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Artificial intelligence in the halal industry: a PRISMA-guided systematic review and bibliometric mapping of Scopus literature (2017–March 2025)

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A B S T R A C T

The research and application of artificial intelligence (AI) in the halal industry were mapped through the adoption of the PRISMA-guided Systematic Literature Review (SLR) to derive a Shariah-compliant research agenda for Halal Industry 4.0. This was achieved by searching Scopus (TITLE–ABS–KEY) for relevant publications from 2000 to March 2025. The records obtained were screened using predefined inclusion/exclusion criteria followed by the analysis of the selected articles through descriptive bibliometrics, inductive thematic coding, and keyword co-occurrence mapping (VOSviewer). The screening showed that 23 out of the 95 records initially identified met the eligibility criteria and were published from 2017 to March 2025 as a reflection of the recency and rapid growth of the AI–halal research field. The analysis also showed that AI such as computer vision/OCR, spectroscopy-data analytics, and AI–blockchain/Internet of Things (IoT) architectures was most frequently used for halal authentication and traceability, efficiency and decision support in certification and supply chains, data-driven applications in halal tourism, fintech, and consumer analytics. However, the evidence remains fragmented due to limited real-world validation, inconsistent reporting of data provenance and model transparency, as well as an underdeveloped conceptual bridge between AI governance and Shariah/maqāṣid al-sharī'ah requirements. Future research should prioritise explainable and auditable AI for halal assurance, interoperable standards for cross-border digital certification, and practical small and medium scale enterprise (SME) adoption pathways through shared infrastructure and regulatory sandboxes.

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1 Introduction

The global halal industry is becoming a major and fast-growing segment of the world economy by extending significantly beyond food to others such as pharmaceuticals, cosmetics, Islamic finance, logistics, fashion, and tourism (Azam & Abdullah 2020; Qadri 2024). Recent estimates placed the halal economy above USD 2 trillion annually due to the demographic growth and rising interest of both Muslim and non-Muslim consumers in the ethics, hygiene, and sustainability attributes of halal (DinarStandard 2025; Zafar *et al.* 2024). In 2023, Muslim consumer spending across key halal sectors reached USD 2.43 trillion and the value was projected to grow to USD 3.36 trillion by 2028. Islamic finance assets were also valued at USD 4.93 trillion and projected to reach USD 7.53 trillion by 2028 (DinarStandard 2025). These trends show that halal is increasingly positioned as a religious standard and also a global value proposition shaping consumption, supply chains, and competitiveness.

The growth of halal is supported by the Industry 4.0 landscape which is transforming into how halal assurance and business operations are managed. Digital technologies such as artificial intelligence (AI) are increasingly identified as enabling tools to improve both efficiency and trust across halal ecosystems. This is associated with the ability of AI to support traceability and authentication, automate elements of certification, and enhance decision-making through supply-chain and consumer analytics. The technology also offers sustainability benefits in the form of efficiency gains, waste reduction, and early detection of non-compliance (Chandra *et al.* 2019; Khairuddin & Rahman 2023; Kurniawati & Cakravastia 2023; Riandari & Defit 2022). Moreover, the expansion of halal supply chains across borders and the inclusion of different actors have led to the urgent demand for transparent, efficient, and interoperable assurance systems (Yusof *et al.* 2020).

Real-world adoption of AI in halal contexts remains constrained by uneven digital infrastructure, fragmented regulatory readiness, as well as unresolved ethical and governance issues in the form of data privacy, algorithmic bias, and model transparency (Harun *et al.* 2024; Nawaz *et al.* 2025; Ridzuan *et al.* 2024). These practical challenges are reflected in the academic literature which is often sector-specific, case-based, and scattered. Therefore, the development of an integrated understanding of what has been examined, what works, where the gaps are identified, and what research directions are most critical for advancing Halal Industry 4.0 is difficult (Ahmad *et al.* 2021; Ashraf 2023; Bouchetara *et al.* 2024).

Existing research reported the potential of AI-enabled halal systems often combined with blockchain for traceability, monitoring, and certification efficiency (Alourani & Khan 2024; Bakar & Rosbi 2019; Ridho 2025). AI applications were also simultaneously required to be in line with Shariah principles through robust governance, accountability, and sensitivity to cultural-religious expectations, particularly in high-stakes sectors such as healthcare and finance (Rahman 2023; Tennin *et al.* 2024). However, the field lacks a consolidated PRISMA-guided synthesis that maps publication dynamics, AI application domains, as well as the opportunities and constraints across sectors in a single analytical view despite the developments recorded. This shows the need for a PRISMA-based Systematic Literature Review (SLR) to provide a transparent, reproducible synthesis of evidence, and establish a clearer research agenda (Moher *et al.* 2010; 2015).

a. RQ1: How have publication dynamics and scholarly methods changed in the analysis of AI applied to the halal industry?
b. RQ2: What AI applications have been discussed in the academic literature on the halal industry?
c. RQ3: What opportunities, challenges, and future research agendas are observed from the identified gaps in this field?

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The questions reflect the three interrelated objectives explored and the first is to map publication trends and methodologies applied in research on AI in the halal industry between 2000 and March 2025 (RQ1). The second is to classify and analyze the AI applications discussed across halal sectors including food, pharmaceuticals, cosmetics, finance, logistics, and tourism to provide a holistic view of the positioning of the technology within the ecosystem (RQ2). The third is to identify key opportunities, implementation barriers, and research gaps as well as formulate a future research agenda to support the advancement of Halal Industry 4.0 (RQ3).

The novelty of this research is in the presentation of the first PRISMA-based SLR that explicitly examines the role of AI in the halal industry across multiple sectors. Previous research is predominantly case-based or confined to specific technologies. However, this research offers an integrative perspective that connects practical applications, strategic opportunities, implementation constraints, and gaps within a single framework. The process positions AI as both an operational tool and a strategic driver that shapes the trajectory toward Halal Industry 4.0.

The theoretical contribution includes an improvement in scholarly discussion on halal economy digitalization by synthesizing evidence on how AI supports transformation toward Industry 4.0 and by providing an analytical basis for more interdisciplinary conceptual development. The practical contribution is the evidence-based insights offered for policymakers, halal certification bodies, and industry stakeholders to design more adaptive policies, strengthen transparent and accountable assurance mechanisms, as well as support feasible adoption pathways particularly for small and medium scale enterprises (SMEs) through enabling infrastructure and regulatory innovation. The aim is to inform technology-driven halal business models, responsive governance frameworks, and a focused research agenda that supports a competitive, inclusive, and sustainable global halal ecosystem.

2 Materials and Methods

A Systematic Literature Review (SLR) method guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol developed by Moher *et al.* (2015) is adopted in this research. The PRISMA is widely recognized as a comprehensive and reliable standard for ensuring transparency, accountability, and reproducibility in the process of selecting and analyzing scientific literature (Ahmad *et al.* 2023; Ashiq *et al.* 2022; Safdar *et al.* 2021). The process led to the implementation of a structured sequence that included literature identification, selection based on strict inclusion and exclusion criteria, eligibility assessment, as well as final inclusion for analysis and synthesis. This systematic method enabled the filtering of literature considered both academically valid and methodologically sound to enhance the reliability and validity of findings while providing a robust foundation for generalization (Parums 2021).

Scopus was used as the primary database due to its ability to offer broad multidisciplinary coverage, consistent indexing of journals and conference proceedings, as well as advanced fielded searching (TITLE–ABS–KEY) suitable for bibliometric mapping. Database-driven selection bias was reduced by reporting the search string in full, applying transparent inclusion/exclusion criteria, as well as conducting quality and reporting appraisal. Moreover, the single-database coverage was acknowledged as a limitation.

The search string used in the database was ((TITLE-ABS-KEY("artificial intelligence") OR TITLE-ABS-KEY("machine learning") OR TITLE-ABS-KEY("natural language processing") OR TITLE-ABS-KEY("big data") OR TITLE-ABS-KEY("data mining") OR TITLE-ABS-KEY("chatbot")) AND (TITLE-ABS-KEY("halal") OR TITLE-ABS-KEY("halal industry") OR TITLE-ABS-KEY("halal business") OR TITLE-ABS-KEY("halal food") OR TITLE-ABS-KEY("halal tourism") OR TITLE-ABS-KEY("halal authentication") OR TITLE-ABS-KEY("halal certification") OR TITLE-ABS-KEY("halal logistics") OR TITLE-ABS-KEY(" islamic finance")). The query was applied to the title, abstract, and keyword fields to ensure comprehensive and representative coverage of the relevant literature. Furthermore, stringent inclusion and exclusion criteria were applied to maintain methodological rigor as presented in Table 1.

The inclusion of evidence related to empirical modelling papers, conceptual papers, and conference proceedings led to the adoption of a lightweight appraisal to improve transparency and interpretability. The assessment was focused on the (i) clarity of halal context and compliance definition, (ii) transparency of data sources and preprocessing, (iii) appropriateness of AI method and evaluation in the form of validation strategy, (iv) reproducibility through availability of parameters, datasets, or workflows, and (v) governance considerations such as explainability, auditability, privacy, and Shariah connection. The appraisal was used to qualify the strength of claims in the synthesis rather than to exclude articles.

The literature selection process was conducted systematically through three main stages. The first was initial identification where all retrieved documents were screened by title and abstract to assess topical relevance. The selected articles proceeded to the screening stage which required a full-text review to ensure connection with the research objectives and methodological rigor. Finally, a comprehensive evaluation was conducted during the eligibility assessment to determine whether the articles met the strict inclusion criteria, particularly regarding the explicit intersection between AI and the halal industry. All the stages of the selection process were systematically documented using a PRISMA flow diagram to present the number of articles retrieved, screened, excluded, and subsequently included for analysis.

Table 1: Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Topic	Research addressing the application, impact, or integration of AI within the context of the halal industry	Research unrelated to AI and/or the halal industry
Type of Publication	Peer-reviewed journal articles, conference proceedings, research reports	Opinion papers, editorials, news articles, popular essays, reviews, book chapters
Language	English	Non-English languages
Publication Period	Year 2000 to March 2025	Publications before 2000
Research Method	Empirical research, literature reviews, and conceptual models related to AI and the halal industry	Irrelevant or non-systematic research

Note: AI = Artificial Intelligence

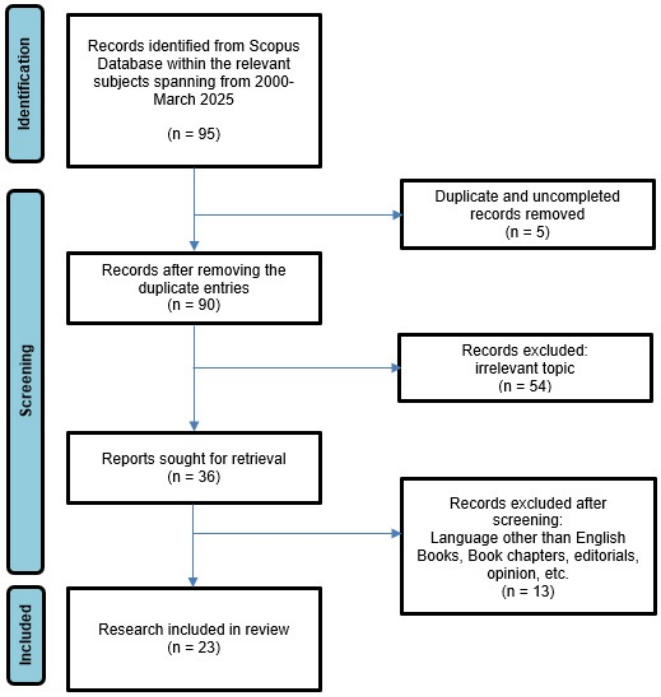

Figure 1: Flow of searched information (PRISMA statement)

Then, data were systematically extracted and manually coded with the assistance of Mendeley for reference management as well as Microsoft Excel for data coding and synthesis to maintain both precision and traceability. The extracted dataset included essential publication details such as title, authors, year, and source in addition to the stated research aims, methodological designs, categories of AI applications in Islamic finance, and the main findings together with scholarly contributions (Moher *et al.* 2015; Parums 2021). The coding procedure was through an inductive thematic analysis which was based on the frameworks of Andreini & Bettinelli (2017) and Braun & Clarke (2006). The initial codes were developed manually by identifying recurrent concepts and patterns across the dataset and subsequently refined, compared, and clustered into higher-order categories, and synthesized into overarching themes. The focus was on the principal domains of AI applications, emerging research directions, and prevailing challenges in the halal context. Rigor was ensured and subjectivity was minimized through collaborative theme generation and refinement with iterative discussions at each stage to achieve consensus on coding decisions. Moreover, a descriptive bibliometric analysis was applied in relevant aspects to show the temporal evolution, geographical spread, and institutional affiliations of the reviewed publications. The keyword co-occurrence mapping conducted through VOSviewer v1.6.18 produced five thematic clusters, indicating the main conceptual groupings and intellectual linkages within the reviewed literature. These clusters reflect groups of closely related keywords that frequently appeared together across publications, thereby highlighting dominant research themes and emerging areas of discussion in the intersection of artificial intelligence and the halal industry. The integration of the thematic and bibliometric methods allowed the analysis to provide both contextual depth and analytical robustness. All

Table 2: List of articles, year, and document type

No.	Title	Authors	Year	Document Type
1	AI-enabled technologies to assist Muslim tourists in Halal-friendly tourism	Battour M.; Mady K.; Salaheldeen M.; Elsotouhy M.; Elbendary I.; Bogan E.	2023	Article
2	Artificial Intelligence Applications in Halal Tourism to Assist Muslim Tourist Journey	Battour M.; Mady K.; Elsotouhy M.; Salaheldeen M.; Elbendary I.; Marie M.; Elhabony I.	2022	Conference paper
3	Artificial intelligence approach for smart sharia tourism: a review	Riandari F.; Defit S.; Yuhandri	2022	Article
4	Artificial Intelligence Application in Discovering the Japanese Manufacturing Market for Indonesia's Policy	Kusumaningrum D.N.; Wardhana D.K.; Lestari W.A.	2021	Conference paper
5	Big data approach to sentiment analysis in machine learning-based microblogs: perspectives of religious moderation public policy in Indonesia	Furqan M.; Nasir A.F.A.	2024	Article
6	Blockchain Redefining: The Halal Food Sector	Chandra G.R.; Liaqat I.A.; Sharma B.	2019	Conference paper
7	Data analytics of fourier-transform infrared spectroscopy (FTIR) for halal and non-halal adult erations	Arief A.; Kartiwi M.; Jaswir I.	2020	Conference paper
8	Efficiency analysis of halal certification bodies in Indonesia: a hybrid data envelopment analysis and machine learning approach	Surjandari I.; Maulina N.R.; Bahri C.	2024	Article
9	Explainable deep learning model for stock price forecasting using textual analysis	Abdullah M.; Sulong Z.; Ashraful Ferdous Chowdhury M.	2024	Article
10	Halal Products on Twitter: Data Extraction and Sentiment Analysis Using Stack of Deep Learning Algorithms	Feizollah A.; Ainin S.; Anuar N.B.; Abdullah N.A.B.; Hazim M.	2019	Article
11	Halal tourism and ChatGPT: an overview of current trends and future research directions	Battour M.; Mady K.; Salaheldeen M.; Ratnasari R.T.; Sallem R.; Al Sinawi S.	2024	Article
12	Halal tourism demand and firm performance forecasting: new evidence from machine learning	Sulong Z.; Abdullah M.; Chowdhury M.A.F.	2023	Article
13	HALALCheck: A Multi-Faceted Approach for Intelligent Halal Packaged Food Recognition and Analysis	Tarannum S.; Jalal M.S.; Huda M.N.	2024	Article
14	Image Segmentation and Verification Based on Machine Learning for Vision Inspection of Chicken Slaughtering	Yusof R.; Afra R.; Yunus M.R.M.; Muhammad N.A.A.N.; Rosli N.R.; Ismail N.	2020	Conference paper
15	Non-Halal Ingredients Detection of Food Packaging Image Using Convolutional Neural Networks	Fadhilah H.; Djamael E.C.; Ilyas R.; Naimurokhamah A.	2018	Conference paper
16	Rapid scoping review of blockchain adoption in halal industry supply chain	Rahim N.F.	2023	Conference paper
17	Review article on potentials of big data in the halal industry	Tan M.I.I.; Fezarudin F.Z.; Yusof F.M.; Rosman A.S.; Husnv Z.J.M.	2017	Review
18	Role of artificial intelligence in halal authentication and traceability: A concurrent review	Nawaz A.; Afzal A.; Khatibi A.; Shankar A.; Madan H.; Faisal H.S.; Shahbaz A.; Usman I.; Zulfiqar N.; Saeed F.; Ahmed A.; Imran A.; Afzaal M.; Karni A.; Ahmed F.; Akram N.; Rasheed M.; Islam F.	2025	Review
19	Smart system based on DOA IoT for products monitoring anti-counterfeiting	Al-Bahri M.; Yankovsky A.; Kirichek R.; Borodin A.	2019	Conference paper
20	Technology as a driver to achieve the performance of family businesses supply chain	Hendayani R.; Febrianta M.Y.	2020	Article
21	The effects of digital innovations and sustainable supply chain management on business competitive performance post-COVID-19	Sumardiah E.; Al-hakeem B.	2023	Article
22	The Influence of Artificial Intelligence to Support Halal Tourism Policy in South Korea	Marlinda A.P.; Cipto B.; Al-Fadhat F.; Jubba H.	2021	Conference paper
23	Toward halal supply chain 4.0: MILP model for halal food distribution	Kurniawati D.A.; Vanany I.; Kumarananda D.D.; Rochman M.A.	2024	Conference paper

Source: Scopus.com

stages from the formulation of the search protocol to the final synthesis of themes were meticulously documented to ensure transparency and replicability.

The initial search in the Scopus database led to the identification of 95 documents as potentially relevant to the research topic which was the application of AI within the halal industry. The identification process and the removal of 5 duplicate or incomplete documents reduced the number to 90 unique documents for further consideration. The next stage was title and abstract screening where each document was carefully examined to ensure connection with the research scope, objectives, and focus. The screening showed that 54 documents were not relevant because the issues discussed were related to the halal industry without explicitly addressing AI or lacking a direct connection to AI applications, impacts, or integration within halal contexts. Therefore, 36 documents proceeded to the next stage which was a full-text review. The evaluation applied additional inclusion criteria such as methodological appropriateness, publication in English, full-text accessibility, and the presence of analyzable data or arguments. This led to the exclusion of 13 documents for not meeting the standards such as the availability of only the abstract form, publications in languages other than English or Indonesian, opinion pieces, editorials, news items, popular essays, reviews, book chapters, or research lacking relevant findings on the intersection of AI and the halal industry.

3 Results and Discussion

3.1 Publication Dynamics and Diversity of Studies

The PRISMA screening produced 23 eligible publications published between 2017 and March 2025 even though the search window was set to start from 2000. This shows that the AI–halal research agenda is comparatively new and has accelerated only in the late-2010s possibly due to wider diffusion of deep learning, mobile computer vision, and blockchain/IoT architectures relevant to traceability and assurance. The corpus is not treated as mature evidence base but rather interpreted as an emerging field where proof-of-concept research dominates and governance or standardization questions are developing.

This research aims to identify and analyze the strategies applied or developed in the literature on the application of AI within the halal industry through SLR. The selection process conducted via the Scopus database produced 23 key documents which were considered relevant and up to date through the publication between 2017 and March 2025. The documents reflect a wide range of methods, models, and challenges associated with AI adoption in the halal industry across different regions.

Table 2 shows that journal articles dominate the corpus with 11 documents followed by conference proceedings with 10 and two review papers. This pattern is a sign that research on AI in the halal industry is experiencing rapid growth. The initial ideas were often presented at conferences and later developed into more mature research published in reputable academic journals. Publication numbers also showed a significant increase in recent years particularly during 2023–2024 which culminated in a comprehensive review published in early 2025 to examine the role of AI in halal product authenticity and traceability.

Further analysis showed that the collected research themes could be clustered into several major domains representing the developmental trajectory of AI adoption in Halal Industry 4.0. Geographically, most research originated from Asia particularly Indonesia and Malaysia supplemented by contributions from the Middle East and East Asia. This focus is unsurprising because the regions are both the largest global halal markets and leading Muslim-friendly tourist destinations. The findings reflected a clear progression of AI analysis in the halal sector which had changed from preliminary trials presented at conferences to more mature

Table 3: Publication outlets

No.	Publication Outlets
1	Journal of Islamic Marketing
2	Lecture Notes in Networks and Systems
3	Journal of Theoretical and Applied Information Technology
4	IOP Conference Series: Earth and Environmental Science
5	Journal of Applied Engineering and Technological Science
6	Proceedings - 2019 Amity International Conference on Artificial Intelligence, AICAI 2019
7	2020 8th International Conference on Cyber and IT Service Management, CITSM 2020
8	Quality and Quantity
9	Expert Systems with Applications
10	IEEE Access
11	Journal of Islamic Marketing
12	Current Issues in Tourism
13	IEEE Access
14	Journal of Physics: Conference Series
15	Proceedings - 2018 International Symposium on Advanced Intelligent Informatics: Revolutionising Intelligent Informatics Spectrum for Humanity, SAIN 2018
16	AIP Conference Proceedings
17	Pertanika Journal of Social Sciences and Humanities
18	Food Control
19	2019 4th MEC International Conference on Big Data and Smart City, ICBDSC 2019
20	Journal of Family Business Management
21	Kybernetes
22	IOP Conference Series: Earth and Environmental Science
23	Procedia Computer Science

Source: Scopus.com

research in journals and reviews. The main streams focused on halal authentication and traceability, support for halal tourism, as well as the application of AI in certification, supply chains, and social data analytics.

Several critical challenges demand further scholarly attention, and an example of the pressing issue is the integration of multiple technologies such as AI, blockchain, the Internet of Things (IoT), and sensors into a comprehensive and interconnected system. Equally important is the matter of AI transparency and reliability towards ensuring the technologies deployed are technically effective and also trustworthy and compliant with Shariah principles. Another major challenge is the need for real-world validation where the technologies are tested and implemented at an industrial scale to ensure the benefits are tangibly realized in day-to-day halal business practices. The 23 documents identified in this review generally provide compelling evidence that AI holds significant potential to serve as a driving force for Halal Industry 4.0. However, the efforts to harness the potential require prioritizing technological integration, ethical–Shariah connection, and large-scale implementation trials within the halal industry in the future.

The outlets publishing research on AI in the context of the halal industry are highly diverse as presented in Table 3. The 23 identified documents are distributed across a wide range of scholarly platforms including reputable international journals and global conference proceedings. This diversity reflects the breadth of academic interest in the intersection of AI and the halal industry which spans domains including information technology, management, and Islamic research. Several articles appear in high-impact and internationally indexed journals such as Expert Systems with Applications, IEEE Access, Food Control, Quality and Quantity, and Kybernetes. The presence of publications in these outlets shows that research on AI in the halal industry extends well beyond Islamic research to other applied sciences, engineering, and data analytics. Moreover, journals with a more specific focus on marketing and business management such as the Journal of Islamic Marketing and the Journal of Family Business Management, emphasize the economic and managerial dimensions of the field.

A substantial proportion of findings are presented through international conference proceedings including the Amity International Conference on Artificial Intelligence (AICAI), International Conference on Cyber and IT Service Management (CITSM), MEC International Conference on Big Data and Smart City (ICBDSC), and the SAIN International Symposium on Advanced Intelligent Informatics. The frequency of publications in these platforms reflects the dynamic and changing nature of the research area which continues to be actively presented and debated within global academic forums. Moreover, several contributions have been published in multidisciplinary outlets such as the IOP Conference Series, AIP Conference Proceedings, Procedia Computer Science, and the Journal of Physics: Conference Series. This shows that the research on AI and the halal industry is not confined to religious or business contexts but is also integrated into scientific platforms with emphasis on computing, intelligent systems, and engineering.

The distribution pattern reflects the inherently interdisciplinary nature of AI research in the halal industry. It shows that the topic transcends the boundaries of Islamic research and extends into technology, management, food science, and public policy. The breadth reinforces the argument that the advancement of Halal Industry 4.0 through AI requires cross-disciplinary collaboration to ensure both a comprehensive understanding and effective real-world implementation.

Table 4 presents the institutions and countries of origin of authors contributing to publications on AI and Halal Industry 4.0. The data shows broad participation from universities and research institutions across Asia, the Middle East, North Africa, the Americas, and Eastern Europe. This international representation is a sign that the integration of AI into the halal industry has gained global attention by extending beyond countries with Muslim-majority populations.

Malaysia is identified as the most dominant contributor in the region due to the participation of a large number of institutions such as Universiti Malaysia Terengganu (UMT), Universiti Sains Islam Malaysia (USIM), Universiti Malaysia Pahang (UMP), Universiti Sultan Zainal Abidin (UniSZA), Universiti Malaya (UM), Universiti Teknologi Malaysia (UTM), Universiti

Table 4: List of institutions and countries of origin of authors

No.	Name of Institution	Country
1	University of Sharjah	United Arab Emirates
2	Universiti Malaysia Terengganu (UMT)	Malaysia
3	Universiti Sains Islam Malaysia (USIM)	Malaysia
4	Mansoura University	Egypt
5	Cairo University	Egypt
6	Adiyaman University	Turkey
7	Tanta University	Egypt
8	Menoufia University	Egypt
9	Kafrelsheikh University	Egypt
10	University of Benghazi	Libya
11	STMIK Pelita Nusantara	Indonesia
12	Universitas Putra Indonesia YPTK	Indonesia
13	Universitas Muhammadiyah Malang	Indonesia
14	Universitas Negeri Malang	Indonesia
15	Universitas Islam Negeri Sumatera Utara (UINSU)	Indonesia
16	Universiti Malaysia Pahang Al-Sultan Abdullah (UMP)	Malaysia
17	Amity University	India
18	International Islamic University Malaysia (IIUM)	Malaysia
19	Universitas Indonesia (UI)	Indonesia
20	Kennesaw State University	United States
21	University of Southampton Malaysia	Malaysia
22	Universiti Sultan Zainal Abidin (UniSZA)	Malaysia
23	Shahjalal University of Science & Technology	Bangladesh
24	King Fahd University of Petroleum and Minerals (KFUPM)	Saudi Arabia
25	University of Malaya (UM)	Malaysia
26	A'Sharqiyah University	Oman
27	Universitas Airlangga	Indonesia
28	United International University (UIU)	Bangladesh
29	Universiti Teknologi Malaysia (UTM)	Malaysia
30	Universitas Jenderal Achmad Yani	Indonesia
31	Kolej Pengajian Islam Johor (MARSAH)	Malaysia
32	Universiti Teknikal Malaysia Melaka (UTeM)	Malaysia
33	Universiti Teknologi Malaysia—HALAL/HOLISTICS Research Lab (UTM)	Malaysia
34	Hunan University of Science and Engineering	China
35	Government College University, Faisalabad	Pakistan
36	Management and Science University (MSU)	Malaysia
37	JAIN (Deemed to be University)	India
38	Chandigarh College of Engineering, Chandigarh Group of Colleges	India
39	Qassim University	Saudi Arabia
40	Nur International University	Pakistan
41	State University of Telecommunications (Saint Petersburg)	Russian Federation
42	PJSC Rostelecom	Russian Federation
43	Telkom University	Indonesia
44	Al-Ihya Islamic University Kuningan	Indonesia
45	Tianjin University	China
46	Universitas Muhammadiyah Yogyakarta	Indonesia
47	Universitas Islam Negeri Sunan Kalijaga	Indonesia

Source: Scopus.com

Teknikal Malaysia Melaka (UTeM), and Management and Science University (MSU). This dominance shows the role of Malaysia as a global research hub in halal and a pioneer in advancing Halal Industry 4.0. Indonesia also exhibits significant engagement with contributions from institutions such as Universitas Indonesia, Universitas Airlangga, Universitas Muhammadiyah Malang, Universitas Muhammadiyah Yogyakarta, Universitas Jenderal Achmad Yani, and Telkom University. The contributions emphasize the commitment of Indonesia to leveraging AI for strengthening the halal industry ecosystem in line with its position as the largest halal consumer market in the world.

The contributions from the Middle East and North Africa are made by leading institutions such as the University of Sharjah in UAE, Mansoura University and Cairo University in Egypt, University of Benghazi in Libya, and King Fahd University of Petroleum and Minerals in Saudi Arabia. The participation shows active interest of the region in combining advanced technologies with Shariah compliance due to its central role in the global halal market. South and East Asia also contributed through Shahjalal University of Science & Technology in Bangladesh, Amity University and JAIN University in India, as well as Hunan University of Science and Engineering and Tianjin University from China. These cases show that AI research in the halal context is not confined to Muslim-majority nations but also resonates in countries with minority Muslim populations. The trend reinforces the status of the halal industry as a cross-faith and global economic sector.

Eastern Europe and North America enrich the international dimension of this field through institutions including Kennesaw State University in the United States as well as the State University of Telecommunications and PJSC Rostelecom in Russia. The situation shows that that interest in AI for the halal industry is not exclusively rooted in Islamic perspectives but also related to the technological and engineering domains.

The findings confirm that research on AI and Halal Industry 4.0 is both multidisciplinary and transnational. The diversity of affiliations and countries shows that the development of the concept is not motivated by a single region but rather through a broader global academic network. This international engagement opens significant opportunities for cross-border collaborations to advance a more comprehensive and sustainable framework for Halal Industry 4.0.

3.2 Applications and Implementations of AI in the Halal Industry

The SLR of the 23 core articles shows that the applications and implementations of AI in the halal industry have expanded into several strategic domains. The articles reported the functional diversity of AI in the halal context and also emphasized the critical ethical, regulatory, and policy challenges.

The keyword co-occurrence mapping conducted through VOSviewer v1.6.18 produced five thematic clusters. Conceptually, these clusters represent a pipeline of 'halal assurance under Industry 4.0' which are (1) sensing and detection (computer vision, spectroscopy), (2) decision and certification support (analytics for halal bodies and compliance auditing), (3) traceability and integrity infrastructures (AI integrated with blockchain/IoT/anti-counterfeiting), (4) market intelligence (big data and sentiment/forecasting), and (5) consumer-facing services (tourism assistants, recommender systems). The theoretical value of the clustering is the presentation of AI as not a standalone solution but rather an assurance system only when technical models are integrated into auditable workflows, interoperable standards, and Shariah-compliant governance.

3.2.1 Conceptual Applications of AI in the Halal Industry

The green cluster emphasizes the conceptual and applicative dimensions of AI in strengthening the halal industry ecosystem. The dominant keywords such as AI, application, technology, industry, research, and implementation show that the research focus is on how AI is understood, positioned, and utilized as a conceptual framework to reinforce the halal industry in the era of Industry 4.0. The contributions of this cluster are primarily theoretical and conceptual rather than purely algorithmic or technical.

Several research reported the importance of AI in developing theoretical models for halal tourism. For example, Battour *et al.* (2022) showed how AI could be applied across different stages of the Muslim travel experience from planning and accommodation to post-travel evaluation. Another subsequent research by Battour *et al.* (2023) introduced the concept of Muslim-Friendly Tourism Experience (MFTX) grounded in customer experience and reference group theories to propose a novel framework that connected AI technologies with the spiritual and religious needs of Muslim travelers. In a more recent development, Battour *et al.* (2024) identified the potential role of ChatGPT in halal tourism and projected the AI as a virtual assistant to support Muslim tourists before, during, and after their journeys.

Conceptual contributions are evident beyond tourism as observed in the domain of policy research. Marlinda *et al.* (2021) examined how AI-based applications supported the implementation of halal tourism policies in South Korea. The findings showed that more than 50% of the applications analyzed effectively addressed Muslim tourist needs while simultaneously reinforcing national strategies to attract the halal tourism market. Similarly, Rahim (2023) explored the integration of blockchain, cloud computing, and AI in the halal supply chain. The findings emphasized that the research remained at an early stage but the urgency of adopting the technologies was increasingly apparent for enhancing transparency, accountability, and public trust.

The cluster further reflects the role of AI in global competitiveness. For example, Kusumaningrum *et al.* (2021) investigated how the food safety standards in Japan influenced the access of Indonesian products to the Japanese market by positioning AI as a potential enabler for compliance with international certifications such as ISO 22000 and the Halal Assurance System. This reflected the role of AI not only as a tool for technical efficiency but also as a strategic instrument in international trade policy.

Research on AI in the halal industry is confirmed in the cluster to remain strongly oriented toward theoretical urgency and adoption frameworks. AI is regarded as both a technological innovation and a conceptual driver for improving efficiency, transparency, and reliability within the halal ecosystem. This trend reflects an early stage of scholarly consolidation where literature is building bridges between practical industry needs and interdisciplinary theoretical frameworks across tourism, supply chains, and public policy.

3.2.2 Technical and Methodologies

The red cluster focuses on the technical and methodological aspects of AI applications in the halal industry. The dominant keywords such as data, model, analysis, algorithm, accuracy, convolutional neural network (CNN), and machine learning show that the cluster focuses on the development of intelligent computational systems for detecting, classifying, and predicting both the halal status of products and the efficiency of the business processes.

An example of the most prominent trends is the use of computer vision and image processing to support halal verification. Yusof *et al.* (2020) developed a machine learning–based vision inspection system to ensure compliance with Islamic poultry slaughtering practices. The integration of the Viola–Jones framework allowed the system to detect organs such as the esophagus with accuracy levels comparable to human inspectors which was 95.6% at one test site. Similarly, Fadhilah *et al.* (2018) designed a CNN-based application for detecting non-halal ingredients from food packaging images. The system achieved a high character-level accuracy of 98% but segmentation challenges reduced overall word-level accuracy to approximately 50%. This showed the importance of data preprocessing quality in determining the success of AI systems in halal contexts.

Recent advances are presented by the HALALCheck system developed by Tarannum *et al.* (2024) by combining YOLOv5 object detection, OCR, and ensemble machine learning models to identify the halal status of packaged foods. The system was validated by Shariah experts and achieved 98% accuracy to serve as a practical solution for Muslim travelers navigating global markets. The research marked a milestone by bridging machine learning outputs with expert validation which was a critical step for ensuring AI reliability in halal contexts.

Big data analytics and predictive modelling represent another major focus of the cluster by extending beyond image processing. Surjandari *et al.* (2024) proposed a hybrid model combining Data Envelopment Analysis (DEA) and Artificial Neural Networks (ANN) to evaluate the efficiency of halal certification bodies in Indonesia. The model classified institutions by performance and achieved a predictive accuracy of 85.06% which outperformed traditional logistic regression. Sulong *et al.* (2023) also analyzed 338,233 data points from Twitter and Google Trends to forecast demand for halal tourism and the financial performance of related industries. Bagged classification trees delivered the highest accuracy of 93.71% among the 14 machine learning algorithms tested to show the potential of AI for real-time demand forecasting in the dynamic halal tourism sector.

Sentiment analysis strengthened the cluster as observed in the efforts of Feizollah *et al.* (2019) and Furqan & Nasir (2024) to apply deep learning models such as CNN, LSTM, and RNN in analyzing public opinion on halal products across Twitter, Instagram, and YouTube. A stacked CNN–LSTM model achieved 93.78% accuracy in classifying sentiment as a reflection of the capacity of AI to extract complex emotional patterns from consumer discourse. These models are relevant for halal producers and also considered valuable for policymakers as reported by Furqan & Nasir who assessed public sentiment toward religious moderation policies in Indonesia.

The cluster features research on the combination of AI with other technologies. For example, Arief *et al.* (2020) used Fourier-Transform Infrared Spectroscopy (FTIR) and decision trees to detect halal–non-halal mixtures while Al-Bahri *et al.* (2019) combined IoT and digital object architecture (DOA) to combat counterfeit halal products. These cross-technology integrations reflect the future direction of the field where AI is not used in isolation but rather as the analytical engine alongside IoT, blockchain, and sensors to safeguard halal integrity.

The red cluster shows a shift from conceptual frameworks toward data-driven methodologies and advanced algorithms. The central focus is on enhancing accuracy, efficiency, and traceability through predictive models and automated detection systems. This is a sign that the cluster

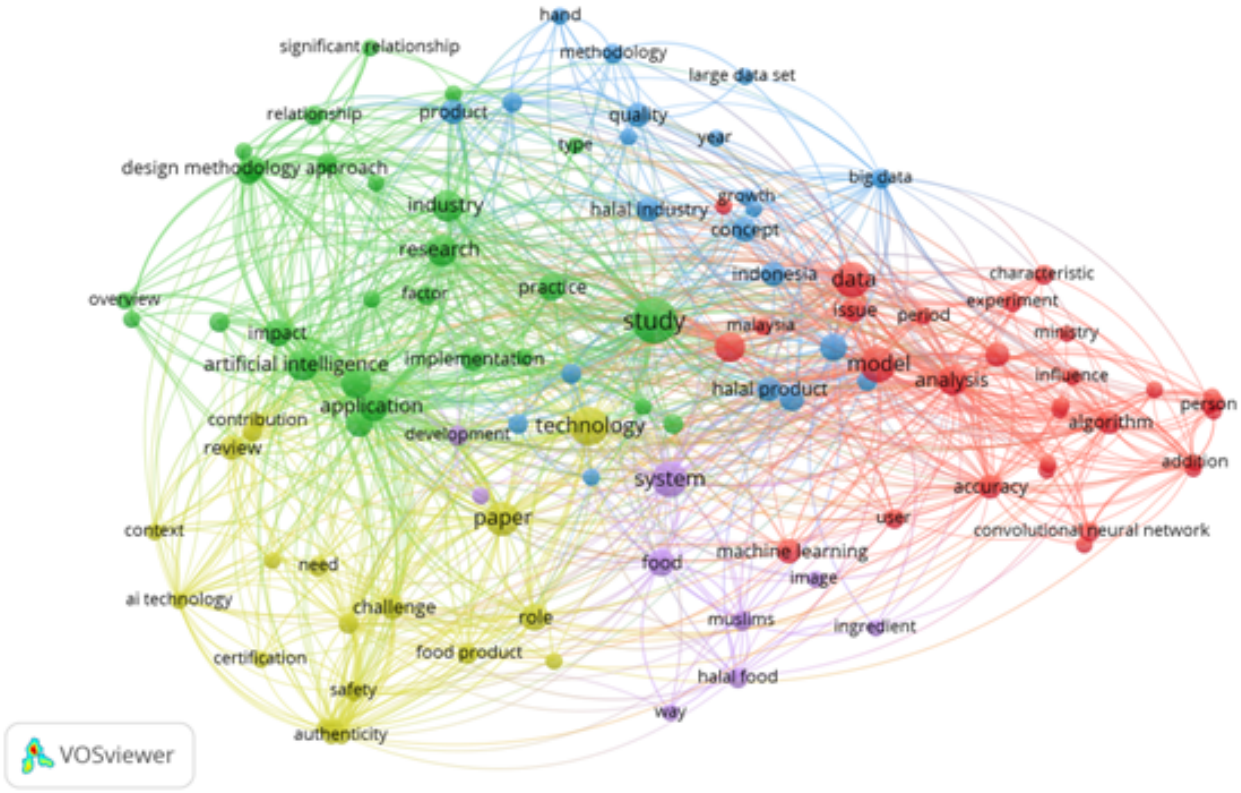

Figure 2: Network visualisation of research on AI applications and implementations in the halal industry

represents the technical backbone of Halal Industry 4.0 to enable tangible implementation across domains such as food processing, halal certification, and consumer behavior analysis in the digital era.

3.2.3 Halal Certification, Authentication, and Supply Chains

The yellow cluster addresses one of the core challenges of the halal industry which is to ensure products are genuinely halal (authentication) in order to maintain integrity throughout the supply chain and improve the reliability, efficiency, and transparency of certification processes. The literature suggests a clear trajectory toward integrating analytical methods such as sensors, spectroscopy, and image processing into digital architectures in the form of blockchain, IoT, and DOA to build a trustworthy and auditable halal ecosystem.

First, significant advances have been observed in sensor-based authentication methods. For example, Arief *et al.* (2020) utilized FTIR data to distinguish between halal and non-halal samples. This led to two critical points which included (1) sensory methods providing physical evidence of product composition and (2) data quality and preprocessing critically determining model success. The trend showed that Total Data Quality Management (TDQM) and data mining methods had become inseparable elements of the authentication pipeline. Similar issues were reported in computer vision and OCR research due to the ability of segmentation errors to substantially reduce overall recognition accuracy despite high character-level accuracy as observed in non-halal ingredient detection systems.

Second, the combination of AI with blockchain and IoT is currently a popular strategy for addressing traceability and counterfeiting concerns. Chandra *et al.* (2019) and Rahim (2023) emphasized that the distributed ledger of blockchain provided tamper-resistant transaction records. Meanwhile, IoT/DOA solutions enabled product identification and physical tracking along the supply chain (Al-Bahri *et al.* 2019). This combination allows stakeholders such as producers, processors, distributors, and certification bodies to record verifiable activities in the form of raw material sourcing, slaughtering processes, and storage conditions with the aim of enabling both auditors and consumers to transparently trace product histories. However, the research reported that blockchain adoption remained in the infancy stage within the halal sector with the implementation impeded by challenges such as cost, limited capacity of SMEs, and regulatory gaps.

Third, empirical research such as Surjandari *et al.* (2024) applied quantitative models to improve the efficiency of Halal Certification Bodies (HCBs) from an institutional and certification perspective. The model combined DEA with ANN and logistic regression to effectively classify efficient versus inefficient institutions as a very important step in reducing certification time and costs for industry players. Kurniawati *et al.* (2024) applied Mixed-Integer Linear Programming (MILP) at the operational supply chain level and reported the real trade-off between halal integrity proxied by the avoidance of cross-contamination and operational costs. The trend showed the need for the distribution model selection to balance product characteristics with risk management priorities.

Fourth, anti-counterfeiting solutions have gained significant attention. The systems that combined DOA with IoT and tagging technologies such as physical unclonable function (PUF) and near-field communication (NFC) offered adaptable frameworks for halal products (Al-Bahri *et al.* 2019). However, the effectiveness of these solutions depends on the manufacturing readiness and SME capacity because high costs and limited infrastructure remain substantial barriers to scalability across many halal-producing countries.

Finally, socio-economic and sustainability dimensions are increasingly considered. This was observed from the reports of Hendayani & Febrianta (2020) and Sumarliah & Al-hakeem (2023) that technology adoption could enhance the effectiveness of family-owned businesses and SMEs in halal supply chains while also strengthening Sustainable Supply Chain Management (SSCM) practices. Meanwhile, technological adoption was identified as capable of improving operational effectiveness without necessarily reducing costs for small-scale businesses. This reality calls for inclusive adoption models, policy subsidies, or shared-service frameworks to ensure that SMEs who form the backbone of the halal economy benefit equitably from digital transformation.

3.2.4 Big Data and Regional Context

The blue cluster shows a shift in research from purely conceptual exploration toward the utilization of big data analytics and the integration of regional contexts. This is particularly observed in Malaysia and Indonesia, which are identified as the epicenters for research on AI in the Halal Industry 4.0. The keywords such as big data, growth, quality, concept, halal product, Malaysia, and Indonesia are a sign that research in the cluster does not only examine technological dimensions but also ensures connection to regional dynamics, policy frameworks, and socio-economic needs in Southeast Asia.

Tan *et al.* (2017) stands as one of the pioneering publications that emphasized the transformative potential of big data analytics within the halal industry. The research adopted SWOT/TOWS analysis to assess the applicability of big data across halal sectors including food, pharmaceuticals, education, and logistics. The findings showed that big data could significantly enhance traceability, strengthen consumer insights, and improve the global competitiveness of halal products. However, critical

limitations were identified particularly in relation to the lack of awareness within the halal industry about the strategic value of big data and the absence of standardized data interoperability.

Furqan & Nasir (2024) subsequently applied big data–based sentiment analysis in Indonesia to examine public debates surrounding policy shifts such as the introduction of a new halal logo and the transfer of certification authority. Datasets from Twitter, Instagram, and YouTube were used in addition to the testing of six machine learning algorithms and the research produced its highest accuracy of 82.27% through Gradient Boosting. The findings showed that big data was not only a technical tool but also a socio-political instrument capable of evaluating public legitimacy and detecting social resistance toward halal policy implementation.

The scope of big data has expanded into halal tourism research. For example, Sulong *et al.* (2023) analyzed more than 338,000 datasets from Twitter and Google Trends to forecast demand for halal tourism and assess the financial performance of halal tourism industries in Malaysia. The findings showed that bagged regression trees achieved the highest predictive accuracy of 93.71%. This confirmed that large-scale internet data were very important in market forecasting for halal tourism. In a complementary effort, Abdullah *et al.* (2024) developed the World Halal Tourism Composite Sentiment Index (WHTCSI) derived from textual analysis which was successfully implemented to predict stock price movements of halal tourism companies. The research established a direct connection between big data, consumer behavior, and financial market dynamics in the halal economy.

The other research articles have advanced methodological refinements such as the adoption of TDQM as observed in Arief *et al.* (2020). The research assessed the quality of FTIR data for halal–non-halal classification through data mining methods. The findings showed that high-quality data formed the backbone of any AI-based halal authentication system. Meanwhile, Kurniawati *et al.* (2024) addressed operational complexities in halal food distribution by adopting MILP. The research reported that large-scale data complexity required metaheuristics and big data analytics integration. The trend shows that traditional supply chain management methods are no longer sufficient to manage halal distribution and this reflects the need for full adoption of Industry 4.0 technologies.

3.2.5 AI in Halal Food and Consumer Behavior

Purple cluster is relatively smaller in scope but holds significant strategic importance because it directly addresses halal food authentication and Muslim consumer behavior. Dominant keywords such as halal food, ingredient, Muslims, image, and way emphasize the applied orientation of this research cluster which focuses on AI as a practical solution for ensuring the consumption of halal, authentic, and Shariah-compliant food products. Research in the cluster is mostly motivated by computer vision, deep learning, image recognition, and natural language processing (NLP) to verify food authenticity and analyze Muslim consumer preferences. Most of the articles focused on image-based AI applications to detect non-halal ingredients in packaged foods as follows:

a. Fadhilah *et al.* (2018) developed a CNN-based system for reading food composition directly from packaging images. The character-level recognition accuracy reached 98% but the system faced challenges in word segmentation by reducing overall verification accuracy to approximately 50%. This reflected segmentation as a critical bottleneck in food authentication using AI.

b. Yusof *et al.* (2020) applied vision inspection through the Syariah Compliance Automated Chicken Processing System (SYCUT) to verify the compliance of the poultry slaughtering process with Islamic law. The Viola–Jones–based object detection framework adopted showed that the system achieved >90% accuracy across test sites to address a critical gap in ensuring halal integrity in poultry processing.

c. Tarannum *et al.* (2024) introduced HALALCheck which was a system developed by combining YOLOv5, OCR, and rule-based classification for packaged food authentication. It was validated by Islamic scholars and achieved 98% accuracy which positioned the system as a potential global mobile application to support Muslim consumers and travelers in halal food selection.

The findings collectively showed that AI extended beyond technical innovation by serving as a consumer empowerment tool to support faster, more accurate, and Shariah-compliant decision-making. The research in the cluster also emphasized the role of AI in enhancing halal food authentication through supply chain transparency in addition to consumer-facing applications as follows:

a. Arief *et al.* (2020) combined FTIR spectroscopy with data analytics under a TDQM framework to show the role of data quality as a critical foundation for AI-driven halal authentication systems.

b. Chandra *et al.* (2019) reported that the combination of blockchain, IoT, and AI significantly improved halal food supply chain traceability. The blockchain ensured auditability while AI provided real-time interpretation of complex data streams.

c. Nawaz *et al.* (2025) advanced the perspective by positioning AI as a multi-functional solution for quality control, compliance monitoring, and consumer trust-building. The AI leveraged NLP, computer vision, and blockchain to detect adulteration, monitor certification processes, and enhance transparency in order to reinforce consumer confidence in halal products.

The cluster extends beyond authentication to examine the intersection between AI and Muslim consumer behavior. These are observed in the following research articles:

a. Feizollah *et al.* (2019) showed that sentiment analysis of Twitter conversations on halal products such as cosmetics and tourism) could effectively capture consumer opinions. The application of stacked deep learning model including CNN, LSTM, and RNN achieved 93.78% accuracy. This showed the potential of consumer voice mining for understanding halal consumption in the digital era.

b. Hendayani & Febrianta (2020) investigated the adoption of technology in family-based halal food businesses in Indonesia. The findings showed that technology improved operational effectiveness but did not often translate into cost efficiency. The research reported that Muslim consumers mostly prioritized halal assurance and product quality over price or speed of distribution.

c. Sumarliah & Al-Hakeem (2023) extended the discussion to sustainability and the post-COVID-19 halal food supply chain. The research reported that AI and big data adoption enhanced competitive performance, but SMEs faced persistent challenges in achieving full implementation particularly due to resource and capacity constraints.

The purple cluster collectively shows that AI is increasingly positioned as a trust enabler within the halal food ecosystem. The aim is to ensure authenticity, enhance supply chain transparency, and deepen insights into Muslim consumer behavior.

3.2.6 Opportunities, Challenges, and Future Research Gaps

The application of AI in the halal industry opens vast opportunities for transformation, efficiency, and global competitiveness. First, the adoption in halal supply chain can enhance product traceability through blockchain, machine learning, and image recognition technologies to ensure end-to-end compliance with the required standards (Ellahi *et al.* 2025; Julian *et al.* 2025; Sunmola *et al.* 2025). The process strengthens consumer trust and expands access to international markets that increasingly demand transparency. Second, the application of AI in the halal food industry enables production optimization via predictive analytics to minimize waste, maintain quality, and rapidly detect non-halal elements in food ingredients (Rahman 2025; Tarannum *et al.* 2024). This is particularly important because halal food represents the largest and most dynamic sector within the global halal ecosystem.

Third, AI-powered fintech solutions in halal finance such as chatbots, credit scoring, and Shariah-compliance screening offer opportunities for broader Islamic financial inclusion particularly for communities previously underserved by formal institutions (Hamadou *et al.* 2024; Ridzuan *et al.* 2024; Sarea *et al.* 2021). The technology also improves the efficiency of risk management and the transparency of Islamic financial products (Kamarudin *et al.* 2025). Furthermore, the adoption in halal tourism and lifestyle domains facilitates personalized experiences through big data analytics. These included recommendations for Muslim-friendly destinations, halal food search applications, and digital services utilizing augmented reality (AR) and virtual reality (VR) (Rahman *et al.* 2023). The trend shows that the integration of AI supports operational efficiency, strengthens value creation, and enhances customer experience.

Several fundamental challenges remain in implementing AI in the halal industry despite the promising opportunities identified. The first are the regulatory and standardization challenges which are associated with the lack of a unified global framework for digital technologies including AI in the halal sector. This has led to inconsistencies in digital halal certification processes across jurisdictions. The second are technical and infrastructural challenges (Hidayati *et al.* 2024; Rasyidah *et al.* 2025). These are associated with the fact that AI implementation requires big data, robust digital infrastructure, and strong system integration. Meanwhile, several halal enterprises particularly SMEs currently face limitations in technology access, cost, and digital human capital. The lack of adequate infrastructure can widen the digital divide in AI adoption between large corporations and SMEs (Aniqoh & Hanastiana 2020; Azwar *et al.* 2022).

The third is the need to address ethical and religious challenges because the AI adopted in the halal industry is required to operate within Shariah principles. For example, Islamic finance requires AI algorithms to avoid riba, gharar, and maysir (Alshaer 2024). The application in consumer data processing also raises ethical concerns regarding privacy and data security which are to be evaluated through the lens of maqāsid al-sharīʿah (Abozaid 2024). The fourth is the challenges of adoption and trust persistence because some consumers and industry actors remain skeptical of the reliability of AI in halal/haram detection such as in technology-based halal certification (Azwar & Usman 2025; Khairuddin & Rahman 2023).

A lack of understanding of the mechanisms associated with AI can foster resistance and hinder acceptance of innovations.

Several articles have explored AI applications in the halal industry, but significant research gaps remain. First, there is a conceptual and theoretical gap due to the absence of integrative models that connect Shariah principles with AI algorithms. Most research focuses on practical applications while epistemological frameworks for "Shariah-compliant AI" remain underdeveloped. Second, empirical gaps exist in the implementation of AI among halal SMEs because. This is because current research largely emphasizes large enterprises or financial institutions with limited investigation into how SMEs can sustainably adopt AI despite their status as the backbone of the global halal ecosystem.

Third, some gaps are identified in relation to global standardization which shows the need for future research to place greater emphasis on harmonizing international regulations for digital halal systems and AI-driven cross-border certification. This is critical due to the global and cross-jurisdictional nature of the halal industry. Fourth, multidisciplinary research gaps persist considering the fact that the utilization of AI in the halal industry extends beyond the technological aspect to the intersection with fiqh, maqāsid al-sharī'ah, economics, sociology, and consumer psychology. However, most research remains fragmented and lacks a comprehensive multidisciplinary synthesis. Fifth, there is a gap in the measurement of social impact and sustainability. AI is believed to enhance efficiency but only a few research has evaluated its effects on social justice, economic empowerment, and environmental sustainability within the halal ecosystem. Therefore, future research agendas should be directed toward developing a holistic framework for AI in the halal industry through the integration of technological efficiency with Shariah values, inclusivity, and global sustainability.

This review contributes a PRISMA-guided, cross-sector synthesis of Scopus-indexed AI research in the halal industry and reframes the field as an emerging 'halal assurance system' rather than a set of disconnected applications. The combination of bibliometrics, thematic analysis, and cluster mapping leads to the clarification of what is currently feasible, what remains largely conceptual, and what governance requirements are to be met for Halal Industry 4.0.

4 Conclusion

The analysis and discussion have led to the formulation of several key inferences. First, research on AI applications in the halal industry is experiencing significant growth. The dynamics of publication show a developmental trajectory which starts with early conceptual ideas presented at conferences followed by the transformation into peer-reviewed journal articles. The rising number of publications within the reviewed period reflects that the field is maturing and attracting wider academic attention.

Second, the literature review shows that AI applications in the halal industry span multiple sectors and take diverse forms. In the halal food sector, it is widely adopted for traceability systems, non-halal ingredient detection, and certification automation using machine learning and computer vision. In pharmaceuticals and cosmetics, the technology supports ingredient analysis, product safety testing, and big data integration to ensure compliance with halal standards. The applications in Islamic finance include Shariah-compliant fintech, robo-advisory, and fraud detection to enhance transparency and efficiency. Logistics and halal tourism have also adopted AI for supply chain optimization, IoT-based distribution systems, and recommender systems for halal travel services. These findings collectively confirm that the function extends beyond being a technological enabler to serving as a catalyst for strengthening consumer trust, improving business efficiency, and advancing the Halal Industry 4.0 ecosystem.

Third, the transformative potential of AI in the halal industry is identified to enhance supply chain traceability, optimize food production, expand Islamic fintech services, and foster innovations in halal tourism and lifestyle through big data, AR, and VR. However, these advancements face critical challenges which include the absence of global standardization, inadequate infrastructure and digital literacy particularly among SMEs, and ethical or Shariah compliance concerns considered capable of influencing user trust. The most pressing gaps identified from a research perspective include the absence of conceptual frameworks that combine Shariah principles with AI algorithms, limited empirical research on SME adoption, weak international regulatory harmonization, insufficient multidisciplinary methods, and inadequate evaluation of socio-economic and sustainability impacts. Therefore, future research agendas need to prioritize the development of holistic frameworks positioning AI both as an efficiency tool and a catalyst for building an ethical, inclusive, and maqāsid al-sharī'ah-compliant halal industry.

5 Research Implications, Limitations, and Future Directions

This research contributes significantly at both the theoretical and practical levels. Theoretically, the findings enrich the literature on AI integration in the halal industry by offering a comprehensive cross-sectoral synthesis. This provides a conceptual foundation for advancing research frameworks on Halal Industry 4.0 grounded in Shariah principles. Practically, the study delivers evidence-based insights for policymakers, certification bodies, and halal industry stakeholders in designing AI adoption strategies. The findings regarding opportunities, challenges, and research gaps can also inform public policy, strengthen digital certification mechanisms, and foster innovation toward more efficient, transparent, and globally competitive halal systems.

Some limitations associated with the research design and the first is the fact that the evidence base is only from Scopus and is limited to English-language publications. The process can lead to the omission of relevant regional studies and grey literature. This shows the need to interpret the findings as Scopus-indexed trends rather than an exhaustive global census. The second is that the synthesis depends on manual or inductive coding and keyword mapping conducted iteratively but some thematic interpretation is unavoidable. The third is that the included articles are heterogeneous such as conference papers, conceptual work, and empirical models mostly with incomparable outcome metrics. This can prevent meta-analysis and limit the strength of cross-study performance claims. The fourth is that limited report is provided by most research on explainability, privacy, and Shariah reasoning of datasets, validation protocols, and governance. This is capable of constraining the depth of risk-of-bias assessment and motivating the research agenda proposed.

Future research is expected to focus on several areas in line with the limitations identified. First, empirical research is required on AI implementation across halal industry sectors particularly SMEs which form the backbone of the global halal economy. Second, integrative models that connect Shariah principles with AI algorithms need to be developed to produce a conceptual framework for "Shariah-compliant AI." Third, multidisciplinary research that combines perspectives from technology, economics, fiqh, sociology, and consumer psychology is required to generate a holistic understanding. Fourth, research on the social, economic, and sustainability impacts of AI adoption in the halal industry needs to be strengthened to ensure that digital transformation remains in line with maqāsid al-sharī'ah and the principles of inclusivity and global sustainability.

Conflict of Interest

The authors declare no conflict of interest.

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