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Quality Control Analysis of Breeding Chicken Eggs at PT. JCI Parungkuda Hatchery Unit in Sukabumi

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Abstract

The average consumption of broiler chickens in Indonesia in 2021 reached 0.4 kg per capita per week, indicating that broiler farming is a promising industry, so many commercial companies and communities are cultivating it, one of which is PT JCI's Parungkuda Hatchery unit. This company unit focuses on hatching and breeding day-old chicks. However, the failure rate of eggs to hatch remains high at 15.31%, exceeding the company's tolerance limit, which can harm the company by reducing the number of Day-Old Chicks (DOC) produced. The purpose of this research is to identify, analyze causal factors, and formulate recommendations for improvement. The analysis method used is Statistical Quality Control, and improvements are formulated using the Kaizen 5W+1H concept with Triangulation analysis. The results showed that the defect rate was not under control, with 8 points exceeding the Upper Control Limit (UCL), involving 3 types of defects: infertile eggs, exploded eggs, and death-in-shell. The factors causing these defects stem from human, environmental, methodological, machine, and material factors. Consequently, corrective actions were implemented, including double-checking procedures, enhanced supervision, the application of eggshell preservation technology and egg nutrition injection, dry washing, and labor training.

Keywords: Day-Old Chicks, hatching eggs, quality, statistical quality control.

INTRODUCTION

Public awareness of the importance of consuming nutritious and protein-rich foods, particularly animal protein, has encouraged people to consume livestock products, and

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one of the most popular among Indonesians is broiler chickens. The Directorate General of Livestock and Animal Health, Ministry of Agriculture (2022), explains that the average household consumption of broiler chickens in 2021 increased by 8.62%, reaching 0.14 kg per capita per week, indicating that broiler chicken farming is a promising industry, leading many companies both commercial and community-based to engage in broiler chicken farming, from breeding to processing the farm's output. One such company is PT JCI, and among its numerous branches across Indonesia is the PT JCI Parungkuda Hatchery Unit.

PT JCI's Parungkuda Hatchery Unit is a company division specializing in poultry, particularly egg incubation and the production of Day-Old Chicks (DOC). Based on observations, the egg incubation process at PT JCI is divided into three phases: pre-incubation, during incubation, and post-incubation. This hatching process begins with the pre-incubation phase, where the first step is grading that is, eggs arriving at the company are selected to determine which meet the company's requirements. However, despite the egg selection conducted during this process, the failure rate of eggs to hatch during the incubation phase remains high at 15.31%. This can be detrimental to the company as it reduces the number of DOCs produced; therefore, quality control measures are necessary to minimize defects and improve production output at PT JCI's Parungkuda Hatchery unit.

METHOD

This study was conducted at PT JCI's Parungkuda Hatchery Unit, Building 1, located in Parungkuda Subdistrict, Sukabumi Regency, West Java. Initial observations were conducted in February-March 2023 to collect data on hatching egg defect rates, followed by interviews and Focus Group Discussions in October–November 2023 to analyze the Fishbone diagram and apply the Kaizen 5W+1H methodology.

The research location was determined using a purposive method (Sugiyono, 2018; Mukhlis et al., 2019; Mukhlis et al., 2024; Asgaf et al., 2025), considering that PT JCI's Parungkuda *Hatchery* Unit is a company operating in the poultry sector, specifically in hatching eggs and raising day-old chicks (DOC), which faces issues related to hatching egg quality during the hatching process. These issues result in hatching failures exceeding the company's established tolerance limit of 9.3%. The research design is a mixed-methods study, combining qualitative and quantitative approaches, with data sources comprising primary and secondary data. The data collection methods employed include observation, interviews, *focus group discussions,* and documentation.

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Data Analysis Methods

The data analysis methods used were quantitative and qualitative analysis. Quantitative analysis included three statistical quality control tools: the check sheet, histogram, and control chart. Qualitative analysis utilized the fishbone diagram and triangulation based on the Kaizen 5W+1H concept (Sugiyono, 2022; Mukhlis et al., 2022; Ogari et al., 2026).

1. Check Sheet

Check sheets are used to facilitate data collection by conducting attribute-based quality inspections (Fitriana et al., 2021). Data tabulation in this study is presented in a table (Table 1) using Microsoft Excel 2019 software. The collected data are secondary data derived from company documents in the form of daily hatching process reports.

Table 1. Check Sheet

No	Hatching process start date	Number of Eggs After Grading (units)	Type of Defect	Number of Defects (units)	Defect Rate (%)	Number of Hatching Eggs/Chicks (pieces)	Date of Hatching
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1							
Total							

2. Histogram

Based on the reference by Yuri and Nurcahyono (2013), a histogram is used in this study to quickly illustrate data in the form of a bar graph, visually presenting the distribution of the number of defects in hatching eggs. In this study, it is used to present data from inspection sheets. Based on the reference by Haizer and Render (2006), the histogram in this study is presented as shown in Figure 1.

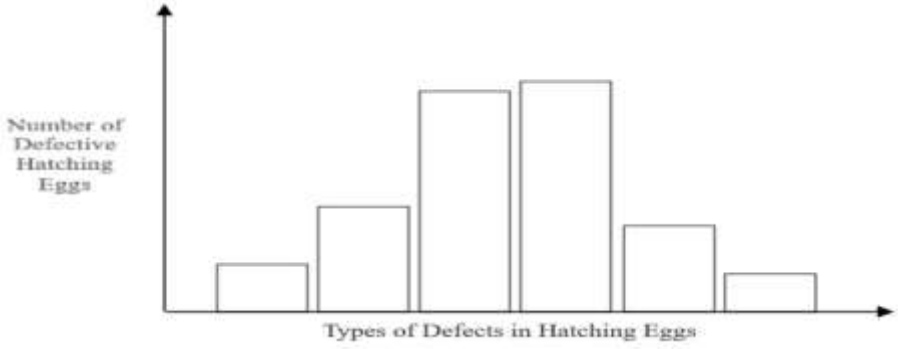


Figure 1. Histogram

Source: Haizer and Render (2006)

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3. *Control* Chart

The control chart in this study is a p-chart (proportion of defects) because the quality inspection was conducted qualitatively and the data obtained were not constant in number. The data used were secondary data found on the inspection sheets, and the steps for creating a p-chart based on the guidelines from Haizer and Render (2006) are as follows:

a. Calculating the defect proportion

$$p = \frac{np_i}{n_i} \quad \text{.....} \quad (1)$$

Note:

p : proportion of defects in hatching eggs
np_i : number of defective hatching eggs in each observation (units)
n_i : number of hatching eggs examined in each observation (units)

b. Calculating the Central Line (CL)

The line indicating the standard value that serves as the basis for calculating deviations in observation results for each sample, or the central line, is the mean product defect rate ($\bar{p}$).

$$CL = \bar{p} = \frac{\sum np}{\sum n} \quad \text{.....} \quad (2)$$

Note:

CL : Central Line
$\bar{p}$: average number of defective hatching eggs (units)
$\sum np$: total number of defective hatching eggs (units)
$\sum n$: total number of hatching eggs inspected in all observations (units)

c. Calculating the Upper Control Limit (UCL)

The upper control line, which indicates the maximum deviation from the standard value or *central line* that is still permissible, is calculated using the following formula:

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \quad \text{.....} \quad (3)$$

Notes:

UCL: Upper Control Limit
$\bar{p}$: average number of defective hatching eggs (units)
n : total number of hatching eggs inspected per observation (units)

If the hatch egg defect characteristics fall within the control limits without any out-of-limit data, the data is considered under control. However, if they fall outside the control

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limits, PT JCI's Parungkuda Hatchery unit must implement corrective actions for the hatch eggs in that hatching process. Based on the reference by Haizer and Render (2006), the p-control chart is presented in Figure 2.

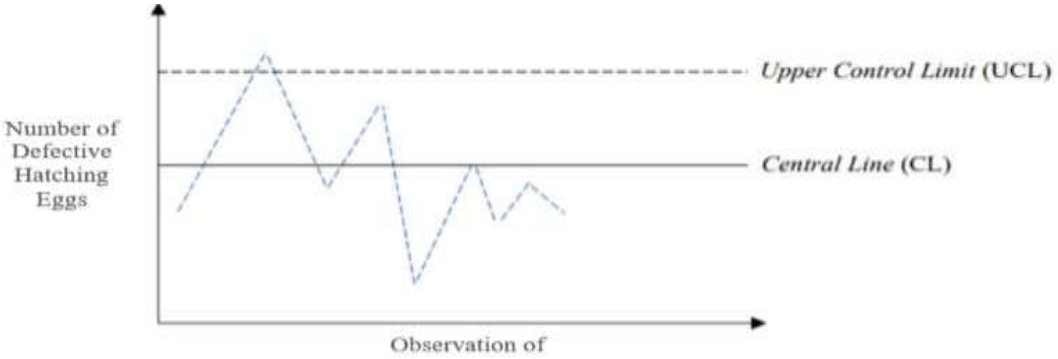


Figure 2. Control Chart
Source: Haizer and Render (2006).

4. *Fishbone* Diagram

The fishbone diagram is used to help identify various factors causing defects that occur during the hatching process of hatching eggs. Based on the reference by Safitri et al (2021), there are six groups of factors studied, namely: Man (workers), Method (methods), Material (raw materials), Machine (machinery), Measurement (work procedures), and Environment (environment). These are mapped in the form of horizontal lines forming six branches of factor groups, which are then analyzed to identify the primary and secondary causes of hatching egg defects that can damage the eggs, as shown in Figure 3.

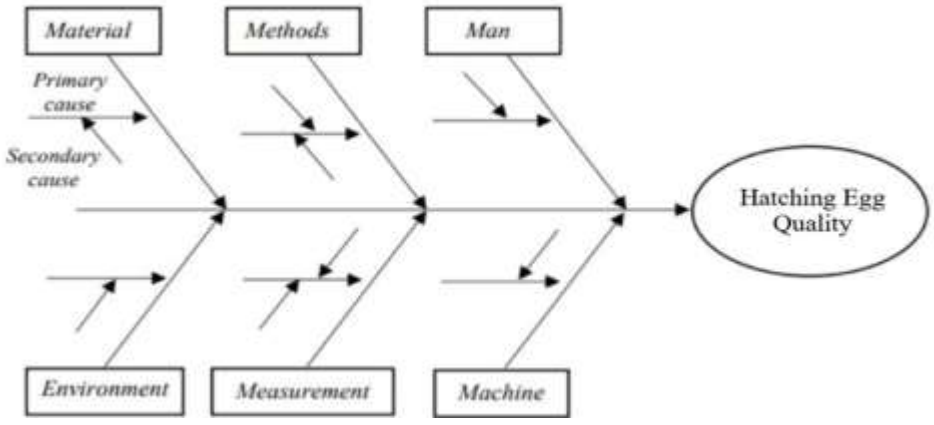


Figure 3 . Fishbone diagram
Source: Ariani (2004)

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5. *Kaizen* 5W+1H Analysis

After conducting the fishbone diagram analysis, the next step is to recommend corrective actions designed using the Focus Group Discussion technique—a group discussion centered on the improvement topic to be implemented based on the issues identified in the fishbone diagram analysis, using the Kaizen 5W+1H concept. This process involves the company manager, hatching supervisor, DOC supervisor, and one hatching division worker, structured around the following questions:

What : What improvements will be implemented?
Where : Where will the improvement plan be implemented?
When : When will the repairs be carried out?
Why : Why is the improvement being implemented?
Who : Who is responsible for the improvement?
How : How should the improvement plan be implemented?

The results of the Focus Group Discussion will be validated using technical triangulation based on the framework proposed by Sugiyono (2017), whereby the data obtained from the Focus Group Discussion will be validated against field observations and relevant documents. The results will be presented in Table 2.

Table 2. The 5W+1H Kaizen Concept

No.	What	Why	Where	When	Who	How
1.	Causes of hatching defects (Fishbone diagram)					

Source: Reswati and Indriani (2018).

6. Data Validity Test

Data accuracy in this study was ensured through source triangulation and methodological triangulation. Source triangulation was conducted through interviews with one informant, after which the data was cross-checked with another informant who was still connected to the first, while technical triangulation was performed by testing credibility through verifying the data with the same source using different techniques; in this study, technical triangulation will be conducted by validating the data obtained from the interview process, *focus group discussions*, and field observation results.

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RESULTS AND DISCUSSION

1. Defect Rate of Hatching Eggs at PT JCI Parungkuda *Hatchery* Unit

The hatching egg defect rate at PT JCI's Parungkuda *Hatchery* unit in this study was measured using *a check sheet*, histogram, and p-chart. To conduct this analysis, the first step was to analyze the types of defects that occurred.

a. Types of Hatching Egg Defects

Based on the results of observations and interviews with informants, there were three types of defects that occurred in hatching eggs during the hatching process, causing the eggs to fail to hatch. The first type of defect was infertility, a type of hatching egg defect that failed to hatch due to the absence of embryonic development, which was identified during candling, where infertile eggs appeared clear and without a dark spot. the second type of defect is "Explode" (rotten), where hatching eggs entering the incubation process explode or break due to bacterial contamination; and the third is "Death In Shell" (DIS), which refers to fertilized hatching eggs that fail to hatch because the embryo dies inside the shell before hatching, a condition detectable after passing through the *hatcher* machine or during *th*e chick-pulling process.

b. Check Sheet and Histogram

The three types of defects occurring at PT JCI's Parungkuda Hatchery unit have been documented in company records; therefore, the data used is secondary data that was subsequently reprocessed using the *check sheet* tool presented in Table 3.

Table 3. Check Sheet for Hatching Egg Defects at PT JCI Parungkuda Hatchery Unit

No	Hatching Start Date	Number of Eggs After Grading (units)	Type of Defect			Number of Defects (units)	Defect Percentage (%)	Number of Hatching Eggs (DOC)	Date of conception
			Infertile	Explode	Death in Shell				
			Grain	Grain	Item				
1	1/9/23	156,672	11,194	805	9,044	21,043	13.43	135,629	1/30/23
2	1/10/23	29,160	1,820	149	1,334	3,303	11.33	25,857	1/31/23
3	1/12/23	185,832	16,368	1,340	14,615	32,323	17.39	153,509	2/2/23
4	1/13/23	174,960	14,688	980	11,720	27,388	15.65	147,572	2/3/23
5	1/16/23	156,672	14,502	1,237	14,308	30,047	19.18	126,625	2/6/23
6	2/17/23	29,160	1,137	99	1,439	2,675	9.17	26,485	2/7/23
7	1/19/23	155,080	10,987	858	8,917	20,762	13.39	134,318	9/2/23
8	1/20/23	160,380	12,052	1,467	13,758	27,277	17.01	133,103	2/10/23
9	1/23/23	185,832	13,714	1,433	15,522	30,669	16.50	155,163	2/13/23
10	1/24/23	174,960	14,020	1,811	18,698	34,529	19.74	140,431	2/14/23

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11	1/26/23	185,832	13,076	1,198	13,324	27,598	14.85	158,234	2/16/23
12	1/27/23	174,960	12,256	1,504	14,464	28,224	16.13	146,736	2/17/23
13	1/30/23	125,568	9,950	1,022	11,220	22,192	17.67	103,376	2/20/23
14	1/31/23	116,640	7,048	613	6,322	13,983	11.99	102,657	2/21/23
15	2/2/23	125,568	10,049	1,301	13,405	24,755	19.71	100,813	2/23/23
16	2/3/23	116,640	9,174	1,325	10,120	20,619	17.68	96,021	2/24/23
17	2/6/23	185,832	14,575	1,304	10,723	26,602	14.32	159,230	2/27/23
18	2/7/23	116,640	6,022	545	5,709	12,276	10.52	104,364	2/28/23
Total		2,556,388	192,632	18,991	194,642	406,265	275.7	2,150,123	
Average		142,022	10,702	1,055	10,813	22,570	15.31	119,451	

Source: Secondary data (processed, 2023)

The data check sheet presented in Table 3 shows that during the hatching period from January 9 to February 7, 2023, with 18 hatching processes, there were 2,556,388 hatching eggs entering the hatching process, with a total of 406,265 defective eggs, or an average defect rate of 15.31%. The most common defect type was Death in Shell, totaling 194,642 eggs with an average of 10,813 defective eggs. The second most common defect is "Infertile," totaling 192,632 eggs, or an average of 10,702 eggs, while the least common defect is "Explode," totaling 18,991 eggs, or an average of 1,055 eggs.

To facilitate the explanation of the defect rates in hatching eggs during the hatching process, a histogram of the defect types and the number of hatching eggs is presented in Figure 4.

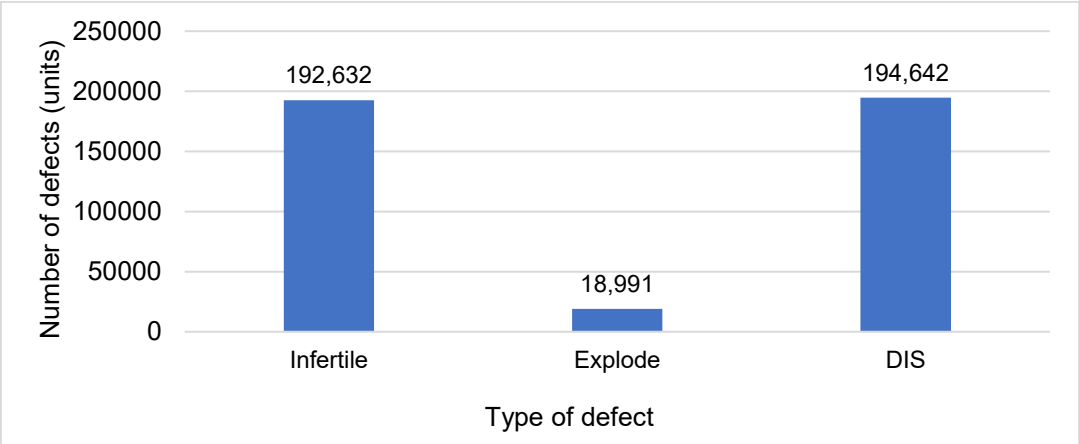


Figure 4 . Histogram of hatching egg defects at PT JCI's Parungkuda Hatchery Unit

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The number of defects occurring in the Death in Shell and Infertile categories in Figure 4 shows figures that are not significantly different but remain quite high compared to Explode. According to the informant, this may occur because the age of the parent hens has a significant impact on egg hatchability and can lead to Death in Shell and Infertile defects. Amalia et al (2013 also explain that one of the factor affecting hatchability is the age of the parent hens; there is a close relationship between the parent hens and hatchability, where the older the parent hens, the lower the hatchability percentage.

c. Control Chart

Measurement of defect rates in this study was conducted using control limit analysis with a p-chart to determine whether the company's operations are under control or not. Calculations were performed using Microsoft Excel 2019, resulting in the data presented in Table 4.

Table 4. Calculation of Control Limits for Hatching Egg Defects

No.	Hatching Start Date	Sample	Number of Defects	P	UCL	CL
1	9/1/23	156,672	21,043	0.134	0.162	0.159
2	1/10/23	29,160	3,303	0.113	0.165	0.159
3	1/12/23	185,832	32,323	0.174	0.161	0.159
4	1/13/23	174,960	27,388	0.157	0.162	0.159
5	1/16/23	156,672	30,047	0.192	0.162	0.159
6	2/17/23	29,160	2,675	0.092	0.165	0.159
7	1/19/23	155,080	20,762	0.134	0.162	0.159
8	1/20/23	160,380	27,277	0.170	0.162	0.159
9	1/23/23	185,832	30,669	0.165	0.161	0.159
10	1/24/23	174,960	34,529	0.197	0.162	0.159
11	1/26/23	185,832	27,598	0.149	0.161	0.159
12	1/27/23	174,960	28,224	0.161	0.162	0.159
13	1/30/23	125,568	22,192	0.177	0.162	0.159
14	1/31/23	116,640	13,983	0.120	0.162	0.159
15	2/2/23	125,568	24,755	0.197	0.162	0.159
16	2/3/23	116,640	20,619	0.177	0.162	0.159
17	2/6/23	185,832	26,602	0.143	0.161	0.159
18	2/7/23	116,640	12,276	0.105	0.162	0.159
	∑	2,556,388	406,265			
	ṕ	0.159				

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Based on the data in Table 4 regarding the calculation of the control limit for hatching egg defects, the p-control chart presented in Figure 5 was obtained.

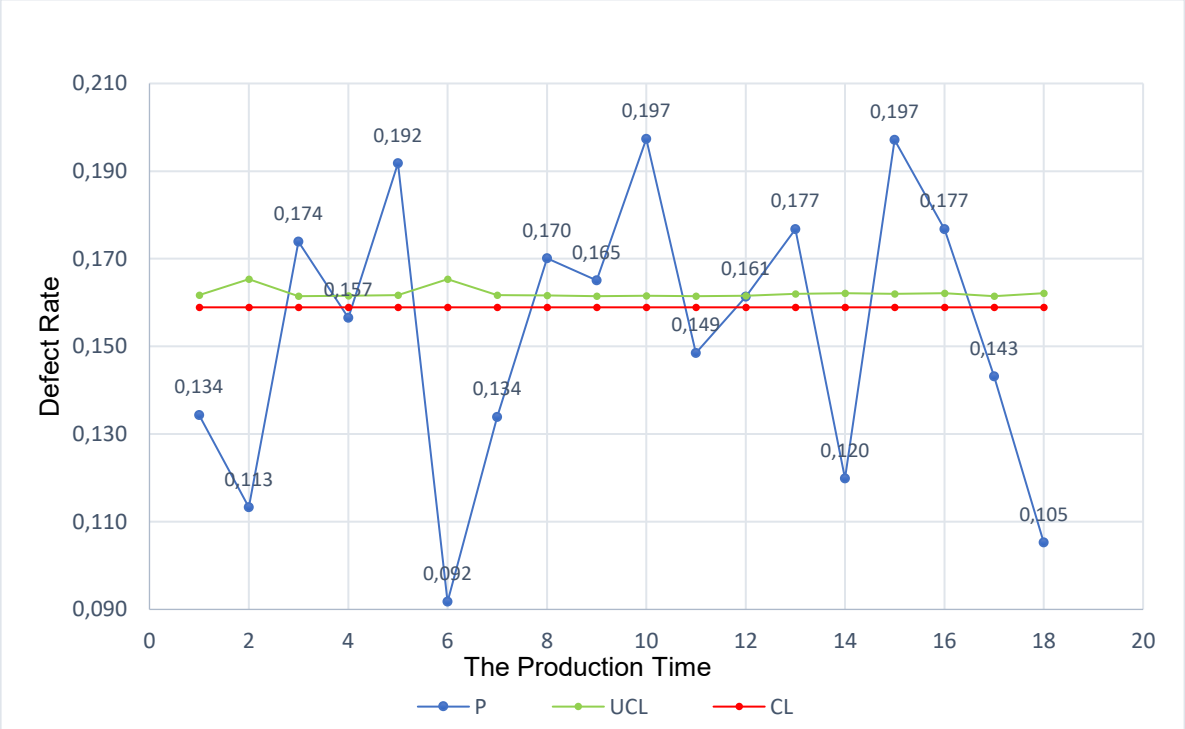


Figure 5. Control chart for hatching egg defects

Based on the p-control chart presented in Figure 5, it can be seen that out of the 18 data points, there are 8 sample points above the upper control limit (UCL): the 3rd point with 32,323 defective hatching eggs, the 5th point with 30,047 defective hatching eggs, the 7th point with 20,762 eggs, the 8th point with 27,277 eggs, the 9th point with 30,669 eggs, the 13th point with 22,192 eggs, the 15th point with 24,755 eggs, and the 16th point with 20,619 defective hatching eggs. Haizer and Render (2006) explain that if product quality is above the Upper Control Limit (UCL), the product is outside the control limits and must be addressed. Therefore, further analysis is needed regarding the causes of defects in hatching eggs during the hatching process at, which in this study utilized a *fishbone* diagram analysis.

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2. Factors Causing Defects in Hatching Eggs at PT JCI's Parungkuda *Hatchery* Unit

The results of the p-control chart analysis at PT JCI's Parungkuda *Hatchery* unit indicate that the number of defective hatching eggs remains outside the company's control limits; therefore, the next step involved analyzing the factors causing the defects using a *fishbone* diagram, as shown in Figures 6, 7, and 8.

Death In Shell

This type of defect has the highest incidence. Based on interviews with informants and observations, there are three factors causing DIS, as presented in Figure 6.

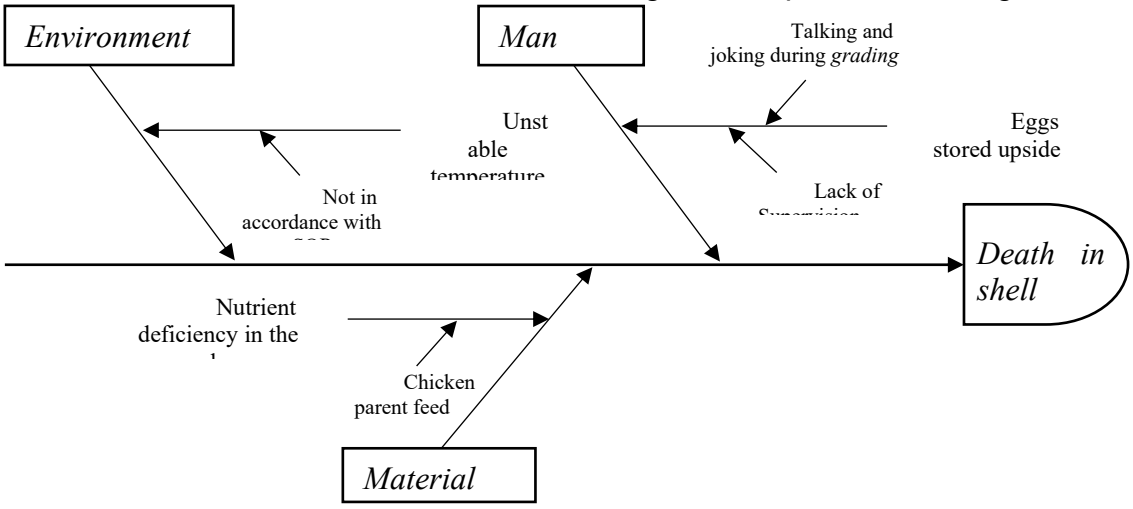


Figure 6. Fishbone Diagram of Death in Shell Defects
Source: Primary data (processed, 2023)

a. Human

Based on the results of observations and questionnaires, during the grading process, workers were sometimes found chatting and joking with one another, which affected their accuracy, and there was a lack of supervision by supervisors who rarely performed checks. Both of these factors can cause hatching eggs to be stored upside down on the tray, with the blunt end of the egg facing downward. According to the SOP, hatching eggs must be stored in trays with the blunt end facing up and the pointed end facing down. Paryanta et al (2019) explain this requirement because the air cell, located at the blunt end of the egg, serves as a reservoir of oxygen for the embryo's respiration within the egg. If the egg is inverted, the embryo's head will be positioned opposite the air cell, preventing pipping (the chick attempting to break the shell with its beak) due to the embryo's weakness.

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b. Environment

According to the informant, the primary factors causing DIS are temperature and humidity in the production room. According to Daulay et al (2008); Rahmawati et al (2021), suboptimal temperature and humidity prevent the embryo from breaking through the shell, which is too hard; however, excessively high humidity causes water to enter the shell's pores, leading to fluid accumulation that prevents the embryo from breathing and results in death. Based on the results of questionnaires with workers and field observations, inconsistent temperatures were frequently observed-sometimes higher or lower by 2-4°C compared to the established SOP.

c. Material

The informant noted that chicken feed is one of the factors causing DIS, and factors influencing feed intake in broiler chickens include environmental temperature, age, breed, body weight, production level, and the metabolic energy content in the feed (Fadillah, 2022). The age of the parent hens at the breeding farm at the time of the study was already quite advanced, ranging from 43 to 60 weeks. According to Fauziah (2021), hens experience a decline in body weight as they age because the feed they consume is utilized for metabolic processes and physiological functions in the hen's body, and undigested food is excreted as feces. However, under these conditions, the hens will maintain their egg production by drawing on protein and energy reserves in their bodies, resulting in low nutrient levels in the hens. These low nutrient levels hinder the digestion of the feed consumed, causing the hens to fail to meet the nutritional standards of the feed.

Furthermore, Hartono and Isman (2012) also explain that embryo death within the shell can occur because the hen suffers from nutrient deficiencies, resulting in suboptimal metabolism and embryo development.

Infertile

Infertility is the second most common defect after DIS, with a total of 192,632 eggs. Based on information from sources and field observations, there are three factors causing infertility: Man, Methods, and Material, as presented in Figure 7.

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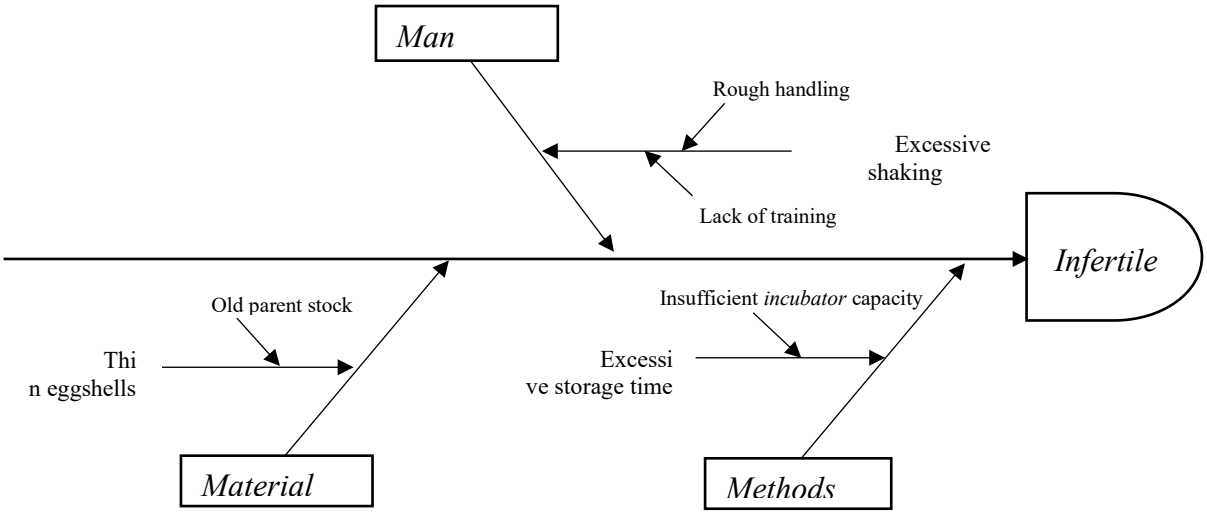


Figure 7. Fishbone Diagram of Types of Infertility Defects
Source: Primary data (processed, 2023)

a. Man

Based on interviews with informants, one of the factors causing infertility is shaking caused by workers during the hatching process. Some hatching processes carried out at PT JCI's Parungkuda Hatchery unit are still performed manually, such as grading and transfer. The grading process is performed manually by workers, with a grading rate of 4,000 - 4,200 hatching eggs per hour per worker. At this pace, there is a high risk of rough handling due to the need to meet production targets. Additionally, the transfer process - moving trays of hatching eggs from the terminal to the fumigation room, cooling room, setter, or hatcher-can also cause excessive shaking if handled too roughly. This is due to a lack of care on the part of workers and insufficient training; according to the informant, the six-month training program is only provided to prospective supervisors, not to all workers.

Hartono and Isman (2012) explain that hatching eggs subjected to excessive shaking during transport due to long distances and rough handling can cause the yolk sac to rupture, leading to embryo death inside the incubator due to starvation.

b. Methods

The duration of hatching egg storage is a critical factor in the hatching process as it affects the hatching rate of the eggs. Survey results indicate that storage should not exceed 7 days, as exceeding this period reduces the hatching rate of the eggs. However, based on field observations, storage sometimes exceeds the tolerance limit due to incubators being full because of the large number of hatching eggs arriving at the

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company, requiring waiting for previous eggs to complete incubation. Paimin (2011) explains that fertilized hatching eggs can be stored for up to 7 days without losing hatchability; between 7 and 14 days, they can still hatch but must be turned daily; and storage beyond 14 days will cause the eggs to lose their hatchability.

c. Material

The informant noted that the age of the parent hens affects the quality of the hatching eggshells and is one of the causes of infertility. According to the established SOP, the ideal age of the parent hens is 25-67 weeks, and at the time of the study, the hens were 43-60 weeks old. Hartono and Isman (2012) explain that the age of the parent hens is highly influential on the quality of day-old chicks (DOC); ideally, the hens should be 25-55 weeks old. If the hen is younger than 25 weeks, the eggs will be small, resulting in insufficient nutrient supply for the embryo; conversely, if the hen is older than 55 weeks, the eggs will have thin and brittle shells, allowing water to easily penetrate through the pores, leading to excess fluid in the egg and causing the embryo to weaken and die.

Explode

Based on information from respondents in the questionnaire and field observations, the primary cause of exploding eggs is bacterial contamination. The results of the fishbone diagram analysis indicate that this type of defect occurs due to three factors- Machine, Material, and Methods as presented in Figure 8.

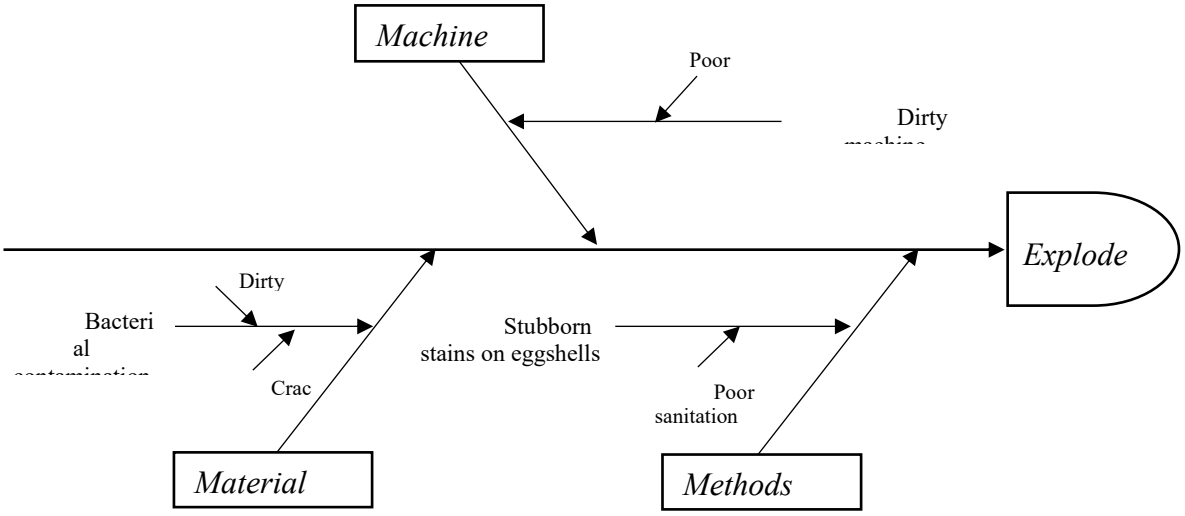


Figure 8. Fishbone Diagram of Explode Defect Types

Source: Primary data (processed, 2023)

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a. Machine

Machine cleanliness, particularly of the setter machine during the hatching process, is a critical concern. A dirty machine can lead to bacterial contamination and cause eggs to explode (Wakhid and Riawan, 2016), necessitating sanitation as quickly and thoroughly as possible. Based on the questionnaire results, sanitation of the hatching machine at the company is performed after the egg explosion removal process using a vacuum cleaner and mopping with disinfectant, while washing and fumigation are only conducted once a year.

Paimin (2011) explains that during the machine cleaning process, even after disinfection, there remains a possibility that bacteria not adhering to the machine may not be killed; therefore, fumigation a process of sterilization via air is necessary. This fumigation process should be conducted after the machine washing and carried out for 24-28 hours before the incubator is used.

b. Methods

Hatching egg sanitation is critically important for preventing explosions caused by bacterial contamination, so fumigation is performed using the appropriate time and dose of. In the field, fumigation does not always successfully remove dirt from the shells of hatching eggs; sometimes, stubborn dirt cannot be eliminated with the dosage and duration of fumigation set by the company. Consequently, this dirt can lead to contamination. However, if the dosage is too high and the fumigation duration is too long and does not comply with the SOP it will cause premature embryo death (Incubators, 2019).

c. Material

Hatching eggs with dirty and cracked shells are the primary cause of egg explosions due to bacterial contamination entering through the pores and cracks in the eggshells. Cracked eggshells are not suitable for hatching because microorganisms can enter the egg, and if forced, the egg will rot (Santoso, 2021). Iswanto (2005) also explains that eggshells must be free of chicken feces adhering to them, as these contain bacteria that can damage the embryo.

The questionnaire results indicate that hatching eggs are always free from feces, pests, and other contaminants. However, based on field observations, cracked hatching eggs can enter the incubation process because the cracks occur during improper transfer and grading procedures, and contaminated eggs can result from inadequate fumigation and the failure to conduct a double-check after fumigation, allowing such eggs to reach the setter machine.

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3. Recommendations for Improvement Using the Kaizen 5W+1H Concept

The design of improvement recommendations in this study was conducted using the Focus Group Discussion technique based on the Kaizen 5W+1H concept, resulting in proposed improvement actions presented in Table 5.

Table 5. Proposed Improvement Actions for Defects in Hatching Eggs at PT JCI Parungkuda Hatchery Unit

Death In Shell						
No	What	Why	Where	When	Who	How
1	Workers chatting and joking during the hatching egg grading process					
	Performing a double-check	To minimize eggs being stored upside down in the tray	Cooling room	While the eggs are being stored in the cooling room	Terminal operator	Re-inspect the hatching eggs in the cooling room before they are incubated
2	Lack of supervision by the supervisor					
	Strengthen supervision during the hatching process	To ensure that production activities comply with the SOP	All production areas	During the hatching process	Hatchery Supervisor	Inspections are scheduled every hour
3	The temperature in the production environment is not constant					
	Implement the use of plastic curtains	To maintain a constant room temperature	The entire production area	During the hatching process	Technical Supervisor	Plastic curtains are installed on every connecting door between rooms
	Strengthening the " " of periodic temperature checks	To ensure room temperature and h es always comply with SOP	All production room es	During the hatching process	Hatchery Super-	e checks are conducted on a schedule every hour to ensure the temperature always complies with SOP
4	Nutrient deficiencies in embryos due to older parent stock and suboptimal feed					
	Addition of supplements	To supply nutrients				Implementing technology -

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	directly into hatching eggs	into hatching eggs and improve hatchability	Terminal room	After the fumigation process	Hatchery supervisor	In-ovo feeding performed after the fumigation process before the eggs are stored in the cooling room
Infertile						
5	Lack of worker training					
	Conduct workforce training and briefings	Because workers must perform grading and transfer in accordance with the SOP	Parungkuda Hatchery Unit	During the selection of new workers and before the production process	Hatchery Manager and Supervisor	Conduct training for at least 1 month during the selection of new workers; for existing workers, briefings are held every morning before starting the production process
6	Eggs are stored for too long due to a lack of setting machines					
	Increase the number of incubators	A shortage of incubators leads to a buildup of hatching eggs in the cooling room	Incubation space	The next 1 to 3 years	Hatchery Manager	Add at least 3 setting machines to the incubation room by utilizing unused space within the company and the company's vast land
7	Thin hatching eggshells due to the advanced age of the parent stock					
	Implement eggshell preservation technology	Thin eggshells can lead to embryo death due to excess fluid	Fumigation room	Before the fumigation process	Terminal operator	Egg preservation technology is carried out using a vaporization

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						system prior to the fumigation process in a fumigation chamber utilizing organic materials such as banana peels
Explode						
8	Machines are dirty due to poor sanitation					
	Increase the frequency of washing and fumigation of the setting machine	Because bacterial contamination can occur through the air	Incubation chamber	Before the incubation process	Hatchery Supervisor	Washing of the incubators can be performed several times a year after the number of incubators has increased so that it can -
						replacement of the washing and fumigation of the incubator is carried out, and the incubation process can continue
9.	Sanitation of hatching eggs with stubborn stains is suboptimal					
	Perform dry washing on hatching eggs with stains adhering to the shell	Since stains that cannot be removed from the eggshell can cause bacterial contamination, but the duration and dosage of	Terminal room	During the grading process	Terminal operator	Hatching eggs with stubborn stains are separated first, then dry-washed before fumigation

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		fumigation cannot be increased				
10.	Cracked and dirty hatching eggs enter the incubation process					
	A double check is performed after the fumigation process	Because cracked and dirty eggs, if placed in the incubator, can cause an explosion, thereby contaminating the other eggs	Cooling room	During the storage process	Terminal operator	A double-check is performed after fumigation in the storage room, and cracked and dirty eggs are separated so they are not included in the incubation process

The results of the 5W+1H Kaizen analysis presented in Table 6 indicate that hatching eggs stored in trays may become inverted due to labor-related factors; therefore, a re-inspection must be conducted when eggs are placed in the storage room, and supervisors must implement scheduled monitoring to ensure workers perform their duties in accordance with SOPs. PT JCI's Parungkuda Hatchery unit also needs to maximize production by maintaining consistent temperatures in every room. According to Maurina et al. (2021), using plastic curtains can serve as a preventive measure to prevent temperature transfer to other rooms and help maintain consistent temperatures.

Aged laying hens are prone to nutritional deficiencies, which can lead to nutritional deficiencies in the embryos within the eggs. Therefore, corrective measures can be taken by delivering nutrients directly into the eggs via an injection system or by implementing In Ovo Feeding technology, which aims to supply adequate nutrients and thereby improve hatchability and post-hatch performance (Rahardja et al., 2019:397).

PT JCI's Parungkuda Hatchery unit also needs to provide uniform training to its workforce, with training conducted at least one month before employees officially begin working at the company. This training should cover Standard Operating Procedures (SOPs) and employee responsibilities to ensure they become more skilled and capable of fulfilling their duties. Additionally, morning briefings are necessary to provide guidance

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before employees begin the production process to ensure operations proceed in accordance with SOPs.

There are 6 machines at the company with a capacity of 15,552 eggs per production run. However, egg backlogs still occur in the storage room, causing eggs to be stored beyond the recommended storage period. Therefore, at least 3 additional machines are needed by utilizing the company's existing space and land. The frequency of machine cleaning also needs to be increased to prevent bacterial contamination. Cleaning and fumigation of the machines can be performed more effectively if there are more incubators, allowing them to be cleaned in rotation so as not to disrupt the incubation process.

Regarding the thin shells of hatching eggs from the breeding farm, the company cannot control this issue. However, prevention can be implemented upon the eggs' arrival at the company by applying eggshell preservation technology. Hastomo et al (2022) explain that hatching eggs with thin shells tend to have larger and more numerous pores, which accelerate quality degradation due to evaporation; therefore, preservation technology is necessary to address this. One method involves sealing the eggshell pores with tannin-based substances using safe, odorless, and non-toxic materials such as banana peels.

The final recommended corrective action pertains to adjusting the dosage and duration of fumigation to suit the condition of the hatching eggs. Adjusting the duration or dosage is not a viable solution as it would affect the embryo inside; however, stubborn stains on the eggshell cannot be tolerated. Therefore, a *dry washing* process should be performed on eggs with stubborn stains to maximize sanitation. Additionally, a re-inspection should be conducted before incubation to immediately separate dirty and cracked eggs, thereby minimizing *the risk of explosions.*

Based on the proposed improvement recommendations that have been compiled, several improvement recommendations that can be implemented in the company, taking into account costs, human resources, and other factors, are presented in Table 6.

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Table 6. Recommendations for Improvement Actions in Quality Control of Broiler Hatching Eggs at PT JCI's Parungkuda Hatchery Unit

Defect Type	Factor	Improvement Recommendations
Death In Shell	Human	Perform a double check of the eggs in the cooling room
		Implement hourly supervision by a supervisor
	Material	Implementing in-ovo feeding injection technology performed after the fumigation process before the eggs are stored in the cooling room
	Environment	Conducting scheduled temperature checks every hour
Infertile	Man	Conducting a one-month training program for new employees
	Methods	Add 3 setter machines to the incubation room
	Material	Implementing egg preservation technology using an evaporation system with organic materials
Explode	Methods	Performing dry washing on hatching eggs with stubborn stains prior to fumigation
	Material	Performing a double check of hatching eggs after the fumigation process and separating dirty and cracked eggs so they are not included in the incubation process

CONCLUSION AND RECOMMENDATIONS

Conclusion

1. The defect rate of commercial chicken hatching eggs at PT JCI's Parungkuda Hatchery unit indicates uncontrolled defects with a relatively high defect count; out of 18 hatching processes, 8 sample points exceeded the upper control limit (UCL) with 3 types of defects: Infertile, Exploded, and Death in Shell.
2. The factors causing the defects are related to the variables of Man, Environment, Methods, Machine, and Material, with causes including storing eggs in upside down trays, poor quality parent stock feed, inconsistent temperature, excessive shaking of hatching eggs, prolonged egg storage, thin, dirty, or cracked eggshells, dirty machinery due to poor sanitation, and poor sanitation of eggs with stubborn stains.
3. Corrective actions, taking into account costs, resources, and other factors, include performing double-checks, implementing hourly monitoring, applying eggshell

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preservation technology, conducting scheduled temperature checks, adding more incubators, implementing egg nutrient injection technology, training staff, and performing dry washing on hatching eggs with stubborn stains.

Recommendations

1. PT JCI's Parungkuda *Hatchery* unit should consider these recommended improvements to minimize hatching egg defect rates and enhance quality control of the broiler chick hatching process at the company
2. PT JCI Parungkuda *Hatchery* Unit should coordinate with *breeding farms* regarding the management of broiler parent stock that has exceeded its productive lifespan.

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