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OPTIMIZING BROILER CHICKEN FARM PRODUCTION USING INTERNET OF THINGS SMART FARM TO REDUCE FOOD LOSS AND WASTE

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Abstract

In the Broiler Chicken farming industry, Food loss and Waste (FLW) is a big challenge that affects production efficiency and environmental sustainability. The use of Internet of Things (IoT) technology is expected to improve control and monitoring of various aspects of production, from environmental conditions to chicken health, which can ultimately minimize food losses and waste. The method used in this research is a quantitative method, which involves collecting data through direct observation, interviews and distributing questionnaires. Observations were made on broiler chicken farms that had implemented IoT technology. The data collected is then analyzed to understand the impact of using IoT on production efficiency and reducing food loss and waste. The research results show that implementing an IoT technology can significantly increase the operational efficiency of broiler chicken farms. IoT sensors installed at various critical points of the farm help monitor temperature, humidity and air quality conditions, as well as provide real-time information about the health of chickens. With accurate and real-time data, farmers can take preventative action more quickly, thereby reducing the risk of chicken death and food waste. The aim of this research shows that broiler chicken farms that use IoT technology experience improvements in environmental management and chicken health, which contribute to reducing food loss and waste. Broiler chicken productivity also increases due to a more controlled environment and more effective management. In conclusion, the integration of IoT technology in broiler chicken farming production is an effective solution to reduce FLW and increase the sustainability and efficiency of the Broiler Chicken farming industry.

Keywords: *Broiler chicken farming production, Internet of Things, food loss and waste, livestock efficiency, sustainability.*

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Introduction

Animal husbandry is a business that is growing very rapidly and has a fairly high demand, especially raising poultry such as broiler chickens Broiler chicken meat is a highly nutritious food that is relatively easy for consumers to obtain both in terms of availability and price. This accessibility is partly due to the rapid development of the poultry industry and its expansion near consumer centers. (B. Ghazal, 2017) (Ilham N, 2017)Low-income consumers can also obtain chicken protein more easily (Saptana*, 2020). However, the main challenge faced in the boiler chicken petiering supply chain is food loss and waste (FLW), which occurs from production to consumption. The Food and Agriculture Organization of the United Nations (FAO) states that every year about one-third of all food produced for human consumption is lost or wasted. These challenges not only cause huge economic losses, but also have a major impact on social justice, food security, and the environment. FLW in chicken farming can be caused by a variety of factors, including animal diseases, lack of cage environmental management, and failure to regulate the food supply. In an effort to overcome the problem of food loss and waste is through production innovations in the field of livestock that aim to increase production efficiency, through internet of things (IoT) technology or smart farms, this has emerged as a potential solution. The Internet of Things (IoT) has now begun to be applied in the agricultural sector, one of which is in the livestock sector. The use of IoT allows farms to become smart farms, namely livestock monitoring systems that can be done remotely using semi-automatic microprocessors. By utilizing sensors, smart devices, and data analysis, IoT systems can provide more accurate and real-time monitoring and management of environmental conditions, animal health, and production processes in farms. (Handigolkar, 2016)

Previous research related to the use of IoT in chicken farming systems has been conducted by . This research develops a smart farm that focuses on monitoring and controlling conditions on farms. Sensors are used to measure the temperature, ammonia, and humidity of the enclosure. The integration of the microcontroller with the PID controller connected to the fan controls the air ventilation in the chicken farm. However, this study has not explained the effect of the application of smart farms on chicken health and mortality levels. This research aims to implement IoT in broiler chicken farms by automating the regulation of environmental conditions and feeding based on the results of sensor readings. This study will compare feed efficiency and chicken mortality rates before and after IoT implementation.(Mayangsari, 2021)

The Research Questions in this study are:

1. How to improve production efficiency in Broiler Chicken farms?
2. How to improve welfare in Broiler Chicken farms?
3. How is the application of the IoT smart farming system in reducing food loss and waste in Broiler Chicken Farms?

By answering this question, this research aims to provide new insights and innovative solutions in addressing the challenges of food loss and waste in the livestock sector, as well as drive the adoption of IoT technology for more sustainable and efficient livestock globally.

Broiler Chicken

Broiler chickens are types of male and female chickens that are raised intensively to obtain optimal meat production. Purebred chickens can be divided into two types, namely laying hens and broilers. Chickens of superior broiler breeds are called broiler chickens. Broiler chickens are produced through crossbreeding, selection, and genetic engineering carried out by breeders. Broiler chicken is a type of chicken that is raised for the purpose of production for meat.(Prihatman 2000)(Yuwanta 2004)

Broiler chickens are meat-producing chickens that are raised until the age of 6-7 weeks with a weight of 1.5-2 kg. Broiler chickens are used for their meat as a source of animal protein. Broiler is a term to refer to a strain of chicken cultivated by technology that has economic characteristics, with the characteristic of fast growth as a meat producer, ready to be slaughtered at a relatively young age, and producing quality meat with soft fiber.(Yuwanta 2004)(Rasidi 2000)

Improving Production Efficiency in Broiler Chicken Farms

Production efficiency is the ability of producers to achieve a certain level of quality at low cost (Soekartawi, 1997 and Coelli et al, 1998). According to Muthukrishnan et al. (2011), production efficiency in broiler chickens includes minimizing production costs by using resources optimally and applying appropriate technology and management at each stage of production. Production efficiency in broiler chicken farms can be improved by implementing controls on maintenance, feed, animal health, and cage environment.

According to research conducted by Kusnadi (2018), the implementation of a strict biosecurity system can prevent the entry of disease agents into the cage and minimize the risk of disease outbreaks. In addition, the use of technology such as automated feeding and drinking systems, as well as cage temperature and humidity control has also been proven to improve production efficiency (Astuti 2021). In an effort to improve production efficiency in broiler chicken farms, not only technical aspects need to be considered, but also economic and business management aspects. A study conducted by Prabowo et al. (2019) revealed that the implementation of good supply chain management can minimize production costs and increase profits for broiler chicken farmers.

Improving Welfare in Broiler Chicken Farms

Animal welfare in broiler chicken farming refers to the physical and mental condition of animals in accordance with their natural behavior, which must be implemented to protect animals from inappropriate treatment by humans against animals that are used by humans. According to Winarso (2008), public attention to animal welfare continues to increase. Improving the welfare of broiler chicken farms can be done with several strategies, including providing a suitable cage environment, such as low density, sufficient lighting, good air circulation, and dry and comfortable cage floors. This reduces stress and aggressive behavior in broiler chickens. In addition to the cage environment, nutrition also plays an important role in maintaining the welfare of broiler chickens. Fanatico et al. (2008) found that feeding with sufficient crude fiber content can increase chicken feeding activities and prevent pecking behavior. The provision of clean and easily accessible drinking water is also important to maintain the health and welfare of broiler chickens (Weeks et al., 2012). (Dawkins 2004)

Proper health services are also key to improving animal welfare. The research of Shao et al. (2015) emphasizes the importance of implementing an effective vaccination program and control timely illness. In addition, the application of biosecurity that Strict includes: Limiting access to cages, provide sanitation who deserves, and cleaning and disinfection routine can prevent the entry of diseases into the cage. The implementation of this strategy can improve animal welfare and improve the quality of broiler chickens. This is important to ensure that the chicken remains quality, safe and fit for consumption.(Jones 2005)

Food Loss and Waste

The main challenge faced in the broiler chicken farm supply chain is food loss and waste (FLW), which occurs from production to consumption. According to FAO, food loss is the loss of a number of foods between the supply chain of producers and the market that occurs as a result of the post-harvest process so that food that does not meet the quality desired by the market will be discarded. Meanwhile, food waste is food that is suitable for disposal due to negligence during the production, processing, and distribution processes (Rezaei & Liu, 2017: 26; fao.org, 2015). In the context of chicken meat, FL is more associated with animal health issues, animal welfare, food safety, and quality control. FL is defined as a product that is discarded from human consumption. FW in the context of chicken meat is defined as the disposal of any part of an animal that is eaten or can be eaten after the handling or processing process.

Smart Farming Iot System on Broiler Chickens

To reduce food loss in broiler chicken farms, it is necessary to improve infrastructure and technology through production innovations that increase efficiency. IoT and smart farming offer potential solutions by utilizing microcontrollers that can efficiently manage various aspects of livestock (Sebayang 2016). IoT enables internet-based remote monitoring and control, with the advantage of faster, easier, and more efficient work (Skad & Nandika 2020). The IoT system in broiler chicken farms uses NodeMCU, Arduino Uno, DHT11 sensors for temperature and humidity, and MQ-135 sensors for ammonia levels. The ideal temperature for broiler chickens is between 30°C to 34°C, and ammonia levels above 25ppm will automatically activate the DC fan (Mansyur, 2018; Puspasari et al., 2018). Automatic feeding uses Arduino and RTC DS3231 to ensure proper feeding schedule. All sensor data is sent to a database and displayed on mobile phones, allowing farmers to monitor and manage farms efficiently. The system is designed to optimize the environmental conditions of the cage and ensure timely and appropriate feeding, which is important for maintaining the health and productivity of chickens and reducing the risk of disease and death.

Method

This research is a research using quantitative research methods. It is called quantitative data because the data collected in this study can be analyzed using statistical analysis. Quantitative research is a research whose data is in the form of numbers that are used as a tool to find information. This research is descriptive. Descriptive research is a research method that seeks to describe and interpret objects as they are without intending to make generally accepted conclusions. Based on the above understanding, it can be concluded that the research that will be carried out by the researcher aims to analyze, and describe the existing phenomena using numbers. The population in this study is farmers. The sample was taken using the purposive sampling technique to ensure that the selected respondents had relevant experience and knowledge with the use of the IoT Smart Farm system. From this population, a sample of 30 respondents who were willing to participate in this study was taken. The data collection method used by the researcher is questionnaire data. For sampling data using the questionnaire method, where the respondents only consisted of a few questions related to how to improve the Efficiency of Broiler Chickens, how to improve the welfare of Broiler Chickens, and the application of the IoT Smart Farm system in reducing food loss and waste. In this study, a Likert scale was used, which is a 36 measurement scale first developed by Rensis Likert. This scale is also known as the summed ranking method, which means that the rating value of each response or answer is summed up resulting in a total value. The Likert scale has five levels of answer preference, each of which has a score of 1-5 with the following details:

Strongly disagree (STS) = 1
Disagree (TS) = 2
Hesitate (RG) = 3
Agree(s) = 4
Strongly Agree (SS) = 5

Through a questionnaire survey approach, this study aims to gain a deep understanding of how the use of the Internet of Things (IoT) Smart Farm for broiler chicken farm production in reducing food loss and waste

Result

Research Findings

PT Charoen Pokphand Indonesia Tbk (CPI) is one of the largest and leading agribusiness companies in Indonesia, with a primary focus on chicken breeding, animal feed production and chicken-based food processing. The company is part of the Charoen Pokphand

Group, a Thailand-based multinational conglomerate, which has businesses in various sectors including agriculture, livestock, and food.

PT Charoen Pokphand Indonesia was first established in 1972, which was founded by two Chinese brothers named Chia Seow Nooy and Shia Exchor. The reason why he established a broiler chicken farming business is because the demand for animal products is very high so that the market demand is still high and the level of competitors is very small.

Test Instrument

1) Validity Test

The validity test is the similarity of data between the actual data that occurs in the research object and the data reported by the researcher. This validity test is used to measure the accuracy of a test to measure a variable. The validity test in this study uses the help of the SPSS (Statistical Package for Social Seiences) version 25 program to determine the validity or not of the items tested. The research criteria for this validity test are:

1) If r calculates > r table (0.05), then the questionnaire item is valid.
2) If r counts < r table (0.05), then the questionnaire item is invalid.

Table 1
RQ1 Validity Test Output Results

Correlations

		X1.1	X1.2	X1.3	X1.4	X1.5	Total_RQ1
X1.1	Pearson Correlation	1	.352	.207	.455*	.247	.734**
	Sig. (2-tailed)		.056	.273	.012	.188	.000
	N	30	30	30	30	30	30
X1.2	Pearson Correlation	.352	1	.140	.463**	.361*	.695**
	Sig. (2-tailed)	.056		.459	.010	.050	.000
	N	30	30	30	30	30	30
X1.3	Pearson Correlation	.207	.140	1	.000	.508**	.567**
	Sig. (2-tailed)	.273	.459		1.000	.004	.001
	N	30	30	30	30	30	30
X1.4	Pearson Correlation	.455*	.463**	.000	1	-.073	.571**
	Sig. (2-tailed)	.012	.010	1.000		.700	.001
	N	30	30	30	30	30	30
X1.5	Pearson Correlation	.247	.361*	.508**	-.073	1	.641**
	Sig. (2-tailed)	.188	.050	.004	.700		.000
	N	30	30	30	30	30	30
Total_RQ1	Pearson Correlation	.734**	.695**	.567**	.571**	.641**	1
	Sig. (2-tailed)	.000	.000	.001	.001	.000	
	N	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 2
RQ2 Validity Test Output Results

Correlations

		X2.1	X2.2	X2.3	X2.4	X2.5	Total_RQ2
X2.1	Pearson Correlation	1	.118	.617**	.257	.123	.683**
	Sig. (2-tailed)		.534	.000	.170	.516	.000
	N	30	30	30	30	30	30
X2.2	Pearson Correlation	.118	1	.203	.342	.250	.568**
	Sig. (2-tailed)	.534		.282	.065	.183	.001
	N	30	30	30	30	30	30
X2.3	Pearson Correlation	.617**	.203	1	.220	.156	.721**
	Sig. (2-tailed)	.000	.282		.243	.409	.000
	N	30	30	30	30	30	30
X2.4	Pearson Correlation	.257	.342	.220	1	.457*	.690**
	Sig. (2-tailed)	.170	.065	.243		.011	.000
	N	30	30	30	30	30	30
X2.5	Pearson Correlation	.123	.250	.156	.457*	1	.569**
	Sig. (2-tailed)	.516	.183	.409	.011		.001
	N	30	30	30	30	30	30
Total_RQ2	Pearson Correlation	.683**	.568**	.721**	.690**	.569**	1
	Sig. (2-tailed)	.000	.001	.000	.000	.001	
	N	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 3
RQ3 Validity Test Output Results

Correlations

		X3.1	X3.2	X3.3	X3.4	X3.5	Total_RQ3
X3.1	Pearson Correlation	1	.635**	.631**	.577**	.544**	.841**
	Sig. (2-tailed)		.000	.000	.001	.002	.000
	N	30	30	30	30	30	30
X3.2	Pearson Correlation	.635**	1	.491**	.565**	.376*	.809**
	Sig. (2-tailed)	.000		.006	.001	.040	.000
	N	30	30	30	30	30	30
X3.3	Pearson Correlation	.631**	.491**	1	.653**	.568**	.819**
	Sig. (2-tailed)	.000	.006		.000	.001	.000

	N	30	30	30	30	30	30
X3.4	Pearson Correlation	.577**	.565**	.653**	1	.354	.816**
	Sig. (2-tailed)	.001	.001	.000		.055	.000
	N	30	30	30	30	30	30
X3.5	Pearson Correlation	.544**	.376*	.568**	.354	1	.674**
	Sig. (2-tailed)	.002	.040	.001	.055		.000
	N	30	30	30	30	30	30
Total_RQ3	Pearson Correlation	.841**	.809**	.819**	.816**	.674**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Based on the results of the table above for the validity test using SPSS version 25 data that has been tested by 30 respondents stated that RQ's statements are How to improve the efficiency of broiler chicken farming (X1), How to improve the welfare of broiler chickens (X2), How the application of the Smart Farming IoT System can reduce food loss and waste in broiler chicken farming (X3). The calculation results show that the calculation r is greater than the r table and it can be seen that the Correvted Item Total Correlation is greater than the r table (0.3610). It can be concluded that the research is considered valid according to describing the phenomenon.

2) Reliability Test

Reliability test measurements can be made by measuring once and then the results will be compared with other questions. The reliability test can be carried out using the alpha cronbach technique, which has a coefficient or alpha of 0.6 as a benchmark.

Table 4
Reliability Test Results

Variable	Cronach's Alpha	Test Scores	Information
Broiler Chicken Efficiency (x1)	0,640	0,6	Realistic
Broiler Chicken Welfare (x2)	0,656	0,6	Realistic
Smart Farm IoT System in FLW (x3)	0,841	0,6	Realistic

Based on the results of table 4, it shows that the statement value of the questionnaire used to test each of the variables studied can be considered reliable. The variables had Cronbach's Alpha Broiler Chicken Efficiency (0.640), Broiler Chicken Welfare (0.656) and

IoT Smart Farm System in FLW (0.841) It can be concluded that all variables are declared reliable because Cronbach's Alpha is greater than 0.6 which is used as a benchmark in reliability testing.

Classical Assumption Test

1) Normality Test

In the classical assumption test, this normality test aims to measure whether the regression model of the perturbating or residual variables has a normal distribution. The researcher used a normality test using the One Sample Kolmogorov Smirnov Test by setting an alpha of 5% or 0.05 with the rule of Decision, if the significance is more than a = 0.05, then it can be said that the data is a normal distribution.

Table 5
Normality Test Results

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		30
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	2.36641136
Most Extreme Differences	Absolute	.169
	Positive	.087
	Negative	-.169
Test Statistic		.169
Asymp. Sig. (2-tailed)		.028c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Based on the results from table 5, it is seen that the residual research has a normal distribution. It is stated that the value of Asymp. Sig. (2-tailed) of 0.028 is greater than 0.05, it can be said that the data is normally distributed.

2) Multicollinearity Test

The next assumption test is the multicoloniality test. The purpose of this test is to find out if there is a correlation between the besas (independent) variable and the regression variable. Multicollinearity can be assessed by looking at the value of Variance Inflation Factor (VIF) and tolerance. If the VIF value is less than 10 and the tolerance is less than 0.1, then multicollinearity does not occur.

Table 6
Multicollinearity Test Results

Coefficientsa

Type		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.	Collinearity Statistics Tolerance	VIF
1	(Constant)	-4.598	4.681		-.982	.335		
	Efficiency of Broiler Chickens	.945	.291	.608	3.245	.003	.538	1.857
	Broiler Chicken Welfare	.172	.257	.125	.669	.509	.538	1.857

a. Dependent Variable: Smart Farm IoT System

Based on the results of table 6, the Multicollinearity Test found that the VIF values for the variables of Broiler Chicken Efficiency (X1) and Broiler Chicken Welfare (X2) were both 1.857, while the Tolerance was 0.538. Since the VIF value of the two variables is not greater than 10 or 5, it can be said that there is no multicollinearity in the two independent variables. Thus, the above model has been free from the existence of multicollinearity.

3) Heteroscedasticity Test

The next classical assumption test is the heteroscedasticity test which is used to test whether the regression model has variance inequality and residual of one observation to another. With a significant value (Sig) of more than 0.05 to prove whether the test has heteroscedasticity or not, the researcher used the Glejser Test and the results of the output on the scatterplot.

Table 7
Heteroscedasticity Test Results

Coefficientsa

Type		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	5.048	2.876		1.755	.091
	Efficiency of Broiler Chickens	-.390	.179	-.528	-2.184	.038
	Broiler Chicken Welfare	.244	.158	.374	1.548	.133

a. Dependent Variable: Abs_RES

Based on the results of table 7, it is known that the heteroscedasticity test in the Glejser Test gives a significant value result of more than 0.05 and it can be concluded that the two variables do not have heteroscedasticity. And based on the image on the results of the heteroscedasticity test, it can be concluded that the distribution of points does not form a certain pattern/flow, so it can be concluded that there is no heteroscedasticity or in other words homoscedasticity occurs. The classical assumption of heteroscedasticity in this model is fulfilled, that is, it is free from heteroscedasticity.

4) Autocorrelation

The autocorrelation test aims to determine whether there is a correlation between the perturbation error in the t-period and the perturbation error at perode t-1 in the linear regression model. If correlation occurs, then it can be said that there is an autocorrelation problem.

Autocorrelation is used using Durbin Watson (DW) statistics. The Durbin Watson (DW) value is compared to the dw table, and the comparison results show that if the du < value dw < 4-du, then no autocorrelation occurs.

Independent variable : $k = 2$
Number of Samples: $n = 30$

Table 8
Autocorrelation Test

Model Summaryb

Type	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.700a	.489	.451	2.452	1.794

a. Predictors: (Constant), Broiler Chicken Welfare, Broiler Chicken Efficiency
b. Dependent Variable: Smart Farm IoT System

The Durbin-Watson table shows that the value of $d_L = 1.283$ and the value of $d_U = 1.566$ so that the criteria can be determined whether or not autocorrelation occurs.
Based on the results of table 4.10, the Autocorrelation Test found that the DW value calculated at 1,794 was greater than 1,566 and less than 1,283 which means that it was in an area where there was no autocorrelation. So it can be concluded that in the linear regression model there is no autocorrelation.

Model Feasibility Test

1) Model Reliability Test (Test F)

The F test is the accuracy of the sample regression function in estimating the actual value. If the significant value of F < 0.05, then the regression model can be used to predict independent variables. In addition, the statistical test F shows whether each independent variable in the model affects together on the dependent variable. The significant value of F is 0.05 (Ghozali, 2018:97). "The hypothesis testing criterion in the use of F statistics is that when the significance value of F < 0.05, then an alternative hypothesis is accepted, which states that all independent simultaneously and significantly affect the dependent variable (Ghozali, 2018:97)."

The following are the criteria for measuring the f test in this study, namely:

1. If f calculates > f table, then H0 is rejected and Ha is accepted, meaning that the independent variable has a positive and significant effect on the dependent variable with a significance value of < 0.05.
2. If f calculates < f table, then H0 is accepted and Ha is rejected, meaning that the independent variable has no significant effect on the dependent variable with a significance value of > 0.05.

Table 9
Test F

ANOVAa

Type		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	155.603	2	77.801	12.935	.000b
	Residual	162.397	27	6.015		
	Total	318.000	29			

a. Dependent Variable: Smart Farm IoT System
b. Predictors: (Constant), Broiler Chicken Welfare, Broiler Chicken Efficiency

Based on the results of table 9, it can be seen that the f test of the table results above the significant value (Sig) is 0.000 < 0.05. It can be concluded that the variables of Broiler Chicken Efficiency, Broiler Chicken Welfare have a positive and significant effect on the implementation of the Smart Farm IoT System in overcoming food loss and waste.

2) Regression Coefficient Test (T Test)

The t-test is used to measure the level of significance of the influence between independent variables and dependent variables. This test riteria is based on probability. In other words, the significance level used is 5%, in other words, it is declared insignificant if the probability of Ha > 0.05, and significant if the probability of Ha < 0.05 (Ghozali, 2018).
The following are the criteria for measuring the t-test in this study, namely:

1. If t counts > t table, then H0 is rejected and H1 is accepted, meaning that the independent variable has a positive and significant effect on the dependent variable.
2. If t counts < t table, then H0 is accepted and H1 is rejected, meaning that the independent variable has no positive and significant effect on the dependent variable.

Table 10
Test T

Coefficientsa

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Type	B	Std. Error	Beta	t	Sig.	Tolerance	VIF

1	(Constant)	-4.598	4.681		-.982	.335		
	Efficiency of Broiler Chickens	.945	.291	.608	3.245	.003	.538	1.857
	Broiler Chicken Welfare	.172	.257	.125	.669	.509	.538	1.857

a. Dependent Variable: Smart Farm IoT System

Based on the results of table 10, it can be calculated in finding t table (a/2 : n-k-1) or (0.05/2 : 30-2-1) = (0.025 : 27) = (2.052), it is concluded that:

1. Explained in table 4.10, the influence of the Broiler Chicken Efficiency Variable (X1) based on the Coefficients output table above is known that the calculated t value is 3,245 > t table 2.052 and the significant value (Sig) is 0.003 < 0.05. Therefore, H0 was rejected and H1 was accepted, so it can be concluded that the Broiler Chicken Efficiency variable has a positive and significant effect on the implementation of the Smart Farm IoT system in dealing with food loss and waste. Thus the H1 hypothesis can be proven or accepted.
2. Explained in table 4.10, the influence of the Broiler Chicken Welfare Variable (X2) based on the Coefficients output table above is known that the t-value is 0.669 < ttable 2.052 and the significant value (Sig) is 0.509 < 0.05. Therefore, H0 was rejected and H2 was accepted, so it can be concluded that the Broiler Chicken Welfare variable has a positive and significant effect on the implementation of the IoT Smart Farm system in dealing with food loss and waste. Thus the H2 hypothesis can be proven or accepted.

3) Coefficient of Determination

The determination coefficient test aims to measure how far the model is able to explain the variation of dependent variables. A low R2 value indicates that the ability of independent variables to explain dependent variables is very limited. A value of almost one indicates that the independent variables provide almost all the information necessary to predict the variation of the dependent variable.

Table 11
Coefficient of Determination Test

Model Summaryb

Type	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.700a	.489	.451	2.452	1.794

a. Predictors: (Constant), Broiler Chicken Welfare, Broiler Chicken Efficiency

b. Dependent Variable: Smart Farm IoT System

When viewed from the R-Square value of 0.489, it shows that the proportion of the influence of the Broiler Chicken Efficiency and Broiler Chicken Welfare variables on the Smart Farm IoT System variable is 48.9%. This means that the variables of Broiler Chicken Efficiency, and Broiler Chicken Welfare have a simultaneous effect on the implementation of the Smart Farm IoT system in dealing with food loss and waste of 48.9% and while the rest

(100 – 48.9%) = 51.1% affect variables outside of those not explained in this study and the model used in this study is feasible.

Conclusion

This study shows that the implementation of the IoT (Internet of Things) smart farm system in broiler chicken farms has significant potential in reducing food loss and waste. By integrating advanced sensors and automation systems, farmers can monitor and control the environmental conditions of their cages, feed consumption, and livestock health in real-time. This allows for more efficient management and more informed decision-making, thereby reducing the risk of livestock mortality, lowering excessive feed consumption, and minimizing resource waste. In addition, smart farm IoT systems also facilitate more accurate and comprehensive data collection and analysis, providing valuable insights for farmers to optimize cultivation practices. Thus, farm productivity and efficiency can be improved, while environmental impact and operational costs can be minimized.

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