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Simulating the Track and Trace of Halal Chicken Meat Produce

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Abstract

Track and trace in halal are globally used all over the world, and consumer still doubted about the halal status of the product in the market. The study focused on the halal critical points (HCP) in producing halal chicken meat to consumers. The objective of the study is to evaluate the existing track and trace system for halal fresh meat, to identify and adapt HCPs into the track and trace system and to measure the performance of the proposed system. There are four main stages considered in the study which are farm, slaughterhouse, producing plants and transportation. The data has been collected from a poultry company in Selangor, Malaysia. The method used throughout the study is literature search, in-depth interview, documentary analysis and simulation analysis. The results of the study state that there are 20 proposed HCPs from the literature search which based on four stages and the simulation model shows positivity in the output by using the proposed track and trace system for halal chicken produce. This study has also suggested a few recommendations for future study.

Keywords: Halal Critical Points; Simulation; Track and Trace

Introduction

Recently, there are many discussions on incidents related to the causes of food poisoning due to unhealthy diet. This creates awareness and more interest among the population to look for healthier way of consuming food. Among which is the movement toward halal food because it is guaranteed for being safe, clean, nutritious of quality and reliable to be consumed. Poor nutrition and unhealthy conditions contributing to modern ill health are the adverse effects of what the public or community consume almost daily in their lifestyle. This move can be viewed through the increasing demand for halal products in the market (The Star, 2016). In general, halal food industry refers to the segment associated with the handling of food and drink items that comply to Islamic law as far as sources of information, production process, packaging, and marketing. In Malaysia, there are a few principles related to processed food industries to be specific manufacturer 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 on the Muslim consumers but also the non-Muslims. The interest on halal food consumption also attract 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.

The increase in demand can be an opportunity in

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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 in 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 makes up 30 percent of the total world population.

There are many processes in supply chain in which include production, transportation, customer services and warehousing. Wallace et al. (2018) stated that supply chain for food is defined as the manufacturing processes of consumable food from the raw ingredients until it gets to the consumers. As stated by Usman et al (2017) a fully integrated supply chain is needed to synchronize both inbound and outbound logistics in maintaining product information and ensuring the halal status from farm (raw materials) to fork (customers). The traceability system that has both forward and backward of product information should be the concept of traceability in halal food supply chain. This paper aims to identify and analyse the entities and the processes to develop halal food traceability system model by augmenting its system to cover the whole logistic activities through its supply chain.

There is an innovation in tracking and tracing of 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 example, bar coding is used in the decision of identification, where the framework for the most restrictive part has their own tracking numbers. The tracking information is shared with both the suppliers and the customers 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 the distribution points focuses on fundamental tracking and tracing (Shamsuzzoha & Helo, 2011).

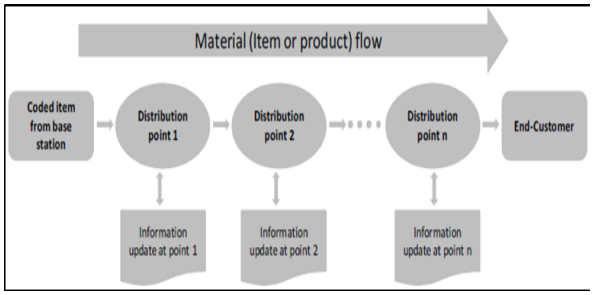

Figure 1: Basic tracking and tracing network

Track and trace in halal product is of current interest globally as consumers are still doubting the label of halal of the product (Zailani et al; 2010; Bahrudin et al.;2011 and Mohamed et al.; 2016). 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. Therefore, this study proposes some steps needed in tracking the halal produce and how to evaluate the performance of the process once it is being put into consideration.

Halal logistics is referred to the use of the halalan-toyyiban principles along with supply chain activities, which includes from the source of supply, storage, transportation, manufacturing, taking handling, and distributing. This implies the halal items should not be mixed together with the non-halal items through the logistics movement in sustaining the halal status (Jaafar et al., 2013).

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

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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 (which now has been revised to MS1500:2019 Halal Food – General Requirements (Third Revision) 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). 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, the 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. A poultry farm is identified as a source of data for adapting the tracking system. An interview with the person 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 whole tracking system is simulated and measured.

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 2 summarises the findings.

Phase 1: Data Collection

Data is first collected 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 daily target of production which are more than 5,184 eggs, approximately equal for a buggy of 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

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from the first to the last hatching, corresponding to 5–10% of embryonic development (Løtvedt & Jensen, 2014). The delivery of chicks depends on the volume of hatched eggs. Once a chick hatches, it will be delivered on the same day to the growing farm. The chicks will be put in boxes during delivery. The hatchery unit uses a quantity of about 80 chicks per box. The delivery made is 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 (based on the number of chicks rejected versus the total number of chicks hatched during the day) at hatchery unit is calculated as follows:

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

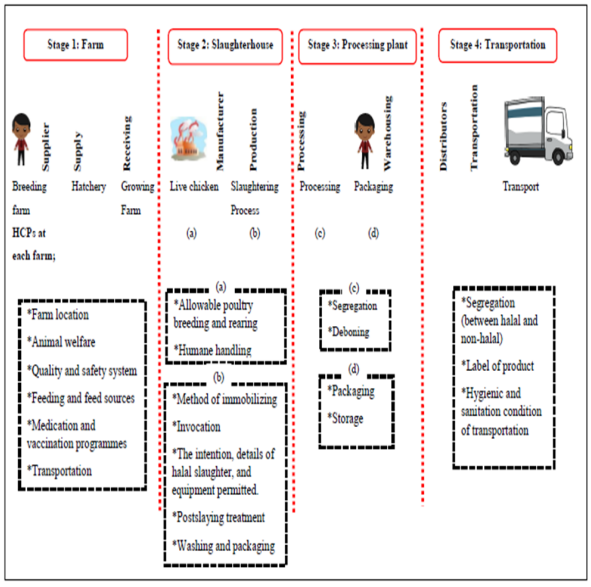

Figure 2: HCPs in halal traceability system (* indicates the HCPs)

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. We can assume that, the incubation system in the hatchery unit built with suitable temperature to ensure the hatching process run smoothly as the temperature of the incubation room also plays a role in ensuring the hatching rate approaching to success rate. 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

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the rate of rejected due to unfulfilled Halal compliance during the slaughtering process. Data is collected in the first two weeks in October 2018. Hence, the rate percentage of rejected chicken is calculated as follows:

(Number of chicken enter-number of chicken to be slaughtered (in kg))/(Number of chicken enter)

63/76,390 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:

76,327/76,390 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:

Drop from line (while being processed)

(Number of chicken drop from line)/(Total number of chicken entered the processing plant) = 10/76,327 X 100
= 0.013%

Disease check

(Number of chicken with disease)/(Total number of chicken entered the processing plant)=51/76,327 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;

Put the title of formulation

(Total number of processed chicken)/(Total number of chicken entered the processing plant) x100
=76,266/76,327 X 100
= 99.920%

Phase 2: Simulation Analysis

Simulation modelling usually involves in

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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. For this study, number of simulation run is for 7 days, this is because the maximum data available is 7 days for breeding farm.

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%.

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.

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Table 2: Stimulated output

Input	Stage 1			Stage 2	Stage 3
	Breeding Farm	Hatching Unit	Growing Farm	Slaughter House	Processing Plant
Day 1		0.0092		0.0789	0.0700
Day 2		0.0090		0.0840	0.0770
Day 3		0.0091		0.0870	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	NA	0.0825	0.0790
Standard Deviation		0.0008		0.0026	0.0045
Average 7-Days	100%	99.08%	99.08%	100.00%	**98.92%**

Conclusion

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 it is ready to be delivered to the customer. From the results, we can conclude that the production of halal chicken meat is 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 the 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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