A Design of Automatic Meat Slicing Machine

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Abstract
The main purpose of the project is to design an automatic machine to slice chicken meat which is to automate the conventional chicken meat slicing method to modern method. BABARITTOS DELIGHT, it supplies Tortillas Wrap to the popular trend of Food & Beverage (F&B) business called Food Truck. The main ingredient of Burritos is slices of boneless chicken meat, where each slice is approximately 5 mm thick. Conventionally, the company practice a manual cutting process; which uses a normal cutting knife with manual human labour causing the truncating production rate and thickness of the meat; while the demands of the Burritos increases by days. This method requires 3 to 4 workers and one and half hour to cut the 30 kg boneless chicken meat to be cut into roughly 5 mm per slice. The main objective of this project is to design an automatic meat slicing machine to increase the production rate of the sliced meat and in the same time to reduce the number of workers in slicing station. The machine only required one worker to operate and the output can be up to 30kg per 30 minutes which almost triple the quantity of output and labour cost saving. Meanwhile the quality of the sliced meat is enhanced as most of the sliced meat is uniformly 5mm thick. The concept of the design is to cut the meat using several circular cutting blades, where the chicken is placed on the moving conveyor and finally will drop into a sterile tray.
Keywords: automate, production, circular blades, chicken meat

1.0 Introduction
BABARITTOS DELIGHT has supplied Burritos or Tortillas Wrap to the popular trend of Food & Beverage (F&B) business called Food Truck. The company sells Tortillas Wrap with their fleet of Food Truck. The main ingredient of Burritos is a slice, boneless chicken meat. The boneless chicken is sliced into thin pieces manually by using cutting knife. Currently, boneless chicken meat, sliced manually by 3 workers. The amount of slicing meats for every worker is 6 kilograms per hour. Due to high demand of Burritos or Tortillas Wrap from Food Truck Business Communities around Klang Valley, the company is facing problem in producing more sliced chicken meats. According to Zhang, et. al (2017), in the past three decades, the total meat production in Asian countries

has been mainly increased because of the rapid growth of the economy and population.

Hence, normal practice by the company, which is the manual method using knife is no longer practical, tedious, not economical and ergonomically feasible to workers and financially unsustainable to the company itself. Therefore, an Automatic Meat Slicing Machine has proposed to replace the existing practice.

Thus, the objective of this machine is to Automatize the cutting practise for boneless chicken meat, lessen the number of workers, to grow the production rate of sliced meat and lastly to reduce the production time.

2.0 Literature Review

Few machines with similar concept were found through studies and survey. The two machines highlighted to be focused on to precede the project are Semi-Automatic Commercial Electric Meat Slicer and Fully Automatic Slicer Machine.

2.1 Semi-Automatic Commercial Electric Meat Slicer

Figure 1 shows an existing machine, where the machine operates with a single blade which made of stainless steel. The axle steel is used so that it can slither along smoothly. Variable-speed Automatic Product Carriage The diameter of blades is 220mm/ 8 inch. The sliced meat is approximately 10mm thick. The meat has to be placed under the blades before the process can be started. The constraint of this machine is that only one boneless chicken meat per cycle. The concept is not suitable for a mass production of sliced meat because there will be time lead between the placement of the meat and the time taken to take out the sliced meat.

Figure 1: Semi-Automatic Commercial Electric Meat Slicer

2.2 Fully Automatic Slicer Machine

Figure 2 shows a fully automatic meat slicer machine. This machine operates with a multiple blades shaft with several circular blades. The circular blade is fully developed cutting configuration and proven speed ratios between blade shafts. Diameter of the blades are 200mm. The minimum distance of blades are 6-8mm, depending on the product. A review of the existing modelling methods from Jimin et al. (2017) used for machining simulation has shown that the voxel-based space partitioning approach is the most computationally efficient. The concept of this machines is also not suitable for mass production of sliced meat because more time required to take off the sliced meat and placed with new meat.

Figure 2: Semi-Automatic Commercial Electric Meat Slicer

3.0 Methodology

3.1 Design Phase

Starting with the sketching and drawing, the project has roughly sketched and ended up with computational drawing, which is using an application in a computer (CATIA V5R21). Few drawings have been sketched and drawn and the best model has been chosen to be the final idea of this project. Figure 3 shows that the final design of the body while figure 4 shows the individual blades dimensions. The task of identifying the specification of each part (i.e. motor, types of material, size of the circular blades, types of inverter and the size and specification of the size of the main body) took place after the finalization of design and concept. For the circular blades sizing, the machine's circular blade can be designed based on the study from McGorrya, et al. (2005), where a study has been conducted in meat packing plants directly measuring the effect of knife sharpness on grip force and cutting moment. They found that blade sharpness had a large effect on the grip forces and cutting moments produced by the meat cutters in the performance of their jobs. Mean grip forces and mean cutting moments were 21% and 33% greater when the blade that was dull, but serviceable was compared to a freshly sharpened knife. About these cutting blade, three intrinsic technical

characteristic of the knife such as blade steel grade, blade inclination with respect sample and edge angle (sharpened part of blade) need to be consider during design blade selection (Area. et al., 2009).

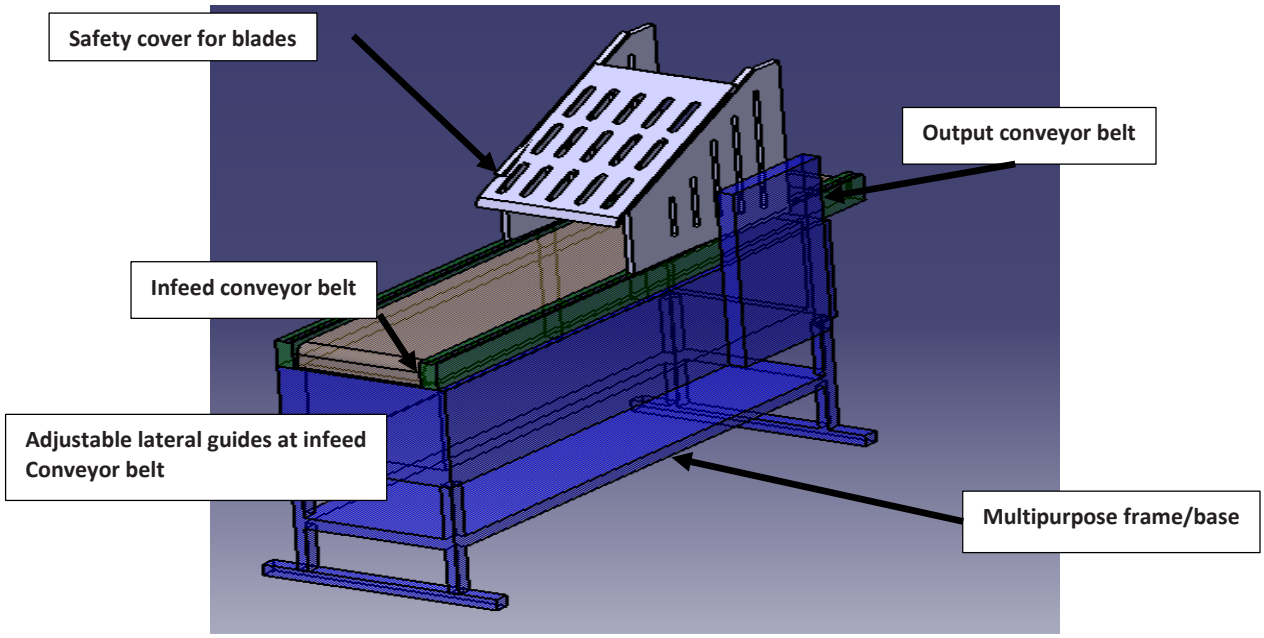
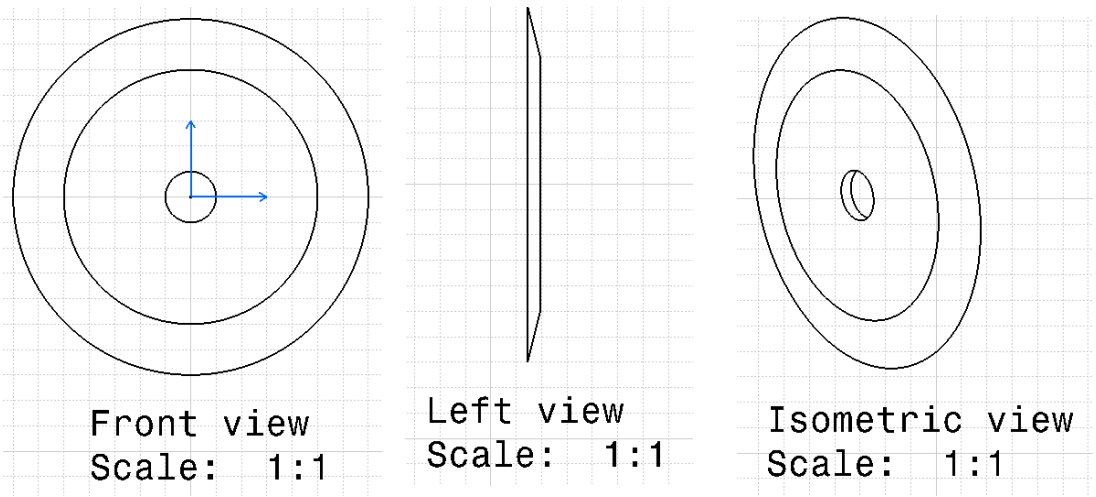


Figure 3: Production Flow for Automatic Meat Slicing Machine

Individual Blade



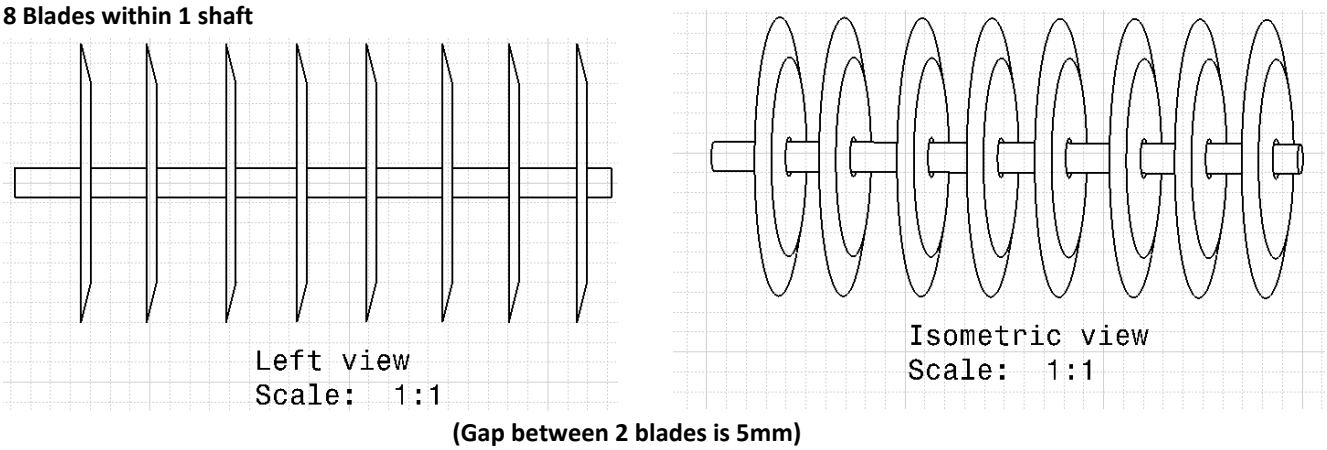


Figure 4: Close-Up View of Blades Slicer Section for Automatic Meat Slicing Machine

3.2 Fabrication Phase

In fabrication phase, there are few main processes involved, which are CNC process, milling process, welding and grinding processes. The frame of the machine is the first part to develop. Two aluminium plates involved, and the welding process took part while developing the frame. The shaft to hold the circular blades involved milling and CNC process where the 5 mm gap to be created. Study based at Jaideep et al. (2016), the meat need gap between cutting process to absorb stress occurred. At the same time, the conveyor, the motor and the inverter, the circular blades bought from the supplier.

3.3 Installation Phase

The installation phase mainly involved the electrical part. The installation of motor, conveyor and the inverter. The main purpose of installation of the inverter is to ensure the conveyor speed can be controlled by the operator. The electrical part ended up to be 3 phase input to cope with the input power off for the motor. There are 4 wheels were plugged in at the base of the machine during this phase. The installation phase consumed the longest time frame because this phase required meticulous work and testing particularly in the electrical part. Figure 5 shows the process of the installation phase.

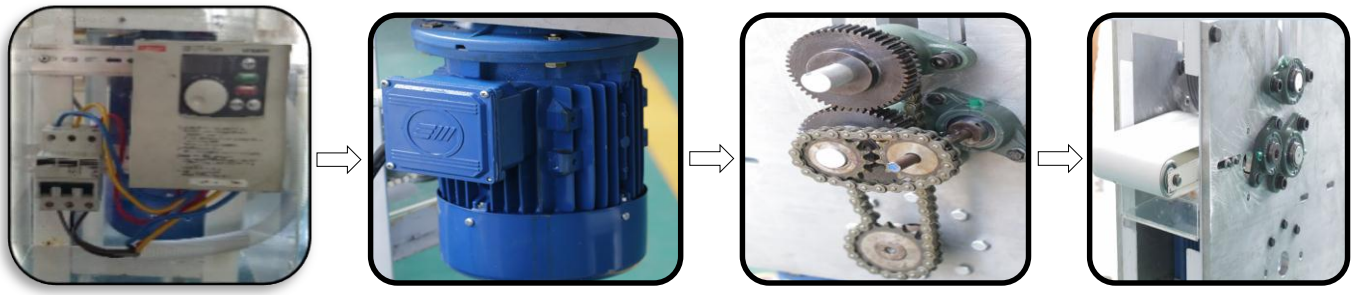


Figure 5: The installation process

3.4 Testing Phase

After the installation completed, there goes the testing phase. During this phase, the operation of the machine has been tested, in terms of the electricity, the appropriate speed of the conveyor, and the slicing operation of the meat by the circular blade and the most important mechanism is the thickness of the sliced meat. The time taken to slice the meat also recognized, to ensure the requirements of the company fulfilled. Throughout the testing, there are no problem in the electrical part in spite of the machine require the three-phase input. Figure 6 shows the testing of slicing meat were operation.

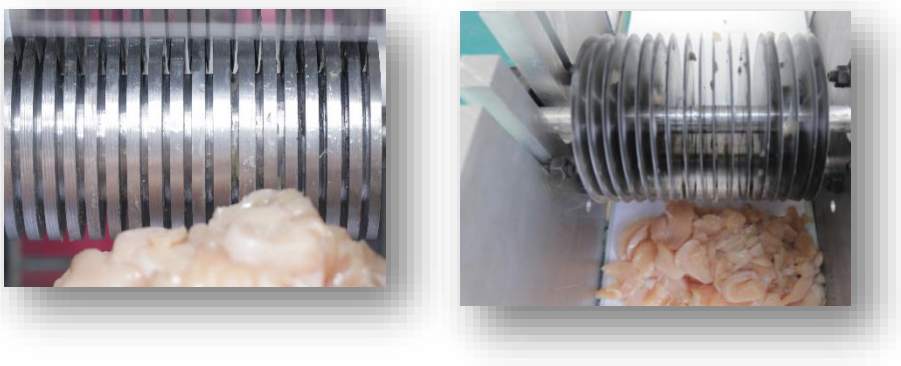


Figure 6: The 10kg meat will be sliced within 3 minutes.
(The approximate time for 1 cycle is less than 5 seconds before the chicken is completely sliced into 5 mm).

4.0 Discussion

There are few factors have to be considered in growing the productivity of the company.

i. Method

The method in producing the product is one of the important factors as it may link to time cycle vs productivity. The traditional or manual method habitually takes longer time in producing any product when it is equal to

the machining method. The longer time cycle taken, the lower the productivity

ii. Budget/money/finance
Budget is one of the keys of productivity. The company may occupy some money in order to buy a new device to upgrade the traditional method to modern method, however the investments can be seen as a positive investment as it may help the company to grow the productivity in terms of lowering the cycle time and reducing the number of labour.

iii. Management
Management is a factor of production and an economic resource. Management is responsible for ensuring that labour and capital are effectively used to increase output.

iv. Labour
Labour is also the key point in increase the productivity. A skilful labour may lead to increase the production.

v. Quality
The quality of the product has to be taken into consideration, as it is one of the customer satisfactions. Generally, the machined product will give better output compared to traditional method. As for the company, they required the sliced meat to be 5 mm thick and the machine is capable to produce a uniformly 5 mm sliced meat and the output will always be precise and consistent, when compared to the knife cutting method.

4.1 Analysis for Worker's Productivity

From the data in Table 1, it can be concluded that the worker's productivity increased by almost 800%, which is from 6.67 kg/hour worker to 60 kg/hour worker.

The machine is capable to slice the meat up to 60 kg per hour and the machine only requires a worker to handle it. The company can save the labour cost and in the same time the productivity of the sliced meat can be increased.

Table 1: Worker's productivity data analysis

Before (manual)	After (Using AMS)
Total Productivity: 30 kg Total time to produce 30 kg = 1.5 hours Total Number of workers: 3 Total Number hours of works = Worker's productivity = $\frac{30\ \text{kg/day}}{4.5\ \text{hour.worker/day}} = 6.67\text{kg/hour.worker}$	Total Productivity: 30 kg Total time to produce 30 kg = 0.5 hour Total Number of workers: 1 Total Number hours of works = $\frac{1\ \text{workers} \times 0.5\ \text{hours}}{\text{day}} = 0.5\ \text{hours.workers/day}$ Worker's productivity = $\frac{30\ \text{kg/day}}{0.5\ \text{hour.worker/day}} = 60\ \text{kg/hour.worker}$

5.0 Conclusion and Recommendation

The design of automatize meat slicing machine has been successfully made. The main objectives of this project are fully accomplished where the machine has helped the company to reduce the number of workers in slicing the chicken meat manually, where the machine only requires one worker to operate AMS Machine.

There are few recommendations for the future researchers to innovate this design, where the thickness of the sliced meat may be varied and the position of the motor can be reviewed because the current location may lead to unbalanced to the machine. The sharp edges of the machine also can be take into account to make improvements to this design.

For the conclusion of this project, the production rate of the sliced meat also has been enhanced, where the current method used by the company can only produce 30 kg sliced meat within 1.5 hours, with the help of 3 workers against using the machine whereby the 30 kg sliced meat can be produced in only 30 minutes. The speed of production time also may lead to cut off the production time of the company. Productivity of slicing boneless chicken meat increased up to 3 times by using automatic methods against manual knife cutting. Therefore, the company fully capable to meet the demand of Burritos or Tortillas Wrap from Food Truck community. The company can actually save two main affected factors to the production rate, which are production time and the number of workers. At the same time the output quality of the sliced meat is much better since the cut is accurate 5 mm per slice and more even.

The creation of AMS machine shows that there is always be an alternative way to increase the productivity when we are capable and take the challenges to innovate the human-helpful-hand machine.

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