

Optimization of Quality Improvement and Production Capacity at Prayogo's Chicken Slaughterhouse SME

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Abstract

Moyudan Subdistrict is an area that has several small industries of chicken farming. Partner who was the participant of this community service program, Prayogo's Chicken Slaughterhouse, an SME in Yogyakarta, had a major obstacles to increase the production capacity of good, neat, clean, and hygienic chicken meat and meeting halal standards. In addition, this business still did not have chicken cutting standards according to factory standards (SNI 01-6160-1999). The cutting process was still done manually and conventionally, with mediocre quality and quantity. Production capacity was low, and many production operators experienced high fatigue in the hands and shoulders or experienced musculoskeletal fatigue. The expected transfer of technology in this program is the design of modifications to poultry cutting machines that suit the needs of this partner and is associated with the selection of portable poultry machine designs and manufacturing technologies that can later improve the quality and capacity of chicken meat processing according to halal standards. The results of this community service activity are; (1) one unit of portable poultry machine given to partner; (2) an increase in production capacity of 429% in terms of cutting capacity per day with smooth, precise, and accurate cutting quality; (3) reduced fatigue experienced by the production operators after the machine in operation. The chicken cutting capacity of Prayogo's Chickens Slaughterhouse can be increased by 4.29 times from 75 chickens a day to a maximum of 321 chickens a day.

Keywords: *chicken slaughterhouse, SME, community engagement, portable poultry machinery, production capacity.*

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Introduction

Sleman Regency, Yogyakarta Special Region Province is an area with a relatively flat land conditioned in the southeast of Prambanan District and partly in Gamping District, covering the districts of Tempel, Turi, Pakem, and Cangkringan. Sleman with an altitude of more than 1,000 m from sea level covers an area of 1,495 ha, about 2.60% of the area covering Turi, Pakem, and Cangkringan Districts. Based on the Central Statistics Agency of Sleman Regency, this district has 17 sub-districts and 86 villages, with a total number of people as many as 1,136,477 people in 2021, where the number of men was 551,483 people and women 584,994 people. Some of the areas is used for trading, rice farming, salak plantations, cattle and goat farming, and poultry (chickens, ducks) farming, and freshwater fisheries.

Prayogo's Chicken Slaughterhouse, a Small Medium Enterprise (SME) is a business located in Moyudan District, Yogyakarta Special Region. This partner business has less than 10 employees. The chicken slaughterhouse condition was still very conventional (using manual cutting knives and has not met the SNI standard 01-6160-1999). This limitations become the major obstacle for the partner in offering good, neat, clean, and hygienic cut chicken production capacity (Figure 1).



Figure 1. Prayogo's Chicken Slaughterhouse in collaboration with the community service team

Chicken meat is one of the food source of the Indonesian people which is consumed the most compared to other types of meat, so the need for chicken meat always increases every year. In everyday life processed chicken meat is often found in restaurants, hospitals, and supermarkets. The restaurant business usually makes processed chicken meat as one of the main menus.

Currently, many poultry industry players are running their businesses with the traditional cutting process, especially the slaughterhouse like Prayogo's SME. This paper will comprehensively explain the process of designing, manufacturing, and verifying the modernization of efficient and effective chicken cutting machine to obtain a faster cutting process and better cutting quality under chicken cutting standards set by hospitals, restaurants, and franchises such as KFC, McDonald's, and other brands.

1.1. Partner Issues

Based on observations and interviews conducted by researchers with the Prayogo Chicken Slaughterhouse, it was stated that this business wants to create a modern chicken cutting system so that it could expand market reach, formulate problems that will significantly affect the improvement of chicken meat quality and production quantity, and economical value of meat sold, as well as increasing work efficiency in the processing of chicken meat. Meanwhile:

- a) Prayogo Chicken Slaughterhouse employed conventional processes in cutting chickens so that the quality and production capacity were still low and cause a significant impact on fatigue for production operators.
- b) Prayogo Chicken Slaughterhouse did not yet have SNI 01-6160-1999 factory standards such as conditions, completeness of tools, completeness of buildings, and standards of cleanliness for the process of chicken cutting (so the chicken meat produced was not guaranteed to be good, neat, clean or hygienic).
- c) The absence of a Home Industry Food Production Certificate (home industry certificate and halal certificate) from the Ministry of Health and the Ministry of Religion causes marketing to be carried out only in local areas.

1.2. Problem Solution

The solutions and external targets implemented refers to the problems encountered by the Prayogo Chicken Slaughterhouse business which are stated in the partner problems in points (a) and (b) above. From there, the expectation of the research team and business partner to answer the existing problems is as follows:

- a) Conventional processes could not meet the broad market, so operating a chicken cutting machine, such as a portable poultry machine, was expected to meet the broader market demand.
- b) The slaughterhouse did not have chicken meat cutting standards owned by factories, so the chicken meat produced was not good, neat, clean, and hygienic. Therefore, increasing

the production capacity of chicken meat that is good, neat, clean, and hygienic and meets halal standards could be achieved by using an appropriate chicken cutting machine. Achievement plans and achievement indicators for the application of chicken cutting machine technology for SME business can be seen in Table 1.

Table 1. Achievements and indicators of the research team's achievements in the application of chicken processing machine technology to the SME partner

Activity	Week	Output	Indicator	Indicator unit	Problem Identification	Solution
Manufacturing process of optimal chicken cutting machine with a larger capacity (capacity compared to the previous applied cutting process)	1	Coordination with Partners	Agreements with partners	Constraints from partners	The current procedure of chicken cutting cannot meet the appropriate standard of meat production	The use of the proper chicken cutting machine to produce cut meat cleanly, neatly, and hygienically, and meets health and halal standards
	2	Preparation of component needs and purchase of machine-making components	Implementation of Researcher Discussions with partners	Design making according to partner needs		
	3	Design process of machine that meets the partner's needs	Offer deal	Calculation of tool dimensions, capacity and cost		
	4-10	Manufacture of machines according to partner's requirements	Machines that can function as the partner wishes	Specifications according to design		
	11-15	Testing and refinement of the machine	The machine is functioning fine	Machine repair and refinement		
	16	Evaluation, machine handover and report generation	On-site testing and report generation for publication	Report generation and writing manuscripts for published journals		

Literature Review

An automatic chicken cutting machine that can cut chicken meat into blocks is expensive. It means that a large investment is needed to start a chicken meat processing business. Small companies have scarce resources that prevent them from innovating (Crawford *et al*, 2011). Tools and equipment help to perform tasks that are not easy to do in a way that is more efficient and ergonomic should be involved in the design to ensure safe and effective operation (Ulrich *et al*, 2016). Therefore, it is necessary to design a manual chicken meat-cutting tool to help

micro-enterprises and household industries to reduce the investment of expensive machines to cut chicken meat faster than using a knife alone. Preliminary research by Lee (2011), Song (2003), Ahn (2003), and Chae (2005) reports that consumers' biggest concern is the quality and safety of meat because consumers are more interested in the quality of meat than in the quantity of meat for consumption. Therefore, a safer and more hygienic chicken-cutting tool is needed, meeting halal aspects to meet the demands of consumers who have food safety problems. Research by Lee (2011), Song (2003), and Choi (2004) exposed that chicken cutting work using an electric jigsaw reduced the rate of chicken meat loss by more than 15% compared to manual cutting through hand work using knives, thereby increasing the company's profits by 11.37% due to reduced costs and increased productivity. As described above, an automatic chicken-cutting machine that can automate the cutting process can increase the company's profit by further reducing production in cost (Lee, 2011 and Song, 2003)

In designing and developing products, it is necessary to understand in advance the basic concepts, which include the perspective of product design and development, the challenges faced in developing products, the character of product development and the types of product development projects. A product is something that is sold by the company to buyers. Product design and development is a series of activities that start from analyzing perceptions and market opportunities and then end with the stages of production, sales and delivery of products (Kang, 2011). Various industries have implemented product development effectively and harmonized various factors affecting it very well, often influenced by the rapidly changing customer market. The success of the product development depends on the response of the consumer, the product from the development is said to be successful whenever it gets a positive response from consumers followed by the desire and action to buy the product. Identifying consumer needs is the earliest phase in developing a product because this stage determines the direction of product development (Ulrich *et al*, 2016).

In design process, product development stage has five types. This character is adapted to the company's capabilities and goals (Heck, 2006), specifically:

- a) Generic type (market pull), in this type the company starts with market opportunities and then gets the appropriate technology to meet customer needs.
- b) Technology push type, in this type the company starts with new technology and then gets the appropriate market. The difference with the market pull type is that the planning stage involves the suitability between technology and market needs. The development of the concept assumes that its technology has become available.

- c) Platform product type, in this type the company assumes that the new product is created based on an existing sub-system of technology.
- d) Process-intensive type, in this type the characteristics of the product are strictly limited by the production process. In this type, the process and product must be developed together from scratch or the production process must be specified from the beginning.
- e) Customized type, in this type the new product allows a slight variation of the existing model.

Prototype Definition

The definition of a prototype is only as a noun, but in product development practice, the word is used as a noun, verb, or adjective. The definition of a prototype is the estimation of the product through one or more dimensions of concern (2). Based on this definition, any form that shows at least one aspect of the product that is of interest to the product development team can be displayed as a prototype.

Prototypes can be classified into two dimensions. The first dimension divides the prototype into two, namely the physical prototype and the analytical prototype. A physical prototype is a real object created to estimate the product. Aspects of the product that the development team is interested in are noticeably made into an object for testing and experimentation. Analytical prototypes are the opposite of physical prototypes that display only unreal products, usually in mathematical form. Examples of analytical prototypes include computer simulations, computer models, and three-dimensional or two-dimensional geometrics.

The description of the science and technology that applied in this community service as modernization of poultry meat processing equipment for Prayogo's Slaughterhouse is how the research team's efforts can solve the problems faced by partners in terms of the chicken meat process according to established standards and can accelerate production capacity and cutting time of each unit of chicken with a machine compared to the manual chicken cutting method practiced. Design and manufacturing technologies on machine tools used in this activity. To show the machine model designed according to the request of the partner, computer-aided design technology was utilized using SolidWorks or Autodesk PShape software to visualize the chicken cutting machine. Conventional machine tooling technology with drilling machines, lathes, milling machines, and tools on work tables used by researchers and members of the research executive to obtain chicken cutting machine components for chicken cutting machine

unit that is efficient, effective, safe and comfortable to operate by the operator in partner's business. The expected capacity of the chicken cutting machine is a machine that can cut one chicken into 6-8 pieces of chicken in less than 10 minutes/chicken with neat, smooth, and precise sliced quality according to hospital standards, and large restaurants such as KFC, McDonald's, etc. Science and technology transferred to partners is in the form of portable poultry cutting machines that can cut chicken/poultry organs quickly, safely, and efficiently as desired, and also to save production costs for fresh meat processing SMEs. This machine refers to the results of the design and manufacture of a meat-cutting machine that was built by the research team in the 2005 community service and was successfully implemented in Sragen. The working principle of this portable poultry machine process is quite simple, that is by attaching the meat to be cut to the cutting guide bar and the operator gives a little force/push towards the blade, then the blade itself takes shape. The disc cutter then cuts through the meat quickly.

Methods

The detail stages of the process of design, manufacturing, and verification of tools in the process of building a portable chicken cutting machine, in general, consists of six stages:

- a) Stage of forming an SME Forum Group Discussion: At this stage, the establishment of a Forum Group Discussion (FGD) for all members of the research team starting from FGD activities to discuss the main obstacles that occur to partners and find solutions to problem-solving.
- b) Design Stage: At this stage the design process of the chicken cutting machine corresponds to the requirements of the partner. The output resulting from this stage is in the form of designs and drawings.
- c) Procurement Stage of Tools and Materials: The design that has been selected then be procured with tools and materials that are following what the partner wants and follow the existing design.
- d) Machine Manufacturing Stage: At this stage begins the process of manufacturing and assembling the machine with existing tools and materials, carried out according to the design.
- e) Machine Testing Phase: At this stage, the machine testing stage is carried out using the testing standards that the machine is expected to use.

- f) Machine Commercialization Phase: The commercialization of machines in these community service is carried out by handing over machines that are expected to overcome the main obstacles of partners.

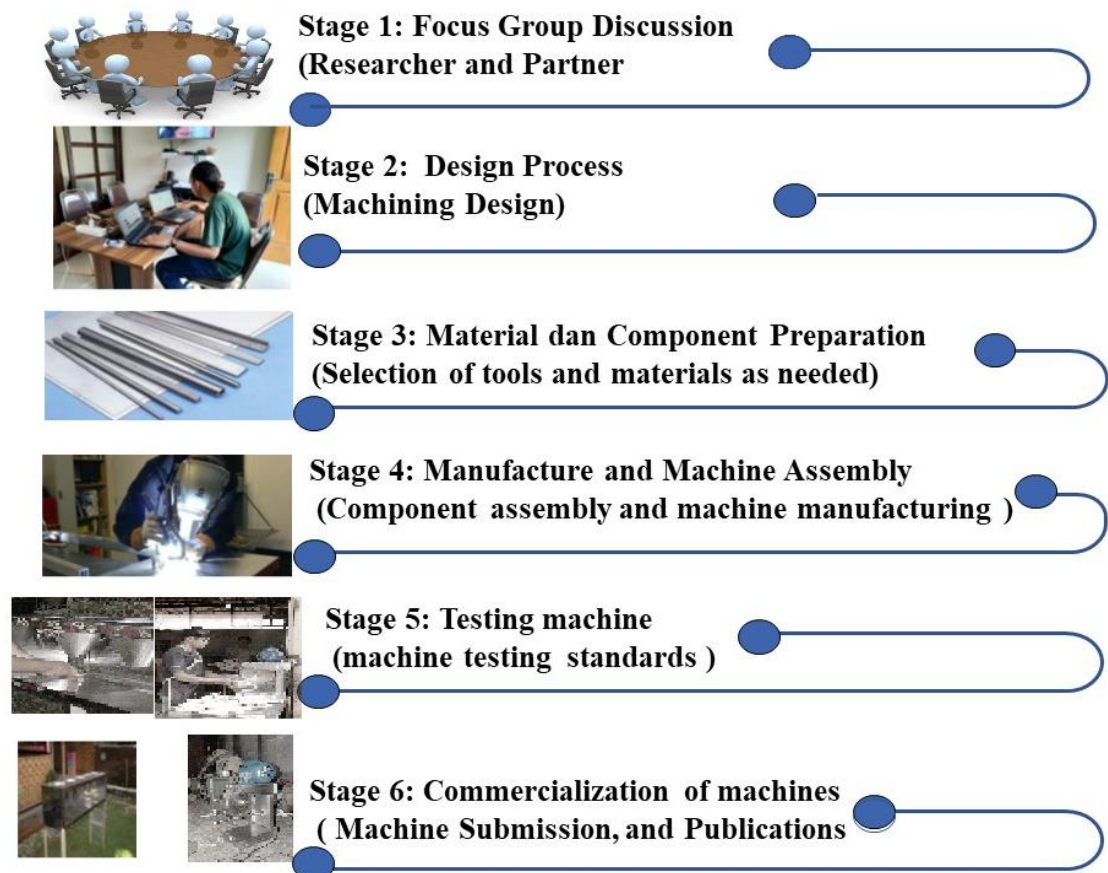


Figure 2. Methodology to build the chicken cutting machine

Results and Discussions

Prayogo's Chicken Slaughterhouse SME is the main partner in this community service activity (Figure 1) and has been running its business for more than 10 years. Following the existing location map, this SME deserves to be chosen as a partner in the community service program since it is still in the Sleman Regency, Yogyakarta Province. As shown in Figure 2, the six methodological stages of community service activities in the fields of design, manufacture, and commercialization stage of the equipment have been carried out by a research team from the Department of Industrial Engineering, Faculty of Industrial Technology, Atma Jaya University Yogyakarta (UAJY), with 1 unit of portable poultry cutting machine that has been handed over to Prayogo's Chicken Slaughterhouse with satisfactory operational results in terms of

increasing the capacity and quality of chicken cutting from traditional models with manual cutting tools to modern cutting tools.

Previously, the process of chicken cutting was done manually by operators using large cutting knives to cut more than 100 chickens per day. This activity certainly results in fatigue in the operator's musculoskeletal muscles which results in excessive pain and discomfort over a long period of time and the cutting position is not ergonomic and can affect the quality of chicken cutting which should turn into 7-8 standard chicken pieces, instead, more than 12 cuts with non-precise cutting quality, not smooth/rough, not geometrically the same (See Figure 3 – Figure 5).



Figure 3. Prayogo's Chicken Slaughterhouse previous chicken-cutting process

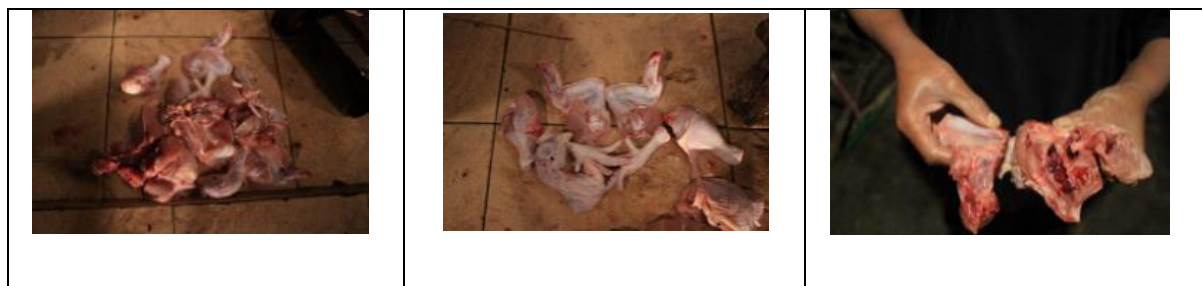


Figure 4. Prayogo's Chicken Slaughterhouse manual meat cutting



Figure 5. Operator non-ergonomic position in chicken-cutting process

From Figures 3, 4, and 5 it can be seen that the cutting process is still manual with simple cutting tools, and the operator's position is less comfortable or not ergonomic due to the support and position of the shoulders and hands on the cutting table and the meat to be cut which has an impact on operator discomfort and has implications in excessive pain in the muscles of the hands and shoulders due to excessive movement. The results of cutting with this manual process look not smooth, and not precise with the amount of meat that is cut not according to the standards of large restaurants (KFC, McDonald's) or hospitals, so it is unable to penetrate the large food industry. The number of chickens slaughtered is still small, a maximum of around 50 to 75 kg a day with a slaughter time of around 20 to 40 minutes per head. This certainly has an impact on the productivity of these SMEs to compete with other poultry slaughterhouses in Yogyakarta and surrounding areas.

The existence of a chicken cutting machine that has been designed and used very well in previous studies by researchers for partners in the Sragen market area was reused in the design and manufacturing procedure for chicken cutting tools for Prayogo's Chicken Slaughterhouse (with improved dimensions, handguards, increased cutting capacity, and engine rotation stability). The results of the design carried out by the community service team using CAD Solidworks software produced a design as shown in Figure 6, with the following specifications.

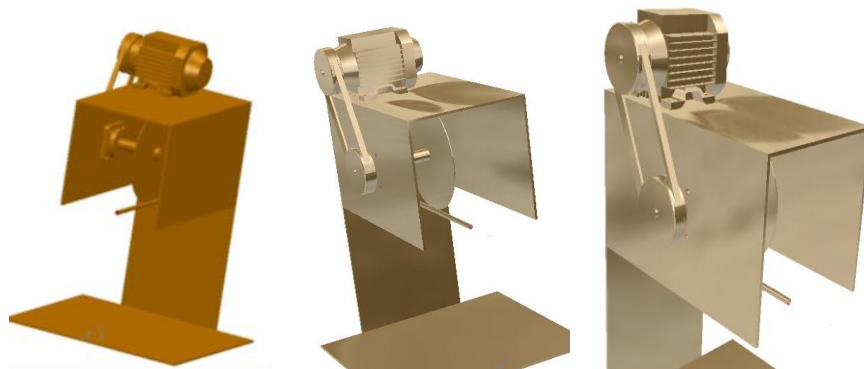


Figure 6. 3D model CAD table poultry cutting machine applied for Prayogo SMEs

The Portable Poultry Machine (PPM) made in the program was planned to have the following specifications:

- a) Switch: Tilt type, enclosed, waterproof.
- b) Interlock Switch: Micro type, waterproof.
- c) Voltage: 110/60/1 phase standard.
- d) Blade: Stainless Steel 316, diameter of 230 mm.

- e) Cutting Guide Bar: Aluminium Alloy, diameter 3/4".
- f) Standard Equipment: Sharpening stone for Blade.
- g) Construction: Base, frame, and extension shaft, all using Stainless Steel 316 material.
- h) Motor Power: 3/4" Horse Power (HP).
- i) Dimensions: 400mm x 250mm x 550mm.

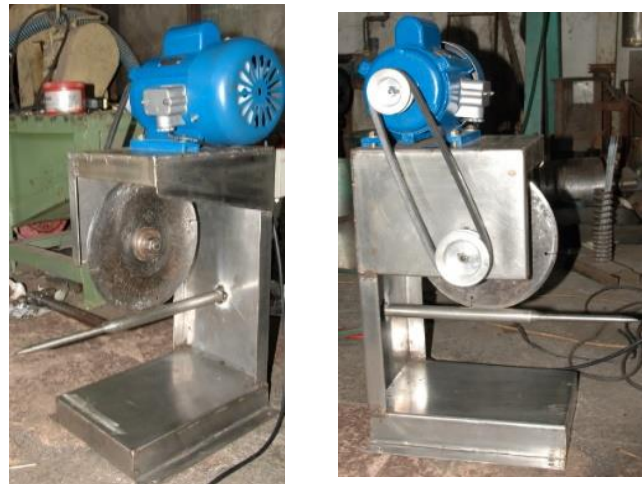


Figure 7. Portable poultry machine made by Team Community Service UAJY

The solutions and methods offered to support the realization of the community service program for Prayogo's Chicken Slaughterhouse in Sleman Regency is to modify the design of the Portable Poultry Cutting Machine with improved dimensions, handguards, increased cutting capacity, and machine rotation stability previously made by the research team for productivity solutions in large companies regarding production optimization factors which include product quality, reducing production costs, ergonomics, functionality, reducing production lead times, and machine cleanliness, as previously described in the Appropriate Innovation Work (2011), which has been proven to be able to operate properly, precise, and fast. Portable Poultry Cutting Machine, allows the process of cutting meat utilizing mass production, where chicken meat that has been cut will be stuck on the Cutting Guide Bar according to its position, which part will be cut, then touched to the Blade Blade with a slight pushing force towards the Blade (eye cut), so that the Blade (cutting eye) will pull & cut by itself, the cutting capacity of this tool can reach 2 pieces at a time, thus speeding up the cutting time of the meat. This is of course very cost-effective and less labor-intensive as well as increasing production capacity, as well as the quality of the cuts of meat which are almost the same as one another.

After the chicken-cutting equipment was obtained (Figure 7), tests were carried out on the machine to measure the capacity and quality of chicken-cutting at the Prayogo's Chicken Slaughterhouse. It takes 30 chickens ready to cut. According to the cutting standards set by large caterers or hospitals or large restaurants such as KFC or McDonald's, good quality cuts are each chicken cut into 4-6 parts with smooth, precise cutting tools, the meat is not deformed or damaged, with a cutting time less than 1-2 minutes per chicken (Table 2).



Figure 8. Operator perform the chicken cutting using portable poultry machine

The operator performs the process of cutting the chicken on the new machine by inserting the chicken into the poultry direction shaft of the portable poultry machine (Figure 8) with the operator standing or sitting on a high chair, the position of the hands adjusted so that the position of cutting the chicken meat is appropriate. The results of machine cutting can be seen in Figure 9.

Based on observations of slaughtering chickens manually and comparing them to slaughtering using a PPM machine, the average manual time is 30 minutes per chicken (with a deviation of 5.88 minutes). Slaughtering using a PPM machine resulted in savings of an average of 7 ± 0.63 minutes (7 minutes with a deviation of 0.63 minutes) per chicken. Productivity Increase Result = $30/7 \cong 4.29$ times or 429%) from 75 chickens a day to 321 chickens a day.

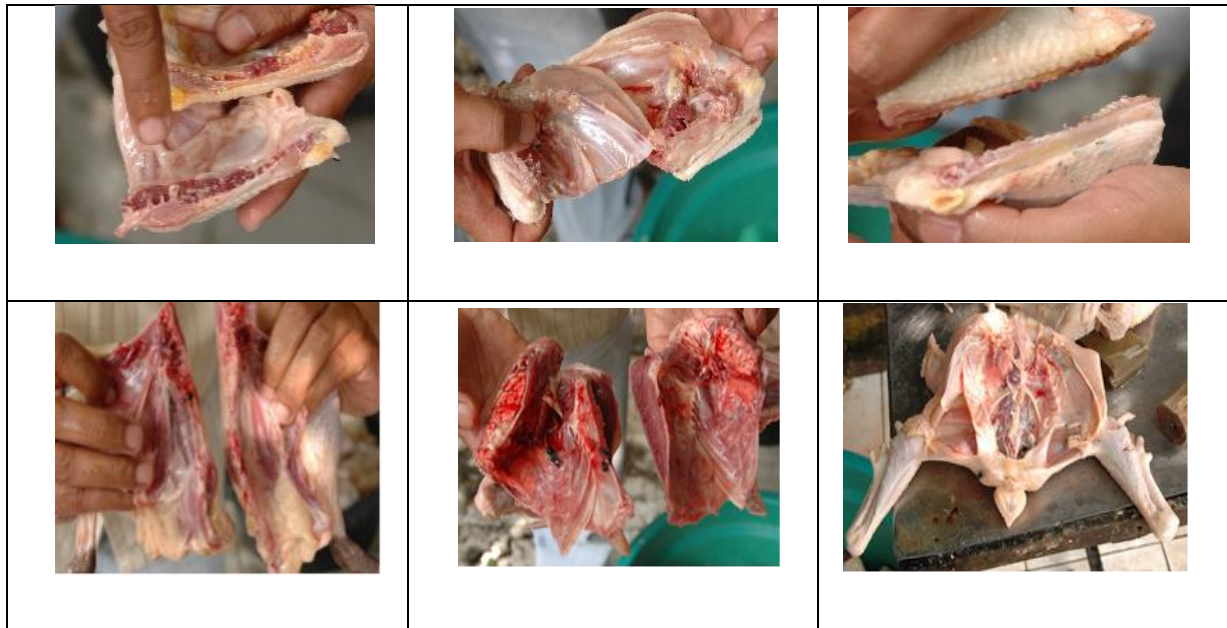


Figure 9. Cutting quality of chicken meat (using the new machine)

Table 2. The average cutting time using Manually and (PPM) methods with 10 observations

No	Manual Cutting Time, minutes	PPM Machine Cutting Time, minutes
1	21	8
2	24	7
3	27	8
4	31	7
5	25	6
6	38	7
7	30	7
8	30	6
9	33	7
10	41	7
Average time, minutes	30	7
Standard Deviation, minutes	5.882176	0.632456

Conclusion

The results of the design, manufacture, and testing of 1 unit of the portable chicken cutting machine showed an increase in the capacity of chicken-cutting by 429% (321 chicken per day) with a machine cutting time of about 7 minutes per chicken. The quality of the chicken pieces

produced compared to the previous manual method is smoother, the meat is cut more precisely, and there are not the slightest defects. The cutting production capacity of Prayogo's Chicken Slaughterhouse can be increased by 4.29 times from 75 chicken per day. to a maximum of 321 chickens per day.

Further research is suggested to test the effect of fatigue on chicken slaughter operators compared to the modernization of cutting tools by comparing the position of the operator while standing or sitting by looking at the elements of operator productivity that have been carried out by the research team.

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