Proposed Model for Halal Blockchain Barrier: Literature Review and Interview

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Abstract: Muslim consumers' concern towards the quality and safety of food and halal is increasing for products consumed according to Islamic law. Blockchain technology is a solution to increase trust and provide full transparency to ensure product integrity throughout the halal supply chain. However, not all companies adopt blockchain in their supply chains, and this is because the application of blockchain technology in the industry faces various obstacles in adopting it. This study proposed model for halal blockchain adoption barriers and factors that can hinder the potential of blockchain in the halal industry. Literature review and interviews with practitioners have been carried out in this study. The SCOR (Plan, Source, Make, Delivery) is adopted to determine the factors of halal blockchain in each of its business processes. The results show eight (8) blockchain barriers, consisting of two barriers on the Plan, Source seven barriers, Make eight barriers, and Delivery four barriers. The practical implication of this research is the barrier factors halal adoption of halal blockchain that can affect companies.

1 INTRODUCTION

Blockchain is a digital technology that can provide solutions to the reputation of halal products caused by cases of halal violations (Tieman & Darun, 2017). As for cases of halal violations such as halal fraud, halal counterfeiting, cross-contamination, logistical problems, and non-standard halal standards (Ali et al., 2021). This halal violation has the potential to affect the loss of consumer confidence in halal products (Khan et al., 2021). Therefore, the use of halal blockchain technology can increase trust and transparency and ensure product integrity throughout the halal supply chain(Vanany et al., 2020). In addition, blockchain is a prospective technological breakthrough and a significant solution in solving supply chain problems and halal (Handayani et al. 2021)

However, blockchain technology is relatively new and developing, so the immaturity of new technologies often creates several barriers to its implementation (Vafadarnikjoo et al., 2021). Besides, technology blockchain still has unresolved problems andchallenges beyond technical, so it requires more exploration and investigation (Xu et al., 2021). Even the implementation of blockchain projects was stopped, and the current blockchainadoption rate is around 20% (Sanka et al., 2021). This indicates that there arebarriers to blockchain implementation, thus motivating researchers to study blockchain barriers such as (Saberi et al., 2019a), resulting in external barriers, inter-organizational, intra- organizational, and technical in sustainable supply chains.

Blockchain barriers in sustainable supply chains were classified by technology, environment, and organization (Kouhizadeh et al., 2021a). Performance expectations, effort expectations, social influence, and enabling factors, such as trust are blockchain barriers in operations and supply chain management (Queiroz et al., 2019). On the other hand, in the context of a developing country such as Indonesia, this obstacle becomes more critical, as conveyed by the Directorate General of Information

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Applications at the Ministry of Communication and Information, stating that Indonesia has not been able to utilize the potential of blockchain technology fully, this is due to uneven penetration. Internet, quality, and quantity of human resources, technical challenges, and audit processes. It is moreover facilitating conditions and trust.

Thus, there are several barriers to applying blockchain technology, but the resulting barriers tend to focus on general industries, not specific to the halal industry. Therefore, the resulting barriers cannot be referenced to the halal industry. This shows that there is still little attention and research on the barriers to blockchain technology in the halal industry, even though blockchain has great potential to overcome the halal problem. Therefore, this study will propose a model for identifying halal blockchain barriers in Indonesia. The proposed model is a conceptual model based on the Supply Chain Operations Reference (SCOR), which includes a plan, source, make, and delivery. The SCOR model is a model that is believed to be able to design, describe, and configure various types of supply chain activities (Sundarakani et al., 2018). With the SCOR model, identification of barriers can be carried out starting from a plan, source, make, and delivery activities. For this reason, obtaining halal blockchain barriers is carried out using literature reviews and expert interviews.

This research aims to obtain a model for identifying and analysing halal blockchain barriers by conducting literature reviews and interviews. This paper consists of section I introducing the background, section II literature review, and the research methodology entered section III. Sections IV-V present the proposed model, and discussion of section VI conclusions.

2 LITERATURE REVIEW

Halal *Blockchain is* a technology that supports halal supply chain management (Tieman et al., 2019) and can improve the performance of the halal supply chain (Surjandari et al., 2021). B*lockchain* Halal provides several advantages for producers, distributors, retailers, logistics service providers, and halal certification bodies. With blockchain technology, it can overcome various halal issues, and product recalls.

Another advantage is that halal supply chain companies cannot commit fraudulent actions. This is because the halal Blockchain has complete information shared with all participants in the halal supply chain network. So that if there are parties committing fraud, it will be easy to identify the perpetrators because this information can be seen (Katuk, 2019). This is because the authenticity and security of Halal Blockchain are a priority in securing confidential data and minimizing the chances of cyber-attacks (Surjandari et al., 2021). Besides, halal Blockchain provides clear benefits and better credibility for halal producers and certification bodies. Therefore, it is essential to adapt to this technology to ensure its haleness from upstream to downstream of the supply chain process. Thus standardization of the halal supply chain can be realized to support the halal industry and its global supply chain.

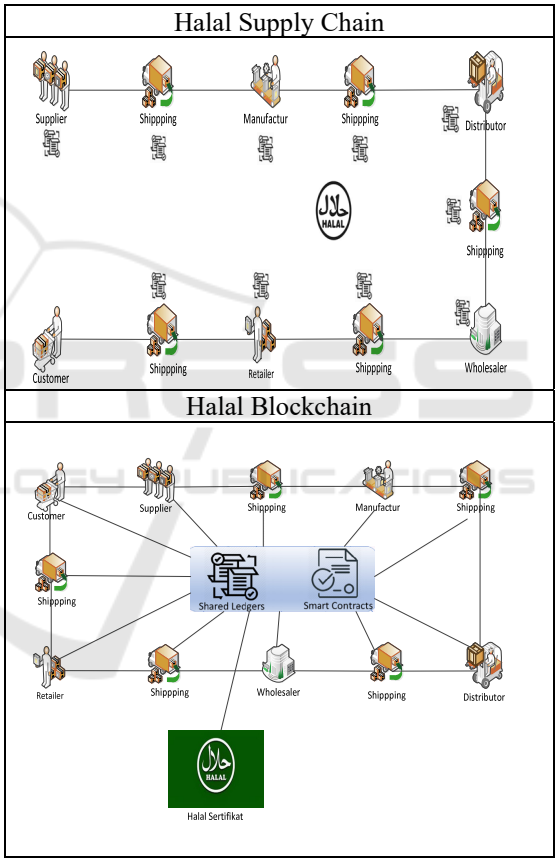

Figure 1: Halal supply chain and halal blockchain.

According to Katuk (Universiti Utara Malaysia & Katuk, 2019), there is a difference between a halal supply chain using blockchain and without blockchain, more details can be seen in Figure 1. All transactions in the supply chain that implement halal blockchain from suppliers, manufacturers, distributors, retailers, logistics providers, and customers store their transactions in a shared ledger, and smart contracts control them. Thus, halal product

certification can be carried out efficiently and uncomplicatedly. This is because halal certification bodies can access shared ledgers and smart contracts for product certification. While the supply chain system is without a halal blockchain, all entities in the system record transactions in the internal ledger separately. Halal certification bodies must ensure halal conditions for all entities individually, making the process complicated.

Empirically Chandra, Liaqat, and Sharma (Chandra et al., 2019) have proven that ownership of halal products can be traced on the blockchain. The blockchain ledger provides a complete audit trail of all operations performed from scratch, making it easy to track product ownership. So Blockchain technology can be a transformational force that improves the status of halal regulations. Blockchain technology in the halal industry will increase trust among halal supply chain actors, ultimately enabling consumers to make more informed and confident choices. The halal supply chain is distinguished with and without blockchain, as illustrated in Figure 1.

3 METHODOLOGY

The objective of this paper is to propose a model of halal blockchain adoption barriers with two stages such as (1) identifying barriers factors of halal blockchain based on a literature review using the scopus database and (2) interviewing experts. in reviewing the literature, the scopus database is the first step. the keywords that are used to search for barriers in halal blockchain research topics are “adoption," barriers, “blockchain," and “supply chain". in the second step, interviews are conducted with academics, practitioners, and professionals or halal blockchain experts. in contrast, the expert qualifications are at least a bachelor's degree and an average work experience of five years in the field. interview with experts or professionals aims to understand experts/professionals' opinions based on qualitative data and conclusions (Bryman, 2016). interview protocol developed to understand barriers to adoption factors of halal blockchain with three sections: blockchain technology, blockchain applications in the supply chain, and halal blockchain.

4 RESULTS

4.1 Proposed Adoption Barriers Model for Halal Blockchain

The proposed model has three levels such as 1) business processes related based on the SCOR model, 2) adoption barriers factors for halal blockchain, and 3) adoption sub barriers factors for halal blockchain; The following is the description:

1) Level 1: Business processes related based on the SCOR model

Much previous research used four business processes (Plan, Source, Make, and Delivery) from the SCOR model (Nyoman Pujawan & Geraldin, 2009); (Lestari et al., 2021)The following describes four business processes as level 1 in the proposed model of halal blockchain adoption barriers:

- *Plan*: describes the entities or stakeholders involved in the form of a Halal Assurance Institution in a country. For example, in Indonesia, BPJPH, MUI. Halal auditors (LPPOM MUI, Sucofindo, etc.). BPJPH, as a halal authority of the Indonesian government, has control for supply chain planning in a halal certification process.
- *Source*: describes suppliers who fulfill raw materials according to halal standards. For example, chicken farming is a supplier of chicken slaughtering companies.
- *Make*: represents activities flow to the halal production process. For example, chicken slaughter companies' production processes are stunning, pre-slaughtering and slaughtering.
- *Delivery*: describes the halal distribution process for finished goods to the end customers. For example, in halal chicken food, chicken slaughtering companies deliver the halal chicken carcass to their customers, such as fried chicken restaurants, supermarkets, and end customers.

2) Level 2 and Level 3: Adoption barriers and sub-factors for halal blockchain

Based on searching in the Scopus database, eight (8) factors of barrier adoption in blockchain applications such as inter-organizational barriers, technological and security, etc. Figure 2 shows the eight barrier adoption factors of blockchain applications based on review literature in the Scopus database from 2017 - 2021

- Inter-organizational barrier. An organizational-level barrier that hinders blockchain implementation. Several inter-organizational barrier factors such as the absence or weakness of

communication, collaboration, and coordination among members of supply chain. Saberi (Saberi et al., 2019b) stated that collaboration is essential in sharing information between supply chain partners, lack of effective the communication, collaboration, coordination, and among supply chain partners can disrupt blockchain implementation. 2) Challenge information exposes policy between partners in the supply chain. Saberi (Saberi et al., 2019b) and Farooque (Farooque et al., 2020) stated that challenging information was the most significantobstacle. 3) Challenges in integration issues with blockchain technology and sustainability in SC. 4) The cultural diversity of supply chain participants, according to Farooque (Farooque et al., 2020) and Saberi (Saberi et al., 2019b) less relevant, so this barrier was excluded from several identified barriers. 5) Lack of consumer awareness of sustainability issues and a willingness to use blockchain technology is an obstacle to the implementation of sustainability(Saberi et al., 2019b). 6) Transparency versus privacy dilemma and uncertainty about blockchain suitability.

- Technological and security barriers. The most crucial obstacle is because blockchain technology has many essential features such as distributed database security and transparency.
- Social and environmental barriers. Covers environmental health and safety issues that are essential application focus for blockchain.
- External barriers. These barriers come from external stakeholders, industry, institutions, and government.
- System-related barrier. A limitation of access to technology in obtaining real-time information (Öztürk & Yildizbaşi, 2020).
- Regulatory barrier. Balancing the opportunities offered with potential unforeseen effects is a difficult task because of regulatory ambiguity (Öztürk & Yildizbaşi, 2020).
- Organizational and individual barriers. Organizational internal impediments include financial limitations, a lack of management commitment and support, a lack of available company policy for using technology, a lack of knowledge and experience, and a lack of new company procedures (Öztürk & Yildizbaşi, 2020).
- Financial and human barrier. A barrier that often occurs in technology adoption because the adoption of new technology causes high investment costs and a lack of information technology personnel.

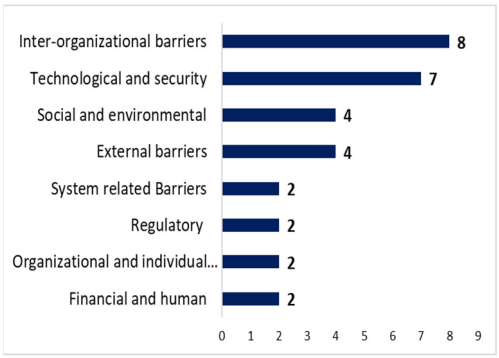

Figure 2. Barrier's adoption factors of blockchain application

Figure 2 is a dimension in identifying various barriers that hinder the adoption of blockchain technology. The results of identifying barriers from the literature review and expert interviews are shown in Table 1. The identified barriers are from the expert as many as eleven (11), while the other barriers result from the literature review.

Table 1: Review and interview for barriers factors.

Barriers Dimension	Barriers Factors	Authors
1. Inter-organizational Barriers	1.1. Coordination, communication, and collaboration in SC	(Saberi et al., 2019b); (Farooque et al., 2020);(Öztürk & Yildizbaşi, 2020);(Choi et al., 2020)
	1.2. Challenge information disclosure policy between partners in SC	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	1.3 Challenges in integration issues with blockchain technology and sustainability in SC	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	1.4 the cultural diversity of supply chain partners	(Saberi et al., 2019b) ;(Farooque et al., 2020);(Choi et al., 2020)
	1.5 Lack of consumer awareness of sustainability issues and technology	(Saberi et al., 2019b) ;(Farooque et al., 2020)
2. Technological And securitybarriers	2.1 A lack of technological sophistication	(Öztürk & Yildizbaşi, 2020); (Choi et al., 2020); (Sabbagh, 2021); (Mathivathanan et al., 2021)
	2.2 Data security	(Sabbagh,

Barriers Dimension	Barriers Factors	Authors
		2021);(Öztürk & Yildizbaşi, 2020); (Kouhizadeh et al., 2021a)
	2.3 Usability	(Sabbagh, 2021);(Öztürk & Yildizbaşi, 2020)
	2.4 Complexity	(Sabbagh, 2021);(Öztürk & Yildizbaşi, 2020); (Choi et al., 2020);(Biswas & Gupta, 2019)
	2.5 Interoperability	(Öztürk & Yildizbaşi, 2020); (Choi et al., 2020); (Sabbagh, 2021) [**Expert Opinion]**
	2.6 Forking	(Öztürk & Yildizbaşi, 2020); (Sabbagh, 2021)
	2.7 Performance and scalability	(Choi et al., 2020); (Sabbagh, 2021)
	2.8 Cost	[**Expert Opinion];** (Choi et al., 2020)
	2.9 Negative perception toward technology	(Kouhizadeh et al., 2021a);(Choi et al., 2020)
	2.10 Access to technology	(Kouhizadeh et al., 2021a);(Choi et al., 2020)
	2.11 Unclear Governance Structure	(Lohmer & Lasch, 2020)
	2.12 Missing standards,	(Lohmer & Lasch, 2020)
	2.13 Complex protocol selection	(Lohmer & Lasch, 2020)
	2.14 Trial and reversibility	(Choi et al., 2020)
	2.15 Lack of large computing power	(Mathivathanan et al., 2021)
2 Social and environmental barriers	3.1 Information sharing	(Sabbagh, 2021);(Öztürk & Yildizbaşi, 2020);
	3.2 Wasted resources	(Choi et al., 2020);(Öztürk & Yildizbaşi, 2020)
	3.3 Lack of industry participationin blockchain adoption and moral and secure procedures	(Kouhizadeh et al., 2021a); (Choi et al., 2020)
	3.4 Governmental policies	(Kouhizadeh et al., 2021a); (Choi et al., 2020)
	3.5 Lack of external stakeholders 'involvement	(Kouhizadeh et al., 2021a) ;**[Expert Opinion]**
	3.6 Lack of rewards and incentives	(Kouhizadeh et al., 2021a)
	3.7 Market competition and uncertainty	(Kouhizadeh et al., 2021a)
	3.8 Perceived impediment to blockchain's correct legal structure and legislation	(Choi et al., 2020)
	3.9 Perceived restriction on an infrastructure that is technologically effective	(Choi et al., 2020)
	3.10 The perception of a governance constraint	(Choi et al., 2020); **[Expert Opinion]**
	3.11 Perceived constraint on encouragement program	(Choi et al., 2020)
4. External barriers	4.1 Lack of government policies	(Saberi et al., 2019b) ;(Farooque et al., 2020); (Lohmer & Lasch, 2020)
	4.2 Market competition and uncertainty	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	4.3 Lack of external stakeholders' involvement	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	4.4 Lack of industry participation in moral and secure procedures	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	4.5 Lack of reward and encouragement programs	(Saberi et al., 2019b) ;(Farooque et al., 2020)
5. System related Barriers	5.1 Security challenge	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	5.2 Access to technology	(Saberi et al., 2019b) ;(Farooque et al., 2020) **[Expert Opinion]**
	5.3 The reluctance to use blockchain technology	(Saberi et al., 2019b) ;(Farooque et al., 2020) **[Expert Opinion]**
	5.4 Because of unfavorable public opinion	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	5.5 Immutability challenge of blockchain technology	(Saberi et al., 2019b) ;(Farooque et al., 2020)
	5.6 Immaturity of technology	(Saberi et al., 2019b) ;(Farooque et al., 2020)
6. Regulatory barrier	6.1 Regulations differ between nations, but nevertheless practical blockchain	(Sabbagh, 2021) (Mathivathanan et al., 2021)

Barriers Dimension	Barriers Factors	Authors
	regulations are still in the development stage.	
	6.2 No universal regulatory binding in each country	(Biswas & Gupta, 2019).
7. Organizational and individual barrier	7.1 Strong bureaucracy and a hierarchical structure	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020)
	7.2 Rigorous administrative oversight	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020)
	7.3 Information sharing obstacles	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020)
	7.4 Mindset of people needs to be changed	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020)
	7.5 Financial Constraints	(Saberi et al., 2019b) ;(Farooque et al., 2020);(Kouhizadeh et al., 2021a)
	7.6 A lack of dedication and assistance from management	(Saberi et al., 2019b) ;(Farooque et al., 2020);(Kouhizadeh et al., 2021a)
	7.7 The absence of updated organizational guidelines for utilizing blockchain technology	(Kouhizadeh et al., 2021a)
	7.8 Lack of experience and knowledge	(Saberi et al., 2019b) ;(Farooque et al., 2020); **[Expert Opinion]**
	7.9 Challenges with modifying corporate culture	(Saberi et al., 2019b) ;(Farooque et al., 2020);(Kouhizadeh et al., 2021a); **[Expert Opinion]**
	7.10 Reluctance to switch to new systems	(Saberi et al., 2019b) ;(Farooque et al., 2020);(Kouhizadeh et al., 2021a); **[Expert Opinion]**
	7.11 Insufficient tools for integrating blockchain technology into sustainable supply chains	(Saberi et al., 2019b) ;(Farooque et al., 2020);(Kouhizadeh et al., 2021b)
8. Financial and human	8.1 Lack of IT personnel	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020) ; **[Expert Opinion]**
	8.2 High investment cost	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020) ;**[Expert Opinion]**
	8.3 A lack of units for research and development	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020)
	8.4 Poor financial support for technological infrastructure	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020) **; [Expert Opinion]**
	8.5 Block chain technology does not receive enough financial support	(Sabbagh, 2021): (Öztürk & Yildizbaşi, 2020) ; **[Expert Opinion]**

5 DISCUSSION

Barriers in plan are in touch with the government as a policy provider supporting blockchain implementation for the halal assurance system in Indonesia. This is in line with (Sanka et al., 2021), who stated that uncertainty in government regulations is a significant barrier to blockchain implementation. The barriers in plan are External and regulatory barriers. Proposed adoption barriers model for halal Blockchain is shown in Figure 3. Source, make, and delivery, namely regulatory and external barriers. Meanwhile, the other six barriers are source, make, and delivery. Thus, the SCOR model can investigate the connections between all the players in the halal supply chain in the face of all obstacles to implementing halal blockchain. suppliers and supporting suppliers must have a halal certificate. For this reason, integrating producers, suppliers, and the government in realizing safe and halal products is the key to the success of halal certificates. However, there are obstacles to implementing halal blockchain-based food safety, including the lack of knowledge, employee skills, costs, and infrastructure (Biswas & Gupta, 2019). These barriers are included in the category of barriers, including Inter-Organizational Barriers – Social environmental – System related barriers, External barriers – Regulatory – Organizational and individual barriers, Financial and human.

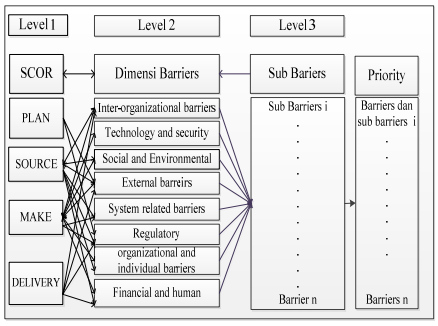

Figure 3: Proposed adoption barrier model for halal blockchain.

Barriers that occur in Make are not only limited to the production process but are extended to physical separationin packaging, and storage, which is guided by HAS 2300 in maintaining the sustainability of the halal production process. All information related to the halal production process from various stakeholders throughout the supply chain is stored in the Halal Blockchain. The involvement of all stakeholders in an integrated system creates barriers to its implementation. The barriers in make stage consist of Inter- Organizational Barriers, Technology, and security barriers, Social environmental- System-related barriers, External barriers- Regulatory- Organizational and individual barriers, Delivery barriers that are both financial and human in natureare the basis of logistics and its most obvious expressions. In halal delivery, non-halal and halal goods cannot be mixed. To maintain the haleness of the product during operation, it must be handled with the proper process by the assigned person (Tieman & Darun, 2017). But there is still a lack of comprehension of the appropriate methods for implementing blockchain technology for distributionsystems (Marsusvita et al., 2021), so there are barriers to halal blockchain. Barriers to delivery include Inter-Organizational Barriers, External barriers, Regulatory, Financial, and human.

6 CONCLUSION

This study applies the SCOR model's theory to identifyimpediments to halal blockchain usage. The identification results show that there are eight blockchain barriersconsisting of two barriers in plan, seven barriers to source, and eight barriers to make and deliver to four barriers. Ofthe eight barriers, there are two main barriers in plan, barriers in plan, source, make, and delivery, namely regulatory and external barriers. Meanwhile, the other six barriers are source, make, and delivery. Thus, the SCOR model can explore the relationship between all actors involved in the halal supply chain in the face of all obstacles to implementing halal blockchain.

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REFERENCES

Ali, M. H., Iranmanesh, M., Tan, K. H., Zailani, S., & Omar, N. A. (2021). Impact of supply chain integration on halal food supply chain integrity and food quality performance. *Journal of Islamic Marketing*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/JIMA-08-2020-0250

Biswas, B., & Gupta, R. (2019). Analysis of barriers to implement blockchain in industry and service sectors. *Computers & Industrial Engineering*, *136*, 225–241. https://doi.org/10.1016/j.cie.2019.07.005

Bryman, A. (2016). *Social research methods* (Fifth Edition). Oxford University Press.

Chandra, G. R., Liaqat, I. A., & Sharma, B. (2019). Blockchain Redefining: The Halal Food Sector. *2019 Amity International Conference on Artificial Intelligence (AICAI)*, 349–354. https://doi.org/10.1109/AICAI.2019.8701321

Choi, D., Chung, C. Y., Seyha, T., & Young, J. (2020). Factors Affecting Organizations' Resistance to the Adoption of Blockchain Technology in Supply Networks. *Sustainability*, *12*(21), 8882. https://doi.org/10.3390/su12218882

D. I. Handayani and I. Vanany, "*Blockchain Application in Halal Supply Chain: Literature Review and Future Research*," 2021 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), 2021, pp. 1387-1391, doi: 10.1109/IEEM50564.2021.9673084. (n.d.).

Farooque, M., Jain, V., Zhang, A., & Li, Z. (2020). Fuzzy DEMATEL analysis of barriers to Blockchain-based life cycle assessment in China. *Computers & Industrial Engineering*, *147*, 106684. https://doi.org/10.1016/j.cie.2020.106684

Khan, S. N., Loukil, F., Ghedira-Guegan, C., Benkhelifa, E., & Bani-Hani, A. (2021). Blockchain smart contracts: Applications, challenges, and future trends. *Peer-to-Peer Networking and Applications*, *14*(5), 2901–2925. https://doi.org/10.1007/s12083-021-01127-0

Kouhizadeh, M., Saberi, S., & Sarkis, J. (2021a). Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers. *International Journal of Production Economics*, *231*, 107831. https://doi.org/10.1016/j.ijpe.2020.107831

Kouhizadeh, M., Saberi, S., & Sarkis, J. (2021b). Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers. *International Journal of Production Economics*, *231*, 107831. https://doi.org/10.1016/j.ijpe.2020.107831

Lestari, F., Nurainun, T., Kurniawati, Y., & Adzkia, M. D. (2021). Barriers and Drivers for Halal Supply Chain on Small-Medium Enterprises in Indonesia. *Hong Kong*, 6.

Lohmer, J., & Lasch, R. (2020). Blockchain in operations management and manufacturing: Potential and barriers. *Computers & Industrial Engineering*, *149*, 106789. https://doi.org/10.1016/j.cie.2020.106789

Marsusvita, A., Suprayogi, S., & Sucipto, S. (2021). Barrier and motivations implementation of safety and halal assurance for apple processed products: A review. *IOP Conference Series: Earth and Environmental Science*, *924*(1), 012068. https://doi.org/10.1088/1755-1315/924/1/012068

Mathivathanan, D., Mathiyazhagan, K., Rana, N. P., Khorana, S., & Dwivedi, Y. K. (2021). Barriers to the adoption of blockchain technology in business supply chains: A total interpretive structural modelling (TISM) approach. *International Journal of Production Research*, *59*(11), 3338–3359. https://doi.org/10.1080/00207543.2020.1868597

Nyoman Pujawan, I., & Geraldin, L. H. (2009). House of risk: A model for proactive supply chain risk management. *Business Process Management Journal*, *15*(6), 953–967. https://doi.org/10.1108/14637150911003801

Öztürk, C., & Yildizbaşi, A. (2020). Barriers to implementation of blockchain into supply chain management using an integrated multi-criteria decision-making method: A numerical example. *Soft Computing*, *24*(19), 14771–14789. https://doi.org/10.1007/s00500-020-04831-w

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019). Blockchain and supply chain management integration: A systematic review of the literature. *Supply Chain Management: An International Journal*, *25*(2), 241–254. https://doi.org/10.1108/SCM-03-2018-0143

Sabbagh, P. (2021). An Uncertain Model for Analysis the Barriers to Implement Blockchain in Supply Chain Management and Logistics for Perishable Goods: *International Journal of Computational Intelligence Systems*, *14*(1), 1292. https://doi.org/10.2991/ijcis.d.210308.002

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019a). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135. https://doi.org/10.1080/00207543.2018.1533261

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019b). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135. https://doi.org/10.1080/00207543.2018.1533261

Sanka, A. I., Irfan, M., Huang, I., & Cheung, R. C. C. (2021). A survey of breakthrough in blockchain technology: Adoptions, applications, challenges and future research. *Computer Communications*, *169*, 179–201. https://doi.org/10.1016/j.comcom.2020.12.028

Sundarakani, B., Abdul Razzak, H., & Manikandan, S. (2018). Creating a competitive advantage in the global flight catering supply chain: A case study using SCOR model. *International Journal of Logistics Research and Applications*, *21*(5), 481–501. https://doi.org/10.1080/13675567.2018.1448767

Surjandari, I., Yusuf, H., Laoh, E., & Maulida, R. (2021). Designing a Permissioned Blockchain Network for the Halal Industry using Hyperledger Fabric with multiple channels and the raft consensus mechanism. *Journal of Big Data*, *8*(1), 10. https://doi.org/10.1186/s40537-020-00405-7

Tieman, M., & Darun, M. R. (2017). Leveraging Blockchain Technology for Halal Supply Chains. *Islam and Civilisational Renewal*, *8*(4), 547–550. https://doi.org/10.12816/0045700

Tieman, M., Darun, M. R., Fernando, Y., & Ngah, A. B. (2019). Utilizing Blockchain Technology to Enhance Halal Integrity: The Perspectives of Halal Certification Bodies. In Y. Xia & L.-J. Zhang (Eds.), *Services – SERVICES 2019* (Vol. 11517, pp. 119–128). Springer International Publishing. https://doi.org/10.1007/978-3-030-23381-5_9

Katuk, N. (2019). The application of blockchain for halal product assurance: A systematic review of the current developments and future directions. *International Journal of Advanced Trends in Computer Science and Engineering*, *8*(5), 1893–1902. https://doi.org/10.30534/ijatcse/2019/13852019

Vafadarnikjoo, A., Badri Ahmadi, H., Liou, J. J. H., Botelho, T., & Chalvatzis, K. (2021). Analyzing blockchain adoption barriers in manufacturing supply chains by the neutrosophic analytic hierarchy process. *Annals of Operations Research*. https://doi.org/10.1007/s10479-021-04048-6

Vanany, I., Rakhmawati, N. A., Sukoso, S., & Soon, Jan. M. (2020). Indonesian Halal Food Integrity: Blockchain Platform. *2020 International Conference on Computer Engineering, Network, and Intelligent Multimedia (CENIM)*, 297–302. https://doi.org/10.1109/CENIM51130.2020.9297968

Xu, Y., Chong, H.-Y., & Chi, M. (2021). Modelling the blockchain adoption barriers in the AEC industry. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ECAM-04-2021-0335