

## **Design Optimization on Cost Efficiency and Benefit Increase of Project Construction Unit Production PT.X**

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### **ABSTRACT**

The increased consumption of poultry in Indonesia, opening up greater business opportunities in the industry. The rapid project construction in the livestock business should be questioned whether the implementation of project has been carried out properly? The evaluation of production requirements, project design scenarios, the cost of project, and the value of every component that have been carried out should be identified by evaluating the requirements, specifications, standard quality, the machines and equipment. In the last 4 years, PT.X has built 4 new breeding farm units, in far different locations, typical layouts, land areas, varied building and installation designs. This resulted in the creation of master plan that was not standardized. By conducting an evaluation related to design optimization on the construction of the 4 PT X breeding farm unit, the better standard design is obtained in terms of cost and value. The research of the method done by analyzing the production needs as a scenario design that produce the parameter design as the reference in making the new standard design. The result of the optimization is an efficient cost with suitable function for the production and also giving some extra benefit by providing more facilities and utilities.

**Keywords:** Cost Efficiency, Design Optimization, Project Cost

**JEL Classification Codes:** D24, D61, O22

### **INTRODUCTION**

The increasing business potential in Indonesia with government policies that make many investors invest in the State of Indonesia. This investment is not limited to local investors (domestic) but also foreign investors. With the increasing population density in Indonesia, it means that human needs are also increasing. Thus, providing the opening of greater business opportunities. According to Abidin (2003), Farmers in Indonesia are required to adapt their products to global world demand.

Consumption of poultry types of chicken in Indonesia is very high as a daily consumption and consumption of celebration moments. Indonesia's climate and seasons are also very supportive of the livestock system used with a tropical climate and only 2 seasons make the livestock cycle run throughout the year. Animal feed as well as broiler chicken become its main commodity and beef cattle as widening product (Addina et al., 2018). The availability of very large land and affordable land prices in rural areas also support investors and businessmen interested in entering the chicken farming industry (Winda et al., 2015).

The poultry industry, has several different types of production units. The process of raising chickens from upstream to downstream also has their own business potential, with different production standards, specifications and criteria for buildings, facilities, electrical and machinery and equipment.

In the last 4 years, PT. X has built 4 new breeding farm units, in very different locations, various typical layout plans, different land areas, as well as various building and installation designs using different suppliers/vendors. This creates a master plan that is not standardized and difficult to compare with one another. By conducting an evaluation related to the analysis of design efficiency on the construction cost performance of the PT X breeding farm development project, it is hoped that a better standard design in terms of function, cost and time has been determined by management. By taking the same production capacity benchmark for each unit, which is 138.000 heads, researchers will conduct research on the following projects

Design standardization in accordance with user needs (production) will greatly affect the costs that need to be incurred in the construction project of PT. X. The design review of previous projects has not been carried out, causing the most efficient design to be unknown and in accordance with production needs. The non-conformance of the specifications and designs made, causes a decrease in the cost performance of the project. Based on the analysis of the budget plan, design specifications and cost performance, it can be determined what design changes need to be made or improved in order to get the proper function of the construction product and be cost efficient.

The formulation of the problem that needs to be discussed in order to achieve the objectives of this research are:

1. What is the most appropriate design scenario for the PT. X?
2. How much is the cost efficiency obtained from the results of design optimization and what additional benefits are obtained?

The scope of research is only limited to:

1. The construction projects analyzed were only four previous construction projects.
2. The project under study is a new business project of PT X with the type of Breeding Farm unit with a total population of 13800 chickens.
3. Does not take into account the cost of land acquisition, licensing and land survey in the budget plan.
4. Types of work items that affect land area and land contours are only calculated from the unit price, because the land area of each production unit varies and cannot be uniformed. (Example: land clearing and cut & fill, road pavement, drainage, retaining wall, boundary fences)
5. Respondents studied only from the point of view of the user (production) and the related project facility team.

Before planning for a breeding farm unit, it is necessary to first know the general principles and business management in breeding farms. So that it can be known the limitations and conditions that must be met in facilitating the running of the production process.

Poultry commodity agribusiness is directed to produce animal protein food as one of the efforts to maintain national food security, increase business independence, conserve and synergistically utilize local resource diversity, to become a sustainable breeder business and encourage and create competitive products in an effort to achieve expansion of exports (Saragih, 2010).

According to the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 31/Permentan/OT.140/2/2014, laying hens are one of the poultry commodities that have an important role in producing eggs and meat to support the availability of animal protein, feathers, and manure that can be used as industrial materials and organic fertilizers. Chicken eggs have dominated egg products for public consumption, so the demand for chicken eggs continues to increase.

Breeding farm or laying hens is the main business unit at PT X. The products produced from this farm are chicken eggs that have been graded based on their quality (Swacita, 2017). Standard of the henhouse building on a breeding farm measuring 124m x 12m with a population capacity of +/-8,000 chickens (Nadzir, 2015).

Biosecurity is a concept that is an integral part of the success of the production system of a poultry farm, especially laying hens in reducing the risks and consequences of the entry of infectious diseases to poultry and humans (Payne et al., 2002). According to Jeffrey (1997), the application of biosecurity on laying farms is divided into three main parts, namely (1) isolation, (2) traffic control, and (3) sanitation.

Although biosecurity is not the only preventive measure against disease, it is the first line of defense against disease. Biosecurity is very important to control and prevent various deadly diseases. Biosecurity can be described as a set of work programs and procedures that will prevent or limit the life and spread of harmful pests and micro-organisms in various places (Woodcock & Cardona, 2005).

These aspects for the chicken farming industry are highly demanded considering the way they are kept in cages, and maintained in large numbers, so that chickens are vulnerable to the threat of various kinds of diseases, both infectious and non-communicable. Therefore, more attention is needed in its implementation, as well as the treatment of dead chickens, the presence of flies, and odors that often cause disturbance to the surrounding population (Winkel, 1997).

Common actions taken in the biosecurity program are 1). monitor the entry and exit of animals; 2). prevent contact with wild animals or animals; 3). regularly clean and disinfect shoes, clothing, and equipment used when handling animals; 4). log incoming and outgoing visitors, animals, and equipment (Barrington et al., 2005).

On a farm, the spread of disease can be very complex, this can be caused by population density in a cage, species or breed of animal, and the sanitation system on the farm, so the development of biosecurity is very important to prevent the entry and spread of harmful diseases. Biosecurity on farms can include livestock sanitation, protective fences, strict supervision of visitor and vehicle traffic, avoiding contact with wild animals, having adequate building facilities, implementing quarantine and implementing a system of animal stock replacement procedures (Casal et al., 2007).

The age of poultry at the time of vaccination against a particular disease and when it needs to be repeated are important factors affecting the level, quality and duration of immunity (S. Hadi, 2012). This biosecurity generally enforces controls on people's traffic, such as locking doors and prohibiting all visitors, or allowing certain people and required personnel (professionals) to enter after they have been disinfected, spray showered, and then wear special shoes, coveralls, and special hats has been disinfected (U.K. Hadi, 2012).

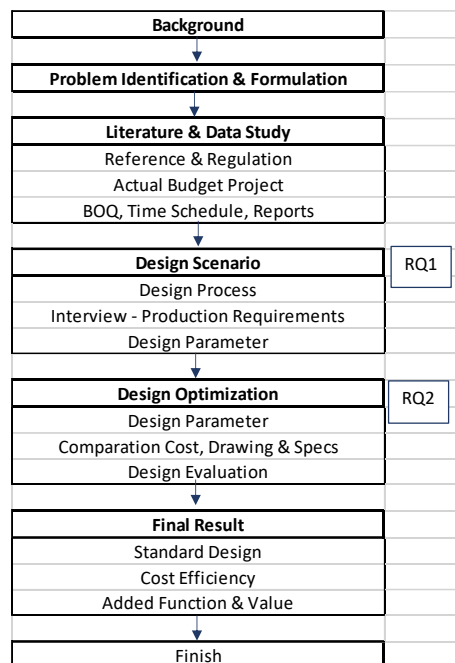
Mortality is an unavoidable situation due to either disease or other factors. Chicken farming business usually determines maximal limit of tolerable mortality as of  $\pm 5\%$ . The more decrease, the more loss suffered by farmers. The total percentage of mortality is one of determining factors (Kalangi et al., 2021).

Every company in the livestock business has its own standards in implementing a biosecurity system that is considered most suitable for production operations. So that the existing theoretical basis cannot be used as the only benchmark and reference for standardizing the biosecurity system at PT. X. Researchers will collect data that can be used as a rationale by conducting further observations on related stakeholders who have the authority and power in determining how the standard of the biosecurity system should be applied in production operational management in the breeding farm business unit of PT. X.

## RESEARCH METHOD

In this study, the research phase was carried out by conducting a literature study and collecting data from previous projects, starting from the actual budget, drawings, time schedule, reports and other supporting data. The design scenario consists of the result mapping the concept of design process and the result of interview of the research population. The result of the design scenario will be the parameter design which are the key-point of the process of optimization design. After all of the scope of project analyzed and optimized will produce a final result as the standard design that has a better cost efficiency and value.

**Figure 1. Research Flowchart**



The concept of breeding farm layout is the area will be divided into 3 areas that have different purpose in the matter of biosecurity system. The division of the breeding farm area aims to tighten the control of the biosecurity system in the farm which greatly affects the process and results of production (Yuwanta, 2005).

Research should be carried out in the Detail Engineering Design (DED) to have a better efficiency of cost and function, because the conceptual layout is already the same.

The design system consists of stages that are carried out to get the best decision making. The requirements or procedures that must be carried out are (1) Analysis of the building system; (2) Synthesis, the selection of components to form a specific goal; (3) System performance assessment, which includes comparing with alternative systems; (4) Feedback, to analyze and synthesize the information obtained on the evaluation of the system to improve the design (Soeharto, 1995).

Generally, the results of the design review led to the redesign stage. This follow-up step needs to be carried out in the project and is very useful if carried out before or at the beginning of project implementation. However, it is also necessary to pay attention to certain aspects or factors in carrying out the design review to prevent unwanted impacts (Pradipta, 2015)

The design review and redesign steps aim to provide better benefits for all parties, including contractors. It should be noted that the redesign will mean a change in design. A project has its own level of complexity where it is generally known that construction projects have the highest complexity. The more changes, the higher the level of complexity that occurs in the project. For this reason, care must be taken in carrying out this step, so that a design review and redesign will be very well done before or at the beginning of project implementation in order to minimize the impact of the high complexity of the project (Jumadianto, 2017)

Optimization is a process to achieve the ideal result or optimization (effective value that can be achieved). Optimization can be interpreted as a form of optimizing something that already exists, or designing and making something optimally (Widada, 2017).

The design scenario was obtained by conducting a survey of the research population that was able to assist the author in the design stage and determining the design parameters in accordance with the production needs of PT. X.

In this study, determined 1 (one) dependent variable (Y) and 2 (two) independent variables (X). The variable (X) in this study is a design scenario that produces design parameters that affect the planning stages and the design specifications used. The variable (Y) in this study is the design standard that will increase the project cost efficiency that will occur.

The population in this study are project-related stakeholders at PT X who understand production needs and understand the project comprehensively.

- a) General Manager Production
- b) Planning Production Manager
- c) Production Manager
- d) Project Division Manager
- e) Engineering Manager

There are 2 types of data that will be used as research material, namely:

#### 1. Primary Data

Primary data is the main data used in analyzing related research, including project design scenarios, minimum standard requirements for production needs, Budget Plan & Actual Project, Budget Plan, work schedule, project S-curve.

#### 2. Secondary Data

Secondary data collection will be done by means of observation and literature study. Literature study consisting of several literatures (books, journals, scientific articles

and so on). Secondary data also includes daily reports, project documentation photos, unit price lists, material and labor data.

There are 2 data collection techniques used for this research:

1. Literature Study

This study is used to find relevant data and information about the theoretical basis sourced from references that are appropriate to the research topic.

- Business process
- Biosecurity Management

2. Interview

Interview is a method of collecting data used to obtain information directly from the source.

- Standard requirements (area, capacity, specifications).
- Design Parameters

Based on the literature study conducted as well as the results of interviews, data will be collected and accumulated to produce a design process and a table of design parameters or provisions that become a reference for detailed design concepts that must be considered when conducting detailed design efficiency (DED). According to Finahari (2017), the conventional design process will depend on the engineer's intuition, experience and expertise. The necessity and need for efficiency will force engineers to show a deeper interest in better and more economical designs.

The main purpose of creating a project design is basically so that the construction product carried out has specifications and other provisions that can meet the needs of production operations. Thus, product designers (product design) should not create design functions or use excessive production materials and materials so that in the end they are useless and the price is high Dhanardono (2008).

So, ideas must be developed starting from:

- a) Cost savings, namely using minimal costs without reducing the function and quality of a product.
- b) Time, which is to make the best use of time, this is intended to use a minimum of time to get maximum results.
- c) Materials, namely using materials that actually fulfill the function and quality.

According to Widada (2017), discussing the design stages, the design procedure traditionally consists of several stages.

1. Program development, aims to collect information from the building to be built to determine the requirements of the building and the user of the building.
2. Schematic or conceptual stages, aiming to translate the project program into drawings.
3. Design development, at the end of the design development stage, drawings and specifications are complete enough to establish and define the size, function, configuration, space, material, building structure and building system.
4. Stages of contract documents, construction documents are collected from design development documents. Inside there are architectural drawings and specifications to complete the project, and all of them are based on bid documents and contract documents.

Using a collaborative approach, between designers and contractors can plan output accurately and in detail from the location needed for the construction of the project until the project is completed (Suryani, 2019).

In conducting design optimization analysis, namely at the design analysis stage, examining performance criteria to fulfilling the design scenario parameters, four main stages will be made that have indicators at each stage. The first one is comparison stage, continued by function analysis stage, the next stage is creation stage, and finished by evaluation stage.

## RESULTS AND DISCUSSION

In selecting the scope of work to be optimized, this research doesn't analyze every scope of work inside the project. Focusing to the scope that have the biggest portion of the budget and the scope that have the most significant differentiation in price will be the most efficient way.

**Table 1. Detail Actual Budget Comparison**

Scope	Price (Rp)				Gap (Rp) (Max – Min)	Rp x 1.000.000	
	Malang (2015)	Pekanbaru (2017)	Pandeglang (2018)	Wonogiri (2019)		Avg (Rp)	GAP (%) GAP (Rp) / Avg (Rp)
Land	4.920	3.049	3.951	5.639	2.590	4.390	59%
Development							
Boundary	775	846	826	623	222	768	29%
Fences							
Henhouse	21.625	20.132	22.586	21.464	2.453	21.452	11%
Building							
General	2.889	3.804	3.974	2.665	1.309	3.329	39%
Building							
Henhouse	7.726	7.547	7.585	7.622	179	7.620	2%
Equipment							
Nestbox	880	1.026	762	653	373	830	45%
Power	858	758	876	850	118	836	14%
Supply							
M/E	5.080	5.345	5.666	4.928	738	5.255	14%
Deep Well	254	400	350	358	147	340	43%
Generator	425	750	730	630	325	634	51%
Total Price	45.431	43.641	47.306	45.432			

*Note. Avg = Average, GAP = Difference*

Using the pareto diagram, we get the biggest percentage of the budget is from the scope of henhouse building. By using the price differentiation comparison we picked four scope that have the most significant gap by using the formula as follow.

$$GAP = \frac{N_{max} - N_i}{\bar{X}} \times 100\%$$

$N_{max}$  = Value (Cost) Maximum  
 $N_{min}$  = Value (Cost) Minimum  
 $\bar{X}$  = Average

According to Besterfield (2009), This Pareto diagram is an illustration that sorts the classification of data from left to right according to the order of highest to lowest ranking. This can help find the most important problems to be solved immediately, to problems that do not need to be solved immediately, Pareto diagrams can also identify the most important problems that affect quality improvement efforts.

By using pareto diagram and the formula, we conclude the best scope of work to be optimized are henhouse building, general building, nestbox, generator, deepwell.

The main work scope of Land Development which consists of land clearing, cut & fill, road pavement and drainage work has a fairly high-cost difference, but the scope is difficult to compare due to the different size of land areas between one and another project.

Henhouse building is the breeding place for the chicken, the size of the building is 12m x 124m as the standard of the PT. X current formula as the most efficient size in the aspect of production.

General building scope is consisting of many facilities buildings and utilities item to provide and facilitate the production activity in the farm such as security post, parking area, pray room, manshower, genset room, office, vaccine storage, egg storage, workshop, husk storage, feed storage, waterpond, water tower, laundry room, egg tray washing area, tools storage and others.

Nestbox is a small chicken coop inside the henhouse as the laying egg spot for the chicken. While a generator is a device that converts motive power (mechanical energy) into electrical power for use in an external circuit. The generator is very much needed in the farm as an alternative power provider when the power goes out. The chicken can't last a couples of hours without the availability of power.

The scenario design is a processed of collecting the needs and the vital point of the production teams and turn it into the parameter design as the primary reference of the design. This process consists of two stage which resulted as the design process and the design parameters (Table 2).

**Table 2. Example of Design Parameter**

Genset Room		
Parameter	Description	Remarks
Condition	Generator & Panel Room Partition	Operator Control
Structure	Generator Foundation & Building Structural is separated	Structure Dilatation
Spesification	No water entered Good Air Flow	Rain / Flood
Control	1 Operator Control	Standby Area
Temperature	Panel Room 24 ~ 26 C	AC

After making all of the design parameters, the steps to design optimization can be done by doing functional analysis, creation analysis and design evaluation by comparing the standard design to all of the previous designs. For example, of the optimization process the table 3 will show the analysis steps:

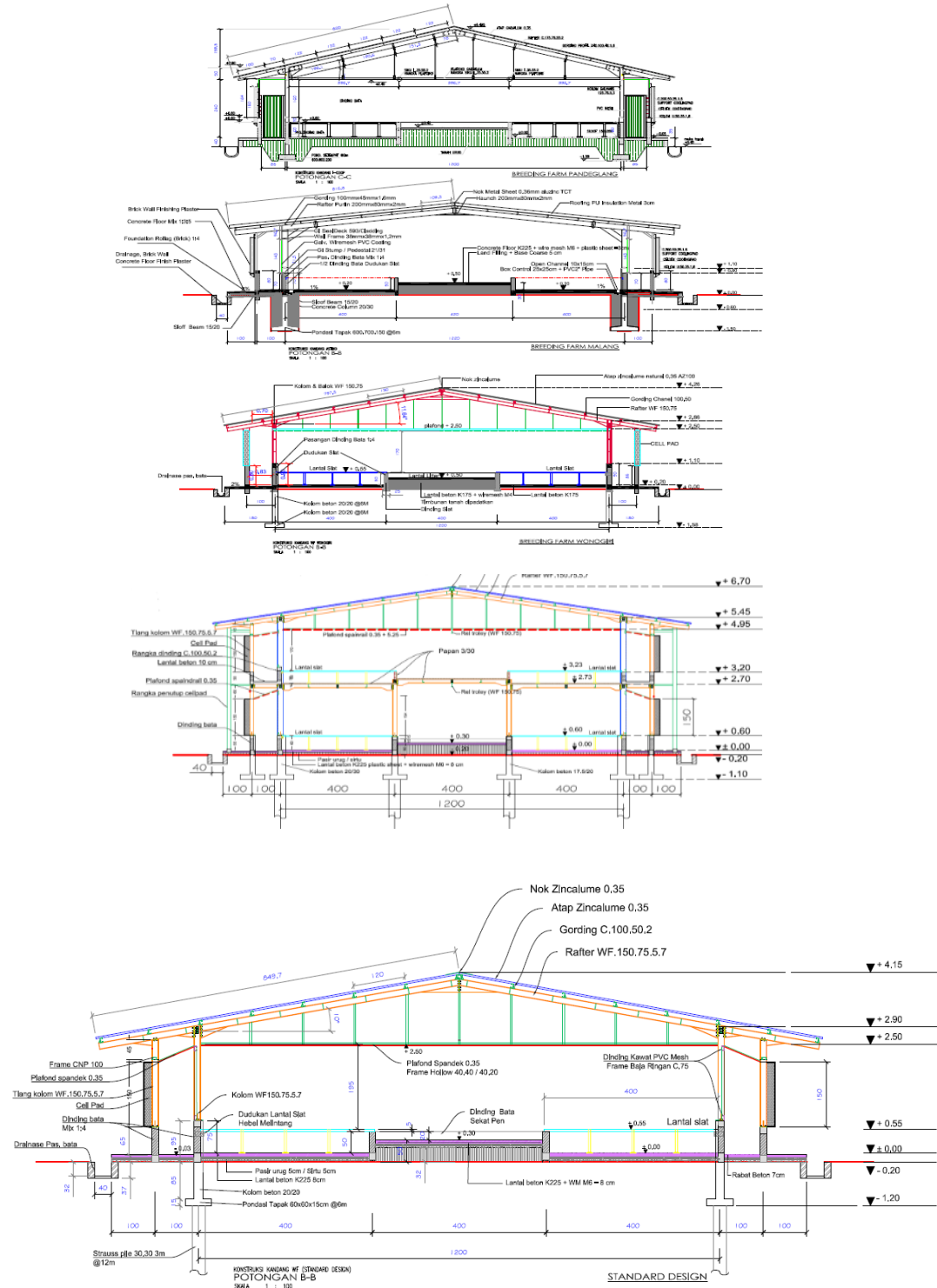
**Table 3. Example of Function Classification of Henhouse Building**

No.	Function	Item of Work (Criteria)
1	Ventilation System	Henhouse Dimension (Height)
		Height of Brick Wall
		Height of Slat Floor
2	Temperature & Humidity	Henhouse Dimension (Height)
		Height of Slat Floor
		Type of Floor
3	Biosecurity	Drainage Inside & Outside



After doing the analysis, the drawing design could be proceeding. An example of the previous and new standard design of the henhouse building scope shown in figure 2.

### Figure 2. Previous and New Standard Henhouse Design



From the design drawing that have been made, the bill of quantity, statement of specification and price estimation can be arranged and be compared to every previous design. The summary of the comparison shown in Table 4.

In the scope of henhouse building the optimization that has been done by the design are the re-design of foundation, wall height, slat floor & support, building height, floor specs, cladding and other component that related to system ventilation and humidity. Pekanbaru design have lower cost because of the design is 2 story building, but a 2-story building it is not effective in supporting management production activity. All of the steps of optimization applied to other scope of work.

The generator machine parameter requirement is that the generator capacity is 20% greater than the maximum load. Brand is not standard, as long as maintenance is carried out regularly as well as good after-sales service and the availability of spare parts is met. The new generator does not require a second spare generator. The total operational power requirement for production is 286.86 KVA added with a safety factor of +20% so that a power of 344.23 KVA is required. By using generator with capacity of 400 KVA is enough to support all of the production activity.

The nestbox scope of work required the total quantity of chicken that have to be provided with a spot of egg laying activity. With the standard model of nestbox that have the capacity to contain 120 chickens each, and the total population of 1 henhouse is around 8.352 chickens, therefore a total of 70 units of nestbox is required. For safety reason during maintenance the production may need some spare of the nestbox around 10%. The specification of the nestbox should be using non-rust material and don't have sharp edges that could harm the chicken inside. So, to fulfill all of the requirement of 138.000 chickens in 16 henhouses, a total of 1232 units of nestbox is needed. It is needed to be straight out because the total quantity of nestbox in every project is varied.

In designing the deep well scope of work, the total amount of water requirement per-day is needed. A chicken consumes 0,35 L of water in average, while for all of the process of production and activity is calculated around 0,15 L / chicken. In total the water consumption per day is minimum 66.816 L. Therefore, the farm will need deep well that could supply with a water discharge at least 5.568 Liter / Hour or 1,55 Liter/second. In the terms of breeding farm construction site need a spacious area of land, the selection of land is considered difficult to find the area that have an aquifer with fertile productivity. Assuming the land only has a moderate productivity aquifer that usually only could supply around 3 m<sup>3</sup>/hour we will need 2 units of deep well. Considering of the environment effect and according to the environmental government regulation, that every 2 deep well will need 1 unit of recharge well to be constructed to unharmed the environment around the area.

The general building scope of work consist of many assets building and utility to support every production activity outside the henhouse. It positioned in every area of the farm. As the item is very prodigious, the improvement result that achieved by the optimization process are the efficient sizing of the building, efficiency material used, the refinement of design criteria, new function and facilities building while also improve environmental aspects by providing new waste treatment system.

Every single item is compared and optimized according to the parameter design and the cost resulted. Every item optimized either will have more function value, size and material efficiency used that would give benefits and appropriate for the production process. Therefore, the final result can be shown in the table 4 below.

The fulfillment of this facility is carried out to complement the ongoing production activities which were not carried out in several previous projects. These facilities are needed both to fulfill production management, improve biosecurity systems in the

farm area, as well as make the necessary waste building and waste treatment facilities. The total cost of all these additional facilities is Rp 516,926,000, -

**Table 4. Final Result – Cost Efficiency and Value**

Scope	Std Design	Price (x Rp 1.000.000)				Remarks Improvement
		Malang	Pekanbaru	Pandeglang	Wonogiri	
Henhouse Building	21.357	21.625	20.132	22.586	21.464	Ventilation System, Temperature & Humidity
General Building	2.934	2.889	3.804	3.974	2.665	Efficiency size & material. Add some new facilities & utilities.
Nestbox	801	880	1.026	762	653	Total Nestbox 77 Unit / HH
Deep Well	550	254	400	350	358	Environmental Improvement
Genset	640	425	750	730	630	Efficiency Capacity
<b>Total Price</b>	<b>26.28</b>	<b>26.07</b>	<b>26.11</b>	<b>28.40</b>	<b>25.77</b>	<b>Full facilities with additional function, environmentally friendly with efficient budget.</b>
<b>Comparation</b>	<b>100%</b>	<b>99%</b>	<b>99%</b>	<b>108%</b>	<b>98%</b>	

## CONCLUSIONS

In optimizing the design, it is necessary to know the production needs both from facilities, criteria and problems that commonly occur during production. This research resulted in a design standard that is more efficient in terms of cost and provides additional benefits in supporting the ongoing production process by comparing it to previous construction projects.

The results of this study are design optimization that provides cost efficiency and increased benefits compared to previous construction projects:

- 1) Design scenario by compiling the main parameters for each scope of project work under study. These parameters were obtained by literature studies, site surveys and interviews with the research population who were experienced and expert in production management and previous construction projects.
- 2) Design optimization is carried out by conducting function analysis, creation and evaluation as well as comparing specifications and costs to previous designs, which results in optimization results:
  - a) The cost efficiency of the project is 8% lower than 1 project, and 1-2% higher than the previous 3 projects.
  - b) This is due to a design approach that is more in line with production needs
  - c) Some additional benefits are obtained from the existence of new facility buildings that support production in aspects of the production process, biosecurity and environment.

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