

# Blockchain Adoption for Halal Food Integrity in Indonesian Food Industry

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## Abstract

The promise of new technology such as blockchain technology is critical to enhancing halal food integrity in the food industry. What motivates Indonesian industry managers to adopt blockchain technology for halal food integrity needs to be investigated. The purpose of this study is to understand how the halal strategy, institutional pressures, and perceived desirability affect the Indonesian food industry's intention to participate in the halal food integrity system using blockchain applications. Two case studies (chicken and milk processing companies) were used to answer the research questions and determine whether halal strategy, institutional pressures, and perceived desirability affect the adoption of blockchain for halal food integrity. The result shows that halal strategy is a significant internal dimension in the adoption of blockchain technology for halal food integrity systems. Both cases also prioritize the use of blockchain technology to strengthen the demand side of the supply chain. In the institution factor, pressure from regulators is a crucial factor that is of greatest concern because their domestic market is in the largest Muslim country, i.e. Indonesia. The expected result of this study is that by knowing the critical factors in adopting blockchain technology for halal food integrity; halal practitioners and authorities can trigger the implementation of blockchain for halal integrity in Indonesia.

## Keywords

Halal food integrity, blockchain adoption, Indonesian Food Industry

## 1. Introduction

The growth of Muslim spending increases continuously along with the rising of Muslim population and their welfare. In 2017, Muslims spent US\$ 1.3 trillion on halal food and beverage products (Thomson Reuters and DinarStandard, 2018). In 2018, the consumption of food and beverages increased to US\$ 1.4 trillion (DinarStandard, 2019). It is estimated that this expenditure will continue to grow and reach US\$ 2.0 trillion by 2024 (DinarStandard, 2019). As the halal market growth increased, scandals affecting the integrity of the halal food supply chain occurred in several countries. Soon et al. (2017) have comprehensively reviewed previous literature and media reports for the cross-contamination of halal food and halal frauds. For example, the presence of pork gelatin in marshmallows and

gumdrops occurred in Turkey in 2014 (Soon et al. 2017, Demirhan et al. 2012). In 2015, there was a halal scandal in slaughterhouses that did not follow the guidelines of the halal assurance system, especially in the slaughtering process in the United Kingdom (Soon et al. 2017, Press Association 2015). In the same year, the presence of pork DNA was detected in chicken sausages in Italy (Soon et al. 2017, Di Pinto et al. 2005). The number of halal scandals that have occurred shows that halal food integrity is important and needs to be handled and managed along the food supply chain.

Halal food integrity is a relatively complex issue because it is related to prohibited and permitted food, and the certainty of the halal status of the whole supply chain, i.e., from raw materials to end consumers (Soon et al. 2017). New technologies has the capability to manage the halal food integrity in a transparent manner that is needed by customers, halal regulators, and food industry players. Blockchain technology is one of the new technologies that are believed and chosen to be able to improve halal food integrity along the supply chain (Sander et al. 2018). The blockchain platform of Indonesian halal food integrity was proposed by Vanany et al. (2020). Several institutions and companies have implemented blockchain technology for halal food integrity, such as Halal Digital Chain, Korea Telecom, Arab-Brazilian Chamber of Commerce, PT Sierad Produce Tbk, and so on. However, to the best of our knowledge, only one company has adopted blockchain applications for halal food integrity in Indonesia's food industry.

This study aims to determine the factors that motivate halal food producers to participate in halal food integrity with blockchain applications. This paper is structured as follows. The following section presents the literature review, research design, and results. The final section presents the discussion and conclusions of the paper.

## 2. Literature Review

Blockchain applications in halal food integrity, institution pressures theory, and perceived desirability are described in this subsection. Tieman et al. (2019) reported that Halal Certification Bodies (HCB) agreed on the potential role of blockchain applications to ensure halal integrity in the supply chain, especially in halal transport, halal storage and halal compliant terminals in Muslim (majority) countries. In practice, many initiatives and partnerships of halal blockchain have been conducted (see Table 1).

Table 1. Application of blockchain technology in food supply chain

Organizations	Blockchain applications	References
Digital Chain	To inform customers for certification of halal products	(Whitehead, 2019)
Korea Telecom	To ensure authentication and fraud of halal products	(Wood, 2019)
Arab-Brazilian Chamber of Commerce	To enhance traceability and increase transparency in the country's halal food supply chain	(Hashem, 2020)
PT Sierad Produce Tbk (halal chicken company in Indonesia)	Applied the blockchain technology for halal food traceability with McDonald's Indonesia as its primary customer	(Winosa, 2020)

The new innovative technology adopted is dedicated to halal food integrity. In this study, blockchain technology was chosen to strengthen the halal food integrity in the food industry. Therefore, the operational strategy to be used is halal-oriented. These strategies apply halal principles (Zailani, 2015) following the Halal Assurance System (HAS) guidelines.

Two (2) approaches can be used to determine how companies are motivated to pursue isomorphism, namely sociology and economics. Institutional theory is one of the basic theories that believe the influences of external institutions in driving isomorphism among firms (DiMaggio and Powell 1983, Yigitbasioglu 2015). Companies are also motivated to do something because they are driven by economic efficiency in pursuing isomorphism (Haunschild and Miner, 1997). This study focusses on institutional theory, considering that most of the previous research on the use of technology is motivated by the need for legitimacy rather than the desire for efficiency (Wang

et al. 2019). Institutional theory has been used in the context of blockchain applications for halal traceability systems (Hew et al. 2020).

The compatibility, complexity, and perceived benefits are the important constructs of perceived desirability (Alsaad et al. 2017, Alsaad et al. 2019). Compatibility refers to the level of consistency an innovation is in a company's business processes, practices, and value systems, while complexity is the extent to which innovation technology is easy to be used (Fosso Wamba et al. 2016). Perceived benefits are the perceived progress and benefits received from an innovation compared to previously owned technology (Fosso Wamba et al. 2016). The mentioned dimensions, factors, and their respected literature sources are summarized in Table 2.

Table 2. Review literature for dimensions and factors in this research

Dimensions	Factors	Reference(s)
Halal strategy	Halal strategy	(Zailani et al. 2015)
Institution	Coercive pressures	(Yigibasioglu, 2015)
	Mimetic pressures	(Hu et al. 2016, Kauppi 2013)
	Normative pressures	(Son and Benbasat 2007, Sauer and Seuring, 2018)
Perceived Desirability	Compatibility	(Lee et al. 2017)
	Complexity	(Fosso Wamba et al. 2016, Wang et al. 2016)
	Perceived Benefits	(Fosso Wamba et al. 2016)

### 3. Methods

This research aims to answer the question, "how does halal strategy, institutional pressures, and perceived desirability affect Indonesian companies' intention to participate in halal food integrity systems using blockchain applications". The Indonesian halal industries in previous research were also elaborated to understand the halal operations and supply chain in Indonesian context (Vanany et al., 2019a, Vanany et al., 2019b, Vanany et al., 2020). The case study approach is used to study the blockchain applications in Indonesia's chicken and milk industry. The case study approach was selected since adopting and applying blockchain in the supply chain was voluntary and entirely up to the participating company.

Semi-structured interviews were conducted with a representative from each case study. Case study 1 represents the chicken processing industry that produces chicken carcass, breaded chicken products, etc. Case study 2 represents the milk processing industry that produces Ultra-High Temperature (UHT) milk as its main product. Purposive sampling was carried out when selecting the interviewees, since the study requires an interviewee with in-depth knowledge and understanding of halal integrity and blockchain applications. Pre-interviews were conducted with two to three candidates from each industry, and the most suitable interviewee was identified.

The results of the interviews were extracted using a grounded theory approach. Text analysis was performed using word processing software in three steps. First, the open coding process was used to identify people, objects, or concepts of interest from the interview transcript. Second, the axial coding process was carried out to find the relationships between open codes. Third, a selective coding process was used to see generality across different interviewees.

### 4. Data Collection

The data collected in this study came from several sources. Primary data were obtained from observations and interviews. Interview for case study 1 was conducted with an interviewee from the production department who had at least five years of experience. Meanwhile, in case study 2, the interview was conducted with a Supply Chain Manager with seven years of work experience. Both interviewees have postgraduate degrees. The interviews were performed based on the guide shown in Table 3, virtually or over the telephone, and lasted about 60 – 90 minutes.

### 5. Results and Discussions

This study adopts two approaches in analyzing the data, namely case and cross-case analysis. Case analysis was used to provide a detailed investigation of each case study. A cross-case analysis was used for in-depth comparisons across cases.

Table 3. Interview guide on halal strategy, institutional pressures, and perceived desirability

Interview section	Questions
Company profile	When did your company start operating?
	What is the scale of your company (number of employees)?
	What are the main products of your company and how many processing plants does your company have?
	From where the main raw materials are supplied and where is the marketing area of your product?
Interviewees Information	What is your position/title in the company?
	How long have you been in the same company or industry?
	What is your highest level of education?
Halal food integrity awareness	Does your company have halal certificate? How important is the Halal certificate to your company? Is it mandatory for your company?
	In what year did your company get the halal certificate?
	How important is the halal certificate to your consumers? How important is the halal certificate to your main consumers?
	To what extent is the awareness of your main consumers toward halal food integrity?
	To what extent does your company refer to halal food integrity in the company, both with your raw material suppliers and the distribution of finished products?
	In your company, who is responsible for the halal status of your products?
	Does halal status form part of your company's strategy?
	Does halal become one of the strategies in your company?
Halal strategy	Is your company's desire to participate in a blockchain-based halal integrity system in accordance with the objectives of your company's halal strategy?
Institution - Coercive pressures	Is the desire to apply blockchain to the halal integrity system driven by (1) regulators, (2) industry associations, (3) main suppliers, or (4) main customers, whether it is done formally and informally?
Institution - Mimetic pressures	Is the desire to apply blockchain to the halal integrity system driven by (1) the desire to imitate the success of other companies, (2) reducing uncertainty in competition and (3) sustainability of company's existence?
Institution – Normative pressures	Is the desire to apply blockchain to the halal integrity system driven by shared norms among (1) supply chain network members and (2) industry associations, whether done formally and informally?
Perceived Desirability - Compatibility	Will the blockchain-based halal integrity system be compatible with (1) facilities and equipment, (2) work practices, values, (3) company beliefs and strategies?
Perceived Desirability - Complexity	Is the blockchain-based halal integrity system compatible with (1) easy to implement, (2) easy to use, and (3) easy to integrate.
Perceived Desirability - Perceived Benefits	Will your company join the blockchain-based halal integrity system because it hopes (1) to improve the traceability system, (2) to integrate, (3) to increase the transparency of your supply chain?

### 5.1 Case Analysis Results

Two companies, food and drink companies, were invited to participate in the study. Case 1 is a chicken and fast-food processing company that produces chicken carcass and breaded chicken products (e.g., nuggets) as the main products. Case 2 is a milk processing company that produces Ultra High Temperature (UHT) milk and UHT tea drinks. Table 4 shows the profile of each case study. The results of the case analysis are described in the following subsection.

Table 4. Case profiles of poultry and dairy industry

Category	Case 1	Case 2
Started operation	1997	1970
Type of food industry	Chicken and fast-food processing industry	Milk processing industry
Total Employees - Company scale based total employees	(±) 1,200 - Large	1,100 - Large
Main products	Chicken carcass, breaded chicken products (nugget, etc.)	UHT milk and UHT tea products
Market	100% Domestic	90% Domestic and 10% Export

### 5.1.1 Case 1 – Chicken Processing Industry

Case 1 is a holding company in the integrated poultry industry. The holding company manages breeding, feed production, chicken slaughtering, and fast-food chicken processing. It is a large-scale food company with an estimated 1,200 employees. The company produces chicken products such as chicken carcass and breaded fast-food products, for instance, nuggets. This company has been operating in Indonesia since 1997 and sells its products in Java, Sumatra, Kalimantan, and Papua. Chicken, as the main raw material, is supplied from their own chicken farm.

Case 1 has received halal certification from LPPOM MUI (The Assessment Institute for Foods, Drugs and Cosmetics – Majelis Ulama Indonesia) since 2003. The production manager is the main person responsible for the halal status of the products, from the time live chickens were received to the delivery to customers. The quality assurance manager helps control all halal critical factors (reception of chicken, workers, especially the slaughterer, equipment used, etc.) that affect the product's halal status. For the company, halal certification is vital because the primary market and location of the company's operations are in Indonesia, with a majority Muslim population. Halal certification is mandatory for the customers, especially for major customers such as fried chicken outlets, hotels, supermarket companies, etc.

The existence of halal certification increases consumer confidence in buying products. The major customers are very aware of the importance of halal integrity. Besides, most of the population in Indonesia who embraces Islam have a high awareness of halal products. Currently, case 1 has the control and halal assurance of their raw materials since the company is involved in breeding their own chicken and feed production. In the future, case 1 is interested in utilizing blockchain to ensure the halal integrity of the processing ingredients from their suppliers and distribution of halal chicken carcass and chicken products. Halal aspect has become a part of the company's strategy to compete in the market.

### 5.1.2 Case 2 – Milk Processing Industry

Case 2 is a milk and beverage company that has operated in Indonesia since 1970. It is a public company with around 1,100 employees. Case 2 produces UHT milk drinks, UHT tea drinks, UHT health drinks, and so on. The composition of its market is 90% domestic and 10% export. Case 2 has ISO 14001, HACCP (Hazard Analysis and Critical Control Point certification), food safety system, and halal certification. The company supplied the fresh milk from their own dairy farm.

Case 2 has received halal certification from LPPOM MUI since 2015. The food safety and quality control department is the main department responsible for the halal status of their products. Halal certification is very important for the company because its primary market is also in Indonesia (approximately 90%). The company also exported some products to the United States, Saudi Arabia, and other countries. Similarly, halal certification is mandatory and is required by major customers of the company such as supermarkets, retail companies, and so on. The existence of halal logo from LPPOM MUI as the halal authority in Indonesia is a guarantee for customers.

Domestic or foreign suppliers of raw materials must provide a Certificate of Analysis (COA) and halal certification. Raw material checks are also carried out on suppliers every year. The raw materials for the packaging include those that must be confirmed to be halal, from the plastic material and the lubricating oil used, to whether they contain pork or not. If the halal certification from a supplier has expired, the supplier may not supply raw material until the

halal certification is reinstated. Halal has become part of the company's strategy and is also implied in the company's vision and mission.

## 5.2 Cross-Case Analysis Results

The following section describes the cross-case analysis for halal strategy, institutional pressures, and perceived desirability effects on Indonesian food companies intending to participate in halal integrity with blockchain application (see Table 5).

Table 5. A cross-case analysis of halal strategy, institution pressures, and perceived desirability

Dimensions-factors-variables	Case 1- chicken processing industry	Case 2 – milk processing industry
<i>Halal strategy</i>		
Demand side	<b>High Priority</b>	<b>High Priority</b>
Supply side	Moderate priority	Moderate priority
<i>Institution-coercive pressures</i>		
Regulator	<b>High pressure</b>	<b>High pressure</b>
Industry association	Moderate pressure	<b>High pressure</b>
Main supplier	low pressure	low pressure
Main customers	<b>High pressure</b>	<b>High pressure</b>
<i>Institution – Mimetic pressures</i>		
Emulate the success of other companies	Moderate pressure	Moderate pressure
Reduce uncertainty in competition	<b>High pressure</b>	Moderate pressure
The sustainability of the company's existence?	<b>High pressure</b>	<b>High pressure</b>
<i>Institution - Normative pressures</i>		
Supply chain network members	<b>High pressure</b>	Moderate pressure
Industry Association	Moderate pressure	<b>High pressure</b>
<i>Perceived Desirability – Compatibility</i>		
Facilities and equipment	<b>Significant compatibility</b>	<b>Significant compatibility</b>
Work practice	Moderate compatibility	<b>Significant compatibility</b>
Company beliefs and strategies	<b>Significant compatibility</b>	<b>Significant compatibility</b>
<i>Perceived Desirability – Complexity</i>		
Easy to be implemented	Moderate	Moderate
Easy to be used	<b>Highly easy</b>	<b>Highly easy</b>
Integration	<b>Highly easy</b>	<b>Highly easy</b>
<i>Perceived Desirability – Perceived benefits</i>		
Increasing traceability system	<b>High impact</b>	<b>High impact</b>
Integration	<b>High impact</b>	<b>High impact</b>
Increasing supply chain transparency	<b>High impact</b>	<b>High impact</b>

### 5.2.1 Halal Strategy

Case 1 and 2 have relatively similar awareness of halal food integrity. Halal aspect is used as their strategy to fulfil consumer requirements and increase their competitive advantages. They also agreed that enhancing halal food integrity between customers, particularly the main customers on the demand side (distribution and marketing) using blockchain applications, calls for more priority than the supply side. This is because both companies have their own poultry or dairy farms and can ensure the halal status of their main raw materials.

Case 1 respondent pointed out that halal food integration between their company and major customers such as fast-food chicken companies should be prioritized. The integration could be assisted with blockchain applications to ensure the food products are processed and transported according to halal guidelines. Meanwhile, case 2 stated that the internal motivation to adopt blockchain for halal food integrity is to serve and meet the requirements of large retail companies (i.e., supermarkets and convenience stores). Case 2 also remarked that blockchain applications would enhance their competitiveness in local and foreign markets.

### 5.2.2 Institution Pressures

In coercive pressures, respondents in case 1 and 2 have relatively different motivation factors in adopting blockchain applications for their halal food integrity system. Case 1 respondent pointed out that external pressure from regulators and main customers has "the high pressure" and the most significant effect on adopting blockchain applications. For example, if the major customers require case 1 to implement blockchain technology, the chicken processing company will abide by the requirement. Meanwhile, in case 2, both the industry association and regulator, such as the halal authority of government (BPJH), represent pressure points in adopting blockchain applications.

The two case studies have different types of mimetic pressures. Since case 1 was established in 1997 and is relatively new to the Indonesian market, it has many competitors within the sector. This resulted in a lesser market share. Case 2 was established in 1970 and is one of the leading UHT milk producers in the country. Case 1 is more encouraged to participate in halal food integrity using blockchain to reduce competition uncertainty, which is a high-pressure factor for case 1. In contrast to case 2, it is more motivated to increase the sustainability of the company's existence as high-pressure factor. In normative pressures, case 1 suggested that supply chain networks would exert more pressure on them, while case 2 felt that industry associations would play a more prominent role in influencing them to adopt blockchain.

### 5.2.3 Perceived Desirability

In compatibility factors, case 2's respondent pointed out that the three variables (company beliefs and strategy, work practice, and facilities and equipment) are significant and should be compatible and compliant with blockchain applications. For example, if the work practice of the operating company is incompatible with blockchain applications, the adoption and implementation of blockchain applications will fail. Similarly, if the company's work strategy and facilities and equipment are not ready nor compatible with blockchain, the application will not be effective. Meanwhile, case 1 believed that company beliefs, strategies, facilities, and equipment are the most significant compatible variables.

In complexity factors, respondents in cases 1 and 2 believed that blockchain applications should be relatively easy to use and integrate, while the implementation program is rather challenging to conduct. In the perceived benefits factor, both respondents believed that improvement in traceability system, integration, and transparency among supply chain members could be achieved by adopting blockchain applications for halal food integrity systems.

## 6. Conclusions

This research found that halal strategy is a significant internal dimension of blockchain adoption for halal food integrity systems. Enhancing halal food integrity system with their customers (demand side of the supply chain) was highly prioritized compared with their suppliers (supply side of the supply chain). However, the desire to participate is minimal or absent without external institution pressures and the perceived desirability of blockchain applications.

The food industry in Indonesia will decide whether to adopt and participate in the halal food integrity system using blockchain applications. Producers from the food industry that already have halal strategy will be more responsive and motivated to existing pressures and understand the perceived desirability of the blockchain applications for halal food integrity systems. Pressure from regulators is a pressing factor of greatest concern because their domestic market is in the largest Muslim country, Indonesia. In addition, they will participate in halal food integrity with blockchain if pressure comes from their main customers. Conducting evaluations by paying attention to what benefits they would get and what difficulties they would face are the basis for deciding whether they would participate in the blockchain-based halal food integrity system.

This research contributes to halal food integrity (e.g. Soon et al. 2017, Ali and Suleiman 2018, Ali et al. 2017) and halal blockchain (e.g., Tieman et al. 2019, Hew et al. 2020). This study also provides practical implications, providing understanding and promotion to halal food and beverage practitioners in Indonesia on blockchain technology that can be applied to halal food integrity. Halal regulators in Indonesia (BPJH and MUI), halal assurance agencies, halal supervisors are also encouraged to initiate and participate in the halal food integrity.

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