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BIBLIOMETRIC TRENDS ON HALAL SCIENCE AND HALAL EDUCATION: A REVIEW

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Abstract:

The global halal industry has grown significantly, driven by contributions from government, industry, academia, community, and environmental stakeholders. This growth underscores the importance of science and technology (S&T) and education in advancing the halal ecosystem. However, limited research has explored halal science within a holistic, faith-based framework or the development of formal halal curricula. Guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), this study investigates publication trends and the body of knowledge in halal science and halal education. Using a bibliometric approach, data from Scopus were analysed through tools like VosViewer software v1.6.13 and Biblioshiny tools (RStudio 2023.12.0) while for Google scholar the search was done through Publish and Perish v8.0 . The study identified 155 Scopus and 96 Google Scholar entries, focusing on trends, thematic mappings, and keyword networks. Findings reveal increasing interest in both domains, with Scopus highlighting halal authentication, profiling, and halal meat research, while Google Scholar focuses on consumer behaviour and perceived knowledge. Both sources lack alignment with a holistic, tawhidic-based approach to halal science and have minimal attention to formal halal education curricula. Research in halal science remains tied to conventional S&T applications, and halal education primarily addresses consumer knowledge rather than structured learning. The study concludes that halal science needs a faith-based paradigm, and halal education requires formal integration into curricula to sustain the halal ecosystem. Future efforts should develop comprehensive halal curricula across educational levels

and integrate tawhidic principles into halal science. These initiatives will bridge gaps, fostering innovation and sustainable growth in the halal industry.

Keywords:

Halal Science; Halal Curriculum; Halal Syllabus; Halal Knowledge

Introduction

The impressive growth of the global halal industry since a few decades ago is fueled by various factors or efforts by stakeholders of the quintuple helix; the government, industry, academia, community (civil society) and the environment; which together constitute the halal ecosystem. This growth is reflected by the values of halal goods traded where in 2021, Dinar Standard reported USD254 billion worth of trade with a projection to reach USD1.8 billion by 2025 (Dinar standard, 2024). To meet this growing demand for halal products and services, science and technology (S&T) is seen as an indispensable tool within the quintuple helix. Established S&T disciplines as commonly known in the academia (such as chemistry, biology, biotechnology, material science, computer science and information technology) have been utilized across the halal research towards applications in halal authentication, halal profiling, halal alternatives and halal traceability. In recent years, the term ‘halal science’ has appeared in the halal research community. The definition of ‘halal science’ varies, but it points to the use of the ‘conventional’ S&T in the areas of halal (as described above) with some researchers putting a weightage on doing S&T in the conscious context of religion considering halalan toyyiban is a faith-based system decreed by Allah s.w.t. (Hashim et al., 2024).

Further upstream of S&T, the demand for halal products and services can only be met through knowledge creation where the academia’s role is unprecedented. Carayannis, Barth, and Campbell (Carayannis et al. 2012) argue that the resource of knowledge is the most important ‘commodity’ in the quintuple helix, and the circulation of knowledge continually stimulates new knowledge that then drives innovation. From the perspective of quintuple helix, Carayannis, Barth, and Campbell (Carayannis et al. 2012) further described that the education system refers to academia, universities, higher education systems, and schools; where the ‘human capital/resources/talent’ (e.g., students, teachers, scientists/ researchers, academic entrepreneurs, etc.) is being formed by diffusion and research of knowledge. In halal related research, however, halal education seems to receive less attention despite its importance in talent development and human resources for the halal industry (Jais, 2014).

While there is a substantial interest and attention in scholarly discourses on halal including a growing number of bibliometric works, there has been a dearth of discussion on ‘halal science’ and ‘halal education’ in the literature leading to unresolved discipline of knowledge. The aims of this work, therefore, are (i) to explore the trends in publication related to halal science and halal education and (ii) to uncover the body of knowledge in halal science and halal education.

Literature Review

Bibliometric study can systematically reveal not just the descriptive data on scientific activity but more importantly it can uncover the research constituents of a topic and its relationship with the contributing research community leading to innovative research ideas for further exploration (Aria and Corrado, 2017; Donthu et al., 2021). These features have captured the interest of academia in various disciplines leading to the surge of bibliometric work in recent

years, including in halal-related fields. In 2023 alone, several bibliometric works concerning halal research were reported ranging from a wide-scope approach such as work by Putera and Rakhel (Putera and Tiurma, 2023) and (Zaki et al., 2023), and more specific areas such as halal food additives and ingredients (Nazaruddin et al., 2023), halal cosmetics and halal pharmaceuticals (Bahrin et al., 2023; Elgharbawy and Eiffah, 2023), halal industry (Darmawati et al., 2023; Safitri and Mukhamad, 2023) and halal tourism (Abdullah et al., 2023), halal and digitalization (Priantina and Devinna, 2023), halal supply chain (Hanoum et al., 2023; Rusydiana et al., 2023), Islamic fashion (Pradana et al., 2023) and Islamic finance within the halal industry (Lestari and Sudarso, 2023).

Across the bibliometric works, researchers utilized various tools for the bibliometric and network analysis including VosViewer, Bibliometrix from R package and CiteSpace. The databases used to source the data also varied with Scopus seeming to be the preferred choice with other reported databases including WOS, Google Scholar and Dimension. Keywords are also different based on research questions. The many variables involved, including the different keywords used could hinder objective and unified interpretation of a set of bibliometric work rendering a careful analysis to arrive at a consensus.

Despite the unique challenges, pros and cons of each approach, all of these variations have fairly contributed to the wealth of information that may develop into a body of knowledge in a certain discipline. Likewise, in the halal related research, bibliometric work may help its research community to identify research gaps, directions and future trends. For instance, in the bibliometric work surrounding halal supply chain (Hanoum et al., 2023), five research clusters were identified namely halal food industry, challenges and opportunities of halal logistics, integrity guarantee of halal food, integrity guarantee of halal logistics and halal logistics performance. Other researchers may use these findings to further study their scope of interest in more depth. Another example, based on their bibliometric work on Islamic fashion, Pradana, Elisa, and Syarifuddin (Pradana et al., 2023) argued that as Muslims' interests are greatly influenced by their beliefs, studies on sentiments in the retail and fashion sector should be explored in more depth.

In a previous bibliometric work, halal science, halal curriculum, and intellectual discourse on halal practice and Islamic faith were among the under-researched areas in the halal field as compared to the more industry-related halal sectors such as food, authentication, marketing and logistics (Hashim et al, 2022). Further, the identified S&T clusters in the article were observed not to be connected to the term 'halal science', rather it portrays the established S&T academic disciplines. This has served as a motivation for this present work to be undertaken to investigate our hypothesis that halal-related S&T research areas are positioned under the umbrella of halal science. This could be addressed once the body of knowledge is uncovered through bibliometric network analysis. Responding to the research gap in halal curriculum identified in the same article, this present work also focuses on the 'halal education' scope to further understand the landscape towards further development in the area.

Methodology

This study adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to achieve the objective and address the research questions. The study commenced with defining the research questions followed by data collection, bibliometric analysis and its visualization, and finally interpretation and explanation of findings.

Data Sources and Collection

This study employs Scopus and Google Scholar as the source of data. Scopus was chosen due to its large variety of articles covering science and social science (Mongeon and Adèle Paul-Hus, 2016). In recent years, Scopus database has been the preferred and trusted choice for bibliometric studies in various fields due to its high-quality curated data (Baas et al., 2020). Although Google Scholar, a crawler-based web search engine is unable to recognize complex search string and has no advanced search features (Houshyar and Hajar, 2018), it was included in this work to assist in finding literature which may not be at par with Scopus requirement but considerably important to be identified (for instance the articles in the emerging areas). Google Scholar was also chosen to allow extraction of sources in Malay language (Bahasa Melayu and Bahasa Indonesia) considering the abundance of research in the halal field is within this language-speaking nations.

The initial data extraction was performed on 31st October 2023, using the search string shown in Table 1. Due to different requirement of each database, the search string was designed to fulfil the specific criteria of each database while maintaining the keywords intended. The search in Scopus was performed across title, abstract, keyword and whole manuscript. Bibliometric and network analyses were performed using VosViewer software v1.6.13 and Biblioshiny tool, a web-specific package from RStudio 2023.12.0.

Meanwhile, for Google Scholar, the search was done through Publish and Perish v8.0. The search was performed across title words and the data was saved in Comma-separated values (CSV) text file format. After screening and verification, the data was saved in Research Information System (RIS) format before visualization in VosViewer v1.6.13. For both databases, there was no time period specified as authors aimed to capture the full evolution of the body of knowledge in halal science and education.

Table 1: Search string for Scopus and Google Scholar

Database	Search string
Scopus	((ALL ("halal education")) OR (ALL ("halal knowledge")) OR (ALL (halal AND curricul*)) OR (ALL (halal AND sylla*)) OR (ALL (halal AND syllabus)) OR (ALL (halal AND curriculum))) OR (ALL ("halal science"))
Google Scholar	"halal science" OR "halal educ*" OR "halal knowledge" OR "halal sylla*" OR "halal curri*"

Two researchers (MAY and YZH-YH) independently performed the initial analysis. In total, 825 items were extracted from Scopus and 101 items from Google Scholar (through Publish and Perish v8.0). The records were then screened. The screening process involved removal of duplicates, articles in foreign language (other than English, Malay and Indonesian), records with incomplete titles and technical errors. Four authors; MAY, YZH-YH, NHS and NA assessed the eligibility of the records. The final number of records found to be relevant to scope of study were 155 (Scopus) and 96 (Google Scholar).

Bibliometric and Network Analysis

To achieve the objectives of this aim, this study employs both bibliometric performance (or descriptive) analysis (BPA) and bibliometric network analysis (BNA) as reported in Kashi and Shah (Kashi and Mohamed, 202) and the references therein. BPA seeks to describe the trend

and most important research constituents such as most relevant countries, institutions, journal, authors and articles. Meanwhile, BNA helps to comprehend the intellectual structure (e.g. co-citation analysis), the social structure (e.g. co-authorship analysis), and the conceptual structure (e.g. thematic map analysis, and title and abstract).

Results and Findings

Due to technical differences in extracting data and subsequent analyses between the two databases, results and findings for records sourced from Scopus and Google Scholar are presented separately in this section. Upon completion of data collection and screening, the authors also observed that the records sourced from the two databases are noticeably different. By considering separate analysis, one can avoid overshadowing relevant information and reaching incomplete or biased conclusions. This approach allows for a more comprehensive understanding of a topic.

Publication Trends for Records Obtained from Scopus

Document by Type

Figure 1 shows that most documents published on halal science and education in Scopus are of article type (75%). Other types of documents include review paper (9%), book chapter (7.0%), conference papers (7.0%), book (1%) and note (1%).



Figure 1: Document By Type (From Scopus Database)

Most of the conference papers were published by the IOP Conference Series: Earth and Environmental Science. It was observed that other conferences were focused on the technology based on established academic disciplines or research areas, such as photonics and nanotechnology, rather than in a specific halal-related scope. For instance, Said et al. (2014) published a conference paper on the scope of electrochemical detection of alcohol using enzyme sensors in the Technical Proceedings of the 2014 NSTI Nanotechnology Conference. Another example, Saad, Othman, and Abd. Rahman (2014) published a conference paper on optical sensing of low ethanol concentration in the Proceeding of the 5th International Conference on Photonics and Expo. It is important to note that in recent years, there are many conferences focusing on halal related themes. However, the conference papers are often not published in Scopus proceedings.

Meanwhile, 14 review papers were published in a decade beginning year 2013. Almost half of the reviews were focused on authentication and its related techniques. Other topics include big data and the Internet of Things (IoT) in the halal industry, halal cosmetics, and halal alternative

materials. While several bibliometric works on halal have been published in recent years (as described earlier), only one article was found in Scopus (Putra et al., 2023) to be using the bibliometric approach to investigate halal research streams.

Year Of Publication – Evolution Of Published Studies

Between the year 2009 to 2018, the documents published per year were ten or less. However, the number of publications increased exponentially from 2018 to the present (Figure 2), indicating a growing interest in scholarly research in halal science and education. The first halal-themed article recorded in the Scopus database was from Thailand. The article appeared in the International Journal of Cosmetic Science, reporting on the development of clay liquid detergent for Islamic cleansing (Angkatavanich et al., 2009).

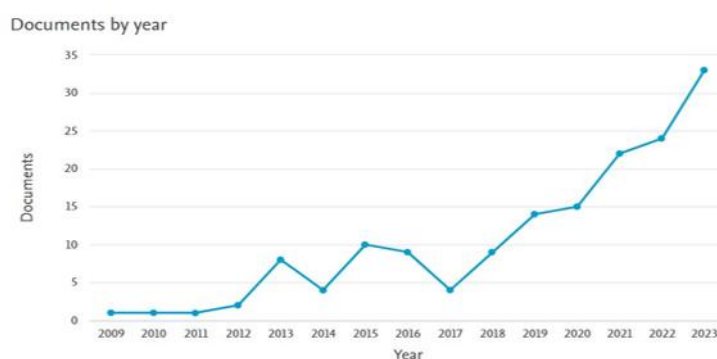


Figure 2: Annual Publication Trends (From Scopus Database)

Most Relevant Authors

Figure 3 showed the top ten authors and their productivity (based on number of articles and total citation per year) over time. Cumulatively, the most prominent author, Rohman, A. published 14 articles, followed by Mustafa, S. (12 articles), Khatib, A (9 articles), Amin, I. (8 articles) and Dahlan, W. (7 articles). It is observed that Dahlan, W. is consistent in publishing his work, spanning from 2009 to present as compared to many of the other authors where publications seem to be time bound.

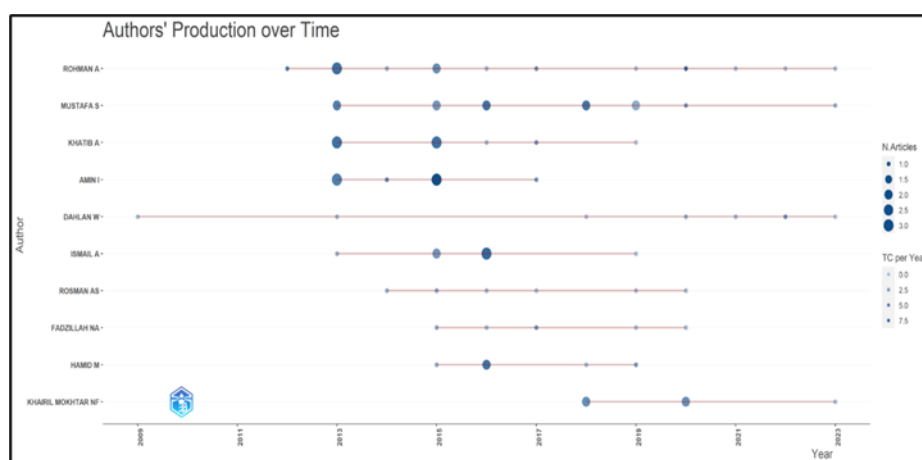


Figure 3: Authors' Production Over Time

Most Cited Articles

Figure 4 shows the most cited documents. The top three most cited documents with more than 50 citations were from Stephenson, M.L (2010), Rohman, A. (2012) and Nur Azira, T. (2014). The article from Stephenson, M.L. was about the Islamic hospitality in the United Arab Emirates, the articles from the other two authors revolved around halal profiling and authentication. The article by Rohman, A. was on analysis of pig derivatives for halal authentication while the article by Nur Azira, T. was on the use of principal component analysis for differentiation of gelatine sources based on polypeptide molecular weights.

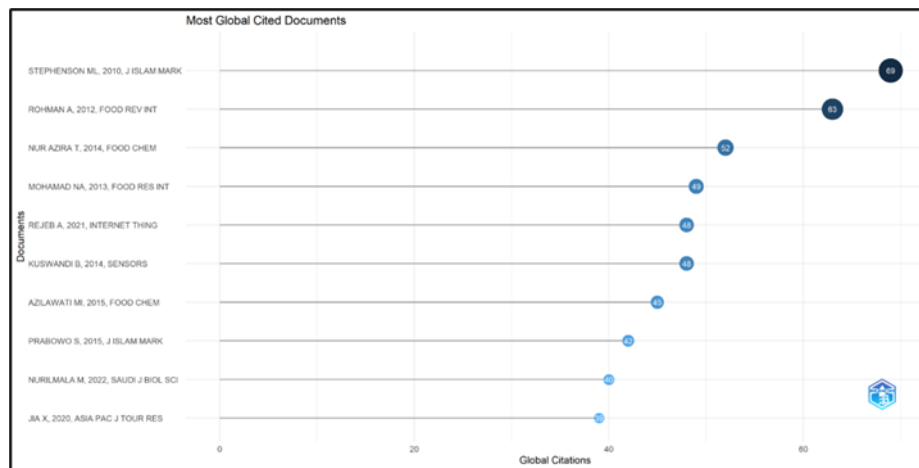


Figure 4: Most Cited Articles

Most Relevant Sources

Figure 5 displays the results of Bradford's law analysis, indicating that a small number of journals (out of 110 journal titles) total are contributing and containing the most published papers in the field of halal science and education. Journal of Islamic Marketing was the most prominent journal while most of the relevant journals were observed to be related to food.

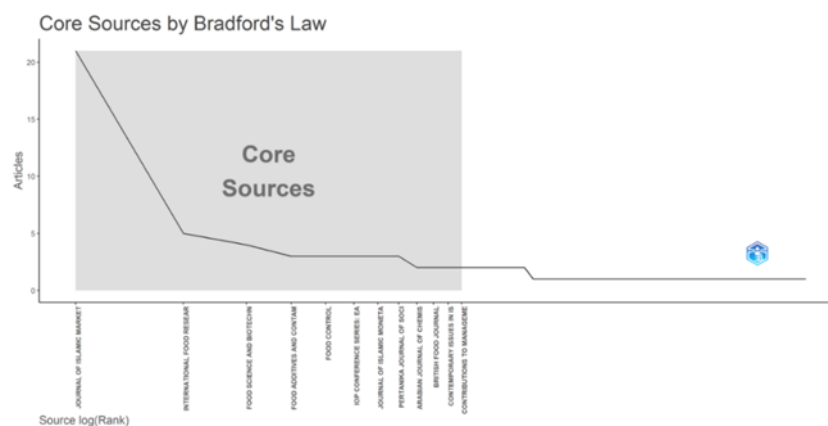


Figure 5: Core Sources By Bradford Law

Most Relevant Countries

Among the top ten countries contributed to the highest number of articles, the majority were of the single-country publications (Figure 6). International co-authorship was reported to be around 25%.

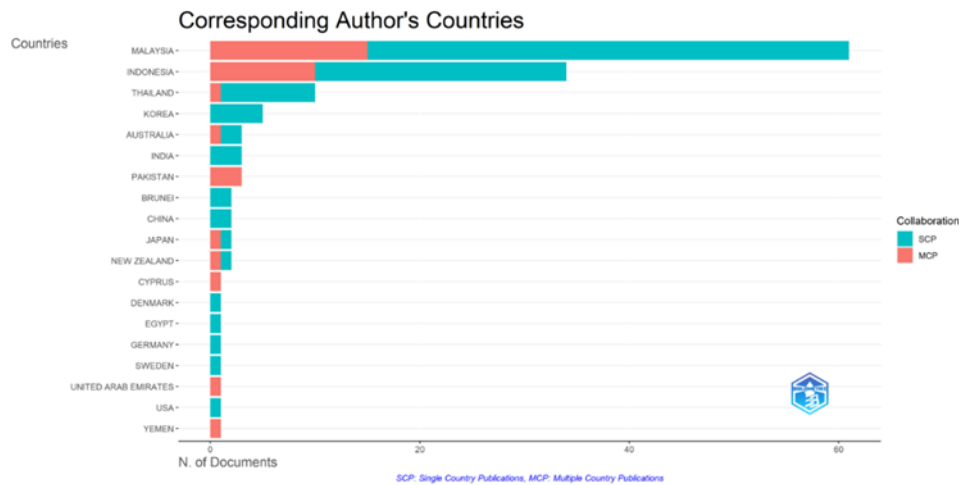


Figure 6: Most Relevant Countries

Malaysia showed a tremendous three-fold increase in publication beginning year 2012-2013 to 2023 (Figure 7). Publications from Indonesia and Thailand started to increase around year 2019 with Indonesia reaching more than 150 articles in year 2023 as compared to Thailand (around 50 articles). The increase in publication, particularly for Indonesia may be due to the Government's push towards a stronger halal ecosystem with the establishment of the National Committee for Sharia Finance and Economy (Komite Nasional Ekonomi dan Keuangan Syariah/KNEKS) under the 2020 Presidential Decree (Peraturan Presiden Nomor 28 Tahun 2020 tentang Komite Nasional Ekonomi dan Keuangan Syariah) (Government of Indonesia, 2020).

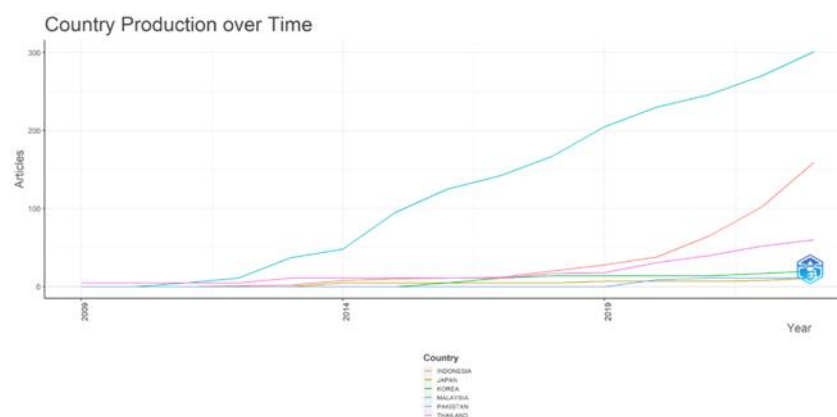


Figure 7: Country Production Over Time

In terms of citation, Malaysia appeared as the highest cited country (821) followed by a considerably large gap by Indonesia (317) while the citation for other countries were less than 100 (Figure 8).

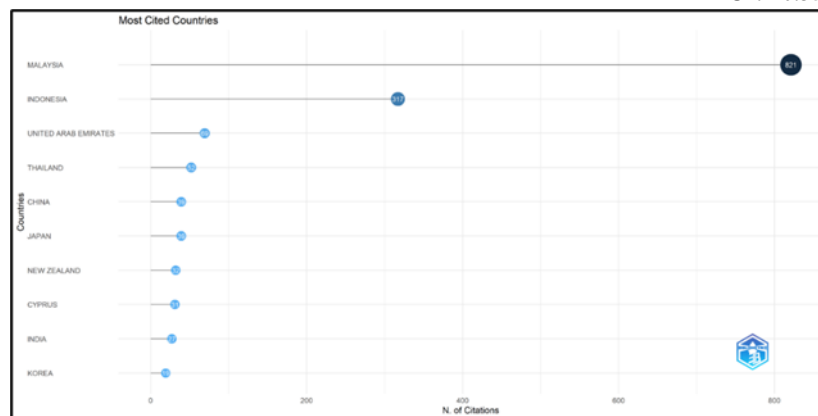


Figure 8: Most Cited Countries

Most Relevant Affiliation

Figure 9 shows that the top ten affiliations by frequency are dominated by institution in Malaysia and Indonesia, with one institution in Thailand (Chulalongkorn University). Universiti Putra Malaysia topped the list with 97 publications. It is noted that there are two occurrences of the Universiti Putra Malaysia (one with its abbreviation, UPM). This may be due to the data entry issues where the latter is considered a completely different institution. Combined, the publication from Universiti Putra Malaysia reached number of 105. The active trend of publication by UPM suggests that its halal-focused institute, the Halal Product Research Institute (HPRI) had momentarily grown in its research and publication endeavours since its establishment in 2006.

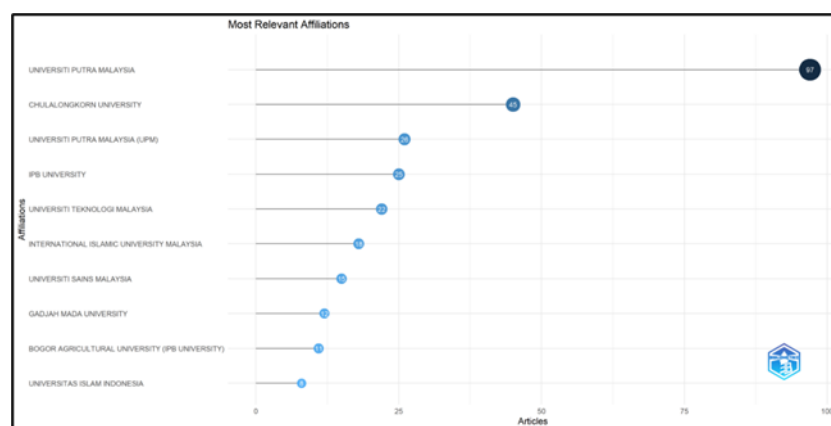


Figure 9: Most Relevant Affiliation

Documents By Funding Sponsor

The top funding sponsors for the research work surrounding halal science and halal education were observed to be either from the governmental (ministry) level or university level (Figure 10). Universiti Putra Malaysia topped the list. Funding has been positively correlated with research publications and its impact as being discussed in other areas such as clinical research (Morisawa et al, 2022), nanotechnology (Wang and Philip, 2015) and schistosomiasis study (Pao, 1991). Consistent with the trend shown earlier (productivity by country and affiliations), funding for research in halal science and halal education may also correlate to more publications and higher impacts.

Documents by funding sponsor

Compare the document counts for up to 15 funding sponsors.

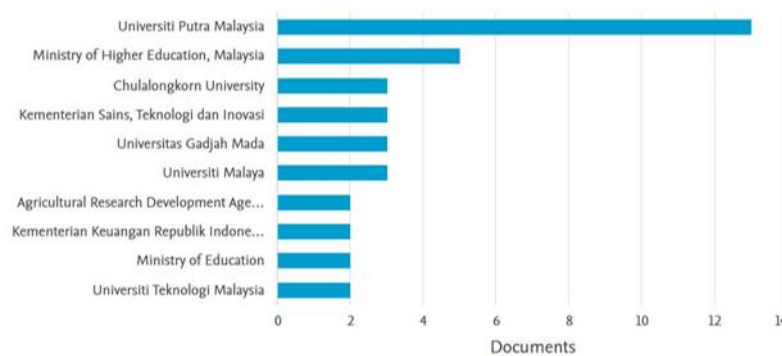


Figure 10: Documents By Funding Sponsor

Most Relevant Words And Trend Topics

A total of 685 keywords were used in the documents. The three most used keywords were food contamination (n=20), gelatine (n=18) and animals (n=15), representing 15% of the 50 most used keywords (Figure 11). The frequency of the most used keywords per year has shifted from butter, molecular weight, gelatine, multivariate analysis, food analysis and principal component analysis as the most used word in the early years of research to mammals, meat, gas chromatography and DNA in the year 2021-2023 (Figure 12).



Figure 11: Treemap Chart Showing The Numbers And Proportions Of The 50 Most Used Document Keywords

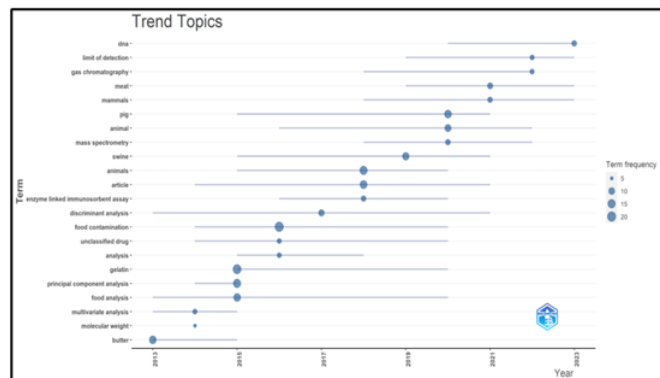


Figure 12: Frequency And Changes Of Keywords Over Time

Social Structure (Co-Authorship Analysis)

A co-authorship analysis is a reliable proxy to identify the most productive or impactful groups of authors within a knowledge community (Kashi and Mohamed, 2023). The social network in of authors working in halal science and halal education field is shown in Figure 13. Ten clusters were identified with Rohman, A., Mustafa, S. and Khatib, A. form the most impactful team of authors.

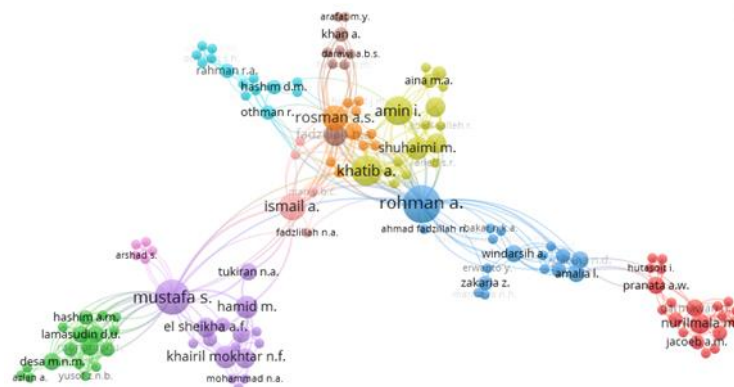


Figure 13: Authorship (Social) Network (From Scopus Database)

Co-Occurrence Of All Keywords

Four clusters were visualized as a network map as shown in Figure 14. Despite the overall observation of overlapping keywords, four clusters could be discerned (red, blue, yellow, green) with two distinct groups (group 1 – green, group 2 – red, blue, yellow). Group 1 reflects the social science aspect while group 2 indicates the science and technology aspects. The red cluster most likely represent halal authentication, blue cluster (halal meat), yellow cluster (halal profiling) and green cluster (social science). To this end, data extracted from Scopus did not show themes in halal education (syllabus/curriculum), rather the term halal knowledge appearing in the green cluster most probable related to studies on consumer behaviour.

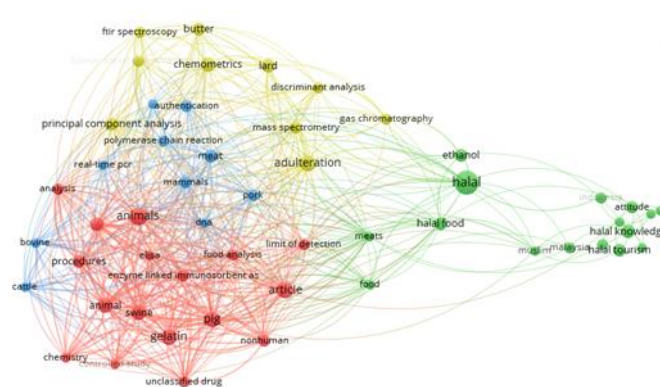


Figure 14: Co-Occurrence Of All Keywords (From Scopus Database)

Conceptual Structure

Title And Abstract Map Analysis

The keywords network in the title and abstract may give some insight into relevant variables in a particular research topic. Figure 15 showed two distinct groups of keywords found in the title and map of articles sourced. Similar to co-occurrence of all keywords, the network here does not clearly show the expected halal science versus halal education clusters, rather it reflects the social science aspects of halal research (red cluster) and natural or hard sciences of halal research (green).

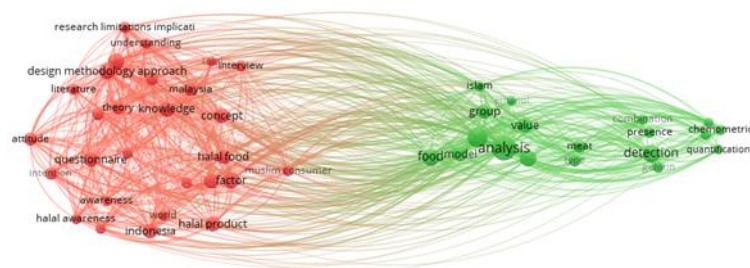


Figure 15: Title And Abstract Map Analysis

Thematic Map Analysis

A thematic or strategic map analysis is used as an indicator of the concentration dynamics of research themes following their levels of centrality (relevance) and density (development) [24,31]. Figure 16 shows the four typologies of research themes in halal science and education extracted from the Scopus database. The first quadrant (motor themes) contains themes that are highly developed and highly relevant, which reflects their established status. The size of the spheres indicates the emphasis or focus of the research theme. For instance, research on animals, particularly pig is observed to be the focus of research in halal area such that it is well-established.

The second quadrant, going clockwise is the basic (transversal/primary) themes, where elements here are highly relevant but with low development. Examples include gas chromatography techniques, social science and halal products. Certification, principal component analysis, mass spectrometry and discriminant analysis are located between the motor and basic themes indicating the active interest in this area. Islamism and tourism development could be the emerging themes in the third quadrant, connoting the current interest and trend of halal research particularly related to Muslim-friendly tourism. Research on ethanol including photonic-based methods along with the drug industry are most likely declining themes as researchers shifted their focus on other areas of halal authentication and profiling. Finally, quadrant four contains the niche areas that are developed but isolated. This includes physicochemical properties (of halal products potentially cosmetics), economic and social effects, and planning.

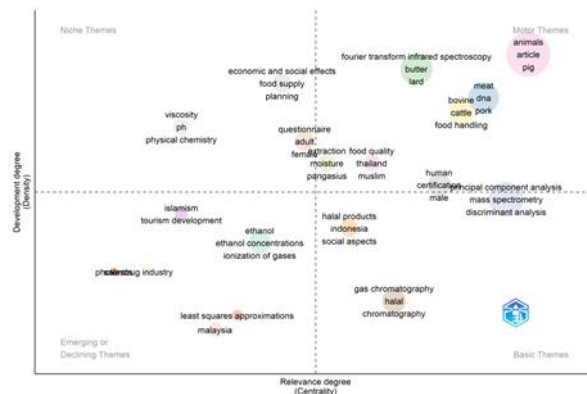


Figure 16: Thematic Map Of Halal Science And Halal Education
Note: Based On The Scopus Data, The Overlapping Item In Emerging Or Declining Themes Are Identified As Photonics And Drug Industry, Respectively

Publication Trends for Records Obtained from Google Scholar

Document by Type

Figure 17 shows that most documents published on halal science and education in Google Scholar are of article type (72 %). Other types of documents include conference papers (13%), thesis (8%), book chapter (3%), review paper (2%) and report (2%).

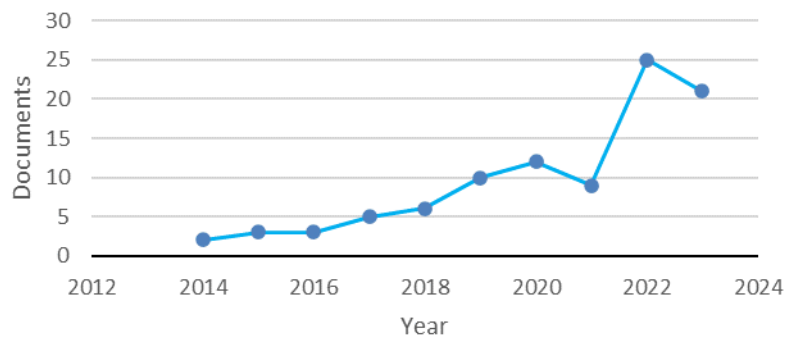


Figure 17: Document By Type (From Google Scholar Database)

Year Of Publication – Evolution Of Published Studies

Between year 2014 to 2019, the documents published per year were ten and less. Interestingly, the number of publications increased 2-fold within a year (2021 – 2022) but had slight drop the year after.

Documents by year

**Figure 18: Document By Type (From Google Scholar Database)*****Documents By Country***

Indonesia topped the list of documents by country (51), followed by Malaysia (31). Number of 19 sources are written in Bahasa Indonesia where 12 were published in homegrown journals such as Jurnal Ilmiah Ekonomi Islam, AL-Muzara'ah, Jurnal Ilmiah Ekonomi Kita (Iqtishaduna) and Jurnal Inovasi Bisnis dan Manajemen Indonesia (INOVIS). The remaining publications are of thesis or conference paper types. Meanwhile, only three papers were found to be written in Bahasa Melayu which were published in BITARA International Journal of Civilizational Studies and Human Sciences, Journal of Fatwa Management and Research, and Journal of Techno Social. There is a big gap beginning from the third country in the Table 2 where Brunei recorded three documents, Philippines recorded two documents and the remaining countries recorded one document each.

Table 2: Documents by country

Country	%
Indonesia	51
Malaysia	38
Brunei	3
Philippines	2
Bangladesh	1
Brazil	1
Japan	1
Taiwan	1
Thailand	1
Turkiye	1
	100.0

Documents By Affiliation

Top Five Affiliations Were Universiti Teknologi MARA (Uitm), International Islamic University Malaysia, Universiti Putra Malaysia, Universitas Islam Indonesia Yogyakarta And Universiti Utara Malaysia Shown In Table 3.

Table 3: Documents By Affiliation

Affiliation	Documents
Universiti Teknologi MARA (UiTM)	8
International Islamic University Malaysia	7
Universiti Putra Malaysia	5
Universitas Islam Indonesia, Yogyakarta,	5
Universiti Utara Malaysia	4
Institut Agama Islam Negeri (IAIN) Kudus, Indonesia	3
Universiti Islam Sultan Agung	3
Universiti Islam Sultan Sharif Ali (UNISSA)	3
University Sains Malaysia	3
Muslim Universiti Indonesia (UMI)	2
Universitas Andalas, Jalan Perintis Kemerdekaan, Padang	2
Universitas Islam Malang	2
Universitas Nahdlatul Ulama Surabaya, Surabaya	2
Universiti Selangor	2

Note: The Remaining List Of Affiliation Recorded One Published Document Each

Social Structure (Co-Authorship Analysis)

The social network in of authors working in halal science and halal education field from Google Scholar database is shown in Figure 19. The network is much less complex than the Scopus network, with three clusters stemming from Sudarsono, H. as the central point. Authors are found to be with affiliated with Indonesian institutions.

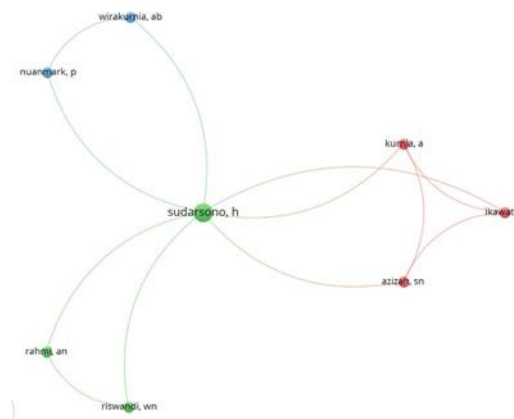


Figure 19: Authorship (Social) Network (From Google Scholar Database)

Co-Occurrence Keyword

Figure 20 shows the network map of keywords for data extracted from Google Scholar. Four clusters were colour-coded (red, blue, yellow, green) yet there were no discernible themes. All keywords appeared to be related to social science area. However, upon analysing the sources it was found that the term 'halal knowledge' (and not halal education, halal curriculum or halal syllabus as per search string) dominates the corpus with only a few articles focusing on halal science.

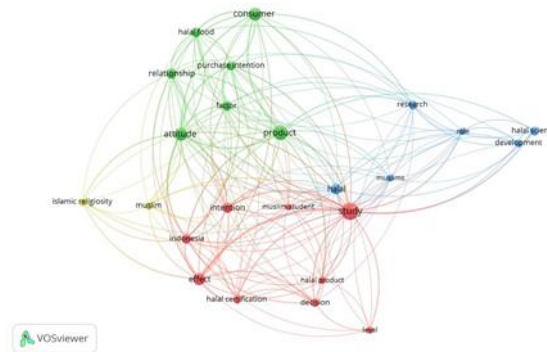


Figure 20: Co-Occurrence Of Keyword (From Google Scholar Database)

Discussion

This section attempts to provide the insights from the findings obtained through bibliometric analysis conducted on halal education and halal science. Scopus search returned more articles (155) than Google Scholar (96). There are several key observations on the trend of publication and its themes or body of knowledge. First, sources from Scopus appeared to be different (with minimal overlapping) from those obtained from Google scholar rendering the distinct analysis between the two sources. Scopus articles were concentrated on applications of science and technology related to halal. Meanwhile, Google scholar articles appeared to be clustered into social science surrounding halal knowledge theme. Both, however, shows increasing trend over the years with several key institutions and authors identified to be leading in certain areas of research.

To delve into the themes hence the initial structure of body of knowledge of halal, it is important to reiterate that this current work was built upon an earlier bibliometric work. As such, this current work was undertaken (i) to further investigate our hypothesis that halal-related S&T research areas are positioned under the umbrella of halal science, and (ii) attempt to fulfil the research gap of halal curriculum identified in the same article (Hashim et al., 2020).

In our previous bibliometric work, the search was conducted in the broad scope of 'halal' from publications within the period of 1996 -2020. It was observed that the S&T-identified clusters were not clearly connected to the term 'halal science', rather it portrays the established S&T academic disciplines in relation to halalan toyyiban applications (Hashim et al., 2024). The term 'halal science' thus far suffers from ambiguous definition but collectively it pointed to the use of the 'conventional' S&T in the areas of halal with some researchers emphasising the need to maintain the element of ruh (doing something in the conscious context of religion) considering halalan toyyiban is a faith-based system decreed by Allah s.w.t. (Hashim et al., 2024). This 'true' halal science could also be viewed as operating in the in tawhidic paradigm. In consonance to the earlier research, this present work although using a more specific term (halal science) also found that the S&T research sourced in Scopus (publication year was not specified to allow broad coverage) were scoped in the established S&T academic discipline related to halalan toyyiban applications with minimal inference to the ruh of doing science as part of fulfilling decree to Allah s.w.t. In this regard, our hypothesis that halal-related S&T research areas are positioned under the umbrella of halal science could be argued in two extremes; it is accepted if 'halal science' definition is referred to S&T used in halal related

applications but it is not accepted when the term is referred to the more holistic definition related to the ruh of doing science as part of fulfilling decree to Allah s.w.t.

From the perspective of ontology, halal science transcends the physical realm, differing it from modern or conventional science (Mhd Sarif et al., 2015). This connotes that halal science is a branch of knowledge that guides the humankind to conform that Allah s.w.t is the ultimate Creator who create all resources in the universe to be benefited by all His creations including the humankind (Said et al., 2014). In this sense, articles clustered in the S&T theme observed from the Scopus sources in this work are void of the holistic halal science elements. This may be due to the established subject areas in Scopus as well as the generally accepted academic disciplines. To forge towards using halal science in its holistic format, homegrown journals could be a way forward in propagating the concept. The term halal science in its holistic construct also deserves more scholarly debates. More efforts should be put in to increase awareness in doing halal science with ruh particularly among the halal-related academic institutions. The reason why this true halal science should be promulgated lies in the premise of halal being a faith-based system decreed by Allah s.w.t. that in turn will safeguard all the mankind.

Pertaining to halal education, the search term used in this present work include halal education, halal knowledge, halal curriculum and halal syllabus/syllaba. The choice of search term was made to extract articles related to halal education in a broad sense with particular interest to see the development of curriculum or syllabus in academic setting. The findings however were in contrast with our initial view. The articles sourced were related to perceived knowledge and customer behaviour studies rather than curriculum or syllabus. To this end, halal education in terms of curriculum and syllabus is still under researched despite its importance in talent development and human resources for the halal industry (Jais, 2014).

The trend and themes revealed further pointed towards the potential dysconnectivity between halal education and halal science. Taking the stance of halal science as the applications on S&T in areas related to halal undertaken with ruh, this dysconnectivity may stem from the lack of proper 'halal curriculum' in schools throughout the child-growing years. While S&T backed halal ecosystem is of paramount importance such that it should be nurtured from an early age, the specific 'halal curriculum' is only available at tertiary education (certificate, diploma, degree, master, and PhD). The integration of halal science and halal education in the mould of Science, Technology, Engineering and Mathematics (STEM) has also been suggested to promote ethical research, sustainable innovation, quality assurance and cultural sensitivity; all of which would benefit the halal ecosystem (Bahrin et al., 2023).

The void of 'halal curriculum' targeted in schools also reflects the loss of opportunity to inculcate halalan toyyiban lifestyle particularly halal science that is genuinely tied to faith-based realm. While there have been short term programmes such as camps and workshops conducted in schools to increase awareness to halal including halal science, these may not be sufficient to build a strong foundation of halal consciousness. To this end, more scholarly work is warranted in the field of halal curriculum and halal syllabus as parts and parcel of the larger scope of halal education and knowledge.

Limitation of Study

This review offers some insights into the research trends of halal science and halal education within certain limitations. Firstly, the dataset only includes Scopus and Google Scholar. Web of Science (WOS) which contain high quality publications is not investigated. In terms of data analysis, Scopus and Google Scholar cannot be merged due to technical disparities. The study resolved to separately analyse the two datasets. The study also only focused on visualising and mapping the link between variables with no content analysis involved such that in-depth discussion on the underlying factors affecting the research landscape of halal science and halal education cannot be provided. These limitations need to be addressed in future studies for a more robust findings reflecting the true research landscape of halal science and halal education.

Practical Implications

Looking from the point of view of quintuple helix (government, industry, academia, community (civil society) and the environment), findings from this current work may guide these stakeholders towards practical implications in the halal field. Some areas of practical implications backed by S&T (halal science) include establishment of limit of detection of halal versus haram status by the authorities towards comprehensive halal standards and certification, development of more halal toyyiban innovative products and services genuinely tied to faith based requirement (rather than merely fulfilling halal certification and standards) and practical use of IR4.0 related technologies by both regulatory bodies and industry in upholding halal integrity. In addition, funding bodies can be correctly informed with the needs and demands in halal field enabling worthy, timely and impactful sponsorship. In terms of education, the findings can be used to inform the government to play more active roles in providing halal education in schools considering the education in the early and formative years are very important especially to inculcate values that conforms holistically to halalan toyyiban living.

Conclusion

In conclusion, this study has identified several S&T related clusters including halal authentication, halal meat and halal profiling from Scopus sources while halal knowledge and education only surfaced in Google Scholar. Over the years, research focus shifted from ethanol to halal authentication and profiling with physicochemical properties of halal products, economic and social effects, as well as planning identified as niche areas. However, the S&T clusters were found not to be tied to the halal science with ruh (tawhidic-based). Meanwhile, halal knowledge and education clusters were centred on perceived knowledge and consumer behaviour studies, and not on the halal curriculum or syllabus. More scholarly work is warranted in both areas within the specified scopes ('true' halal science and halal curriculum/syllabus) as part of the endeavours to provide strong fundamentals as well as to sustain the halal ecosystem.

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