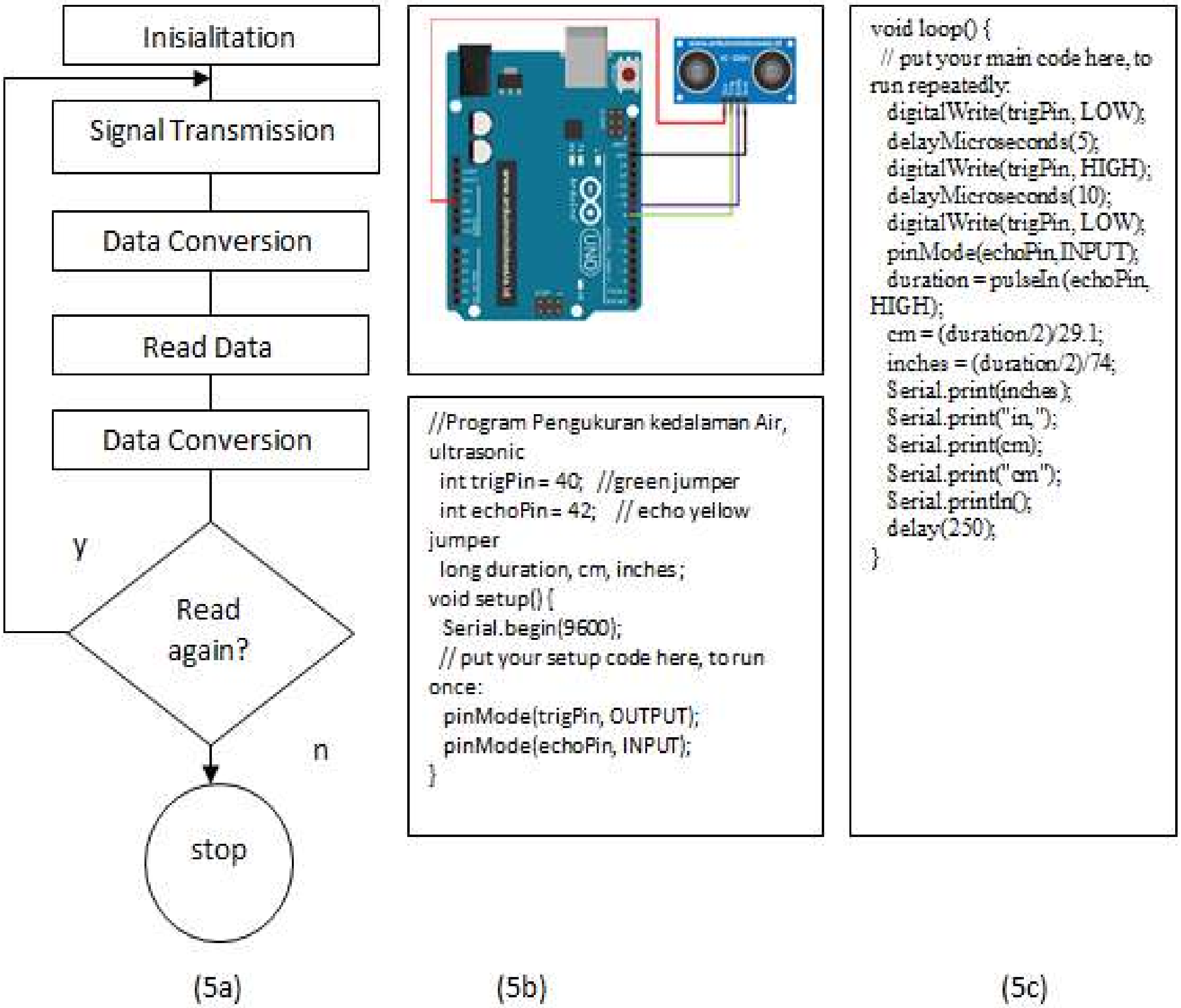

Figure 5: Flow chart of data acquisition algorithm (5a), scheme (5b) and computer code (5c) of the water depth data acquisition system

The transmitter unit emits a mechanical wave (ultrasonic) towards the object (water level), then the object reflects the wave and the reflected wave is captured by the receiver.

The working system of measuring the depth of the water sensor in the maintenance pond is: piezoelectric generating mechanical energy which is converted from ultrasonic waves generated by the transmitter with a certain wavelength, for example at a wavelength of 20 kHZ to 40 kHZ. This wave generator comes from an oscillator which is assisted by a signal amplifier. Piezoelectric function is to convert electrical energy into mechanical energy. Piezoelectric materials are materials that produce an electric field when subjected to mechanical stress or strain. Conversely, if an electric field is applied, the material will experience mechanical strain or stress. If the measuring circuit operates on the same piezoelectric element pulse mode, it can be used as a transmitter and a receiver. The generated frequency depends on the oscillator which is adjusted to the working frequency of each transducer. Because of these advantages, piezoelectric transducers are more suitable for ultrasonic sensors.

The receiver receives the reflected wave from the object (water level), the wave receiver component consists of a piezoelectric material which becomes an ultrasonic transducer. The existence of piezoelectric properties (reversible reaction occurs), namely the generation of electric voltage when exposed to ultrasonic waves and this contact causes the vibration of the piezoelectric material. Koval at. al (2016) applied the measurement of water depth using the SRF08 sensor with NI USB 845. In the IoT-based backyard aquaculture model in the smart village area in Bulukumba Regency using the HCSR04 ultra sonic sensor with the Arduino Mega micro controller.

IoT Development

According to Sachin Kumar et. al. (2019). IoT technology is experiencing rapid development and has become an important part of human life, IoT has been applied in various fields. In this study, applying IoT for backyard-scale aquaculture models in the smart village area in Bulukumba district, In the explanation above, the existence of Arduido as a microcontroller device for each sensor, but in making IoT systems, it is possible to use only one Arduino unit or it is also possible to use ESP321 to synergize with the Cloud network. The main components of Internet of Thing are sensor units that contain big analog data, micro controllers, Perpetual Connectivity which is connectivity that continuously connects devices to the Internet. Really Real Time starts from the sensor or when data is acquired. Real time for IoT does not start when data hits a network switch or computer system. Real time data is facilitated by RTC (real time control).

Is a device related to its position in the five phases of data flow, namely real time, in motion (moving), early life, at rest (at rest), and archives. Cloud server, is a device that stores software and data. In this study, Pythonanywhere Server is used as a web server. Modem router, functions to convert digital data into analog and users. The IoT development scheme for aquaculture can be seen in the following figure:

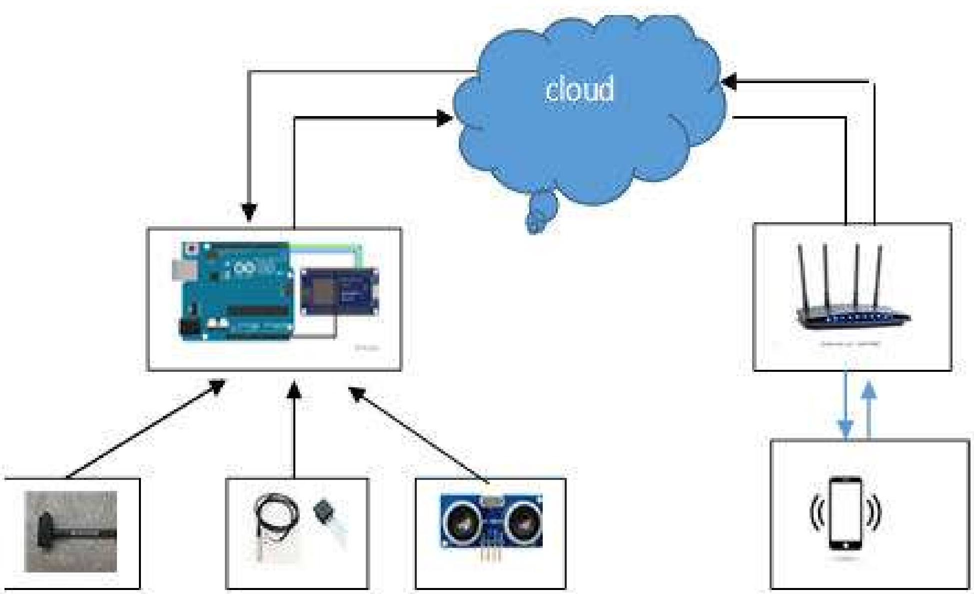

Figure 6: IoT Architecture for backyard scale aquaculture model based on iot in smart village area in Bulukumba regency south sulawesi

Capital Analysis

According to Wati and Fadchurrozie (2019), in the fishery business, a number of funds are needed as a basis for financial measures for business development, sources of funds can be obtained from banks or own capital or assistance from financial institutions. Business capital includes investment, working and operational capital. The investment costs for developing an IoT-based backyard aquaculture model in the smart village area in Bulukumba Regency are as follows:

Table 4: Investment costs for developing an IoT-based backyard aquaculture model in a smart village area in Bulukumba Regency

No	Componen of Cost	Unit	Cost Perunit	Econ. age	Total
1	Ponds diameter 3 m	6	852000	10	5112000
2	Pump 40 watt	1	450000	10	450000
3	Pipe d 3/4 inch	6	38500	10	231000
4	Aerator	1	1395000	10	1395000
5	Arduino mega	1	215000	10	215000
6	Salinity Sensor	6	200000	10	1200000
7	Sensor TDS	6	413100	10	2478600
8	Sensor acesory	6	225000	10	1350000
9	Temperature Sensor	6	25000	10	150000
10	Pipe acesory	35	3500	10	122500
11	Acesory for micro controller	3	100000	10	300000
12	Canal C	10	98000	10	980000
14	Land				55000000
					68984100

Source: Calculation Results, 2022

The investment cost for developing an IoT-based backyard aquaculture model in the smart village area in Bulukumba Regency is Rp. 68,984,100,- the cost is based on the shadow price that applies in Makassar in 2022. Depreciation cost or depreciation is the accumulated value of the cost which is a portion of the financing at a certain time. There are three depreciation methods that can be applied to the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district, namely: the straight line method, the declining balance method, and the activity (production unit) method (Warren, Reeve, and Fess. 2008) . However, the method used in this analysis is the straight-line method. Depreciation cost is calculated based on the predetermined capital cost, as mentioned above.

Table 5: Depreciation Costs for developing an IoT-based backyard aquaculture model in a smart village area in Bulukumba Regency

No	equipment	values	Resid.value	Eco. age	depreciation	Percens
1	pond diameter 3 m	5112000	511200	5	920160	0.10
2	Pump 40 watt	450000	45000	5	81000	0.10
3	Pipe d 3/4 inch	231000	23100	5	41580	0.10
4	Aerator	1395000	139500	5	251100	0.10
5	Arduino mega	215000	21500	5	38700	0.10
6	Salinity Sensor	1200000	120000	5	216000	0.10
7	TDS Sensor	2478600	247860	5	446148	0.10
8	Sensor acesory	1350000	135000	5	243000	0.10
9	Temperature Sensors	150000	15000	5	27000	0.10
10	Canal C	980000	98000	5	176400	0.10

Source: Primary data after processing, 2022

Table 6: Projection of depreciation Costs for developing an IoT-based backyard aquaculture model in a smart village area in Bulukumba Regency

			years			
No	Cost	1	2	3	4	5
1	pond diameter 3 m		920160	1840320	2760480	3680640

2	Pump 40 watt		81000	162000	243000	324000
3	Pipe d 3/4 inch		41580	83160	124740	166320
4	Aerator		251100	502200	753300	1004400
5	Arduino mega		38700	77400	116100	154800
6	Salinity Sensor		216000	432000	648000	864000
7	TDS Sensor		446148	892296	1338444	1784592
8	Sensor acesory		243000	486000	729000	972000
9	Temperature Sensors		27000	54000	81000	108000
10	Canal C		176400	352800	529200	705600

Source: Primary data after processing, 2022

Book value also means Net Asset Value (NAV) or Net Asset Value (NAV) of the company, we get the calculation from total assets minus intangible assets (patents, goodwill) and liabilities. Book value at the beginning of the year is the net asset value of a business unit. The book value at the beginning of the year can be calculated from the initial investment value minus the depreciation value at the beginning of the year.

Table 7: Early Years Book Value on the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district

No				**Years**		
	cost componen	1	2	3	4	5
1	pond diameter 3 m	5112000	4191840	3271680	2351520	1431360
2	Pump 40 watt	450000	369000	288000	207000	126000
3	Pipe d 3/4 inch	231000	189420	147840	106260	64680
4	Aerator	1395000	1143900	892800	641700	390600
5	Arduino mega	215000	176300	137600	98900	60200
6	Salinity Sensor	1200000	984000	768000	552000	336000
7	TDS Sensor	2478600	2032452	1586304	1140156	694008
8	Sensor acesory	1350000	1107000	864000	621000	378000
9	Temperature Sensors	150000	123000	96000	69000	42000
10	Canal C	980000	803600	627200	450800	274400
	Total	13561600	11120512	8679424	6238336	3797248

Source: primary data after processing (2022)

Year-End Book Value is the value calculated in the books. The amount of the book value at the end of the year can be determined from the reduction in the book value at the beginning of the year with the annual depreciation expense. The amount of the Year-End Book Value in the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district is as follows:

Table 8: End of Year Book Value on feasibility analysis of IoT-based backyard aquaculture model in smart village area in Bulukumba Regency

			Years			
	Cost Componen	1	2	3	4	5
1	pond diameter 3 m	4191840	3271680	2351520	1431360	511200
2	Pump 40 watt	369000	288000	207000	126000	45000
3	Pipe d 3/4 inch	189420	147840	106260	64680	23100
4	Aerator	1143900	892800	641700	390600	139500
5	Arduino mega	176300	137600	98900	60200	21500

6	Salinity Sensor	984000	768000	552000	336000	120000
7	TDS Sensors	2032452	1586304	1140156	694008	247860
8	PH Sensors	1107000	864000	621000	378000	135000
9	Temp. Sensors	123000	96000	69000	42000	15000
10	canal C	803600	627200	450800	274400	98000
	Total	11120512	8679424	6238336	3797248	1356160

Source: primary data after processing (2022)

Variable costs in the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district can change proportionally according to the amount of production produced. This cost is the marginal cost of backyard-scale aquaculture production activities. This marginal cost is influenced by the production target. The higher the production target, the higher the variable costs. The variable cost components of IoT-based backyard aquaculture activities in the smart village area in Bulukumba district are: the cost of purchasing shrimp seeds, purchasing feed, purchasing dolomite lime, purchasing molasses, purchasing probiotics, electricity usage and labor costs.

The amount of production targeted for each production cycle is 864 kg, with a total of 6 ponds with a diameter of 3 meters. This number is the estimated number of ponds that can be accommodated in each household's yard on the coast of Ujung Loe, Bontobahari, Bontotiro, Herlang and Kajang sub-districts. The results of the calculation of variable costs for IoT-based backyard aquaculture activities in the area are as follows:

Table 9: Variable Costs in the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district

No	material	volume	unit	price/unit	total	Total cost
1	Post larvae	7500	ekor/kolam	35	6	1575000
2	Feed	138	kg/kolam	9200	6	7617600
3	Dolomite	5	kg	5000	1	25000
4	Molases	5	kg	8800	1	44000
5	Probiotic	2	kg	120000	1	240000
6	Electricity	72	kwH/bulan	1467	6	633865
7	Labour	6	org bulan	1500000	1	9000000
	Total					19135465

Source: primary data after processing (2022)

Cash Flow (Cash Flow) is a flow that describes the rise and fall of the amount of money from a business unit. The rise and fall of the amount of money is influenced by income, fixed costs and variable costs. If there is an income that is smaller than the expenditure, there will be a negative cash flow, on the other hand if there is an income that is greater than the expenditure, there will be a positive cash flow. In the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district, negative cash flow occurs as a result of investment costs at the beginning of the activity (Year 0), then it will become positive in Years 1 to 5. Cash Flow Analysis the activities of the business unit are as follows:

Table 10: Cash Flow on the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba regency

years	income	Fixed cost	Variabel cost	Cash Flow
0	0	68984100	57406395	-126390495
1	129600000	2441088	57406395	69752517
2	142560000	2441088	57406395	82712517
3	142560000	2441088	57406395	82712517
4	155520000	2441088	57406395	95672517

5	168480000	2441088	57406395	108632517

Source: primary data after processing (2022)

From the calculation of the cash flow, then the calculation of the Net Present Value can be done. The results of the NPV calculation from the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district are as follows:

Table 11: Calculation of NPV from feasibility analysis of backyard-scale aquaculture model based on IoT in smart village area in Bulukumba district

Tahun	CasFlow	PV
-	-126390495	-18000000
1	69752517	62279033
2	82712517	65937912
3	82712517	58873136
4	95672517	60801614
5	108632517	61641008
	NPV	291532703
	NPV	291532703
	IRR	57%

Source: primary data after processing (2022)

The NPV calculation is carried out with the aim of assessing the potential for developing IoT-based backyard aquaculture in the smart village area in Bulukumba district for the next few years. The calculation results show that the NPV value in the next 5 years is IDR 291,532,703, - a positive NPV value, meaning that the development of an IoT-based backyard aquaculture model in the smart village area in Bulukumba district is feasible to be developed or can be recommended.

Internal Rate of Return (IRR) is the level of efficiency or an indicator to estimate the profitability of a business unit. The IRR application can also be used to calculate the interest rate on an investment. The IRR value in the analysis of the feasibility of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district is 57%. Research conducted by Devi Aprilia (2020), in the cultivation of Vaname shrimp, an IRR of 25.4% was obtained. Differences in IRR can occur due to differences in business scale. It can be seen that the IRR on the IoT-based back yard scale is higher than the IRR on a large scale as researched by Devi Aprilia et al. (2020).

Table 12: Calculation of the B/C Ratio in the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district

Tahun	Income	Fixed Cost	Variable Cost	Cash Flow	BC Rasio
0	0	68984100	57406395	-126390495	
1	129600000	2441088	57406395	69752517	2.17
2	142560000	2441088	57406395	82712517	2.38
3	142560000	2441088	57406395	82712517	2.38
4	155520000	2441088	57406395	95672517	2.60
5	168480000	2441088	57406395	108632517	2.82

Source: primary data after processing (2022)

From this value, the investment in the developed aquaculture business increased by 57%. The rate of return on investment in aquaculture development efforts will be profitable. Pindo Witoko et. al.(2018), if the B/C Ratio > 1 then the project can be considered feasible. In the feasibility analysis of the IoT-based backyard aquaculture model in the smart village area in Bulukumba district, it has a B/Ratio between 2.7-2.8, based on this criterion, the development of a back yard-scale aquaculture business in the area can be decided to be feasible.

Based on data from sea level, the number of households, the assumption of the number of ponds in each household (6 household pools), the geographical position of each sub-district and the productivity of each pond is 144 kg/pond, it is found a suitable location for the development of aquaculture models (shrimp vaname) IoT-based backyard scale in Bulukumba Regency. The level of income is directly proportional to the amount of production and the price of goods produced. All income received is total revenue. The estimated total revenue from the feasibility development of an IoT-based backyard aquaculture model in the smart village area in Bulukumba district is as follows:

Table 13. Estimated income on an IoT-based backyard aquaculture model in a smart village area in Bulukumba district.

Sub-District	Est. Production	Prices/Kg	Income (Est.) (Rp)
Ujung Loe	749952	50000	37497600000
Bontobahari	1508544	50000	75427200000
Bontotiro	650592	50000	32529600000
Herlang	654048	50000	32702400000
Kajang	1026432	50000	51321600000
Total	4589568		229478400000

Source: primary data after processing (2022)

The total revenue for developing an IoT-based backyard aquaculture model in the smart village area in Bulukumba district is: IDR 229,478,400,000,-.

CONCLUSIONS AND RECOMMENDATIONS

Some conclusions that can be delivered from the above discussion are as follows:

- The design of the IoT-based aquaculture model in Bulukumba Regency that is appropriate is in the Ujung Loe, Bontobahari, Bontotiro, Herlang and Kajang sub-districts. The data acquisition system developed is a sensor unit for big analog data, a micro controller, perpetual Connectivity for Internet connection and RTC for facilitating data traffic management.
- A technical and economic study of the aquaculture model in the smart village area in Bulukumba district has been carried out. The amount of production targeted for each production cycle is 864 kg, with a total of 6 ponds with a diameter of 3 meters. The NPV value is IDR 291,532,703,-, the IRR value is 57% and the B/C ratio ranges from 2.1 to 2.8.
- Spatial allocation for introducing backyard-scale aquaculture in Bulukumba Regency is Ujung Loe, Bontobahari, Bontotiro, Herlang and Kajang Subdistricts, with an estimated income of IDR 229,478,400,000 per year.

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