A Framework for Tracing the Flavouring Information to Accelerate Halal Certification

S.F.M. Hashim[1], J. Salim[1], S.A. Noah[1], W.A.W. Mustapha[2]

[1]Center for Artificial Intelligence Technology, Faculty of Information Science and Technology,
Universiti Kebangsaan Malaysia 43600 Bangi, Selangor Darul Ehsan, Malaysia.
[2]School of Chemical Science and Food Technology, Faculty of Information Science and Technology,
Universiti Kebangsaan Malaysia 43600 Bangi, Selangor Darul Ehsan, Malaysia.
p73051@siswa.ukm.edu.my

Abstract— **Halal industry is a new sector in the manufacturing industry in Malaysia and is a fast-growing global business. In Malaysia, JAKIM is the body responsible in matters relating to approve the halal certification. However, the process of issuing the halal certificate is time consuming. Based on the delay in issuing the halal certificate, this study conducted a case study to examine issues in halal certification. The reasons for the delay in issuing halal certification is the constraints in determining halal status of flavouring due to the absence of halal certificate when auditors were processing the documentation for applying certification. In addition, the inconsistent use of terms among the food producers and the auditors makes it difficult to trace halal status of flavouring. The case study also found that there is no framework that can help to trace the halal status of flavouring ingredient systematically. Thus, the study contributes a framework for tracing flavouring information to accelerate halal certification.**

Index Terms—**Halal; Halal Certification; Ontology; Traceability Framework;**

I. INTRODUCTION

Food produced by third parties requires an assurance that the food is safe for consumption by Muslims and meets the Islamic tenet of 'Halal' [1]. In Malaysia, halal logo is placed on products that have been certified halal so that consumers know that the product is halal [2]. Halal certificate for a product is obtained through a process known as halal certification [3][4]. Halal certification refers to the official recognition of the orderly process of preparation, slaughtering, cleaning, handling, and other relevant management practices by the established body [4]. According to [4], the certification is not limited to poultry and meat; it also covers consumers' items such as cosmetics, pharmaceuticals, and toiletries.

JAKIM is the sole authority appointed to manage and approve the halal certification in Malaysia [5]. Research by Siti Khadijah & Zurina [6] reported that JAKIM takes about six months to approve the halal certification and this does not include renewal of the Halal certificate. Delay in the processing of halal certification occurred due to the fact that officers in the Halal Hub Division are busy with other work such as field inspection, management and attending courses related to halal certification [6]. This study aims at investigating the factors that contribute to the delay in approving the application of halal certification in order to design a framework for tracing flavouring information to accelerate the halal certification.

The structure of this paper is as follows: In Section 2, it describes the concept of halal and the ingredients. The Section 2 also discuss the prior studies regarding halal certification, traceability system, traceability framework and ontology in traceability. For Section 3, we describe our methodology for this study. Section 4 provides the case study at Halal Hub Division. In Section 5, we describe our suggested framework for tracing the flavouring information to accelerate halal certification. Lastly, Section 6 presents the conclusion.

II. LITERATURE REVIEW

Based on the critical evaluation of the literature and prior studies, the researcher has identified the key concepts that were addressed which are halal concept, halal certification, traceability system, traceability framework ontology in traceability and ingredients.

A. Halal

According to [7], halal is an Arabic word which means allowed or permitted according to Shariah (Islamic) law. Halal covers everything from raw material sourcing to distribution of products, right up to delivery to consumers [8]. Food and drink and/or their ingredients permitted under the Shariah law must fulfil the following conditions [9]:

i.   does not contain any parts or products of animals that are non-halal by Shariah law or any parts or products of animals which are not slaughtered according to Shariah law;

ii.   does not contain najs according to Shariah law;

iii. safe for consumption, non-poisonous, non-intoxicating or non-hazardous to health;

iv.   not prepared, processed or manufactured using equipment contaminated with najs according to Shariah law;

v.   does not contain any human parts or its derivatives that are not permitted by Shariah law; and

vi.   during it's preparation, processing, handling, packaging, storage and distribution, the food is physically separated from any other food that does not meet the requirements stated in items i, ii, iii, iv or v or any other things that have been decreed as najs by Shariah law.

In the Quran, Allah has commanded Muslims and all mankind (regardless of their religion and race) to eat and live on Halal and Tayyib (pure, clean, wholesome, nourishing and pleasing to the taste) food. Among the many verses of the Quran that convey this message are:

And eat of the lawful and good (things) that Allah has given

you, and be careful of (your duty to) Allah, in Whom you believe (Al-Maida 5:88).

O men! Eat the lawful and good things out of what is in the earth, and do not follow the footsteps of the Shaitan; surely he is your open enemy (Al-Baqarah 2:168).

O you who believe! Eat of the good things that We have provided you with, and give thanks to Allah if Him it is that you serve (Al-Baqarah 2:172).

B. Halal Certification

Halal certification refers to the examination of food processes which composed of preparation, slaughtering, ingredients used, cleaning, handling, processing and storage including transportation and distribution [3]. Halal certification can only be obtained when the food has been verified as nutritious and prepared from permissible ingredients in a clean and hygienic manner [3].

Halal authority such as JAKIM has the responsibility to encourage food manufacturers to apply for Halal certification and ensure their clients obtain Halal certification successfully. Malaysian halal certification issued by JAKIM is based on standards for halal food that is MS 1500: 2009, Halal Food - Production, Preparation, Handling and Storage - General Guidelines (Second Revision) and Malaysian Certification Procedure Manual issued by JAKIM. According to [3], halal certificate issued by JAKIM is world recognized based on strict criteria and have a strong relationship with major world trade as well as strong support from the government [4]. Malaysian halal certification issued by JAKIM is open to local and international food manufacturers. Malaysian halal certificate application can be applied through e-Halal system (https://apps.halal.gov.my/apps/e-halal.php?new=).

Studies on the halal certification seem to focus on the applicant's perception towards the quality service in processing the application of halal certification [3] [4] [10] [1] [11]. Issues regarding the delay in processing the application of halal certification highlighted the inefficiency in the operation stage for halal certification by Nurulhuda et al. [12] due to two factors: applicants and internal. Some of the operational inefficiency on applicants' side are: i) Lack of understanding of the halal procedures; ii) Delay in submitting the supporting documents; iii) Delay in making payment of certification fee; and iv) Unaware of the acknowledgement that has been sent to them through the e-mail or e-Halal information system. Some of operational inefficiency on the internal factor are: i) Lack of expertise as new staffs with little experience of the system contribute to the slow processing and without a tight coordination minimised the number of halal certificate approval; ii) Unsystematic filing system; iii) Premise inspection may require more than a day to be completed especially for the multi-national industry and hotels; and iv) Delay in receiving lab test result.

However, several issues have been identified from previous studies in connection with the certification approval process that takes longer time. Shahidan & Md. Nor [13] found that the delayed in issuing halal logo is because JAKIM has no research unit capable of processing each application for certificates immediately and JAKIM or the State Islamic Religious Department would need to get assistance of a third party (food technologists, chemists or experts) from local universities to confirm the analysis from laboratory testing and perform on-site inspections. Besides that, Ahmad Hishamuddin [14] claim that insufficient IT support for database and information system that lead to lack of capacity to execute duties and responsibilities. In halal certification, the concept and process of halal certification need to understand in order for designing the traceability framework to accelerate halal certification.

C. Traceability System

Traceability capabilities is needed to ensure the entire process chain can be traced and measured, as well as ensuring the safety and quality of products, especially food products [15]. Traceability in food products is needed as there is increasing demand for food safety products from end users [16]. Sarig [17] found that the only mandatory traceability system currently applying to a complete food chain enables beef on sale within the European Union to be traced back to where it originated.

Research on the traceability system that focuses on the food supply chain systems were conducted by [18]-[22]. However, traceability study conducted by [21] aimed at supporting food quality and safety. There are previous studies concerned on the needs of the traceability system to verify the halal logo on food packaging [23]. Salampasis et al. [23] found that Radio Frequency Identification technology (RFID) can be used to verify the authenticity of halal logo. One advantage of RFID is that it can be used in the development of real-time systems in the halal logo verification. However, until now there has not been any research on the traceability system that helps the authoritative to accelerate the process of issuing halal certificates to food producers.

D. Traceability Framework

Previous studies regarding traceability framework started in 2005. Almost all previous studies regarding traceability framework focused on food supply chain. Among these are red wine [24], cheese [16], meat [25] and others. Prior studies regarding the traceability framework are more focused for food producers to use the framework in order to trace their product stream. Food producers usually need a traceability framework to guide them to trace the food chain generated by them [16] [21] [24].

Apart from being a guide to trace the food chain, these traceability frameworks aim to integrate information on the traceability of a food product involving various members in the food supply chain [24] [21]. In the study [16], traceability framework is needed to clarify the aspects of laws and regulations in tracing food chain as well as to develop a framework for the traceability system. There are previous studies that require the implementation of a traceability framework for a secure supply chain [25]. The traceability framework designed by [6] is the only framework that emphasizes on halal aspects in order to develop a framework to help manufacturers produce halal products.

Other than traceability framework, prior studies traceability methods involve different traceability methods. Skoglund & Dejmek [19] uses fuzzy traceability in improving the quality of dairy products. This fuzzy traceability method uses a dynamic model to configure and simulate actual process in the production of dairy products. This method aims to review each stage in the production of dairy products in the batch respectively. However, this method is more suited to the manufacturers to trace if there are any problems with dairy products produced by them. Apart from traceability fuzzy

method, there are some previous studies such as studies by [18]- [22] that used ontology in their traceability studies respectively.

E. Ontology in Traceability

There are few studies that use ontology in tracing food supply chain such as in agricultural products. Chifu et al. [18] used ontology to trace meat while Wang et al. [20] used ontology to develop traceability system for fruits and vegetables. Salampasis et al. [21] also applied ontology in their research to produce an efficient traceability of the food supply chain system for production of UHT pasteurized cocoa milk.

Chifu et al. [18] proposes an ontology model which allows semantic annotation of Web services aiming at automatic Web service composition for food chain traceability. The proposed model consists of a core ontology and two categories of taxonomic trees: Business Service Description trees and Business Product Description trees. While Wang et al. [20] used ontology to develop traceability system for fruits and vegetables in order to upgrade the quality and safety of fruits and vegetables. Salampasis et al. [21] used TraceALL which is a Semantic Web (SW), ontology-based, service-oriented framework which aims to provide the necessary infrastructure enabling food industry (particularly SMEs) to implement traceability applications using an innovative generic framework. The framework builds upon the idea of the Semantic Web and provides an open and extensible underlying platform that allows different traceability interconnected applications to be designed and developed.

Nurul Aswa et al. [26] also developed an ontology about food particularly on E-numbers. The development of E-numbers ontology involves a variety database of E-numbers such as Chemical Entities of Biological Interest (ChEBI) and PubChem Compound Database (PubChem). The purpose of E-numbers ontology is to help users verifying the halal status of a food product in the market. The review of past study regarding tracing methods found that ontology can be used to trace the product stream because ontology is capable of integrating multiple sources of information into a form of knowledge representation [18] [20] [21] [26].

F. Ingredients

Ingredients are the raw materials needed to make something [27]. In the domain of food industry, the process of identifying the contents of a food product is important in order to know the ingredients used in producing a food product [28].

A variety of ingredients can be found on the label of the product purchased. Some of it is simple or single components such as salt, sugar and water. However, there are also complex components such as food colouring, powdered cheese, seasonings, flavouring, fats, and other spices. In some product labels, ingredients are listed according to function as antioxidants, emulsifiers, preservatives, flavouring and thickening [29].

However, some of the ingredients will have issues on halal status such as alcohol, enzymes, fats and gelatin which is not explicitly listed but it is hidden in seasoning, cheese and ice cream. This ingredient is made up of several types of such raw materials derived from animal or plant, microbial and synthetic sources. Ingredients can be classified as halal if it fulfills the following conditions [30]:

- Ingredients derived from animals; the animals must

undergo slaughter in accordance with sharia.
- Ingredients consisting of alcohol must be less than 0.5%; the resulting product of the alcohol must have less than 0.1% alcohol.

In food processing, food manufacturers cannot avoid using additional ingredients in foods that most of it is imported and made from a variety of sources, whether animal or plant [7]. Food producers should aware of the ingredients used for food processing such as food additives, amino acids, animal fats and proteins, food colourings, sauces and seasonings, emulsifiers, enzymes, fats and oils, coatings based on fat and grease, flavourings, gelatin, glycerin, hydrolyzed protein, meat and meat-based products, packaging materials, stabilizer, thickener, vitamin, and whey protein. For the processing of halal products, all related to the contamination of ingredients that are not lawful should be avoided.

III. METHODOLOGY

The research design in this study is exploratory as it involves the exploration of previous studies and current issues that has been faced. A qualitative approach is considered as appropriate approach to be used for this study because it involves a relatively new phenomenon, in which certain populations who are experienced in a certain context. The research design in this study as shown in Figure 1:
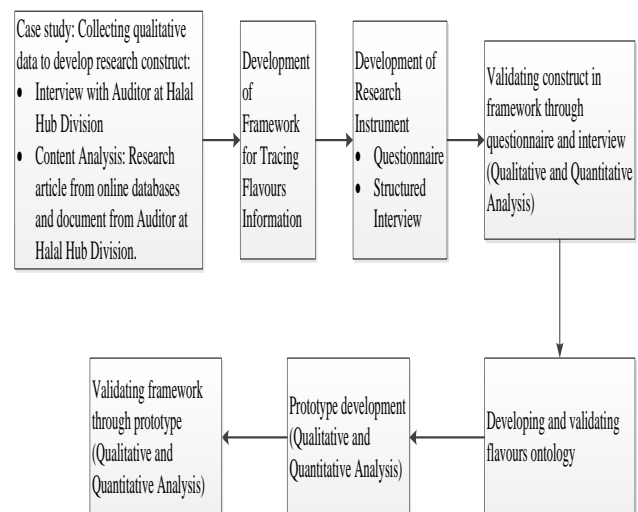

Figure 1: Research Design

Drawing on the literature from the topics of halal certification and traceability, a case study involving qualitative data collection and document analysis was undertaken at JAKIM Halal Hub Division. The researcher adopted face-to-face interviews with the auditors to gain deeper understanding of the process and issues relating to halal certification. This was also supported by McNamara [31] who argues that interviews are useful for detail investigation from the informants. The researcher also adopted document analysis in order to get the supplement information regarding the Standard Operating Procedure (SOP) for halal certification process and also the policy regarding the halal certification.

Data collected from the literature survey, interviews and document analysis was analysed to identify the factors affecting halal certification. From the factors, the researcher is able to categorize the constructs in order to propose a

traceability framework to accelerate halal certification. After designing the framework, the research instrument was designed in order to validate the constructs in the framework. The research instruments consist of questionnaire and structured interview. The questionnaires were given to the selected respondents who are the Auditors in the Halal Hub Division. Structured interviews were conducted to gain other feedbacks from Auditors.

After the constructs in the framework had been validated, the flavouring ontology will be developed and validated. After the validation of flavouring ontology, this ontology is implemented in the form of prototype. Then, the researcher need to do the validation of the framework using the prototype that has been developed. The framework is validated using the questionnaire that the respondents (auditors in the Halal Hub Division) need to answer after using the prototype.

IV. CASE STUDY

This research used case study approach to collect the data regarding the halal certification process and the current problems faced by auditors at Halal Hub Division in processing the application of halal certification. The collection of data involved 2 techniques which are brainstorming and document analysis. The researcher conducted three brainstorming sessions.

Analysis for first brainstorming session focuses on the traceability process. According to the auditors of the Halal Hub Division, the validation status of a critical ingredient which is either halal, haram or syubhah requires both aspects which are technical (scientific) and Sharia (Islam). Technical aspects verifying information the composition of chemicals contained in an ingredient, the basic source of an ingredient, and aspects that are used for the production of an ingredient. While the Sharia aspects involve verifying ingredients considered important in order to qualify halal status according to Islamic law.

Analysis for second session of brainstorming focused on the procedure to determine the halal status of flavouring and to identify metadata needed in order to determine halal status of flavouring. For feedback regarding the current procedure in determining the halal status of an ingredient, it was discovered that the main factors affecting the halal certification application process is in the identification of the halal status of ingredients which include flavouring. During the process of revising the application documents, the auditors still use the manual approach by referring to multiple information sources to detect whether an ingredient complies with the laws. The special documents include: Food Act 1983, Malaysian Standard on Halal Food MS (1500:2009), Handbook of Fenaroli and the academic journals. Furthermore, the issue of delay in processing applications for halal certification is due to the inconsistencies of ingredients' terminology used by food producers and auditors. For example, as shown in Figure 2, food producer lists a flavouring named 'aldehyde ethyl ether' which has similar meaning as the term 'ethyl vanillin' which is a term commonly used by the auditors. There is no previous studies that examined the issue of delay in processing applications of halal certification due to traceability of the halal status of flavouring contained in food products.
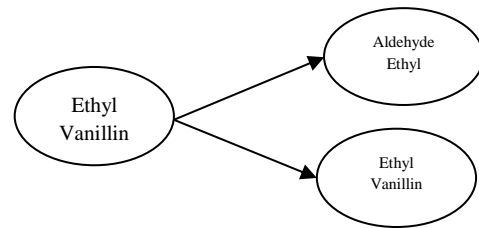
Figure 2: Inconsistencies in flavouring term

Analysis for third session of brainstorming focused on structured flow in identifying halal status of ingredients. According to the auditors at Halal Hub Division, the structured flow is as shown in Figure 3.
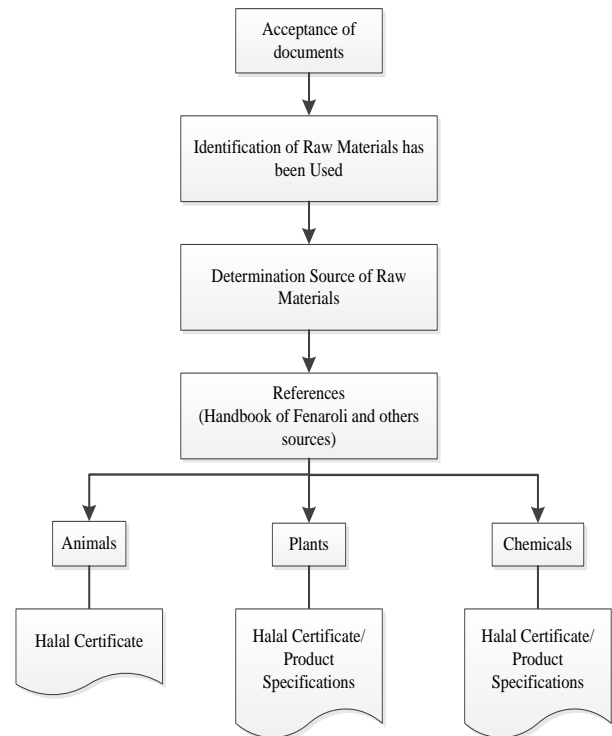
Figure 3: Structured Flow in Identifying Halal Status of Ingredients

Based on Figure 3, the first process involved in identifying flavouring information is the acceptance of the documentation of halal application from the applicants. The auditors at Halal Hub Division need to revise the document to make sure the documentation of halal application is complete with the supporting documents such as halal certificate of raw materials, product specification, lab analysis, etc. After the revision of the documentation, the auditors need to identify the list of raw materials that has been used by applicants in the application form. When the auditors have identified the list of raw materials that has been used by applicants, the Auditors need to determine the source of raw materials by referring to the references (supporting documents) such as certificate of raw materials, product specification, lab analysis, etc.

Next, scope for determining the halal status of an ingredient is based on two main aspects: i) proof through documentation involving halal certification and product specifications and ii) field inspection. However, the time taken to determine the halal status of an ingredient depends on whether or not the application document is complete and the process for field inspection.

After the brainstorming sessions, the researcher performed

the analysis of document on Halal Certification Procedure Manual MS 1500: 2009. Based on the analysis of documents on Halal Certification Procedure Manual MS 1500: 2009, researchers were able to categorize the work processes in halal certification in Malaysia according to those responsible parties in Table 1:

Table 1
Halal certification process in Malaysia

No	Responsible Party	Work Process
1.	Food manufacturer	Apply for the certificate with access to e-halal system and fill in the relevant forms in the system.
2.	Food manufacturer	Pay a fee for processing applications for halal certification
3.	Audit Process Unit	Accepting applications for halal certification. Assessment of documents including an application form and supporting documents as well as detailed analysis of the company's profile with declared ingredients, supplier details, manufacturing process and procedures etc.
4.	Auditor Process Unit	Physical examination, including assessment of ingredients, methods of storage for raw materials and finished products, cold rooms, processing factories manufacturing flow and control aspects of production, packaging materials, hygiene, quality control and assurance practices.
5.	Technical Committee	Technical inspector will write a full report on the status of the application based on the examination site.
6.	Auditor Process Unit	The report will be presented and evaluated by the Evaluation Committee and the Reserves.
7.	Auditor Process Unit	When approved, JAKIM will issue the certification and permission to use the halal logo will be given. The certificate is valid for two years and the renewal of the application should be submitted three months before the expiry date. JAKIM will carry out continuous monitoring to ensure compliance with halal standards

V. FRAMEWORK

Based on analysis of literature and case study conducted, the framework as shown in Figure 4 need to focus on these elements:

- Checking the application documents [6; 32]
- Identification of raw materials that have been used [33; 32]
- Determination of the source of the materials [6; 34; 32]
- Reference sources for determination halal status of ingredients [35; 32]

The first step in tracing the halal status of flavouring, the auditors check the application form together with the list of supporting documents such as company's profile, halal certificate of ingredients (flavouring), products specification and processing flowchart of ingredients [6; 32]. After checking the application document with the supporting documents, the auditors need to check the raw materials (ingredients) that have been listed in the application document whether the ingredients have a halal certification. If the ingredients have the halal certificate, the auditors can proceed to the field inspection. If not, the auditors need to categorize the ingredients as critical ingredients [32]. For the critical ingredients, the auditors need to check the supporting documents such as ingredient's background, processing flowchart of ingredient and lab analysis.

After identifying the raw materials that has been used, the auditors need to determine the source of raw materials. Determination of the source of raw materials is a key component in the traceability of halal status [32; 33]. The source of raw materials for flavouring needs to be identified and investigated whether it derived from animals, plants or chemicals [33]. When the source of the raw material has been identified, the next step is to trace the halal status of the source of raw materials whether it is halal, haram or syubhah. To determine the halal status of a raw material for flavouring, technical and sharia aspects are required [6; 34; 32]. Technical aspects are the specifications for ingredients, process flow chart, life storage, analysis of lab result, allergen information, and storage methods. From the aspects of sharia, these regulations must be complied: the cleanliness of the material, alcohol free, do not contain animal blood, pork free and does not pose any danger. However, both of these aspects require the knowledge of experts in determining the halal status of flavouring.

According to the study conducted by Nurul Aswa et al. [26], they used ontology to integrate various sources to develop ontology on E-Numbers. [26] used the ontology to solve the problems in integrating various halal sources. Findings from. Nurul Aswa et al. [26] implied that ontology can be used for this work to integrate various sources including technical aspects (chemical properties of flavouring), sharia aspects and expert knowledge to develop an ontology of flavouring. The development of flavouring ontology followed the 101 Method [36]. The first step was defining ontology domain and scope. For this work, the ontology domain has been identified through the discussion with the domain expert which is flavouring. The scope of ontology is identified based on the constructing the competency questions as follows:

- Find the source of raw materials that has been used in Ethyl Vanillin.
- Find the chemical properties for Ethyl Vanillin.
- Find the information from sharia aspects for Ethyl Vanillin

After identifying the ontology domain and scope, the second step was to consider reusing existing ontologies. We did some revision of previous research regarding the development of ontology in tracing the information of food supply chain. There is a research that closely related for this work which is the research by Nurul Aswa et al. [26] that developed ontology on E-Numbers for helping users verifying the halal status of a food product in the market. The development of E-numbers ontology involves various databases of E-numbers such as Chemical Entities of Biological Interest (ChEBI) and PubChem Compound Database (PubChem). Based on the work by Nurul Aswa et al. [26], we considered using the existing ChEBI ontology in this work.

Besides using the ChEBI ontology, the proposed flavouring ontology will also be integrated with the information from explicit reference sources proposed by auditors such as Handbook of Fenaroli, ChEBI and also the knowledge from domain expert in flavouring [35; 32]. After that, we define the classes and the class hierarchy. The class hierarchy could be developed in three possible ways: top-down, bottom-up or a combination of both [36]. For this work, we chose combination as a process to define a few top-level concept and a few specific concept. After defining the class and class hierarchy, we define the properties of the classes. According to [36], the class alone will not provide enough information to answer the competency questions. Each class must have properties to provide detail information for answering the

competency questions. This flavouring ontology will standardize the flavouring terminologies which give the semantic meaning between food producers and auditors (synonymn). This ontology will be implemented in a

prototype form to provide the output which is crucial information of flavouring in order to accelerate the process for auditors in verifying the halal status of flavouring.
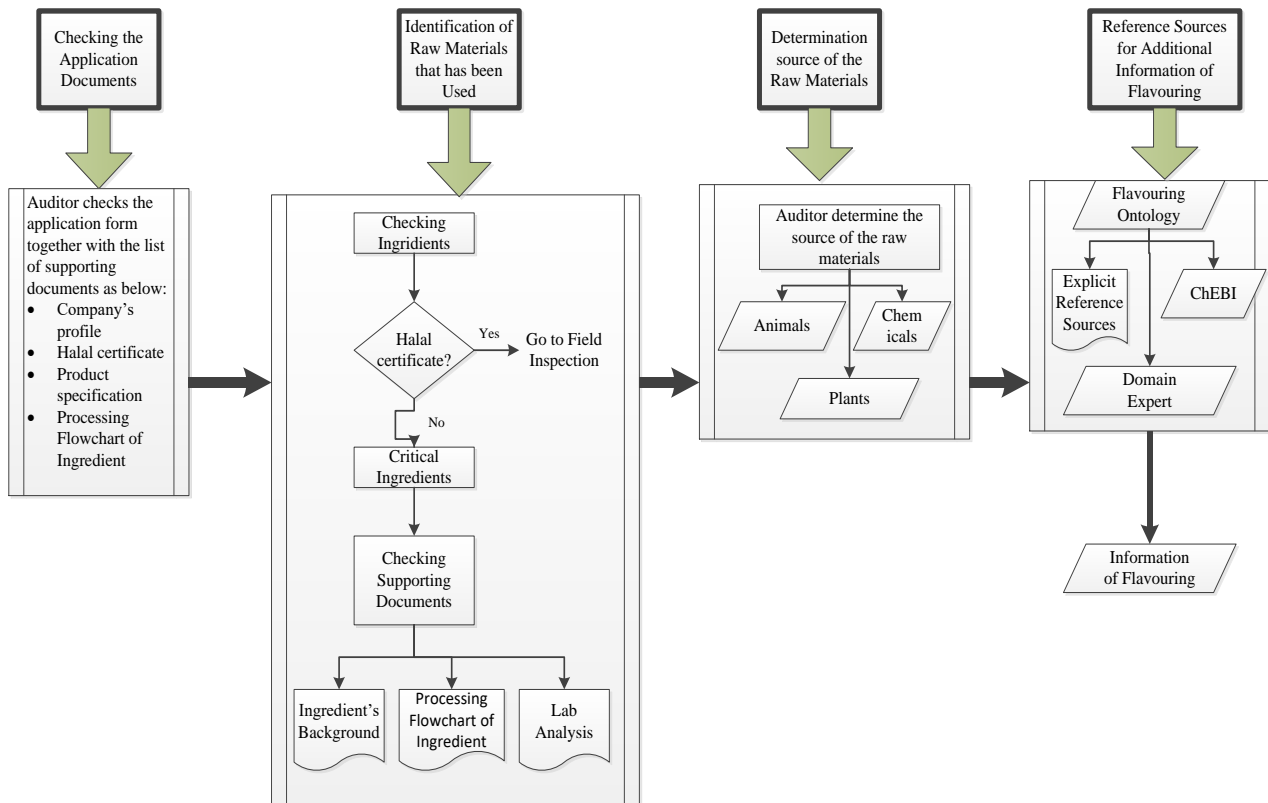

Figure 4: A framework for tracing the information of flavouring

VI. CONCLUSION

Studies on issues in halal certification addressed by prior research concentrated on the managerial perspectives and not from the technology perspective. Previous studies on traceability framework mostly focused on the framework for food producers to trace their product stream in food production. There is no study regarding the traceability on the halal status for ingredients in order to support the halal certification process. Findings from the case study revealed that auditors had difficulties in tracing the halal status of flavouring. Apart from traceability framework, there are few prior studies concerning the use of ontology in tracing the food supply chain. The review from prior studies on ontology in traceability showed the ability of ontology in tracing the product stream because of the capability of ontology in integrating multiple sources of information from various parties in food supply chain. This research focuses on the factors concerning the tacit and explicit knowledge sources that auditors have to refer and how ontology is capable of integrating multiple sources of information into a
form of knowledge representation that can accelerate the process of verification of the halal status of flavouring. In accelerating the process of halal certification, this research designed a framework that concentrates on determining the source of raw materials, the halal status of raw materials and ontological development involving the integration of references sources related to flavouring in the application of semantic technology. Once the framework is developed and validated, the framework will be implemented in the form of

a prototype to track the halal status of flavouring. The expected outcome of this study is a system that can help expedite the halal application process in terms of tracing the halal status of flavouring. When the halal certification application process is accelerated, food producers would be able to market their products faster.

ACKNOWLEDGMENT

REFERENCES

[1] Mohani Abdul, Hashanah Ismail, and Mazlina Mustapha, "Halal Food Certification: Case of Malaysian SME Entrepreneurs," China-USA Bus. Rev., vol. 12, no. 2, pp. 163–173, 2013.

[2] R. Chen, C. Chen, K. C. Yeh, and Y. Chen, "Using RFID Technology in Food Produce Traceability," WSEAS Trans. Inf. Sci. Appl., vol. 5, no. 11, pp. 1551–1560, 2008.

[3] B. Badruldin, Z. Mohamed, J. Sharifuddin, G. Rezai, A. M. Abdullah, I. Abd Latif, and M. G. Mohayidin, "Clients' perception towards JAKIM service quality in Halal certification," J. Islam. Mark., vol. 3, no. 1, pp. 59–71, 2012.

[4] Yuhanis Abdul Aziz and N. V. Chok, "The Role of Halal Awareness, Halal Certification, and Marketing Components in Determining Halal Purchase Intention Among Non-Muslims in Malaysia: A Structural Equation Modeling Approach," J. Int. Food Agribus. Mark., vol. 25, no. 1, pp. 1–23, Jan. 2013.

[5] R. Z. Adam, "KL keen to tap lucrative halal industry", *Business Times*, http://www.halaljournal.com/ artman/ publish/article_511.shtml. 2006. [5 February 2013].

[6] W. M. N. W. S. K. Zurina Shafii, "Halal Traceability Framework for Halal Food Production," World Appl. Sci. J., vol. 17, pp. 1–5, 2012.

[7] Siti Norlina Muhamad, Zamzarina Che Mat, Maznah Ali, Mohd Nasir Ripin, Kamarul Azmi, and Ahmad Kilani Mohamed, "Kecenderungan Ibubapa Muslim Terhadap Pemakanan Halal: Kajian di Skudai, Johor Bahru, Johor.," Skudai, 2005.

[8] Yaakob B Che Man and Awis Qurni Sazili, "Food production from the halal perspective," in Handbook of Poultry Science and Technology, 2010, pp. 183–215.

[9] *MS 1500:2009 - Halal Food - Production, Preparation, Handling and Storage – General Guidelines (Second Revision)*, MS1500:2009, 2009.

[10] Sharifah Zannierah Syed Marzuki, C. M. Hall, and P. W. Ballantine, "Restaurant managers' perspectives on <IT>halal</IT> certification," J. Islam. Mark., vol. 3, no. 1, pp. 47–58, 2012.

[11] M. van der Spiegel, H. J. van der Fels-Klerx, P. Sterrenburg, S. M. van Ruth, I. M. J. Scholtens-Toma, and E. J. Kok, "Halal assurance in food supply chains: Verification of halal certificates using audits and laboratory analysis," Trends Food Sci. Technol., vol. 27, no. 2, pp. 109–119, Oct. 2012.

[12] Nurulhuda Noordin, Nor Laila Md Noor, Mardziah Hashim, and Zainal Samicho, "Value Chain Of Halal Certification System: A Case Of The Malaysia Halal Industry," in European and Mediterranean Conference on Information Systems, 2009, vol. 2009, no. 2008, pp. 1–14.

[13] Shahidan Shafie and Md Nor Othman, "Halal Certification: an international marketing issues and challenges," in Proceeding at the International IFSAM VIIIth World Congress, 2006, pp. 1–11.

[14] Ahmad Hishamuddin. "Community Participation and Empowerment:An Approah for JAKIM Halal Verification and Feedback Mechanism" (unpublished Master dissertation, UiTM). 2007.

[15] G. Schiefer, "Information management in Agri-Food chains", *Quantifying the Agri-Food Supply Chain*, pp. 137-146, 2006.

[16] Regattieri, M. Gamberi, and R. Manzini, "Traceability of food products: General framework and experimental evidence," J. Food Eng., vol. 81, no. 2, pp. 347–356, Jul. 2007.

[17] Y. Sarig, "TRACEABILITY of FOOD PRODUCTS," CIGR J. Sci. Res. Dev. Invit., vol. v, no. December 2003, pp. 1–17, 2003.

[18] V. R. Chifu, I. Salomie, and E. Ş. Chifu, "Ontology-enhanced description of traceability services."

[19] T. Skoglund and P. Dejmek, "Fuzzy Traceability: A Process Simulation Derived Extension Of The Traceability Concept In Continuous Food Processing," Food Bioprod. Process., vol. 85, pp. 354–359, 2007.

[20] Y.Wang, , Y.Yang, , Y Gu, "Research on quality and safety traceability system of fruit and vegetable products based on ontology", *Journal of Convergence Information Technology (JCIT)* 7: 86–93, 2012.

[21] M. Salampasis, D. Tektonidis, and E. P. Kalogianni, "TraceALL: a semantic web framework for food traceability systems," J. Syst. Inf. Technol., vol. 14, no. 4, pp. 302–317, 2012.

[22] T. Pizzuti, G. Mirabelli, M. A. Sanz-Bobi, and F. Goméz-Gonzaléz, "Food Track & Trace ontology for helping the food traceability control," J. Food Eng., vol. 120, pp. 17–30, Jan. 2014.

[23] Norman Azah Anir, Md Nasir Mohd Hairul Nizam, and Azmi Masliyana, "The Users Perceptions and Opportunities in Malaysia in Introducing RFID System for Halal Food Tracking," WSEAS Trans. Inf. Sci. Appl. Norman, vol. 5, no. 5, pp. 843–852, 2008.

[24] A. Bechini, M. G. C. A. Cimino, B. Lazzerini, F. Marcelloni, A. Tomasi, and I. Elettronica, "A General Framework for Food Traceability," in Proceedings of the The 2005 Symposium on Applications and the Internet Workshops (SAINT-W'05), 2005, pp. 5–8.

[25] S. Mukviboonchai, P. Kovintavewat, and D. Thammasiri, "The conceptual framework for the development of Thailand economic animal traceability system," 5th Int. Conf. Electr. Eng. Comput. Telecommun. Inf. Technol. ECTI-CON 2008, vol. 1, pp. 201–204, 2008.

[26] Nurul Aswa Omar, Shahreen Kasim, and Rathiah Hashim, "A Process for Building Ontology E numbers from Various Databases," J. Ind. Intell. Inf., vol. 1, no. 3, pp. 179–184, 2013.

[27] Kamus Dewan Bahasa Ed. Ke-4, Kuala Lumpur: Dewan Bahasa dan Pustaka, 2007.

[28] Nur Adila Azram and Rodziah Atan, "Software engineering traceability method for food ingredient tracing," in 2011 Malaysian Conference in Software Engineering, 2011, pp. 141–145.

[29] S.F.Quadri, M. Majeed, & M. Khan, "What is in Our Food…? Is It Permissible?", http://www.ifanca.org/cms/wpages/detail/4c74f711-5ecc-4392-9d7a-22321b830f0c, 2013 [20 Disember 2013]

[30] B. Haider, "Page 16 - Halal Consumer - Issue 24 Islamic," no. 24, pp. 24–25.

[31] C. McNamara, "General Guidelines for Conducting Interviews.", http://www.managementhelp.org/evaluatn/intrview.htm, 1999, [23 August 2016]

[32] S.F.M. Hashim, J. Salim, W.A.W Mustapha, S.A. Noah, "A Framework for Tracing the Flavouring Information to Accelerate Halal Certification," Laporan Teknik Fakulti Teknologi dan Sains Maklumat", 2016.

[33] M. H. Ali, K. H. Tan, and D. Ismail, "A supply chain integrity framework for halal food," Br. Food J., 2017.

[34] Emi Normalina Omar and Harlina Suzana Jaafar, "Halal supply chain in the food industry - A conceptual model," in 2011 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA), 2011, pp. 384–389.

[35] M. Hafiz, M. Mohamed, and M. S. Ab, "Conceptual Framework on Halal Food Supply Chain Integrity Enhancement," Procedia - Soc. Behav. Sci., vol. 121, pp. 58–67, 2014.

[36] Noy, N.F. and D.L. McGuinness, Ontology Development 101: A Guide to Creating Your First Ontology, 2001.