Research Article
Halal Supply Chain Management Using Blockchain Technology

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ABSTRACT

A halal supply chain consists of a supply network where special attention is paid to products to ensure halal integrity. Given the growing demand for halal products from both Muslims and non-Muslims worldwide, it is important to ensure product quality through an integrated supply chain. Integrity means honesty and constant monitoring and strong ethical principles and values. Maintaining the integrity of the halal supply chain is important, all aspects of halal food integrity must be carefully protected and all actors in the supply chain must take all necessary measures to avoid cross-contamination causing product damage. convert to non-halal. In addition, food safety is part of the halal integrity and traceability process, which produces traceable information from the source of the product to the store. In this way, the unit can track and trace food, such as food ingredients and expiration date, date of preparation, packaging during production, and record during the process, including when, where and how. To achieve better traceability, it is necessary to move and digitize the traditional supply chain, which can be done with blockchain technology in halal supply chain management (SCM). Three smart contract features, including traceability, decentralization and anonymity, are added to the model as moderators to investigate their impact on the integrity of the halal supply chain.

1. Introduction

Today, with the global security crisis, consumer concerns about food safety, quality, origin and authenticity have increased, and the lack of uniformity has created problems in the halal supply chain [1][2]. The traditional supply chain is complex and all information is fragmented and cannot be clearly traced. This is because everything is recorded on paper, so full visibility is a prerequisite for fast data transfer [3][4][5]. Another concern is food ingredients and the purity and cross-contamination of halal food with non-halal ingredients during storage and distribution, which is against Islamic principles. Some studies have suggested existing technology such as radio frequency identification (RFID) to develop and improve halal traceability [6][7][8]. A halal supply chain consists of a supply network where special attention is paid to products to ensure halal integrity [9] [10] [11][12]. Given the growing demand for halal products from both Muslims and non-Muslims worldwide, it is important to ensure product quality through an integrated supply chain [13]. To achieve better traceability, it is necessary to migrate and digitize the traditional supply chain, which can be done in a halal supply chain management (SCM) system using blockchain technology [14].

2. The Proposed Conceptual Framework

The four main operations that make up the halal supply chain are production, distribution, and logistics [15], In order to employ blockchain technology in the halal supply chain, records must be kept on the product or goods, certificates of origin, suppliers, resources, and materials, including halal species and any genetic

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contamination brought on by Haram species through routine reproduction [16]. A halal producer is a company that creates halal products. A halal certification must also be present for any additional ingredients or raw materials utilised in halal manufacturing [17]. Using blockchain technology, this organisation may confirm the product's quality, expiration date, manufacture date, and any ingredients or additional Halal-compliant components [18][19][20]. Halal transportation has benefited halal logistics [21][22][23][24]. Hypothesis 1 is: Adopting blockchain in halal supply chain positively impacts the integrity of the halal supply chain in the food industry.

In the halal food industry, traceability allows practitioners to track the halal status of a product through the blockchain network [18]. Therefore, the Hypothesis 2 is: Traceability positively moderates the relationship between blockchain-based halal supply chain and halal supply chain integrity. The goal of Blockchain technology is to create a decentralized environment where no third party is in control of the transactions and data [20]. Therefore, Hypothesis 3 is: Decentralization positively moderates the relationship between blockchain-based halal supply chain and integrity of halal supply chain. The presence of untrusted parties interacting in a distributed environment often encourages an anonymity component [19][21]. So our fourth hypothesis is: Halal supply chain integrity and blockchain-based halal supply chain relationships are actively coordinated through anonymity.

This proposed conceptual framework in Figure 1 is derived from a comprehensive literature review that includes halal supply chain blockchain as the independent variable (IV) (halal supply, halal production, halal distribution and halal logistics) and traceability as moderating variables. , decentralization and anonymity as three moderators to investigate the effect of variables on improving halal supply chain (SCH) integrity.
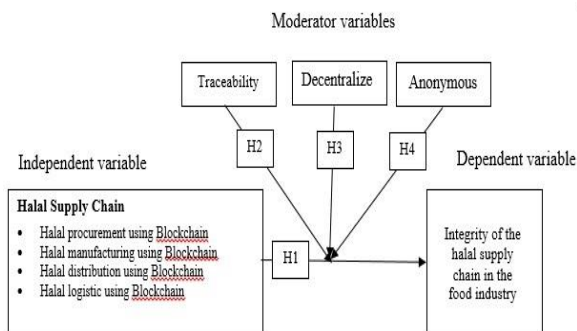

Fig.1: The Proposed Conceptual Framework

3. Research Methodology

In this study, the quantitative approach is employed to assess the association between the independent variable (halal supply chain using blockchain) and dependent variable (integrity of halal supply chain). This method begins with data collection and followed by application of descriptive as well as inferential statistics. Data collection is a technique of gathering data from the specific sources in order to find the answers of research question and assessing the hypothesis and outcomes. Several quantitative data collection techniques, including questionnaires, interviews, focus companies. Considering halal supply chain is a new approach in the supply chain industry, in this research a survey questionnaire is used, to get relevant data from the perspective of each respondent and experience in order to identify the effect of blockchain technology in halal supply chain. A survey questionnaire helps to gain valuable knowledge about large populations by only surveying a selected sample of the population. In this approach, researchers provide questionnaires to the respondents and demonstrate the result of responses in the form of descriptive statistic and other statistical analysis. In this study, a close-ended questionnaire approach is used. In this study, it may consist of the rationale for selecting respondents, sampling size, selection method, sampling frame and location and form of data generated, whereas the part of probability sampling consists of a time of sampling selection and depth of information per respondent. Therefore, the sampling was chosen halal food supplier, manufacturer, distributor, retailer, and target halal small-medium enterprises (SME) and companies. The study location was chosen Kuala Lumpur, to interview the target companies those participants, and also through presentations to explain to them about the project. Those who were interested and participated in this study. The target population combined of small and medium size enterprises (SME) in Kuala Lumpur. According to the report provided by The Edge Communications Sdn. Bhd. [25], around 320 small and medium size of enterprises from various industry, including food and beverages, cosmetics, halal ingredients, logistics, biotechnology, pharmaceutical and personal care attended the Malaysia Halal Expo 2019. The questionnaire is distributed in halal

companies including Nestle foods Malaysia Sdn. Bhd, Kawan food, Yakult, Secret receipt, and Old Town White Coffee. These included supply chain employees and staff, directors or managers, operations directors or managers, purchasing directors or managers, Logistic directors or managers. Each category of respondents will be providing some information which will be useful for this study.

The selection of respondents needs to be representative of the population. The population of this study will be targeted on quantitative research, which is considered necessary, where the information is composed through a series of interviews and specific populations. For this research study, the data is collected from entities in the halal small business enterprises that are related to the supply chain, such as suppliers, manufacturers, distributors, retailers, because those all the entities are sharing information for the benefits of the end-user customers. Shared information is using blockchain technology to record all the information digitally to share with all entities. This study used quantitative methodology to focus on the goals of the statistical, or numerical analysis of data collected through votes, and selected questionnaires. Since this study evolved around supply chain entities that suppliers, manufacturers, distributors, and retailers of small enterprises of managers based whole equity, therefore, relationship with blockchain technology is significantly the most acceptable notifies for this research study. Because of the importance of halal food and consumption in the halal market are particularly suitable for this study. Sample size calculated by targeted SME population size 32000, according to the 3200 SME Company and each company have 10 employees, which is involve of the supply chain operations. The confidence level 95%, margin of error 5%, so the purpose of the number of respondents who would be taking part in the survey 380 responders. The questionnaire is developed based on existing research and designed in English as it is widely understandable. The researcher ensures individuals about the confidentiality of information, and it will not be disclosed to the public or any unauthorized person. The questionnaire is divided into two main segments, which are Segment A and Segment B. Segment A addresses demographic information of each respondent, and Segment B includes questions about specified variables. This study consists of measurement of independent variables including Halal supply chain, Smart contract,

and Halal supply chain integrity for SME in halal supply chain in Malaysia. All questions are adapted from previous research studies which have been done in similar areas of study. The questionnaire is designed based on the dependent variable (DV) and independent variable (IV), which were discussed in the previous chapters. Measurement is crucial to a quantitative study because it has the importance in connecting between empirical survey and quantitative analysis of numerical data. There is no guarantee of a quantitative study worth that, it just has used statistics as statistics can be misapplied either intentionally or unwillingly. Below are the details on the questionnaire.

Halal procurement [26][27]
HP1: Using BT helps to make sure suppliers are reliable and can fulfil requirements of JAKIM (Jabatan Kemajuan Islam Malaysia)
HP2: Using BT helps to improve relationships with suppliers.
HP3: Using BT helps to make sure the meat and food is Halal

Halal manufacturing [26][27]
HM1: Using BT helps to ensure the integrity of Halal Manufacturing (eg, it guarantees that only certified halal raw materials are used)
HM2: Using BT helps to monitor the situation as the records are visible to all the market participants in SC
HM3: Using BT helps to eliminate possible inclusion of Haram or doubtful substances in the products
HM4: I feel good that in BT certificates and qualification statuses will remain immune from forgery and other compromises.

Halal distribution [26][27]
HD1: Using BT helps to ensure the integrity of Halal Distribution (eg it guarantees that containers used for halal products are not mixed together with the ones used for non-halal products)
HD2: Using BT improves food ingredients safety by making sure the selected packaging materials do not have any toxic effect on the product.
HD3: Using BT improves halal traceability of the packaging and helps to determine product's origin

Halal Logistic [26][27]

HL1: Using BT Facilitate origin tracking in SC and helps to know where the ingredients came from and where they were delivered

HL2: Using BT helps to ensure the integrity of Halal logistics (e.g., it makes sure the container or lorries used in the delivery are used only to deliver halal products)

Traceability [27]

TS1: I feel good that the public will see the information which is sent over the blockchain

TS2: It is good that smart contracts allow us to track real-time performance and improve trust between the participants

Anonymity [27]

ANN1: I think using smart contracts protects our privacy as it allows us to use a generated address to avoid identity exposure

ANN2: I prefer to use a public key rather than my personal information

Decentralization [28]

DEC1: I think it is a good idea that smart contracts eliminate the requirement for any intermediaries (e.g., banks) to validate and verify the transactions

DEC2: I feel decentralized systems will be better compared to conventional centralized transaction systems (e.g., banks)

DEC3: Using smart contracts will minimize my transaction delays

DEC4: I feel safe using smart contracts as it reduces the risk of fraud

Integrity [26][27]

INT1: I think using BT improves public's trust and ensures the trustworthiness of Halal food integrity

INT2: Implementation of BT in halal food supply chain will improve quality of our products.

INT3: Implementation of BT in halal food supply chain will improve trust between partners

INT4: Using BT improve food ingredients safety through establishing SC transparency in all processes from manufacturers to the individual consumers

INT5: I trust BT as the records are permanent and immutable. (e.g., it is not possible to falsify a SC payment transaction or the records of inventory, warehousing conditions, delivery times and dates etc.)

This study uses a five-point Likert scale to specify the degree of participants' agreement or disagreement with each statement, in which 1= strongly disagree, 2= disagree, 3= neutral, 4=agree, 5= strongly agree. The items measure the degree of effect of blockchain technology, on supply chain collaboration with smart contract, on supply chain integrity from local firm's perspective in Kuala Lumpur.

Prior to conducting the actual survey for the research, a pilot test is necessary to determine if the questions are consistent and reliable. Reliability refers to the degree to which a measure is un-bias, thereby shows consistent measurement in different time and different items in the instrument. The suggested sample size for the pre-test should be between 15-30 respondents, which is required to be distributed among the same populations as the actual survey. Hence, in this research sample size of 30 is chosen. It is crucial to perform data screening attainment in any multivariate analysis to ensure the outcome from quantitative research is meaningful. The quality of data screening directly affects the quality and the output of the analysis. Therefore, data screening is important to check the reliability and validity of the data. It is crucial to determine the missing data before starting analysis. Because problems might occur if there is missing data during the research process. Missing data may affect the generalization of the result of the study or cause bias issues as the respondents may leave the questions unanswered. One of the steps to screen the data is to examine the outliers. Outliers state the observations that are more distant in comparison with the rest of data. A multivariate outlier is a combination of unusual scores on at least two variables. One way to detect the outliers effectively is by examining Mahalanobis distance. The Mahalanobis distance helps to discover influential multivariant outliers by using predetermined threshold that will show if a point can be categorized as outliers.

The normality test of collected data is a prerequisite assessment for conducting statistical tests in quantitative research. If the collected data are not normally distributed, resultant mean for the value of output is not representative, which means a wrong selection of value of output and furthermore results wrong eventual interpretation to the analysis by using such a set of value to calculate significance value of output [25]. There are variety of methods that are applicable to test data

normality, Shapiro-Wilk and Kolmogorov-Smirnov test are the two well-known and widely applied methods to test normality out of these methods. Both of two methods can be utilized for dealing with large sampling size that over 50 samples. For Shapiro-Wilk and Kolmogorov-Smirnov methods, null hypothesis states that data are taken from normal distribution if $P > 0.05$.

Linearity represents the association between Independent Variables (IV), and Dependent Variables (DV). It represents the degree to which change in the dependent variable is constant across the range of values for the independent variable. The linearity should be less than $p < 0.05$ to show there is some significant linear association between DV and IV. Multicollinearity refers to the relationship between variables and indicates when at least two variables are strongly correlated. The redundant information increases the possibility of error, which will alter the output of analysis. Therefore, such data needs to be reconsidered. Multicollinearity can be calculated via measuring Variable Inflation Factor (VIF) for all independent variables. Following is the rule of thumb for the VIF: If VIF is less than 3; then there is no problem; If VIF is more than 3; then there is a potential problem; If VIF is more than 5; then there is very likely problem; If VIF is more than 10; then there is problem. The statistical software used in the research is the IBM Statistical Package for the Social Science (SPSS) to analyze data collected. It is a reliable and comprehensive tool to manage the data collected from the respondents.

Descriptive analysis includes gathering of data, which is related to present study, and then organization, tabulation, depiction, and description the outcomes of collected data. The main objective of descriptive analysis is to provide a knowledge base which can be a foundation and ground for further quantitative analysis. One of the most common approaches of descriptive analysis is the survey method which is closely related to present study.

In quantitative research, reliability refers to the uniformity, immutability and repeatability of outcomes. In other words, the results that the researcher concluded is considered reliable if corresponding outcomes have been achieved in same situations but different circumstances. However, it is also meant to ask whether the approach that employed by the researcher is consistent even across different researchers as well as different projects. However, one issue of reliability is

necessary to be concerned about is time as it is closely associated with subjectivity. For instance, once a researcher adopts a subjective approach for the study, there is a compromise towards the degree of reliability inside the work. The coefficient of reliability is ranging between 0 and 1, in which 1 equaling with perfect reliability while 0 equals no reliability. Reliability is also calculated by employing the test of correlation in the test-retest and alternate forms. For high stakes setting, reliability must be more than 0.9, but in less important situations, values of 0.8 or 0.7 are also acceptable. Generally, it is considered as high if reliability is greater than 0.7. The Pearson correlation analysis is conducted to evaluate the strength of association between two variables. A Pearson coefficient (r) can be in the range of +1.00 to -1.00. This statistical test is utilized to assess the covariation, or relationship, between one variable to another. If the value of coefficient found to be 0, it means there is no relationship between two specified variables. If the r value is more than 0, it indicates there is positive correlation while less than zero indicates negative correlation. Pearson Correlation analysis is used in this research to test the association between independent variables and dependent variables. Regression analysis is referred to as a statistical tool that is utilized for clarifying association between dependent variable (DV) and independent variables (IV). It is said that regression tool has long been central to the field of econometrics, that is economic statistics. Regression analysis with a single explanatory variable is regarded as simple regression. However, the other type of regression analysis – multiple regression more suited the present study as it allowed additional factors to separately enter the analysis so that the consequence of each can be calculated. At the base of present study, halal certification, price, quality, trust, and commitment stood for independent variables whereas consumers purchase intention towards halal brand cosmetics products. Therefore, it was more valuable to choose multiple regression analysis to measure the effect of various coinstantaneous influences upon a single dependent variable.

4. Hypothesis Analysis and Findings

In this section the hypothesis will be analysed based on the results.

Hypothesis 1. Adopting blockchain in halal supply chain positively impacts the integrity of the halal supply chain in the food industry

According to the results of statistical analysis that was carried out in this research, this hypothesis is accepted. Considering the value of person correlation coefficient (.668) and a significant value of 0.000 (less than 0.01), there is a strong positive relation between blockchain in halal supply chain (HSC) and integrity in halal supply chain (INT). Moreover, the result of simple linear regression with p value of 0.000 (less than 0.05) and the beta value of 0.612 (B= 0.612), indicates that, HSC is one of the important factors influencing integrity of halal supply chain (INT).

Hypothesis 2: Traceability positively moderates the relationship between blockchain-based halal supply chain and integrity of halal supply chain
According to the results of statistical analysis that was carried out in this research, this hypothesis is accepted. The moderating effect of traceability (TS) was examined by utilizing bootstrapping method and assessing the effect of HSC on INT in the presence and absence of TS by using multiple linear regression. According to the results, the value of p is 0.0011 (less than 0.05) and value of beta is 0.2144, meaning that the TS significantly contribute to positive effect on integrity of halal supply chain (INT).

Hypothesis 3: Decentralization positively moderates the relationship between blockchain-based halal supply chain and integrity of halal supply chain
According to the results of statistical analysis that was carried out in this research, this hypothesis is rejected. The moderating effect of decentralization (DEC) was examined by utilizing bootstrapping method and assessing the effect of HSC on INT in the presence and absence of DEC by using multiple linear regression. According to the results, the value of p is 0.28, which is greater than 0.05. It indicates that DEC has insignificant effect on integrity of halal supply chain (INT).

Hypothesis 4: Anonymity positively moderates the relationship between blockchain-based halal supply chain and integrity of halal supply chain
According to the results of statistical analysis that was carried out in this research, this hypothesis is rejected. The moderating effect of anonymity (ANN) was examined by utilizing bootstrapping method and assessing the effect of HSC on INT in the presence and absence of ANN by using multiple linear regression. According to the results, the value of p is 0.7691, which is greater than 0.05. It indicates that ANN has insignificant effect on integrity of halal supply chain (INT).

5. Conclusion, Implication and Limitation

This research investigated and provided an in-depth insight about the influence of blockchain on halal supply chain in Malaysia (Kuala Lumpur). According to the aim and objectives of the research, the direct influence of blockchain on halal supply chain (HSC) is evaluated, and the moderating role of three features of smart contract namely as traceability (TS), decentralization (DEC) and anonymity (ANN), as a link between blockchain and integrity (INT) of halal supply chain, are assessed. In order to accomplish the purpose of the study, a comprehensive literature review on existing research is done, and a conceptual framework is proposed. The proposed conceptual framework is comprised of one independent variable, which is blockchain in halal supply chain (halal procurement, halal manufacturing, halal distribution, halal logistics), and three moderator variables including traceability, decentralization and anonymity. Given the variables, four hypotheses have been developed in which the findings indicated that two hypotheses were accepted, and two hypotheses (moderating role of decentralization and anonymity) were rejected. Findings of the research suggested that according to the supply chain practitioners, blockchain has a significant positive effect on integrity of halal supply chain. It indicates that blockchain is generally accepted, and it is believed to be influential in integrity of halal supply chain, especially in halal procurement and halal logistic, in which the information of origin of product as well as transportation is recorded.

The results further show that traceability has a significant positive moderating effect on the integrity of halal supply chain. It indicates that the participants found traceability as an important variable, and they are willing to share halal status of a particular food product at every stage of the supply chain. Therefore, it is easier to trace the products and ensure the quality and safety of halal food. The findings revealed that based on the supply chain participants, the moderating effect of decentralization is insignificant in integrity of halal supply chain. Decentralization includes using a decentralized transaction system which eliminates the third party from controlling the transactions and data. It indicates that participants are not sure if security is preserved, or it is endangered when a trusted third party is eliminated. According to the results, this moderator has no significate positive or negative effect, which shows the blockchain providers must increase awareness about trustworthiness

and security of such decentralized technology, as the main concern of the supply chain participants is in banking transactions. Similarly, the results of the survey indicated that the moderating role of anonymity is insignificant toward the integrity of halal supply chain. Anonymity as a feature of smart contract, allows the users of blockchain based technologies to use their identities anonymously. In the blockchain each user is given a public key instead of personal information which protects the user privacy and avoids identity exposure. According to the survey results, the supply chain practitioners believe anonymity has no significant positive or negative effect on integrity of the halal supply chain. It indicates the blockchain providers must increase awareness about privet or public options that allows using identities publicly or protecting the identities by using public key instead. The main concern of participants is willingness to share identities to enhance the transparency and allow other users I the network to acknowledge who is responsible for a certain transaction or data. Therefore, this research reveals insights into blockchain in halal supply chain from perspective of supply chain practitioners, which can be used by supply chain technology providers to understand factors influencing integrity of halal supply chain.

Supply chain actors are the primary key in maintaining and guaranteeing the halalness of a product. Therefore, cooperation between different actors must be maintained to ensure the trustworthiness of halal food integrity. Using blockchain can help the integrity of halal supply chain and ensures the quality and halalness of the food. As the actors of the supply chain plays the key roles in halal supply chain integrity, the findings of this research assist companies to understand the concerns about the blockchain technology in halal supply chain. Therefore, the findings help to manage and successfully implement blockchain technology in halal supply chains. There are some recommendations that companies can take them into consideration while implementing blockchain technology. For instance, the concept of blockchain is generally accepted by the halal supply chain and most of the participants believes blockchain improves the integrity of halal supply chain. However, the companies have to increase knowledge and awareness of the employees about the features of smart contract such as decentralization and anonymity. Majority of participants stated decentralization has no significant effect on

integrity of halal supply chain which shows that enough trust is not stablished between users of supply chain, and they prefer to have a trusted third party in order to accomplish transaction.

Moreover, the results show that majority of participants are either neutral or agreed to use public key instead of personal information. However, the anonymity had an insignificant effect on integrity of halal supply chain. It indicates that the users are willing to use public key instead of their identities, however anonymity is not a key indicator of integrity of halal supply chain. Hence, it can be concluded that supply chain actors did not find such feature disturbing, or cause of any discomfort. Therefore, the researcher suggests the companies to ensure that users are aware of private or public options for privacy, that allows users to choose the status for identity exposure, and highlight the importance of such feature in the integrity and blockchain technology. Using these findings will help companies to implement blockchain technology in a way that improve integrity of the halal supply chain, which entails mutual benefits across the whole halal supply chain.

There have been limitations during accomplishing this study that can be further improved in future studies. Firstly, the data collection is limited to companies in Kuala Lumpur, which limits the generalization of the findings. In order to increase the reliability of the results, future studies can extend the sample size to include greater number of companies. Secondly, blockchain technology in supply chain is relatively new concept, and the participants are familiar with blockchain technology but lack experience or practical knowledge about this revolutionary technology. Additionally, this study focused on smart contract features (traceability, decentralization, and anonymity) however other constructs such as inter-organization trust can help to understand the influence of blockchain on integrity of halal supply chain. Finally, the current study did not discuss the influence of blockchain in each halal supply chain activities including halal procurement, halal manufacturing, halal distribution, halal logistics). Thus, the future studies can investigate their relationship with integrity of halal supply chain.

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Authors Introduction

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