Halal Risk Analysis at Indonesia Slaughterhouses Using the Supply Chain Operations Reference (SCOR) and House of Risk (HOR) Methods

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Abstract. The Halal supply chain is one of the most important factors for Muslim because the product to be consumed must be halal, from the source to the end consumers. This research was conducted at several feedlots (fattening cattle), slaughterhouses (RPH), and traditional markets in the city of Medan and surrounding areas. In this study identified all activities in the slaughterhouse, activity mapping, determination of risk events, risk agents, and Aggregate Risk Potential (ARP) calculations in the red meat supply chain with the adoption of the SCOR model namely plan, source, make, deliver, and return and HOR (House of Risk). The results showed that there were 19 activities (sub-processes), 28 risk events and 28 risk agents. The selected risk agents based on the five highest ARP values are less cleaned floor after slaughtering (Ag17), the accumulation of blood into clots (Ag20), lack of machine maintenance management (Ag2), too many cattle to be slaughtered (Ag3), and increased consumer demand (Ag1). Knowing the risks and causes of risks will facilitate handling so that supply chain performance can be improved. It is necessary to study appropriate risk mitigation actions so that risk events can be reduced.

1. Introduction
A supply chain is a concept where there is a regulatory system related to product flow, information flow, and financial flow. This arrangement is important to do with the number of links involved in the red meat supply chain and the price is relatively high when compared to other livestock commodity yields [1]. A complex supply chain structure that involves many parties, both internal and external, can cause problems if the company does not know the extent to which supply chain performance has been achieved. A well-managed supply chain can produce cheap, quality, and timely products so that the target market is met and can generate profits for the company [2].

Halal is the main requirement for Muslim in consuming food products. There is a halal guarantee to be added value in the competition of the food industry today. A halal guarantee is not only needed for the final product but also at every stage of the supply chain. This can be assessed by consumers through halal traceability of a product or commodity. Halal traceability in the supply chain of a commodity makes consumers aware of the halal status of the products they consume [3].
The Halal supply chain is a supply chain network, starting from the preparation and enforcement of halal materials for production and delivering final products to customers following Sharia law. The concept of a halal supply chain is to maintain the integrity of halal food and ensure that the food is Tayyip. The Halal supply chain also avoids direct contact with haram goods, manages cross-contamination between halal and haram goods, pays attention to special facilities for halal products, and ensures supply chain management is in line with the perception of Muslim consumers [4].

Halal guarantee system is a management system developed, implemented and maintained by a halal certificate holder company to maintain the continuity of the halal production process following the provisions of LPPOM MUI. There are 12 halal guarantee system criteria, namely: Halal policy, halal management team, training and education, materials, products, written procedures for critical activities, traceability, handling of products that do not meet criteria, internal audit, management review, and food safety [5]. Halal supply chain management is halal network management to expand the integrity of halal from the source to the point of purchase of consumers. Halal supply chain covers all activities such as product coordination, inventory, location and transportation used along the supply chain. When the process of slaughtering, Muslim slaughter must use a knife (equipment) that is sharp following Islamic law [6].

The principles in halal logistics function to create a global halal logistics system, minimize difficulties for the halal industry, define cross-contamination between halal and haram and how to avoid them that need to be considered in supply chain management [7]. Previous research by Cahya Kusnida, et al, regarding risk management in the supply chain concluded that risk identification can be done using the Supply Chain Operations Reference (SCOR) model by determining risk events and risk agents to get the Aggregate Risk Potential (ARP) [8].

SCOR divides supply chain processes into 5 core processes, namely plan (the process of balancing demand and supply), source (the process of procuring goods or services to meet demand), make (the process to transform raw materials/components into products the customer wants), deliver is a process to fulfill the demand for goods or services, including order management, transportation, and distribution and return (the process of returning or receiving product returns for various reasons) [9].

In this research, identification of the causes of contamination risk to halal products is done by taking the SCOR (Supply Chain Operations Reference) and HOR (House of Risk) approaches so that red meat supply chain performance can be improved.

2. Methodology
This research was conducted in 3 Slaughterhouses in Medan and surrounding areas. The research carried out is an analysis of the activity and risk of contamination that can cause obstructions to slaughtered cattle. The object observed was the activities and working environment conditions at the slaughterhouse. Information needed to be obtained from leaders, employees, and workers on the production floor of 3 Slaughterhouses in Medan and surrounding areas. The steps in data collection and processing are:

1. Observation of all activities and working environment conditions at the slaughterhouses
2. Mapping the slaughterhouses activity using the SCOR model (plan, source, make, deliver, return)
3. Classification and assessment of risk events
4. Classification and assessment of risk agents
5. House of risk I [9]

Rp calculation is done by the following formula: Rp = Oj Σ Si Rsj

Where:
Rp: Aggregate Risk Potential
Oj: Occurrence
Si: Severity
Rsj: Relationship
3. Results and Discussions
The first stage carried out in this study is to map the activities of slaughterhouses based on the SCOR (Supply Chain Operations Reference) model that can assist in determining the supply chain sequence from the planning, sourcing, making, delivering and returning stage. The results of mapping activities based on the SCOR model can be seen in Figure 1.

Figure 1. Activity Mapping Based On SCOR Model

The events that could disrupt activities of the supply chain are called risk events. Risk events are obtained from observation of slaughtering activities and interviews which are then coded using the “Ev”. The risk event assessment is carried out by giving a severity score to the form. The classification and assessment of risk events in slaughterhouses can be seen in Table 1.

Table 1. Classification and Value Assessment of Risk Event in Slaughterhouses

| Risk Event                                                                 | Code | Severity |
|----------------------------------------------------------------------------|------|----------|
| Sudden cattle demand                                                      | Ev₁  | 3        |
| Damage to the engine and equipment during the slaughtering                | Ev₂  | 7        |
| Changes to the slaughter system                                           | Ev₃  | 3        |
| Change in the cutting area                                                | Ev₄  | 4        |
| Error in red meat delivery plan                                           | Ev₅  | 4        |
| Error in Delivery Order number                                           | Ev₆  | 4        |
| Great distance between feedlots and slaughterhouses                       | Ev₇  | 5        |
| Lateness delivery of cattle from feedlot to slaughterhouses               | Ev₈  | 4        |
An agent that can cause a risk event to occur is called a risk agent. Risk agents are obtained from observation and interviews which are then coded using “Ag”. Risk agent assessment is done by giving the occurrence value on the form. The classification and assessment of risk agents in slaughterhouses as in Table 2.

### Table 2. Risk Agent Classification and Assessment in Slaughterhouses

| Risk Agent                                                | Code  | Occurrence |
|-----------------------------------------------------------|-------|------------|
| Increased consumer demand                                 | Ag1   | 4          |
| Lack of machine maintenance management                    | Ag2   | 7          |
| Too many cattle to be slaughtered                          | Ag3   | 4          |
| Insufficient cutting area                                 | Ag4   | 4          |
| Lack of coordination                                      | Ag5   | 5          |
| Lack of checker’s accuracy                                | Ag6   | 4          |
| Feedlot location is far away from slaughterhouses          | Ag7   | 6          |
| There is interference with the conveyance                  | Ag8   | 3          |
| Lack of communication                                     | Ag9   | 4          |
| Inaccurate checking in the reception                       | Ag10  | 5          |
| Lack of accuracy in cattle transport drivers               | Ag11  | 2          |
| Fatigue in cattle due to a fairly long trip                | Ag12  | 6          |
| Too long stored in a cage                                 | Ag13  | 5          |
| Slaughter knives are less sharp                            | Ag14  | 1          |
| The lateness of the slaughterer                            | Ag15  | 5          |
| Lack of slaughterer with halal certification               | Ag16  | 2          |
| Less cleaned floor after slaughtering                      | Ag17  | 7          |
| Less skilled red meat cutting operator                    | Ag18  | 5          |
| The innards are not cleaned properly                      | Ag19  | 4          |
| The accumulation of blood becomes clots                   | Ag20  | 7          |
Limited transportation containers  \( Ag_{21} \)  \( \text{5} \)
Less precise transport operator  \( Ag_{22} \)  \( \text{4} \)
Interference during travel  \( Ag_{23} \)  \( \text{4} \)
Late to slaughter  \( Ag_{24} \)  \( \text{3} \)
Distributor/ carrier not yet certified halal  \( Ag_{25} \)  \( \text{5} \)
Lack of coordination  \( Ag_{26} \)  \( \text{5} \)
Limited transportation  \( Ag_{27} \)  \( \text{4} \)
The conveyance is broken  \( Ag_{28} \)  \( \text{4} \)

In Phase I, House of Risk is used to determine which risk agents are prioritized and then mitigation actions are planned as shown in Table 3 and Table 4. In the House of risk phase I, each risk event looks at the level of relationship with the risk agent and is given a value of 1 (level of relationship low), 3 (medium relationship level), and 9 (high relationship level).

### Table 3. House of Risk Phase I: A1-A14

| Business Processes | Risk Event | Risk Agent | Sev. |
|--------------------|------------|------------|------|
| Plan  | Ev1 | 3 | 1 | 1 | 3 | 3 |
|  | Ev2 | 1 | 9 | 3 | 1 | 1 | 7 |
|  | Ev3 | 3 | 3 | 1 | 1 | 3 |
|  | Ev4 | 3 | 3 | 3 | 1 | 1 | 4 |
|  | Ev5 | 1 | 1 | 1 | 1 | 1 | 1 | 4 |
|  | Ev6 | 1 | 1 | 1 | 1 | 1 | 1 | 4 |
| Source | Ev7 | 1 | 3 | 1 | 1 | 3 | 5 |
|  | Ev8 | 1 | 3 | 1 | 1 | 1 | 4 |
|  | Ev9 | 1 | 1 | 1 | 2 |
|  | Ev10 | 1 | 3 | 1 | 3 | 3 |
|  | Ev11 | 1 | 1 | 1 | 2 |
|  | Ev12 | 1 | 1 | 3 | 4 |
|  | Ev13 | 1 | 1 | 1 | 4 |
| Make  | Ev14 | 1 | 3 | 1 | 2 |
|  | Ev15 | 1 | 3 | 1 | 4 |
|  | Ev16 | 1 | 1 | 1 | 2 |
|  | Ev17 | 1 | 3 | 7 |
|  | Ev18 | 1 | 1 | 3 |
|  | Ev19 | 1 | 1 | 4 |
|  | Ev20 | 1 | 3 | 7 |
|  | Ev21 | 1 | 1 | 5 |
| Deliver | Ev22 | 1 | 1 | 1 | 1 | 4 |
|  | Ev23 | 1 | 1 | 3 | 1 | 4 |
|  | Ev24 | 1 | 1 | 1 | 4 |
| Return  | Ev25 | 1 | 3 |
|  | Ev26 | 1 | 3 |
| Occurrence  | 4 | 7 | 4 | 4 | 5 | 4 | 6 | 3 | 4 | 5 | 2 | 6 | 5 | 1 |
| Aggregate Risk Potential  | 372 | 525 | 512 | 96 | 245 | 100 | 186 | 39 | 220 | 85 | 48 | 162 | 20 | 8 |
| Peringkat Potensial  | 5 | 3 | 4 | 13 | 6 | 12 | 9 | 22 | 8 | 16 | 20 | 10 | 25 | 28 |
### Table 4. House of Risk Phase I: A15-A28

| Business Processes | Risk Event | Risk Agent | Sev. |
|-------------------|------------|------------|------|
|                   |            | Ag15       | Ag16 | Ag17 | Ag18 | Ag19 | Ag20 | Ag21 | Ag22 | Ag23 | Ag24 | Ag25 | Ag26 | Ag27 | Ag28 |
| Plan              | Ev1        | 1          | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
|                   | Ev2        | 1          | 1    |      | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
|                   | Ev3        | 1          | 1    |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev4        | 1          |      | 1    |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev5        | 1          |      | 1    |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev6        | 1          |      |      | 1    |      |      |      |      |      |      |      |      |      |      |
| Source            | Ev7        | 1          | 1    |      | 1    |      |      |      |      |      |      |      |      |      |      |
|                   | Ev8        | 1          | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |
|                   | Ev9        | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev10       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev11       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev12       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev13       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Make              | Ev14       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev15       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev16       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev17       | 9          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev18       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev19       | 3          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev20       | 9          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev21       | 9          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Deliver           | Ev22       | 3          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev23       | 3          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev24       | 3          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev25       | 3          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev26       | 3          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Return            | Ev17       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                   | Ev18       | 1          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Occurrence        |            |            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Aggregate Risk Potential | 50 | 16 | 882 | 15 | 60 | 609 | 130 | 32 | 88 | 24 | 95 | 225 | 56 | 76 |
| Peringkat Potensial | 21 | 26 | 1 | 27 | 18 | 2 | 11 | 23 | 15 | 24 | 14 | 7 | 19 | 17 |

ARP values are sorted from largest to smallest and risk agent handling priorities are chosen using the Pareto concept as shown in Figure 2.

![Figure 2. Pareto ARP Risk Agent Diagram](image-url)
Details of the Pareto diagram above can be seen in Table 5. In Table 5 can be seen that the highest risk agent is Ag17 (17.76%) and the lowest is Ag14 (0.16%).

| Risk Agent | ARP | Rank | Percentase | Kumulatif |
|------------|-----|------|------------|-----------|
| Ag17       | 882 | 1    | 17.76%     | 17.76%    |
| Ag20       | 609 | 2    | 12.26%     | 30.02%    |
| Ag12       | 525 | 3    | 10.57%     | 40.60%    |
| Ag11       | 512 | 4    | 10.31%     | 50.91%    |
| Ag7        | 372 | 5    | 7.49%      | 58.40%    |
| Ag6        | 245 | 6    | 4.93%      | 63.33%    |
| Ag25       | 225 | 7    | 4.53%      | 67.86%    |
| Ag9        | 220 | 8    | 4.43%      | 72.29%    |
| Ag12       | 186 | 9    | 3.75%      | 76.04%    |
| Ag11       | 162 | 10   | 3.26%      | 79.30%    |
| Ag21       | 130 | 11   | 2.62%      | 81.92%    |
| Ag6        | 100 | 12   | 2.01%      | 83.93%    |
| Ag4        | 96  | 13   | 1.93%      | 85.86%    |
| Ag25       | 95  | 14   | 1.91%      | 87.78%    |
| Ag23       | 88  | 15   | 1.77%      | 89.55%    |
| Ag10       | 85  | 16   | 1.71%      | 91.26%    |
| Ag28       | 76  | 17   | 1.53%      | 92.79%    |
| Ag9        | 60  | 18   | 1.21%      | 94.00%    |
| Ag7        | 56  | 19   | 1.13%      | 95.13%    |
| Ag11       | 48  | 20   | 0.97%      | 96.09%    |
| Ag15       | 40  | 21   | 0.81%      | 96.90%    |
| Ag8        | 39  | 22   | 0.79%      | 97.68%    |
| Ag22       | 32  | 23   | 0.64%      | 98.33%    |
| Ag24       | 24  | 24   | 0.48%      | 98.81%    |
| Ag13       | 20  | 25   | 0.40%      | 99.21%    |
| Ag6        | 16  | 26   | 0.32%      | 99.54%    |
| Ag18       | 15  | 27   | 0.30%      | 99.84%    |
| Ag14       | 8   | 28   | 0.16%      | 100.00%   |
| **Total**  | **4966** | | | |

With the Pareto approach, the 5 causes of risk can result in the greatest potential risk impact. In Table 5 above, it can be seen that 5 risk agents have a percentage of 17.85%, giving an impact of 58.40% to the potential risk. The five risk agents are:

a. Less cleaned floor after the slaughtering (Ag17)
b. The accumulation of blood becomes clots (Ag20)
c. Lack of machine maintenance management (Ag2)
d. Too many cattle to be slaughtered (Ag3)
e. Increased consumer demand (Ag1)

Handling of risk agent priorities is a further task that must be done so that most risk events can be reduced and supply chain performance can be improved.
4. Conclusions
Conclusions obtained from this research are:
1. Identification of the risks inherent in the red meat supply chain activity produces 19 sub-processes, 28 risk events, and 28 risk agents.
2. The dominant cause of risk in the supply chain at slaughterhouses is the lack of cleaning the floor after the slaughter process (Ag17), the accumulation of blood into clots (Ag20), the lack of maintenance management on the machine (Ag2), the number of cattle to be cut too much (Ag3), and increasing consumer demand (Ag1).

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