Research status in Halal: a review and bibliometric analysis

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Received 23 June 2019
Revised 29 September 2019
Accepted 12 November 2019

Abstract

Purpose – Halal is an emerging business sector and is steadily gaining popularity among scholars and practitioners. The purpose of this paper is to critically evaluate and review the reported literature in the broad area of Halal using bibliometric technique and network analysis tools. Moreover, this paper also proposes future research directions in the field of Halal.

Design/methodology/approach – This paper employed a systematic review technique followed by bibliometric analysis to gain insight and to evaluate the research area associated with Halal. Furthermore, data mining techniques are used for analysing the concerned article title, keywords and abstract of 946 research articles obtained through the Scopus database. Finally, network analysis is used to identify significant research clusters.

Findings – This study reports top authors contributing to this area, the key sub-research areas and the influential works based on citations and PageRank. We identified from the citation analysis that major influential works of Halal are from the subject area of biological science and related areas. Further, this study reports established and emerging research clusters, which provide future research directions.

Research limitations/implications – Scopus database is used to conduct a systematic review and corresponding bibliometric study; the authors might have missed some peer-reviewed studies not reported in Scopus. The selection of keywords for article search may not be accurate for the multi-disciplinary Halal area. Also, the authors have not considered the banking/financial aspects of Halal. The proposed four research clusters may inform potential researcher towards supporting the industry.

Originality/value – The novelty of the study is that no published study has reported the bibliometric study and network analysis techniques in the area of Halal.

Keywords Halal, Research clusters, Bibliometric analysis, Halal supply chain management

Paper type Research paper

1. Introduction

In response to the demand for superior quality goods and services, products labelled as Halal have emerged in the market whose spirit is to provide safe and wholesome consumption. Halal products are emerging as a new paradigm for assuring quality and safety by affecting the people's attitude, tastes and values (Lada *et al.*, 2009; Khan and Haleem, 2016). A general perception is that products/services labelled as Halal are for a particular faith of population. However, Halal is a universal mandate which dictates the aspect of consumption, as well as to conduct modes of earnings, relationships, etc. (Alzeer *et al.*, 2018).

Literally "Halal" means permitted or lawful in Shariah, and all consumables are deemed to be Halal, until and unless specifically restricted. Public view limits Halal to the domain of consumables that is free from pork, alcohol as well as their derivatives, and the animals slaughtering is as per the ritual. However, it is evident from the literature that

Modern Supply Chain Research and Applications
Vol. 2 No. 1, 2020
pp. 23-41
Emerald Publishing Limited
2631-3871
DOI 10.1108/MSCRA-06-2019-0014

the concept of Halal is applicable beyond the dietary requirements and, as earlier stated, covers every aspect of life (Alzeer *et al.*, 2018; Demirci *et al.*, 2016; Khan and Haleem, 2016). The term "Toyyib" is used to compliment Halal, and it refers that the Halal product should be wholesome, i.e. nutritious, pure, non-poisonous, non-hazardous as well as non-toxic (Tieman, 2011; Demirci *et al.*, 2016). Specifically, Toyyib characterises that Halal products are clean, free from intoxicant, derived from Halal sources, not causing pain and misery to people consuming or producing it. Rahman *et al.* (2014) and Khan, Haleem and Khan (2018) relate the concept of Toyyib to food ethics, with the main issues being "animal welfare", "humane treatment of animal before slaughtering", "environmental protection", and "fair trade and sustainable consumption practices". The Halal production system eliminates elements hazardous to human health and the environment (Hassan, 2016).

Although research reported in the area of Halal is growing with an upward trend (Alzeer *et al.*, 2018), to the best of authors' knowledge, no study has reviewed and evaluated the subject area of Halal using bibliometric and network analysis techniques. Therefore, to address this gap, this paper reviews the available literature in the broad area of Halal dating back to the year 2006; identifies top contributing authors, countries, affiliations, journals, primary keywords through bibliometric analysis; identifies influential research and cluster them based on citations and PageRank; and suggests future research direction related to different sub-research areas of Halal. The aim of doing bibliometric analysis is to analyse the research in a systematic, reproducible and transparent manner to inform present and future researcher about the trend and evolution of a subject area, thus to minimise research bias through exhaustive mining/audit trail of literature databases. In upcoming sections, relevant literature has been reviewed to gain more in-depth insight into various aspects of Halal followed by methodology undertaken to perform this research.

2. Literature review

A literature review is an essential work to be done before initiating any research project (Khurana *et al.*, 2019). It assesses the relevant literature of the area, to map the work done and to find out the possible research gaps which would help in strengthening the body of knowledge (Tranfield *et al.*, 2003; Sufiyan *et al.*, 2019).

In the area of Halal, major reported articles have explored the attitude of the consumers towards Halal-certified products (Ali, Ali and Sherwani, 2017; Ariffin and Wahid, 2017; Aziz and Chok, 2013; Bashir *et al.*, 2018; Ali, Xiaoling, Sherwani and Ali, 2017; Izberk-Bilgin and Nakata, 2016; Lestari *et al.*, 2018), their biological and chemical aspects to establish integrity and quality of Halal meat (Park *et al.*, 2017; Premanandh and Bin Salem, 2017; Aghwan *et al.*, 2016; Al-Kahtani *et al.*, 2017; Farouk *et al.*, 2014) and parametric evaluation of effect of stunning on ritually slaughtered animals and their welfare (Fuseini *et al.*, 2016; Rahman, 2017; Nakyinsige *et al.*, 2013; Grandin, 2010; Farouk *et al.*, 2016; Farouk, 2013). However, it is observed that only the recently published literature have focussed on managing operational activities of Halal products (Khan, Khan, Haleem and Jami, 2019; Khan, Haleem and Khan, 2018; Zulfakar *et al.*, 2018; Alzeer *et al.*, 2018; Soon *et al.*, 2017; Haleem and Khan, 2017) and on developing Halal standards as a contemporary standard taking modern lifestyle into consideration (Ahmad *et al.*, 2018; Chandia and Soon, 2018; Talib *et al.*, 2017; Muhamad *et al.*, 2017; Butt *et al.*, 2017).

Bonne *et al.* (2007) discussed a case to determine the factors influencing the consumption of meat in France. The finding of this study shows that a positive personal attitude of Muslims is the primary driver towards the consumption of halal meat in France. Alam and Sayuti (2011) used the theory of planned behaviour on Malaysian customers to identify their food

purchasing intentions and supported to invest in making Malaysia a Halal Hub. Wilson and Liu (2011) determined the challenges associated with the concept of Halal and how Halal-conscious customer makes a decision. Furthermore, this study advocates the halal decision-making paradigm as a basis for constructing notable and engaging brands. Lada *et al.* (2009) identified the intention of consumers to choose Halal product through an empirical study focussed on Malaysia. Wilson and Liu (2010) discussed the development of Halal as a brand with the growing market among both Muslims and non-Muslims. Khan, Haleem, Khan, Abidi and Al-Ahmari (2018) emphasized that traceability played a medium to assure the integrity of Halal product and identified the factors which are critical to the successful implementation of traceability in HSCM.

Nakyinsige *et al.* (2013) described various acceptable methods of stunning by Islamic authorities, highlighting the requirements for stunning to be acceptable in Islam and suggesting practical ways to improve the humanness of slaughter. Karim and Bhat (2008) discussed the rationale for developing an alternative for gelatine, as it is not Halal, and further identified its origin and applications.

Zailani *et al.* (2011) explored the non-compliance to Halal norms by most of the hoteliers in Malaysia. They established that perceived benefits towards Halal certification could be as one of the factors that influenced hoteliers not to apply for the certification. Tieman (2011) gave basic principles to incorporate Halal in supply chain management through exploratory research. Moreover, this study pointed out that one of the essential principles for Halal supply chains is to maintain the integrity of the Halal product until the point of consumption. Bonne and Verbeke (2008) discussed the social-technical quality and control in the Halal meat chain and identified its crucial attention point. Karia and Asaari (2016) established that to facilitate Halal goods/services, and 3PLs need to gain access to and transform the right resources into Halal value creation. Ngah *et al.* (2017) identified the determinants of the adoption factors of Halal warehousing activities among Halal manufacturers in Malaysia. The finding of this study suggests that customer pressure, cost, perceived benefits and organisational readiness have a significant relationship with the adoption of Halal warehousing services by Halal manufacturers. In this row, Ngah and Thurasamy (2018) employed the TOE framework to identify the factors that influence the adoption of Halal transport services by Halal pharmaceutical and cosmetic manufacturers.

Ali and Suleiman (2018) through literature review attempted to provide a broad view of Halal food supply chain management. In this review, factors that pose a challenge to food integrity were underlined. These factors are categorised as per supply chain dimensions, related to raw materials, production, service and the consumer. Khan, Haleem and Khan (2018) defined Halal supply chain management to develop a rational understanding of Halal from supply chain perspective by categorising the existing definition reported in this area as per the focus of Halal and supply chain management. Talib *et al.* (2016) using institutional theory analysed the factors that could potentially explain the impetus of Halal food certificate implementation. This study suggests that Halal certificate implementation in the industry depends upon government regulations, demands from the Muslims for Halal foods and intense industry competition.

In the context of the Halal certification, various studies are available in the literature, and some recent studies are mentioned here. Khan *et al.* (2019b) evaluated the inter-relationship among barriers which are detrimental in the adoption of Halal certification and suggested that the effective adoption of Halal certification can achieve a higher level of customer satisfaction through assessment and accreditation. Talib (2017) reviewed the motivation and benefits of implementing Halal food safety certification. It suggests that firms are striving for Halal food safety certification in response to the growing demand for Halal food products and rising concern among the consumers over the series of foodborne illnesses. Khan *et al.* (2019a) using integrated interpretive modelling evaluated initiatives which facilitate the harmonisation of Halal standards by

considering the cost of accomplishment and associated benefits. Haleem *et al.* (2019) have identified and analysed the barriers towards the adoption of Halal certification assessment and accreditation using interpretive structural modelling. The finding suggests that there is a requirement to develop a globally accepted halal certifying body to address the issue of mislabelling and fake logo. From the above discussion, it is evident that reported studies in the area of Halal are very divergent and need an interdisciplinary approach.

3. Research methodology

This study primarily focusses on the bibliometric analysis applied to examine and categorise the body of the literature published in Halal. The objective of the bibliometric study is to quantitatively analyse a research area of Halal to get useful insights into how this field has developed over a span of time through network maps (Apriliyanti and Alon, 2017). Bibliometric analysis is also used to handle all the existing studies in the adopted area efficiently and so that it provides an understanding of the research breadth. The structure of bibliometric analysis used in this paper follows the structure of many bibliometric studies performed on other topics (Fahimnia *et al.*, 2015; Mishra *et al.*, 2017). Figure 1 shows the research methodology adopted in this study.

3.1 Defining keywords

The first step of the bibliometric analysis is the identification of the keywords that are used for the selection of research papers. This study investigates the area of the "Halal", and it is a general term used in many contexts ranging from food, tourism, finance, to various functional areas. To encompass every aspect of this area, we have separately searched for keywords such as "Halal"; "Halal Supply Chain"; "Halal Products", "Halal Authentication", "Halal" and "Supply Chain" in Scopus database but excluded the articles on finance, banking and insurance. In this research, we have excluded the areas of finance, banking and insurance as our focus is on the operational aspects of the Halal product rather than the financial services.

3.2 Initial results

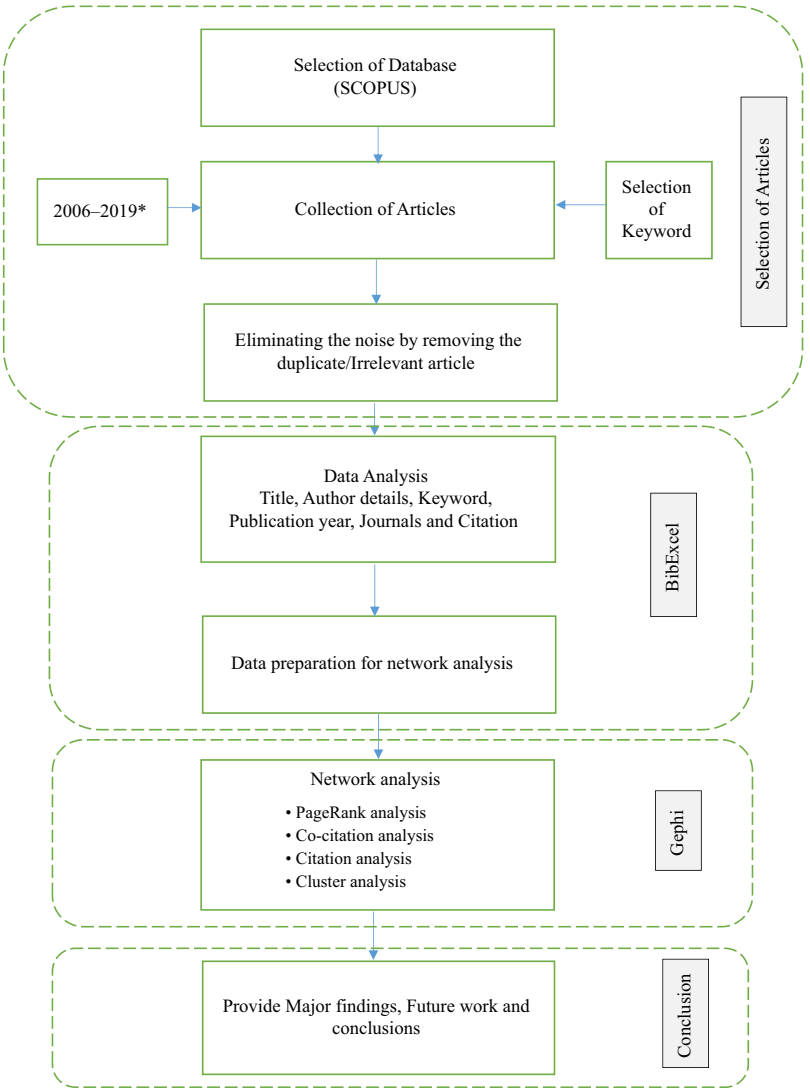
After finalising the keyword, the next step is the selection of the databases that are considered for the study. We have limited our searches in the English language to Scopus database because it is the largest bibliographic database of peer-reviewed articles: academic journals, conference proceedings and book chapters with more than 22,000 peer-reviewed journals, in the fields of science, technology, social sciences (including arts and humanities) and medicals. During the initial search, 1,208 documents were obtained in total, which were later refined as per the criteria mentioned in upcoming sections.

3.3 Refining the initial results

Initial results are refined by excluding book chapter, short surveys and magazine articles. As per the objectives of the research, we have considered only scientific publications (articles and reviews) which appeared in peer-reviewed journals as they are also termed as "certified knowledge". This refinement leads to 946 relevant documents, published during 2006–2019*. The final data file is stored in the RIS format for undertaking further analysis.

3.4 Data analysis

The data analysis process is a two-step procedure, which starts with bibliometric analysis and is followed by network analysis. According to Ismail *et al.* (2012), to measure and assess a large number of scientific articles as well as the citation, a bibliometric analysis is the most suitable technique. Network analysis with the help of a bibliometric tool becomes a



Note: *Represent Data taken up to May, 2019

Figure 1.
Flowchart for the study

robust approach to specifying emerging and established research area in the relevant field (Mishra *et al.*, 2018; Fosso Wamba and Mishra, 2017). Bibliometric analysis was conducted using BibExcel software, which provides data statistic containing the keyword, author and affiliation statistics.

4. Bibliometric analysis

This study is conducted using BibExcel because it has a flexible nature and can handle data from different databases like Scopus and Web of Science. Other applications such as HistCite, Publish and Perish can also manage bibliographic data but have some limitation regarding the

source of data. The upcoming sub-sections reveal statistics of authors involved, their respective associations, journals, keywords frequently used as obtained from the bibliometric analysis.

4.1 Authors involvement

Fields containing authors' detail were extracted from the data file using BibExcel. Table I displays the contribution of Top 10 authors. It is evident from Table I that Rohman, Abdul with 20 publications in the field of Halal dominates the list and is followed by Sazili, Awis Qurni, who has 13 papers.

4.2 Affiliations statistics

BibExcel is used to extract affiliations (with their geographical locations) producing research in Halal from the RIS data file. Figure 2 shows the major institutions with their publication count in the area of Halal.

Figure 3 shows the major contributing countries in the research area of Halal. Malaysia is the major contributor followed by the UK and Indonesia.

S. No.	Authors	No. of articles
1.	Rohman, Abdul	20
2.	Sazili, Awis Qurni	13
3.	Fischer, Johan	12
4.	Zailani, S.	12
5.	Regenstein, J.M.	11
6.	Jaswir, I.	10
7.	Zulkifli, I.	10
8.	Goh, Y.M.	9
9.	Tieman, M.	9
10.	Mohamed, Zainal Abidin	8

Table I.
Top 10 contributing authors

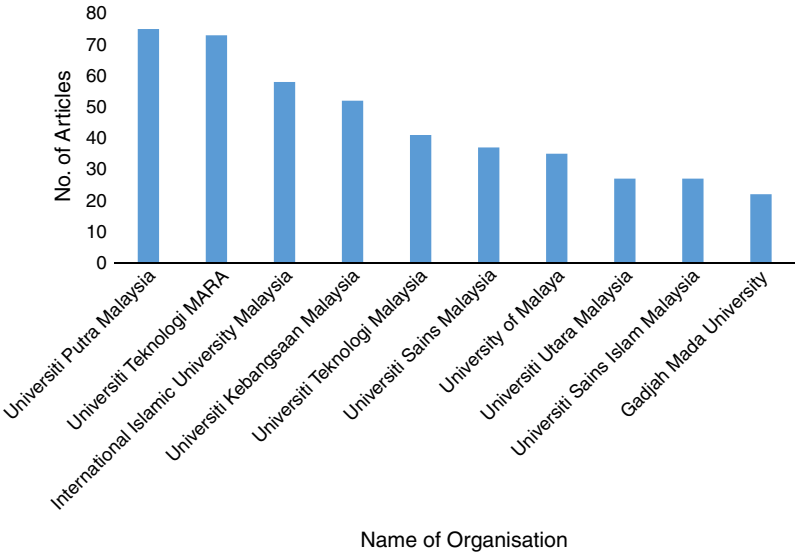


Figure 2.
Major universities contributing to Halal

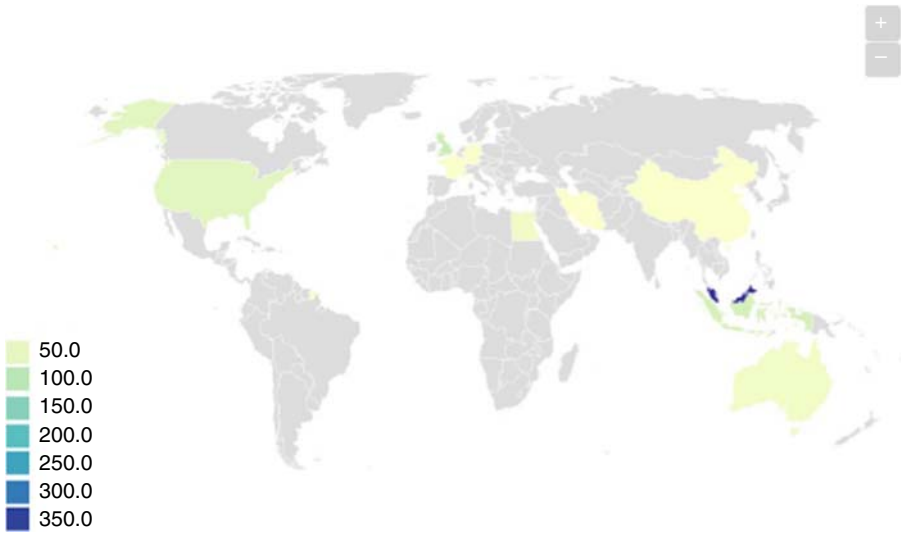


Figure 3.
Status of research in Halal in various countries/territory (Top 10)

4.3 Journal statistics

Using the Bibexcel software, we have extracted the top ten journals which have published the articles in the area of Halal. Table II shows the list of the top ten journals concerning the number of articles published from 2006 to 2019*. It also represents the total number of articles published in each year. It is observed that these journals had published 314 articles in this field of research. The maximum number of papers are published in the *Journal of Islamic Marketing* which has the highest number of articles, approximately 26 per cent of the total papers published by the top ten journals. The published literature associates Halal with Islamic dietary law and is only for non-vegetarian foods.

4.4 Keyword statistics

Similar to the previous sub-sections, using the frequency of the same tool of repeatedly used keywords (terms) in the abstract, document title and the list of authors, keywords were obtained as shown in Table III. On comparing these three columns of Table III, we observe an apparent uniformity in the use of terminology. For instance, the most repeatedly used keywords include Halal, Food, Products, Muslims, Islamic and Malaysia. It is evident that the word "Halal" is used mostly for food, that too, with a focus on Muslims.

5. Network analysis

Different software packages are available to conduct network analysis such as Graph Maker, Gephi, VOS viewer, HistCite and Pajek. Gephi (2013) provides flexible visual aids and has a powerful filtering tool and can handle different data formats (Mishra *et al.*, 2016). Gephi is also capable of dealing with complex data sets and generates purposeful visualisations. However, Gephi cannot handle the RIS format file; therefore, the data file is converted into a .NET format to undertake network analysis.

5.1 Citation analysis

Citations have used a measurement of influence in academia. If the citation index of any author, affiliation or publication is high, then the author, affiliation or publication will be considered as influential in that field. To evaluate the citation frequency for ranking

Table II.
Top journals contributing to the area of Halal

Journals	Publishing year														
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Journal of Islamic Marketing					3	5	8	3	4	11	9	16	21	3	83
Meat Science		1	3	2	1	3	5	4	7	4	4	3	1	1	39
Food Manufacture				1	1	4	9	6	2	3	2	8	3		39
International Journal of Supply Chain Management									1		5	5	24	4	39
International Food Research Journal				1	1	1	2		3	5	6	8	3		30
Advanced Science Letters										5	3	16			24
British Food Journal		2	1					1		6	2	5	9		26
Journal of Food Products Marketing		1				1	1	1	1	2	1	2	3	1	14
Food Control		1						1			1	4	4		11
Journal of International Food and Agribusiness Marketing				1				4	2		1	1			9
Total	0	5	4	5	6	14	25	20	20	36	34	68	68	9	314

the journals as per their significance in the research area (Garfield, 1972) and to indicate the scientific research impact, citation analysis is undertaken. It also provides insights into the popularity of articles and the impact of authors based on their citation and co-citation. Using this technique, we have identified the Top 10 authors according to their research citation in Scopus (please see Table IV).

5.2 PageRank analysis

According to Ding and Cronin (2011), the importance of the research article is measured through citation analysis. Popularity and prestige are assumed to be correlated; thus, in 1998, Brin and Page introduced "PageRank" to measure priorities of keyword search results (Mishra *et al.*, 2017). The PageRank value of the Top 10 articles is calculated as per Brin and Page's (1998) methodology.

Consider a paper "A" has been cited by papers $T_1, \ldots, T_n$. A parameter d is defined called "damping factor", which represents the fraction of random walks that continue to propagate along with the citations. The value of parameter d is fixed between 0 and 1. Now, $C(T_i)$ is defined as the number of times paper T_i has cited other papers. The PageRank of paper A, denoted by "PR (A)", in a network of N papers is calculated as follows:

$$\mathrm{PR(A)} = \frac{(1-d)}{N} + d\left(\frac{\mathrm{PR}(T_1)}{C(T_1)} + \cdots + \frac{\mathrm{PR}(T_n)}{C(T_n)}\right).$$

It is important to note that if $C(T_i) = 0$, then $\mathrm{PR}(T_i)$ will be divided into the number of papers instead of $C(T_i)$. The value of parameter d has been the subject of debate, with scholars suggesting a value of 0.85 (Brin and Page, 1998), whereas others a value of 0.5 (Chen *et al.*, 2007).

S. No.	Frequency in document title Keywords	Frequency	Frequency in abstract Keywords	Frequency	Frequency in keywords Keywords	Frequency
1	Halal	475	Halal	2,862	Halal	241
2	Food	154	Food	1,149	Islam	108
3	Islam	80	Products	699	Meat	103
4	Meat	75	Islam	607	Malaysia	99
5	Malaysia	73	Muslims	578	Animal welfare	89
6	Products	63	Meat	420	Religion	50
7	Muslims	62	Malaysia	354	Human	42
8	Certification	52	Consumers	314	Halal food	39
9	Quality	40	Religious	308	PCR	36
10	Slaughter	36	Certification	296	Gelatine	35

Table III. Showing frequently used keywords in the abstract, document title and the list of authors keywords

Author (year)	Citation
Wilson and Liu (2010)	150
Alam and Sayuti (2011)	143
Rohman *et al.* (2011)	133
Wilson and Liu (2011)	133
Bonne *et al.* (2007)	124
Bonne and Verbeke (2008)	115
Aida *et al.* (2005)	107
Nakyinsige *et al.* (2012)	93
Murugaiah *et al.* (2009)	90
Mukhtar and Mohsin Butt (2012)	82

Table IV. Top 10 authors based on citation analysis

In the area of Halal, the Top 10 papers were identified and analysed using PageRank analysis, and Table V shows the result of these papers along with the citations. However, we found from this analysis that citations and top papers are not very well correlated, and this may be because of the mutually exclusive behaviour of respective research areas, or there may be citations from local journals of Malaysia, which are not indexed by Scopus.

5.3 Co-citation analysis

Co-citation analysis is used to track the relationship between authors, journals, keywords or topics. It is applied to measure the correlation degree between two distinct articles. A co-citation occurs when two articles share one or more same references (Walter and Ribière, 2013). When this co-citation analysis is applied to authors, it identifies the structure of the social relationships between them. If this analysis is used for publications, then it gives the intellectual structure of a field and provides the evolution and variation of research over time.

In this paper, Gephi is used to conduct the co-citation analysis. Here, we have analysed the ".NET" file for all the available articles in Gephi. However, this generates a random map with no identifiable (visible) pattern. Thus, to restore visibility, an algorithm named "Force Atlas" of Gephi is used to show the networks of co-cited related articles that was recommended by several researchers (Fahimnia *et al.*, 2015). Additionally, after adjusting the strength, repulsion and other characters in Gephi, Figure 4 reflects the Force Atlas layout of the 946 nodes network. It shows that only strongly connected nodes were allowed to be at the centre, whereas loosely connected nodes are at the boundaries. The relative size of the bubbles in Figure 4 shows the relative citation they have received. Force Atlas layout map represents the connection between co-cited articles, and at the same time, a rarely

Table V.
Top article based on PageRank analysis

Author (year)	PageRank	Citation
Wilson and Liu (2010)	0.023329	40
Zulfakar *et al.* (2014)	0.017117	7
Zakaria (2008)	0.016793	19
Zailani *et al.* (2010)	0.016542	9
Wilson and Liu (2011)	0.013537	29
Zakaria and Abdul-Talib (2010)	0.011045	8
Tieman (2011)	0.009317	53
Zailani *et al.* (2015)	0.009176	8
Lada *et al.* (2009)	0.008032	34
Eliasi and Dwyer (2002)	0.007825	11

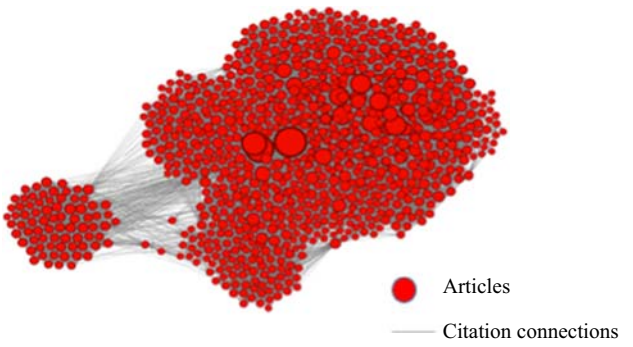


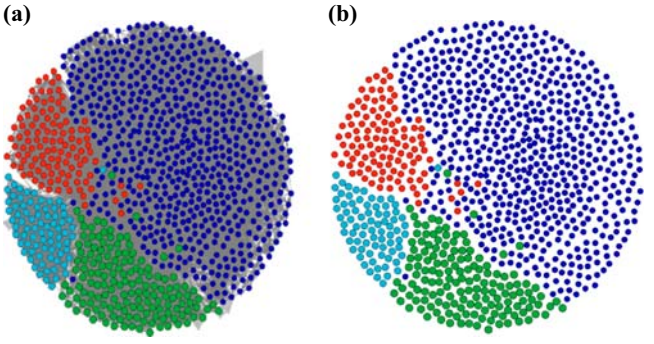
Figure 4.
Force Atlas layout of 960 nodes

connected node is moving away from the centre. In data clustering, the nodes which are isolated from rest of the network are taken as outliers and excluded.

5.4 Data clustering

The data clustering method helps to group articles in different clusters (Mishra *et al.*, 2017). It is used in the literature for classifying given set of publications and termed as modularity. Data clustering places together the sets of articles sharing the same characteristics. In this study, data clustering is conducted as per Clauset *et al.* (2004) and the concept of modularity to measure the density of links as per Blondel *et al.* (2008) is used. Gephi is used for making measurement calculations and observed that here the value of modularity index varies between −1 and +1. In this paper, we have applied the Louvain algorithm to a network of 946 nodes. Figure 5 shows the identified four significant clusters obtained through this analysis and the same are depicted along with their positioning and interaction. The value of the modularity index is 0.54, indicating a healthy relationship among the nodes within each cluster.

Table VI shows the co-citation analysis and papers listed in each cluster of research areas as provided through PageRank. The research areas identified through these clusters help in identifying different phases of research in Halal.



Notes: (a) With arcs; (b) without arcs

Figure 5.
Structure of four clusters

Cluster 1	Cluster 2	Cluster 3	Cluster 4
Zakaria (2008)	Zivotofsky and Strous (2012)	Zhou *et al.* (2006)	Eliasi and Dwyer (2002)
Wilson and Liu (2010)	Vergara and Gallego (2000)	Zhou and Regenstein (2004)	Yusop *et al.* (2011)
Tieman (2011)	Zulkifli *et al.* (2014)	Zayas (1997)	Tanabe *et al.* (2007)
Wilson and Liu (2011)	Vergara *et al.* (2005)	Surh *et al.* (2006)	Yang *et al.* (2005)
Zulfakar *et al.* (2014)	Velarde *et al.* (2003)	Yi *et al.* (2006)	Wu *et al.* (2009)
Zakaria and Abdul-Talib (2010)	Rosen (2004)	Ward and Courts (1977)	Rohman *et al.* (2011)
Riaz and Chaudry (2004)	Webster (1994)	Yang *et al.* (2007)	Tartaglia *et al.* (1998)
Zulfakar *et al.* (2012)	Velarde *et al.* (2014)	Zhou and Regenstein (2005)	Syahariza *et al.* (2005)
Zakaria and Abdul-Talib (2010)	Wotton *et al.* (2000)	Yamauchi *et al.* (1980)	Rohman and Che Man (2009)
Zailani *et al.* (2010)	Newhook and Blackmore (1982)	Schrieber and Gareis (2007)	Xu *et al.* (2012)

Table VI.
Clusters and respective top contributing authors

Table VII shows the four major clusters and the associated research areas of Halal to help the researcher community. The first cluster is labelled as "Supply Chain, Branding and associated aspects of Halal". Therefore, this cluster suggests developing the measures to analyse perception of non-Muslim consumers, branding of Halal for non-Muslims customers, integrating cold chain in Halal logistics with cradle to grave approach, developing framework for Halal reverse logistics, measuring customer satisfaction and customer delight with the belief in Halal and developing framework to extend Halal integrity from farm to fork and risk analysis in Halal Supply Chain. This cluster is evolving, and most researchers are focussing on Halal from a supply chain perspective.

The second Cluster focusses on "Slaughtering and Stunning aspects of Halal". Early research in this area focusses on the legality of stunning for Halal meat, and after developing the consensus, the focus is on the effect of stunning on meat quality. Future research is to focus on developing humane slaughtering methods while improving the quality of the meat.

Labelled the third cluster as "Additives in Halal Foods". Research in this sub-area focusses on developing additives that are Halal and not derived from non-Halal sources. Research in this cluster also focussed on developing and improving the processing of Halal additives.

The fourth cluster is labelled as "Food Chemistry and associated Sciences". Research in this area is focussing on developing testing methods to ascertain the integrity of Halal products. Extensive research is being undertaken in this area as compared to other sub-areas.

6. Discussion of results

Halal as a research area is highly divergent, and most of the authors involved are from Islamic countries and have contributed to different related subject areas. The broad research area seems to be "biological sciences", especially "meat sciences" and "food technology", and Halal appears to be a sub-area of these broad areas. The significant contributions are from the research institutes of Malaysia and Indonesia. There is a need to develop this area to cater to the industry needs, which has a size of more than $3.66 trillion. Unless researchers from all over the world are involved, there will always be a problem of acceptability of Halal-based research, technology and process.

Table VII.
Clusters and corresponding research suggestions

Cluster number and label	Future research areas and suggestions
Cluster 1: supply chain, branding and associated aspects of Halal	Developing measures to analyse the perception of non-Muslim consumers
	Branding of Halal for non-Muslims customers
	Integrating cold chain in Halal logistics with cradle to grave approach
	Developing a framework for Halal reverse logistics
	Measuring customer satisfaction and customer delight with the belief in Halal
	Developing a framework to extend Halal integrity from farm to fork
	Risk analysis in Halal supply chain
Cluster 2: slaughtering and stunning in Halal meat production	Measuring the effect of stunning on meat quality and its parametric evaluation
	Process design and development to safeguard animal welfare
	Develop methods which assure stunning criteria meet Halal compliances
Cluster 3: additives in Halal foods	Developing new additives in vegetarian and non-vegetarian Halal foods
	Determine the role of preserving agents and additives on Halal integrity
	Establish new testing methods to diagnose Halal integrity
	Permissibility of toxics/banned items/intoxicants in Halal foods
Cluster 4: Halal related food chemistry and sciences	Developing implementable chemical processing methods for Halal foods
	Develop a better understanding of Halal foods chemical composition
	Effect of physiochemically altered ingredients on the Halal status of consumables
	Develop expertise in chemistry, food technology or other related science with a pharmaceutical background in order to cater to emerging Halal issues

Contemporary authors have rarely touched upon the operations management aspect of Halal, and this is also a major limitation. The need is to undertake research in "Halal" with a perspective of "Operations Management" and stress "Halal" as a "process-oriented" approach instead of a product-oriented. Thus, it involves practitioners and researchers from all over the world, and not from some few countries. One needs to include new development in the areas of medicine (pharmaceuticals), natural products, cosmetics and tourism in the area of Halal.

The important keywords identified in this subject area are "Halal", "food", "products", "Muslims" and "Islam", and this shows that researchers are more interested in the food aspect of Halal and inferred that Halal is only for Muslims. A significant area of Halal, such as Halal Cosmetics, Halal Pharmaceuticals, vegetarian and natural products remains untouched. Also, "Toyyib" aspects of Halal products are rarely touched, which compliment Halal and conceptualise it in a broader term.

Citation analysis reveals that "Halal" as a research area receives less citation as compared to other similar research areas of food safety and security. We have identified four significant clusters based on PageRank analysis. We have used the concept of Modularity as given by Blondel *et al.* (2008) to measure the density of the links. The Louvain algorithm has been used in Gephi to measure the modularity. These four clusters are Supply Chain, Branding and associated aspects of Halal; Slaughtering and Stunning; Additives in Halal Foods and Food Chemistry and associated Sciences.

7. Conclusion, limitation and future work

Halal being an upcoming industry seems to have insufficient support from the research and development as the research work around Halal appears to be in infancy. All possible articles which are listed in the Scopus database were extracted. We have tried to analyse the designated area of Halal using bibliometric analysis like identifying the top authors, journals, and citation, and further data mining techniques are for analysing article title, keywords and abstract of 946 articles obtained through Scopus. PageRank analysis has been done to identify four significant clusters by considering the top research articles. Research direction has been identified using available bibliometric and data mining techniques. Through this study, an attempt was made to explore the different sub-fields in the area of Halal that will provide the direction for future researchers.

This study has some limitation as, during this study, only the Scopus database was used to conduct a systematic review and bibliometric study; some peer-reviewed studies may have missed. As Halal is a broad area, the selection of keywords for article search may not be accurate. Also, we have not considered the banking/financial aspects of Halal. Moreover, we have employed the bibliometric technique of citation and co-citation analysis for reviewing the literature, but there may be other methods to be used for citation and co-citation analysis. Conclusively, this study will help in the identification of the future research areas in Halal and may cater to the need of the associated developing industry.

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