Bantara Journal of Animal Science **p-ISSN: 2656-9701**
Vol. 8, No. 1, April 2026 **e-ISSN: 2657-1587**
DOI: ***https://dx.doi.org/10.32585/bjas.v8i1.8205*** Journal homepage: https://journal.univetbantara.ac.id/index.php/bjas/index

Quality Control Analysis of Layer Chicken Production Performance Using Fishbone Diagram Approach

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* *Received for review May 5, 2026 Accepted for publication May 30, 2026*

Abstract: This study aims to analyze quality control in layer chicken production using Statistical Quality Control (SQC) and the Fishbone Diagram approach at one of CV Layer Farm's partners in South Lampung. Primary data were collected through direct observation, interviews, and environmental measurements, while secondary data consisted of daily production records and feed consumption over an 11-week period.The results show an average Hen Day Production (HDP) of 90.91%, with a Feed Conversion Ratio (FCR) of 2.22 and mortality rate of 1.2%. However, House 3 (89.65%) did not reach the optimal standard of 92.7%, with the lowest fluctuation occurring in week 27 (84.54%). Fishbone analysis identified root causes such as environmental factors (heat stress at 33°C), managerial issues (absence of written SOPs and reliance on manual recording), and limited monitoring facilities. Economically, the farm remains efficient with a positive R/C ratio, though improving HDP in House 3 could further enhance profitability. Recommended corrective actions include digitalizing recording systems, mitigating heat stress through housing modifications, and standardizing SOPs for farm management.This study highlights that applying SQC and Fishbone analysis is effective in detecting production variability and provides strategic recommendations to improve quality, efficiency, and sustainability in layer chicken farming.

Keywords: layer chicken; quality control; Statistical Quality Control; Fishbone Diagram; production efficiency

Introduction

Layer chicken farming is one of the key sectors in providing affordable animal protein for society. However, production success is determined not only by the quantity of eggs produced but also by the consistency of production quality. Egg quality is influenced by various factors such as climatic conditions, feed management, housing systems, and the application of technology. Instability in these factors may lead to quality variations, thereby necessitating a systematic approach to quality control.

Tropical climate variability is one of the main causes of fluctuations in production quality. Akshaya et al. (2024) reported that summer conditions in India reduced feed intake by 20–30% and egg production by 25–35%, while also worsening shell quality. Utami et al. (2025) added that in Indonesia, the rainy season increases humidity and disease risk, thereby reducing profitability, whereas the dry season is more profitable but prone to heat stress. These conditions highlight the need for a quality control system capable of anticipating climatic influences.

Feed formulation and management practices play a crucial role in maintaining egg quality. Alaraji (2024) demonstrated that adjusting the ratio of limestone, lighting, and vitamins could increase production by nearly 10% and improve shell thickness. Chisowa (2023) showed that local chickens fed with layer mash produced more eggs compared to free-range systems, although egg weight remained relatively similar. This emphasizes that nutrition directly affects the consistency of production quality.

Input efficiency is also closely related to quality and business sustainability. Anang et al. (2024) identified factors such as chick quality, labor, housing space, farmer experience, and ND vaccination as key determinants of productivity. Gani et al. (2025) emphasized that despite high feed costs, efficient upstream management and marketing still generated profits with an R/C ratio of 1.2. This analysis indicates that quality control is not only linked to technical production but also to economic efficiency.

Housing systems influence the balance between productivity and animal welfare. Shoji et al. (2025) found that enriched cages outperformed conventional and aviary systems in terms of production levels and feed efficiency, although aviary systems showed signs of stress in chickens. Schreiter and Freick (2023) highlighted the trade-off between production quantity and welfare quality, which must be considered in quality control. In addition, Irba et al. (2024) demonstrated a significant difference in the quality of eggs from Isa Brown layer chickens raised in closed-house and open-house cages. The study found that egg weight and egg index were higher in closed-house cages (63.80 g; index 79.06), while yolk index and Haugh Unit were higher in open-house cages (0.74; HU 64.40). These findings emphasize that housing systems affect not only productivity and animal welfare but also the quality of eggs produced.

The integration of digital technology has emerged as a modern solution for quality monitoring. Sabado (2024) introduced a web-based management system that was highly accepted by farmers due to its ability to improve efficiency in financial recording, inventory, and reporting. This digitalization supports the application of Statistical Quality Control with more accurate and real-time data.

Given the complexity of factors influencing egg production, a structured analytical framework is required to identify root causes of quality variation and propose corrective measures. Statistical Quality Control (SQC) provides a quantitative basis for monitoring production consistency, while the Fishbone Diagram approach enables systematic identification of causal factors across categories such as climate, feed, housing, labor, and technology. Together, these methods offer a comprehensive toolset for diagnosing problems, reducing variability, and improving both productivity and product quality in layer chicken farming.

Materials and Methods

Research location and time

This research was conducted at one of CV Layer Farm’s partners in South Lampung, selected through purposive sampling based on the consideration that the farm maintains comprehensive daily production records. Data collection will be carried out over an 11-week period to capture the variability of environmental conditions and feed management.

Data types and sources

The data used in this study comprised two main categories: primary and secondary data. Primary data were obtained through direct observation in the housing area and in-depth interviews with the management regarding feed management techniques, vaccination programs—specifically for Newcastle Disease (ND)—and the specifications of the housing system implemented. Additionally, primary data collection involved direct measurements of essential environmental parameters, such as ambient temperature and humidity. Secondary data were collected from historical daily egg production records, which included production volume, egg weight, and details of damaged or defective eggs, as well as comprehensive records of feed consumption over a specified production cycle or period.

Data analysis stages

This study employed two primary approaches: Statistical Quality Control (SQC) to quantitatively identify deviations, and the Fishbone Diagram.

Statistical Quality Control (SQC)

The statistical quality control steps in the egg production process began with the use of Check Sheets to systematically collect and organize production data and types of defects, such as cracked eggs, shell-less eggs, or non-standard sizes. Following data collection, the next stage involved the application of Control Charts (p-Charts) to monitor whether the egg defect rates remained within the established tolerance limits. This process required comprehensive mathematical calculations, including the determination of the proportion of defects, the central line (CL), as well as the Upper Control Limit (UCL) and Lower Control Limit (LCL). Through the integration of these two tools, quality deviations could be detected early, allowing for immediate corrective actions to maintain the quality stability of the production output.

Fishbone diagram analysis *(Ishikawa)*

Once the points outside the control limits (out of control) were identified, a root cause analysis was conducted using the Fishbone Diagram by evaluating five main factors referenced from the literature findings in the introduction. The analysis included the Man factor, focusing on the farmers' experience in egg handling and labor precision (Anang et al., 2024), and the Method factor, which reviewed lighting management, vaccination efficiency, and the use of both digital and manual recording systems (Sabado, 2024; Anang et al., 2024). Regarding Material, the evaluation focused on the quality of day-old chicks (DOC), the availability of drinking water, and feed formulation concerning limestone and vitamin ratios (Alaraji, 2024). Meanwhile, the Machine factor considered the type of housing—such as Enriched, Conventional, or Aviary models—along with its sanitation equipment (Shoji et al., 2025). Finally, the Mother Nature (Environment) factor was analyzed to observe the effects of heat stress, humidity fluctuations during the rainy season, and the impact of the tropical climate on feed consumption rates (Akshaya et al., 2024; Utami et al., 2025).

Ekonomic efficiency analysis

To complement the quality control analysis, the Revenue-Cost (R/C) Ratio was calculated to ensure that improvements in quality management maintain economic profitability (Gani et al., 2025). The R/C ratio is formulated as follows:

$$R/C = \text{Total Revenue} / \text{Total Production Cost}$$

Research Framework

The study commenced with the collection of daily production data, followed by control chart analysis to detect variability. Upon identifying data points outside the control limits, a brainstorming session was conducted to develop a Fishbone diagram, aimed at formulating recommendations for improving production management and poultry welfare.

Result and Discussion

Research results

Based on observations and daily record collection over an 11-week period (week 26 to week 36) at CV Sumber Energi Pangan, the production performance for two housing units (H3 and H4) was obtained as follows:

Table 1. Summary of layer production performance

Parameter	House 3 (H3)	House 4 (H4)	Combine Average	Standart
HDP (%)	89,65	92,18	90,91	92-94
FCR	2,25	2,19	2,22	1,95-2,00
Total Mortality (%)	1,40	1,00	1,20	1,00-1,80

Statistical Quality Control (SQC) Analysis

The analysis results indicated performance variability between the housing units. The Hen Day Production (HDP) in House 4 (92.18%) nearly approached the optimal standard; however, House 3 (89.65%) showed a significant deviation below the minimum standard of 92.7%. The lowest fluctuation in H3 occurred during week 27 (84.54%), indicating technical disturbances or environmental stress during that period. This is consistent with the findings of Akshaya et al. (2024), which state that heat stress can reduce feed consumption by up to 30% and egg production by up to 35%.

Root Cause Analysis (Fishbone Diagram)

Based on the deviation data in House 3 (H3), an analysis was conducted using a Fishbone diagram to comprehensively identify root causes by dissecting various contributing factors. These ranged from the Man aspect, such as lack of PPE discipline, and the Method aspect regarding non-standardized work instructions, to Environment and Machine factors that potentially trigger occupational accidents. The in-depth analysis through this fishbone framework aims to map the causal relationship between observed field symptoms and systemic failure sources, enabling the company to formulate targeted corrective actions and prevent the recurrence of future incidents

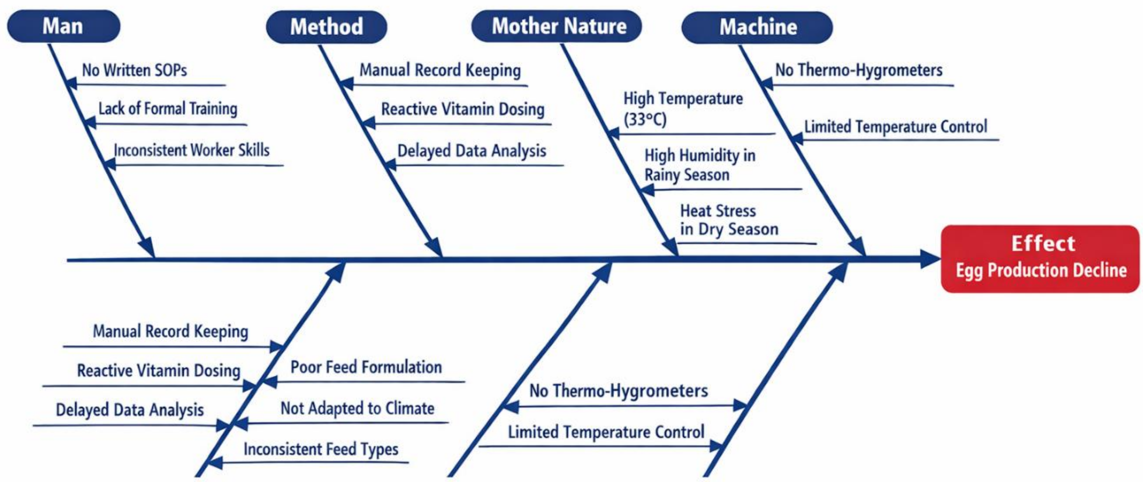

Figure 1. Fishbone Diagram Illustration for Layer Chicken OHS (Occupational Health and Safety)

Man: The absence of written SOPs and formal training for farm workers results in inconsistent management between housing units. Worker skills in detecting production decline symptoms remain largely intuitive. According to Anang et al. (2024), labor experience and skills significantly influence the productivity of layer chickens. Method: The use of manual recording leads to delays in data evaluation. Furthermore, reactive vitamin administration is less effective compared to preventive supplementation programs. Alaraji (2024) demonstrates that Vitamin D_3 supplementation and lighting management can increase egg production by up to 9.6%. Material: Feed formulations are not

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yet fully adaptive to peak production phases and climatic fluctuations. Chisowa (2023) emphasizes that providing layer mash increases egg quantity compared to scavenging systems, although egg weight remains relatively similar. Mother Nature: Housing temperatures reaching 33°C in the open-house system trigger the risk of heat stress. Utami et al. (2025) reported that the rainy season increases humidity and disease risks, while the dry season is more favorable but prone to heat stress. Machine: The open-house system limits temperature control. The lack of monitoring tools, such as thermo-hygrometers, hinders the anticipation of extreme temperatures. Shoji et al. (2025) found that enriched cage systems are more efficient in terms of production and poultry welfare compared to both aviary and conventional housing.

Economic Efficiency Analysis

Despite the HDP deviations observed in House 3, the enterprise overall continues to demonstrate positive economic efficiency. With an average FCR of 2.22 and low mortality rates, the risk of fatal losses can be minimized. However, improvements in the HDP aspect of House 3 have the potential to increase profitability through a more optimal R/C ratio. Gani et al. (2025) demonstrate that even with high feed costs, the implementation of efficient upstream management and marketing still generates profit with an R/C ratio of 1.2.

Recommended Corrective Actions

The recommended corrective actions commence with the implementation of digitized recording through a spreadsheet-based system to facilitate real-time early detection of deviations in Hen Day Production (HDP) and Feed Conversion Ratio (FCR) (Sabado, 2024). This is further supported by heat stress mitigation efforts, including the installation of additional fans or shading nets on sun-exposed sides of the housing to reduce effective temperatures (Akshaya et al., 2024). Finally, these measures are reinforced by work standardization through the development of simple maintenance SOPs that must be followed by all farm workers to ensure consistent quality across all units (Anang et al., 2024).

Conclusion and Recommendations

Based on the analysis of production performance and quality control at a partner CV layer farm in South Lampung, it can be concluded that the average Combined Hen Day Production (HDP) reached 90.91% with a Feed Conversion Ratio (FCR) of 2.22 and a mortality rate of 1.2%. However, egg productivity in House 3 (89.65%) did not meet the optimal standard of 92.7%. Statistical Quality Control (SQC) revealed variability between housing units, while the Fishbone Diagram identified environmental heat stress and managerial shortcomings as the primary root causes of reduced efficiency. These findings confirm that systematic quality control is essential to ensure consistent production performance and egg quality.

To improve production performance and business efficiency, strategic steps should include technical modifications to the open-house system—such as adding fans or rooftop sprinklers to mitigate heat stress—coupled with the implementation of standardized SOPs for farm workers regarding feed management and preventive health. Furthermore, the digitalization of daily recording systems is crucial for real-time evaluation, supported by the optimization of nutritional aspects through the use of anti-stress feed additives and adjusting feeding schedules to cooler times of the day to maintain optimal nutrient intake.

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