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MODELLING IMPACT OF CONTROL POINTS USING SIMULATION IN PROCESSING CHICKEN MEAT PRODUCE

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Abstract

Tracking and tracing the source and movement of food produce has become an interest of many researchers especially through the current pandemic. The interest has become global as consumers are still in doubt of source of food they consume and a knowledge on its movement can be a relief. This study is focused on the control points in producing consumable chicken meat to consumers. The objective of the study is to evaluate the existing track and trace system for consumable fresh meat, to identify and adapt control points (CP) into the track and trace system and to measure the performance of the proposed system especially on its impact to the producers. There are four main stages considered in the study which are farm, slaughterhouse, producing plants and transportation. The base data has been collected from a poultry company in Selangor, Malaysia and analysed using simulation approach. The results of the study imposed 20 proposed CPs throughout the four stages and comparable output from the simulation model. This study also highlighted on issues and challenges during the pandemic and recommended a few suggestions for future study.

Keywords: *Control, Points, Simulation, Track, Trace.*

INTRODUCTION

Recently, there has been a lot of discussion about unpleasant incidents caused by food such as food poisoning, chronic diseases due to unhealthy diet and more. This has resulted in a deeper awareness and need among the population, to ensure that the food eaten is clean and healthy and healthier. Among them is to find food that is certified halal because it is guaranteed safe, clean, nutritious quality and reliable to eat. This happens not only among the Muslim population but also among non -Muslims. Previous studies have also supported this phenomenon because poor nutrition and unhealthy conditions will contribute to modern diseases that result from what people eat every day in their lifestyle. This move can be viewed through the increasing demand for halal products in the market (The Star, 2016). The pandemic has also contributed to an increase in awareness among consumers about

the importance of consuming halal and hygienic food. It has also led to a blanket ban on wild animal trade and consumption (Asia Pacific Food Industry, Nov 2020).

In general, the halal food industry refers to segments related to the handling of food and beverage goods that comply with Islamic law, production, packaging, and marketing and other related processes. In Malaysia, there are a few principles related to processed food industries to be specific manufactural of grain-based foods, dairy products, food crops products, marine product, meat product, and cordial drinks (Noor et al, 2016). The definition of halal stated by Soong (2007), is not depending on the religion only but also about the cleanliness and purity. Similarly, halal users are not only focusing to the Muslim consumers but also the non-Muslims. The interest on halal food consumption also attracts the global food investors as they are now shifting their attention to halal food production and its delivery in order to gain a greater market share in the halal industry.

During the pandemic Covid 19, there were changes in the food supply chain system, and there was a risk of changing the status of halal to non-halal due to various sources (Wahyuni et al, 2021), despite the increase demand that can be an opportunity in ensuring the supply chain process in compliance to halal standard. Based on Moi et al (2016), the overall Muslim population is predicted to increase from 1.6 billion of every 2010 up to 2.2 billion individuals by 2030. 26.4 percent of 8.3 billion individuals of the total population in 2020 are Muslims and by 2050, the Muslim population is assessed to be approximately at 2.6 billion individuals and make up 30 percent of the total world population. The halal industry could survive the ravaging COVID-19 and still has the potential to be explored. Expectedly, it makes this occasion an assessment or benchmark to improve the Halal industry and lifestyle in the future (Hidayat et al., 2021).

In order to support the sustainability and validity of Halal food movement, there are a lot of innovation in tracking and tracing of the product. A few innovations in tracking and tracing of logistics include barcode, radio frequency identification (RFID), magnetic stripe, voice and vision systems, optical character recognition and biometrics. For an example, bar coding is used in the decision of identification, where the framework for the most part restrictive has their own tracking numbers. The tracking information is shared with the suppliers of the tracking and the customer through interfacing or organizing with the tracking framework. Figure 1 demonstrates the major outline of the tracking framework, where the coded item pass-through from base station to the end-customer through different distribution points. The information from each of distribution points focuses on fundamental tracking and tracing (Shamsuzzoha & Helo, 2011).

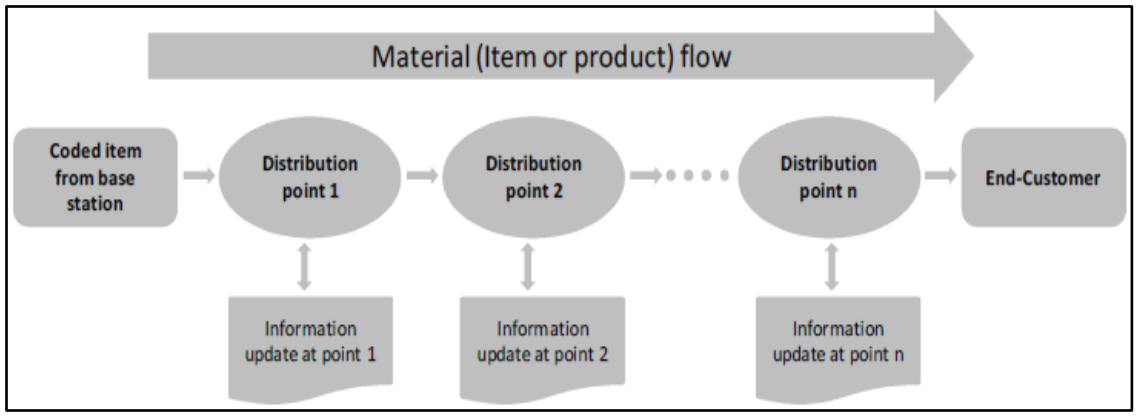


Figure 1: Basic tracking and tracing network

Track and trace in halal produce is of current interest globally as consumers are still doubting the label of halal of the product. Traceability is also known as the combination of track and trace in logistics, in which it has the ability to track the food item through its processing stages until the storage and its distribution to the end consumers. The system is readily available for many products however, the same system that tracks and ensures

that the halal products remain halal throughout its movement from supplier to customer is not yet established and create more interest among the researchers. Tan et al., (2020) applied the idea of blockchain in Halal food traceability in the concept of smart contracts. In this case, smart contracts can be set up at critical points along the Halal supply chain namely the farming stage, food production stage and storage stage. The farming stage is critical within the Halal supply chain since it is at the beginning of the Halal process of any food products (Mohzal and Shariff, 2019). RFID or sensors (translated into QR code) is tagged to animals breeds at every point of farming stage with information obtained being based on their origin, breed, animal type and feed. The QR code structure continues to be tagged at the next stage even at the slaughter house and proceeded to being processes into different parts. Similarly, Tan et al., (2020) has proposed a consortium Block Chain for halal supply chain in Figure 2 that is powered by Control Tower – a unified visualisation layer that combines data from traditionally siloed functions into an insights-driven decision-making platform.

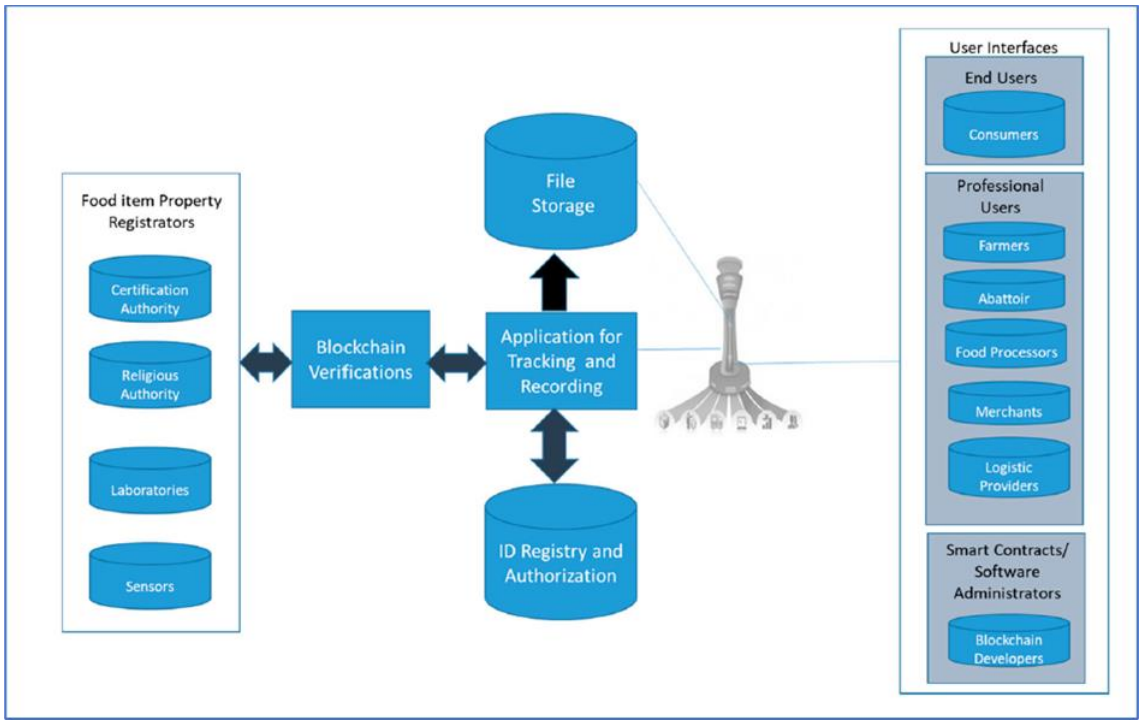


Figure 2: Consortium Blockchain for Halal food supply chain (Tan et al., 2020).

On the other hand, as Ali et al. (2021) gathered ideas that firms are now more inclined towards being sustainable and socially responsible and Halal production is regarded as sustainable because of its specific processes. In addition, not all of the food parameters can be monitored using analytical methods (Kamilaris et al., 2019). Even if proper information input is available when blockchain technology is adopted, the process is still tedious, exhaustive, and costly for SMEs in the halal food SC (Wong et al., 2020). The conflicting ideas and findings trigger this study on the importance of collecting data at the Critical Control Points (CCP) along the chain to determine the strength of the traceability system and its decision-making capability. Therefore, this study proposes some steps that involved collecting data at the CCP in tracking the halal produce and how to evaluate the performance of the process once it is being put into consideration.

Halal chicken meat production

In Malaysia, the production of Halal fresh meat such as chicken meat is guided by the Malaysian Protocol for the Halal Meat and Poultry Production developed by the Department of Islamic Development Malaysia (JAKIM). This protocol is used together with Malaysian

Standard MS 1500-2009 on Halal Food- Production, Preparation, Handling and Storage and MS 2400-2010 on Halalan Toyyiban Assurance Pipeline (Department of Standards Malaysia, 2009 & 2010). As mentioned earlier, in the integrated Halal supply chain, there are many processes along which the Halal compliance need to be checked and reassured. The points are referred as Halal Control Points (HCP). The HCPs for poultry processing have been identified and proposed in several studies (Chaudry & Riaz, 2004; Shahdan et al., 2016). In this study, the proposed HCPs are compared and summarised. At the same time, some new HCPs are proposed to ensure that the movement of the chicken meat along the supply chain is Halal compliance.

There are some challenges in the Halal Supply Chain not only in production, transportation but also in breeding. Among which is the Halal product segregation from the non-Halal during the transportation as well as storage (Mohamed et al., 2016; Yener, 2016; Kadir et al., 2016, Ramli et al., 2020). The process of traceability leads to the challenges faces by the manufacturer or producers in maintaining the halal status of the product until reach the end consumers. Halal products such as fresh chicken meat, particularly those without the proper packaging, are very vulnerable and have the highest risk to be contaminated if it is not handled separately during the production, transportation and storage activities. In this study, a performance of Halal chicken meat tracking system is measured in order to estimate the effect of HCPs in the production volume.

METHODOLOGY

There are two objectives in this study which are to re-confirm on HCPs for Halal chicken meat and to measure the performance of the tracking system when HCPs are applied. Hence, the first objective is met by summarizing findings from the previous studies as well as a visit to the poultry farm and the slaughter house. A poultry farm is identified as a starting point of data for adapting the tracking system. An interview with the persons in charge was done in order to get a more concrete ideas about the actual process. At the same time, primary data on the unit of analysis as well as the production volume at each process is collected, in order to achieve the second objective. The data collection process was done at both places, since first week of October 2020 until December 2020 for more recent updates. The whole tracking system is simulated from the initial point at the poultry farm until the chicken has been cut into several parts for distribution, and the performance of the system is measured. For the simulation purposed, daily data are accumulated in several days, 7, 15, 30 and 100 days for consistency.

RESULTS AND DISCUSSION

Based on the literature, the flow consists of 4 stages which are farm, slaughterhouse, processing plants and transportation. The flow has 6 elements in total, which is further divided into 4 stages where HCPs should be detected. The first stage is located at the farm comprises of breeding farm, hatchery and growing farms. The second stage is located at the slaughterhouse which includes the slaughtering process and the third stage is at the processing plant; and last stage is for transportation or distribution to end customers. Figure 3 summarises the findings.

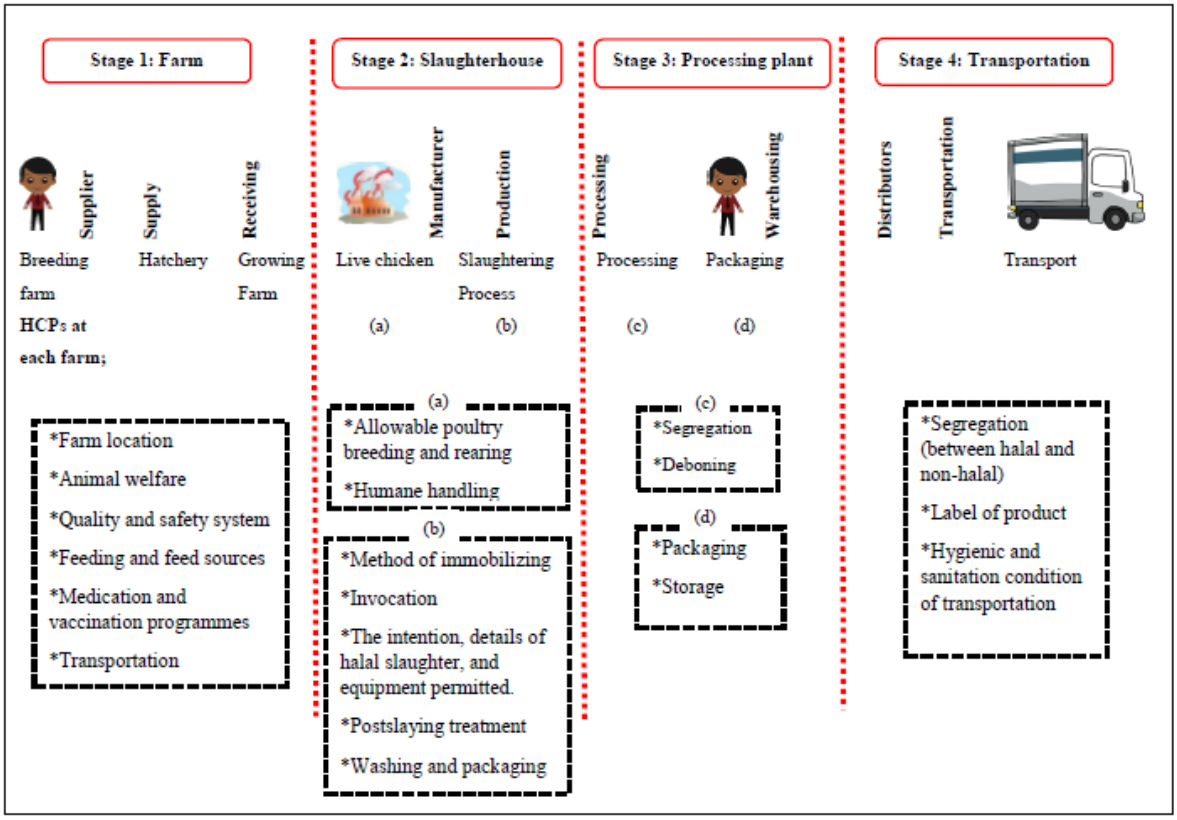
Phase 1: Data Collection

The first data collected is from the breeding farm, where the production of the fertilised eggs occur. The data collected from the farm is the number of fertilised eggs to the hatching unit which are delivered 4 times a day. According to the farm's manager, the delivery of the eggs depends on the production target for a day which is more than 5,184 eggs. The second data collected at hatching unit which includes rejected chicks, hatch chicks and total of chicks delivered to growing farm. Note that the eggs that being delivered from breeding farm will not be the same as the number of chicks that hatch within the day. Chicken eggs hatch after approximately 21 days of incubation, but within a single batch there may be a gap of 24-48 hours from the first to tlhe last hatching, corresponding to 5–10% of embryonic

development (Løtvedt & Jensen, 2014). The delivery of chicks depends on the hatching of eggs and as chicks hatch it will be delivered on that day to the growing farm. Hatchery unit expected quantity of about 80 chicks per box. The delivery will be made around 240 boxes per day or approximately 19,200 chicks. Eventually not all eggs can be delivered due to several factors such as death, non-hatch and handicap. The rate of rejected chicks at hatchery unit is calculated as follows:

$$=1,589/172,800 \text{ X } 100=0.920\%$$

Figure 3: HCPs in halal traceability system (* indicates the HCPs)



Source : Mohzal and Shariff, 2019

The rate of rejected chicks in the hatching unit is about 0.920% that occurs from chick abnormalities. According to Iqbal et al. (2016) stated that fertility and hatchability of flock depends on the age of breeder hen, as the age of breeder hen increases the fertility rate reduces and the hatchability of hen itself. Based on the observation, the hatching success rate with normalities is about 99.080% which shows a high rate of hatching compared to the study done by The Flip Flop Ranch (2014) which stated that human success rates for incubating eggs is about 80% while hens are at 90%.

Since, the hatchery unit uses the incubation system with the suitable temperature of hen while incubating the eggs and the rate of the unit is almost the same with the rate incubate by hen. According to Boleli et al. (2016), maintaining constant eggshell temperature at 37.5-38.0 °C throughout incubation period promotes high hatchability and good chick quality. Hence, the optimum temperature of the incubation room for the hatchery unit is about 37.5°C which is found at the place of this study. Constant eggshell temperature during incubation results from a balance between embryo or fetus heat production and heat transfer between the egg and the environment. Hence, the rate of the hatching eggs in the hatching unit is still showing a higher success rate approaching 100% at 99.080%.

The next data is collected at *growing farm* which includes the number of chicks entering the farm to grow, the number of chicken die while growing and the number of matured chickens being delivered to the slaughterhouse. The collected data are chicken's weight per box, total chicken delivered and date of delivery. In this growing farm, chicken breed until it reaches the matured weight around 1.6 kg to 1.9 kg per chicken. This usually takes from 2 to 6 months (60 days to 180 days). Each box of chickens weighs around 16 to 19 kg, and the number of chickens per box about 10 chickens. The total delivery of chickens for slaughtering within 2 weeks is about 76,390 chickens with average delivery 5,456 chickens.

At the slaughterhouse, the data is collected at two locations: at the receiving area and the slaughterhouse itself. This is to calculate the rate of rejected due to unfulfilled Halal compliance during the slaughtering process. Data is collected in the first two weeks in October 2018 and October 2020 during the pandemic Covid 19. Hence, the rate percentage of rejected chicken is calculated as follows:

$$\frac{\text{Number of chicken enter} - \text{number of chicken to be slaughtered (in kg)}}{\text{Number of chicken enter}}$$

$$= \frac{63}{76{,}390} \text{ X } 100 = 0.0825\%$$

The percentage of rejected chicken is about 0.0825% which that approaching to 1 percent. The rejected chicken referring to the chicken that fail to fulfil the element needed in Halal slaughtering, such as the tract is not properly cut, or the chicken neck is fully cut. A fully cut of chicken neck is considered as *makruh*, as the governed body such as JAKIM has rejected to consider *makruh* status to be Halal, in order to ensure that the meat is safe to be consumed. Among all the HCPs, this stage is the highest critical point. The rate of proper slaughter is calculated as follows:

$$\frac{\text{Total Number of chicken properly slaughtered (in kg)}}{\text{Number of chicken to be slaughtered}}$$

$$= \frac{76{,}327}{76{,}390} \text{ X } 100 = 99.918\%$$

The percentage of proper slaughter checked by the halal checker shows a high percent with 99.918 %, which it is close to 100%. The result shows that the organisation in this study is very committed in maintaining the halal status of their products through the training of slaughtermen and the quality.

In the *processing plants*, the parameters involved in data collection process are the number of chickens enter the processing plant and the number of rejected chickens. Since, the chickens are delivered every day at the receiving area, hence the chickens will be processed on the same day and get delivered to the consumer. The chickens are rejected in processing plants due to two reasons:

i. Drop from line (while being processed)

$$\frac{\text{Number of chicken drop from line}}{\text{Total number of chicken entered the processing plant}} = \frac{10}{76{,}327} \text{ X } 100 = 0.013\%$$

ii. Disease check

$$\frac{\text{Number of chicken with disease}}{\text{Total number of chicken entered the processing plant}} = \frac{51}{76{,}327} \text{ X } 100 = 0.067\%$$

During the processing plants, there is low percentage of the chickens might be dropped from the line and it happens due to dislocated of chickens at the machine. According to the person in charge, chickens that are already drop from the line will be removed and will not be processed in order to maintain the quality of the chicken.

Moreover, the rejection during disease check is based on a few factors such as purple like spot at the joint. Rate of rejection during disease check shows lower percentage with 0.067% which can show that company does provide a suitable vaccination and medication programmes to the chicken thorough growth process in order to reduce disease and increase immunity, to maintain the quality of chicken. We can conclude that, the company has a good processing plants system in order to reduce the rate of rejection. Hence, the rate of process chicken for two weeks is calculated below;

$$\frac{\text{Total number of processed chicken}}{\text{Total number of chicken entered the processing plant}} = \frac{76{,}266}{76{,}327} \text{ X } 100 = 99.920\%$$

Phase 2: Simulation Analysis

Simulation modelling usually involves in management plan formulation in considering the impacts of decisions on the management of a system (Banomyong & Sopadang, 2010). The simulation model is to analyse the effect of how much halal compliance activity affect the productivity volume. For the halal chicken meat produce, the model also comes under a constant re-evolution as suggested by Banomyong and Sopadang (2010) for emergency response model. This is because if produced chicken does not match requirements then it is the duty of the responsible unit to further procure and respond to the need of customers.

Step 1: Identification of Parameter

Table 1 shows parameters to be used in the simulation model.

Table 1: Parameter of proposed halal chicken model

Activity	Timeline
Information on demand	Not available (not within the scope of study)
Coordination mechanism	Not available
Physical flow	
Farm	Within 76 days which includes 2 days in cold room after laying
Slaughterhouse	Within 12 hours
Processing plant	Within 7 hours
Transportation	Ready for delivery

Step 2: Number of Simulation Runs

The number of simulation run should be based on number of days, because all the activities are done in daily basis. Hence, simulated output should be run on several numbers: 7 days, 15 days, 30 days, 100 days and 300 days.

Step 3: Compilation of Stimulated Output

Table 2 shows the production output of Halal chicken after being simulated for 7 days. The rate in the breeding farm shows the full percentage with 100 % since it is the starting points in process. While, for hatching unit is about 99.080% and the failure rate is 0.920. The percentage at the hatching unit remain the same as it approaches growing farm and there is no failure rate shown due to limitation in collection of data. Besides, the delivery of the chicken to the slaughterhouse depends on the age and weight and on random selection. As it approaches second stage which is the slaughterhouse, the output shows 99.918% with failure rate is about 0.0825 which referring to the improper slaughtering and fully cut of the chicken neck. Lastly, the third stage is at the processing plant where the result shows 99.836% and the failure rate is about 0.080 due to "drop from line" or disease. The result shows that 98.918% of the chickens that went through the HCPs are Halal and safe to consume. The result also implies that by tracking the production and ensuring the halal compliance, the end production volume only decreases by 1.08% and consistent with results in 2018.

The percentage shows a good performance from the company in managing the halal chicken meat, which shows lower failure rate in each stage. The rate of failure may cause from the environment issues and failure in machine.

Table 2: Stimulated output

Input	**Stage 1: Breeding Farm**	**Hatching unit**	**Growing Farm**	**Stage 2: Slaughter Hour**	**Stage 3: Processing Unit**
Day 1		0.0092		0.00789	0.0700
Day 2		0.0090		0.0840	0.0770
Day 3		0.0091		0.08870	0.0800
Day 4		0.0089		0.0835	0.0790
Day 5		0.0110		0.0824	0.0810
Day 6		0.0088		0.0810	0.0820
Day 7		0.0089		0.0810	0.0840
Average Failure Rate		0.0093		0.0825	0.0791
Standard Deviation		0.0008		0.0026	0.0045
Average 7 days		99.08%	99.08%	100.0%	**98.92%**

For validity of the results, the data were collected for the duration of 100 days (until December 2020) and simulated for the traceability process. Table 3 summarises the results and shows that the final output in 2020 actually reduced to 93.99% as compared to that in 2018. From the simulation, it can be seen that there is a potential drop in the total volume of Halal produce during the pandemic but still within acceptable level of only less than 5 percent reduction.

Table 3: Compilation of simulated output decision making

Input	**Stage 1**			**Stage 2**	**Stage 3**
	Breeding Farm	Hatching unit	Growing Farm	Slaughter House	Processing Plant
7-days	100.00%	99.08%	99.08%	100.00%	98.92%
15 days	100.00%		99.01%	91.80%	92.36%
30 days	100.00%		99.04%	91.75%	91.94%
100 days	100.00%		99.11%	91.92%	92.75%
Failure Rate	0.0%	0.92%		0.0825%	0.08%

Final Output	**93.99%**
Final Output in 2018	98.918%
Difference	-4.928%

CONCLUSION & DISCUSSION

The performance of the propose system is measured through the application of simulation model. The model then be called proposed halal chicken produce model which explaining about the output gain from the starting stages until ready to be delivered to the customer. From the results, we can conclude that the production of halal chicken meat is quite good plus the company does follow the proposed halal control points. Lastly, the company can implement the proposed halal chicken produce model in the future for producing a better quality of halal product and also applied the proposed halal control points. This simulation model may provide huge contribution for logistics sectors in maintaining the halal status of products. There are many studies that have been done these kinds of research to help muslim and non-muslim to felt safe in consuming the product. The halal status not only for the muslim people, the non-muslim people also enjoying the product of halal because it is about the cleanliness and purity.

Other than the method applied, Traceable Resource Unit (TRU) also can be applied. TRU usually embark in industrial application which referring to batch during the production. TRU is a unique unit from the traceability perspective but in the event of a continuous process, it depends on the raw material TRUs or processing conditions. It is also recommended that a questionnaire to be distributed to the logistics companies about their knowledge and opinion in maintaining the halal status. Instead of method and technique applied, the application of advanced technology also can provide huge contribution in halal logistics.

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