Analysis of the Application of Artificial Intelligence (AI) in Halal Product Supply Chain Management: A Systematic Literature Review

Shofia Rizka Julianti[1], Agung Fatwanto[2]

[1]Industrial Engineering Department, Faculty of Science and Technology, UIN Sunan Kalijaga, Indonesia
[2]Information Departement Department, Faculty of Science and Technology, UIN Sunan Kalijaga, Indonesia
*Corresponding author: 24206061007@student.uin-suka.ac.id

Abstract

The development of globalization has made digital technology play an important role in increasing the efficiency of supply chain management to ensure that its products are truly halal at the point of purchase for consumers. The technology that plays an active role in supply chain management is artificial intelligence (AI). This study aims to determine the effectiveness of implementing AI in halal product supply chain management. The object of this study is a scientific article that implements AI technology in halal product supply chain management with a qualitative approach through the Systematic Literature Review (SLR) method. Literature studies were conducted using Google Scholar and Science Direct to obtain detailed and up-to-date information on the topics to be studied. This study found 12 AI models that can be used in supply chain management. However, its implementation in the field of halal supply chains has not been widely implemented. This study also found that the implementation of AI in the halal product supply chain can improve operational efficiency and improve supply chain performance. However, successful adoption depends on technological readiness, good collaboration between technology and human expertise, and consumer trust. Investing in AI-based systems can significantly improve supply chain integrity and consumer trust.

Keywords : artificial intelligent; halal supply chain management; literature review

INTRODUCTION

Indonesia is a country with a majority Muslim population. The number of Muslims in Indonesia reaches 245.97 million people (BPS, 2024). There is a known projection that the growth of the Muslim community will increase from 1.6 billion in 2010 to 2.7 billion in 2050 (Pew Research Center Religion & Public Life, 2015). When the growth of the Muslim population increases, the demand for halal products also increases. According to the State of the Global Islamic Report (SGIER) 2023-2024, consumption of halal products in the world is estimated to reach USD2.4 trillion in 2024. People are starting to be aware by starting to care about the halal certification of every product they use. One of the factors that causes public concern regarding halal products to continue to increase is because of a belief or conviction that using Halal and Tayyib products is a commandment in Islam.
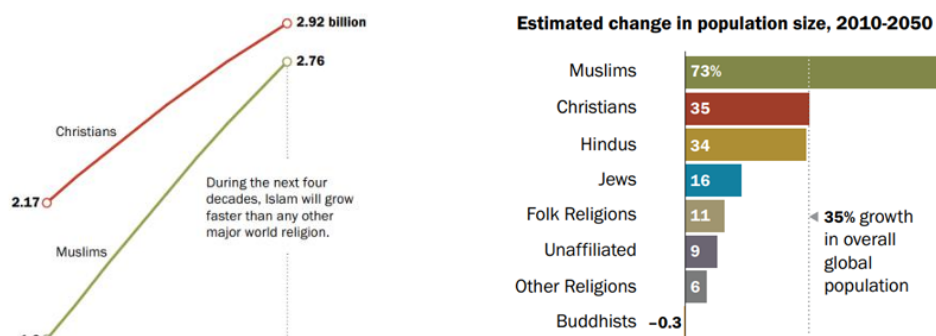
Figure 1. Estimated Muslim Population Growth
Source: Pew Research Center Religion & Public Life (2015)

Halal comes from the word "Halal" which is found in the Qur'an Surah Al-Baqarah verse 168 which means, "O Mankind! Eat from what is lawful and good on earth, and do not follow the footsteps of Satan. Indeed, Satan is a clear enemy to you". The translation of the verse states that the sharia firmly states that Muslims are prohibited from consuming what is haram. Halal products do not only have halal qualifications from sharia. Halal products must also be guaranteed halal from the product series process during the production process including procurement of raw materials, processing, storage, packaging, distribution, sales, and of course presentation of the product (BPJPH, 2024). Products that have met these criteria can be called Toyyib. Halal logistics plays an important role for the halal industry in providing raw materials to finished products to consumers. Therefore, the halal industry needs to realize the importance of halal supply chain management. Halal supply chain management aims to extend halal integrity from the source to the consumer's point of purchase. To ensure that products are truly halal at the consumer point of purchase, it is important to define the principles in halal supply chain management (Kuncorosidi et al., 2021).

The development of the era of globalization and increasingly tight market competition has made digital technology have a very important role in increasing efficiency and competitiveness in an industry. Digital technology is an alternative and innovation in various fields, especially in the economy (Nurbaiti et al., 2023). An industry that successfully manages halal supply chain management will innovate by utilizing technology and available resources. So that it has the ability to control risks that may occur throughout the supply chain flow, problem solving, and create risk control management based on the best recommended information (Kumar et al., 2023). One of the technologies that plays an active role in the transformation of supply chain risk management is artificial intelligence (AI).

Artificial intelligence (AI) is an innovation in the field of information technology by creating software that can think like humans. AI technology that has human-like problem-solving capabilities. The source of knowledge from AI is data, just like humans. AI has the ability to recognize patterns, solve problems, and process large amounts of data in a short time. AI is used in supply chain management to analyze large data sets, identify potential risks, predict their likelihood and impact, and optimize logistics processes. By analyzing large data sets, AI can help organizations identify potential risks that may not be visible manually (Khairi et al., 2024).

The integration of AI technology can provide significant benefits to the halal supply chain, such as better traceability, better inventory management, and increased operational efficiency. In addition, the integration of AI intelligence into the halal supply chain offers many opportunities to improve efficiency and profitability. In addition, the use of AI in halal supply chain management is expected to improve raw material procurement. AI-based analysis can help companies make the right purchasing decisions by analyzing market trends, supplier performance, and pricing models. By accurately estimating demand and identifying the best halal raw materials, companies can minimize costs and ensure raw materials meet halal standards (Rochim, et al., 2024).

Based on the literature study, there are several reasons for the urgency of research on AI in the halal supply chain so that it needs to be done. These are the lack of research on the impact of AI on the overall performance of the halal supply chain, the lack of research on the factors that influence the success of implementing AI in halal supply chain risk management, and the lack of research on the challenges and risks associated with implementing AI in the halal supply chain. This can cause companies to have difficulty in implementing AI technology effectively. For this reason, this study seeks to fill the gap in the literature by providing a comprehensive analysis that includes operational efficiency. This study aims to advance the understanding of how stakeholders can navigate the complexity of the halal supply chain in an increasingly digital world (A, 2024). Thus, this study is expected to contribute to the halal market by ensuring that the application of AI in the halal supply chain can provide optimal benefits.

METHODS

The object of research in this literature study is a scientific article that implements AI (artificial intelligence) technology in halal product supply chain management. This study aims to determine the contextual view to find solutions to the underlying phenomena. Based on this, the recommended research approach is a qualitative approach with the Systematic Literature Review (SLR) research method. The stages of the SLR method are literature study, determination of inclusion and exclusion criteria, and data analysis process, which are described as follows:

1. Literature Search Process
   Researchers collect scientific articles related to the research topic systematically. Researchers use Google Scholar and Science Direct by selecting search terms that are appropriate and relevant to the research topic, namely "implementation of artificial intelligence in halal supply chain management".
2. Inclusion and Exclusion Criteria Determination Process
   Researchers determine inclusion and exclusion criteria to identify data that can be used in this study.
   a. Inclusion Criteria
      - Articles published in 2020-2025
      - Articles with a focus on AI in halal product supply chain management
   b. Exclusion Criteria
      - Article about companies not implementing AI for halal product supply chain management
      - Article about halal product supply chain management without implementing AI
3. Data Analysis Process

Researchers conducted data analysis based on inclusion and exclusion criteria. Researchers used ChatGPT in the data analysis process on articles that were in accordance with the research questions. The data collected will be analyzed to determine and show the following: **(RQ1)** AI models that can be used in supply chain management, **(RQ2)** The role of AI in improving the efficiency of halal product supply chain management, **(RQ3)** Challenges in implementing AI in halal product supply chain management.

RESULT AND DISCUSSION
(RQ1) AI Models That Can Be Used in Supply Chain Management

Artificial intelligence (AI) is already widely known by the public, but AI models are still little known by the public or companies so that they have not been widely applied in halal supply chain management. The following are AI models applied in supply chain management in various fields:

Table 1. Supply Chain Management AI Model

Num	AI Models	Description
1.	Machine Learning (ML)	Machine Learning is a branch of artificial intelligence that focuses on the development of algorithms and models that allow computers to "learn" from data (Bintoro et al., 2024)
2.	Deep Learning (DL)	A branch of Machine Learning that uses artificial neurons or multi-layered neural networks to process or learn from data. Deep learning allows computers to learn directly from experience, allowing systems to recognize complex patterns in data (Bengio et al., 2021)
3.	Adaptive Logistic Regression Classifier (ALRC)	One of the classification models used to predict the probability of data belonging to a certain category based on previous data. ALRC works by continuously adjusting data weights to improve prediction accuracy (Arulmozhi et al., 2020).
4.	Support Vector Machine (SVM)	SVM is known as a support network in Machine Learning with a continuous learning algorithm that analyzes data for classification and regression analysis. Used for classification by separating data using a hyperplane that maximizes the margin between two classes (Bintoro et al., 2024).
5.	Decision Tree (DT)	This model is a graphical representation of possible solutions to a decision based on certain conditions. Used for classification or regression, by dividing the dataset into smaller subsets based on informative features (Bintoro et al., 2024).
6.	Neural Networks (NN)	This model is a generalization of the mathematical model of the biological nervous system consisting of a collection of connected neurons. It is used for a variety of applications, from image classification to speech recognition, especially Deep Learning (Bintoro et al., 2024).
7.	Bayesian Network (BN)	The BN model is a type of graphical model that uses probability to determine the occurrence of events or is known as a cause-and-effect network. BN consists of a directed cyclic graph and a conditional probability table to determine the probability of an event. The graph is acyclic where one node can reach another node. In contrast, the probability table shows random variables that have certain values (Khairi et al., 2024).
8.	Random Forest (RF)	Random Forest is a type of Machine Learning for classification and regression. This algorithm is one of the hybrid learning that combines several simple prediction models to obtain accurate and stable predictions (Khairi et al., 2024).
9.	Ensemble Learning (EL)	Esemble Learning is a machine learning technique that combines multiple models to improve prediction performance compared to using a single model. The basic idea of hybrid learning is to combine different types that may have different weaknesses, so as to create a robust and stable model (Khairi et al., 2024).
10.	Naive Bayes (NB)	Naive Bayes is a Machine Learning algorithm that can be used to solve classification problems. It is called Naive Bayes because its operating principle is based on Bayes' theory. It is one of the simplest

Num	AI Models	Description
		and most powerful Machine Learning algorithms used in many industries (Khairi et al., 2024).
11.	Extreme Learning Machine (ELM)	Extreme Learning Machine (ELM) is a learning method used in the field of Machine Learning and Neural Networks to accelerate the learning process and increase the generalization capacity of machines (Wang et al., 2022)
12.	Decision Support System (DSS)	Decision Support System is a computerized information system. This system is part of the knowledge management system and functions to support decision making in business and organizations (Khairi et al., 2024).

AI approaches have yet to be applied in the field of halal supply chain research. Therefore, more studies on the implementation of AI in the field of halal supply chain and linking it to sustainability using AI methodology are needed (Kuniawati et al., 2023). However, other literature studies have shown that AI can significantly improve trust management and data privacy in agri-food applications. This study can advance the field by identifying gaps in current research, proposing strategic recommendations, and outlining future directions for AI-based systems in the domain of agri-food research. The insights presented provide a strong foundation for researchers, policymakers, and stakeholders in the agri-food sector to build a more resilient and intelligent ecosystem (Halder, et al., 2025).

In addition, the application of machine learning, which is one of the AI models in the field of mineral mining, has also attracted the attention of investors, resulting in significant investment. However, relying solely on machine learning can ignore the important role of human creativity in generating and evaluating new search strategies. Effective implementation requires collaboration between data scientists and geoscientists, leveraging machine learning as a tool to test hypotheses and analyze diverse data sets. Therefore, by combining technological advances with human expertise, the mineral exploration industry can increase the success of discoveries and achieve long-term sustainability (Davies, et al., 2025).

The role of AI for supply chain management in government is to increase operational efficiency. AI can optimize shipping and distribution routes, and automate routine tasks such as document processing and inventory management. In addition to saving time. It can also reduce human error. AI can also increase transparency and tracking by monitoring goods in real-time, providing full visibility into the movement of goods. Decision making is also improved with predictive analysis that allows for accurate planning and identification of potential risks. AI helps in terms of cost savings, by ensuring inventory is as needed and supporting more efficient contract negotiations so that it can reduce waste (Khairi et al., 2024).

The business sector that is always developing is also a field that uses a lot of AI methods in supply chain management. AI has an important role in reducing the risks that occur. AI helps companies identify risk factors and predict market demand and possible risk situations, which means that when the supply chain faces challenges in terms of time, cost, and resource constraints, ML becomes an excellent approach to overcome them (Yang et al., 2023). AI also helps in classifying different methods based on data characteristics, thus supporting the selection process of the right AI method in optimizing demand forecasting.

(RQ2) The Role of AI in Improving the Efficiency of Halal Product Supply Chain Management

Based on the articles that have been analyzed, it is known that the application of AI models is very effective in helping to reduce the risks that occur in the supply chain. The implementation of AI technology into the halal product supply chain presents significant opportunities to improve operational efficiency and improve overall supply chain performance. By using an AI model that is appropriate to existing supply chain problems, companies can reduce or eliminate risks that occur in the supply chain. The appropriate AI model can help companies identify, analyze, and manage risks that can occur in the supply chain according to the fields that exist in the company. Implementation will be more effective when there is good collaboration between data scientists and geoscientists. So by combining technological advances and human expertise, it is expected to increase the success of a company's supply chain.

AI includes various technologies, including machine learning, data analysis, and automation that can be used to simplify various processes (Hew et al., 2020). The application of AI in supply chain management allows for optimal and dynamic product route planning, optimizes processes, and minimizes errors which ultimately save costs and labor. In addition, machine learning systems and neural networks are very useful in supply chain management, enabling prediction of the impact of the bull-whip effect, resource allocation through lead scoring, and lead time adjustments based on analysis of audio and video communications between customers and sellers. These technologies, overall, improve the decision-making process in the flow of goods and services along the supply chain, thereby saving time and resources and increasing efficiency (Kehayov et al., 2022).

AI can improve the halal supply chain in raw material procurement. AI-based analytics can help companies make informed purchasing decisions by analyzing market trends, supplier performance, and pricing models. By accurately forecasting demand and identifying the best sources of halal raw materials, companies can minimize costs while ensuring their raw materials meet halal standards. In addition to procurement, AI also plays a vital role in inventory management. Through predictive analytics, AI can optimize stock levels by anticipating demand fluctuations and minimizing excess inventory. By reducing stockouts and excess stock, AI helps maintain product quality and ensures that halal products reach consumers in optimal condition. Thus, companies can increase customer satisfaction and successfully comply with the standards expected in the halal supply chain. In addition, AI technology also has a significant impact on the quality control process. AI can be used to monitor the production process and identify product defects in real-time. This not only ensures that products comply with halal requirements but can also increase consumer confidence in product integrity (Maulidizen, 2019).

(RQ3) Challenges in Applying AI to Halal Product Supply Chain Management

Integration of AI technology can provide significant benefits to the halal supply chain, such as improved traceability, better inventory management, and increased operational efficiency. However, the application of AI also raises dilemmas related to data privacy, algorithmic bias, and accountability. For example, reliance on AI-driven decision-making processes can inadvertently override human judgment, potentially leading to outcomes that are not aligned with ethical standards or halal principles. Identifying these challenges is critical to maintaining the integrity of the halal supply chain and safeguarding the interests of all stakeholders involved (Rochim, et al., 2024).

One of the main challenges in the halal supply chain implementing AI technology is algorithmic decision-making that may not be aligned with halal principles. Just as AI systems use data to make critical procurement decisions, if the data used is biased regarding halal requirements, the results may be contrary to ethical standards. In addition, the application of AI can also lead to the potential for ignoring transparency in operational processes. In the context of the halal supply chain, lack of transparency can lead to distrust by consumers, who rely on clear and verifiable information regarding the source and integrity of halal products. If a company's operational processes are not transparent, consumers may question whether the product truly meets halal standards, thereby undermining their trust in the brand and halal certification itself (Maulidizen, 2019).

The challenges arising from the integration of AI in the halal supply chain require careful consideration and proactive management. Issues related to algorithmic decision-making, transparency, and worker welfare must be addressed to uphold the integrity of halal practices. By implementing ethical guidelines, promoting transparency, engaging stakeholders, and investing in workforce development, companies can effectively address these issues. Thus, these challenges not only strengthen the halal supply chain but also contribute to a more sustainable corporate environment (Azzaky et al., 2024). AI has become a force in various industries, helping companies to make better decisions, increase efficiency, and create new products and services.

CONCLUSION

This study can conclude that there are 12 artificial intelligence (AI) models used to help reduce the risks that will occur. However, its implementation in the field of halal supply chain research is still not widely applied. Companies that have not used AI as a tool to overcome risks that will occur due to several factors such as operational costs, lack of understanding of AI and so on. Thus, more studies need to be conducted in the field of halal supply chains and link them to sustainability using AI methodology.

This study also found that the implementation of AI technology into the halal product supply chain presents significant opportunities to improve operational efficiency and improve overall supply chain performance. Using an AI model that is in accordance with existing supply chain problems, companies can contribute to raw material procurement, inventory management, and quality control processes. However, the use of AI still has obstacles and barriers because companies are still not optimal in managing AI. The main challenge in the halal supply chain that implements AI technology is algorithmic decision making that may not be in line with halal principles. In addition, the application of AI can also lead to the potential for ignoring transparency in operational processes.

The challenges arising from the integration of AI in the halal supply chain require careful consideration and proactive management. By implementing ethical guidelines, promoting transparency, engaging stakeholders, and investing in workforce development, companies can effectively address these issues. Therefore, while AI has demonstrated its effectiveness in halal supply chain risk management in certain contexts, there needs to be a good collaboration by combining technological advancements and human expertise, which is expected to improve the success of a company's supply chain.

AI and emerging technologies have great potential to transform halal supply chain management by improving safety and efficiency. However, successful adoption depends on technological readiness, good collaboration between technology and human expertise, and consumer trust. This study contributes to the growing body of knowledge on AI-based halal supply chain management and provides a structured contextual view for stakeholders to develop a strategic roadmap for digital technology transformation in the halal industry.

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