Sukuk on Blockchain: Application, Advantages, and Challenges

Sukuk pada Blockchain: Aplikasi, Keunggulan dan Tantangannya

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ABSTRACT

This paper aims to identify key insights from the available literature review on blockchain in the sukuk market and provide a commentary of its prospects specifically in its application within the sukuk market advantages and challenges. The paper primarily applies a qualitative approach and literature review as a research method. The result showed that smart sukuk has the potential of becoming the future for sukuk issuances and may contribute to the spread of sukuk more widely, leading to the expansion of Islamic funding. The advantages of smart contracts could facilitate transactions in convenient way and hence would contribute to wellbeing of the ummah, thus achieving the maslaha. The use of smart contracts designed to protect against fraud is also consistent with maqasid al-Shariah (purposes of Shariah), which is the protection of al-mal (property).

Keywords: sukuk, blockchain technology, cyber risks, maqasid al-shariah, the post-Covid-19 world

ABSTRAK

Artikel ini bertujuan untuk mengidentifikasi wawasan utama dari tinjauan literatur yang tersedia tentang blockchain di pasar sukuk dan memberikan komentar tentang prospeknya. khususnya dalam penerapannya, keunggulan dan tantangannya di pasar sukuk. Artikel ini menggunakan pendekatan kualitatif dan tinjauan pustaka sebagai metode penelitian. Hasil penelitian menunjukkan bahwa penerbitan smart sukuk berpotensi di masa depan dan dapat berkontribusi pada penyebaran sukuk secara lebih luas, yang mengarah pada perluasan pendanaan syariah. Keuntungan dari smart kontrak pada sukuk ini dapat memfasilitasi transaksi dengan cara yang nyaman dan karenanya akan berkontribusi pada kesejahteraan umat, sehingga mencapai maslahat. Penggunaan smart kontrak dirancang untuk melindungi dari penipuan juga konsisten dengan maqashid al-Shariah (tujuan Syariah), yaitu perlindungan al-mal (properti).

Kata Kunci: *sukuk, blockchain technology, cyber risks, maqasid al-shariah, dunia pasca Covid-19*

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1. Introduction

Sukuk are Shariah-compliant bonds that are structured in a particular way. Unlike traditional bonds, where the bondholder and issuer are essentially lenders and borrowers, the sukuk holder gets undivided beneficial ownership of the underlying sukuk assets, resulting in both gains and losses. "Investment Sukuk are certificates of equal value representing an undivided share in ownership of tangible assets, benefits, and services or (in ownership of) specific project assets or specific investment activities," according to the Accounting and Auditing Organization for

Islamic Financial Institutions (AAOIFI) in Sharia Standard No. 17 Investment Sukuk (AAOIFI, 2017, p. 468). Sukuk can be organized utilizing a variety of Sharia contracts, including ownership of leased assets, ownership of revenues, *salam, istisna', murabahah, musyarakah*, profit sharing *(muzara'ah),* irrigation *(musaqat),* and agriculture, according to AAOIFI (2017) (*mugharasah*).

A sukuk is more complicated to issue and administer than a traditional bond. Depending on the underlying Shariah contract, it necessitates several contracts with unique terms, conditions, and operating mechanisms. In comparison to a standard bond issuance, Figure 1 depicts the additional processes involved in a sukuk issuance. This increases the operational risk of sukuk issuance, including I legal risk from ineffective, invalid, or incomplete legal documents, and (ii) Shariah non-compliance risk from inappropriate legal paperwork and execution of each step within the sukuk lifecycle.
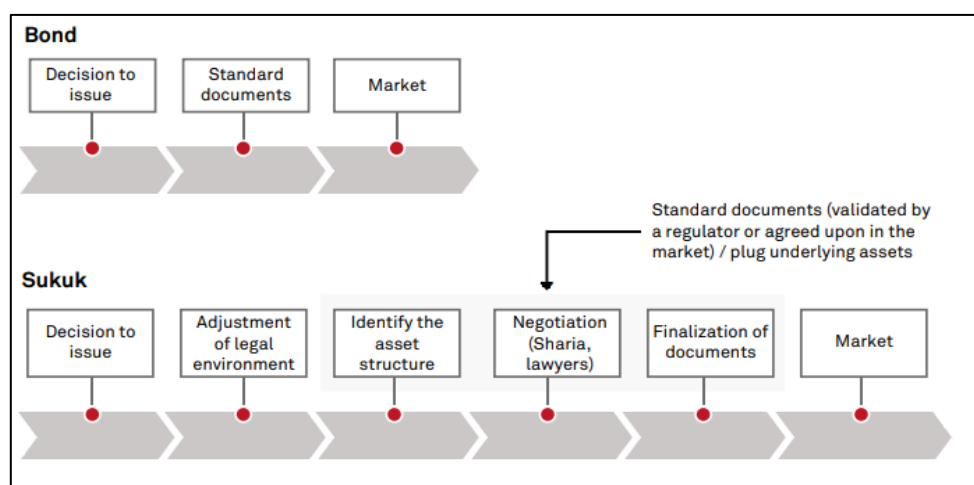

**Figure 1 Comparison of Issuance Process Between Bond and Sukuk
(S&P Global Ratings, 2020)**

New technologies such as blockchain offer a new method to data management and sharing, that financial practitioners have hailed as a game changer that can simplify contracts, increase transaction traceability, and eliminate traditional intermediaries in part. As a result, financial instrument pricing may become more competitive and cost efficiency may improve. Given the extra complexity of sukuk structures, which has frequently been the scourge of its own development, the value proposition of blockchain for the sukuk market is significant in this regard.

This paper aims to identify key insights from the available literature review on blockchain in the sukuk market and provide a commentary of its prospects specifically in its application within the sukuk market. The paper is organized as follows; section 2 describes the research methodology used; section 3 provides a blockchain application in sukuk issuance; section 4 presents an analysis of available literature review and section 5 discusses the advantages and challenges of blockchain application in sukuk issuance and management. Finally, we conclude our observations in section 6 with our recommendations.

2. Literature Review

Academic research on blockchain, with a specific application in finance, is limited. Ali et al. (2020) conducted a systematic review of 87 scholarly articles on blockchain technology in the financial sector identified through the various databases (as at 5.3.2018), and presents a classification framework based on three dimensions: blockchain-enabled financial benefits, challenges, and functionality. The sub-categories of the dimensions of the final framework are provided in the Appendix. Findings from the paper suggest the need for further empirical study on issues such as fast transaction, data sharing, wasted resources, scalability, and data protection. Khan et al. (2020) also provides a taxonomy of blockchain applications in finance and Islamic finance, which is provided in the Appendix.

We employ similar steps to identify relevant literature. Figure 6 presents a summary of the search results from the ScienceDirect and Emerald Insight databases conducted on 16 April 2021.

Table 1 Summary of Search Results of Related Keywords

Keywords	ScienceDirect*	Emerald Insight
"blockchain"	228	836
"blockchain" and "bonds"	21	130
"blockchain" and "sukuk"	1	7

* Subject areas were restricted to include (i) business, management and accounting and (ii) economics, econometrics and finance

We filter the search to identify literature that a relevant to the objective of the paper and identified 16 papers (including grey literature). We classify the literatures based on the following dimensions namely blockchain bond or sukuk structures (functionality), benefits and challenges (discussed in section 5), green bonds, credit rating and financial inclusion.

Table 2 Summary of Available Literature by Dimensions

Dimension	Authors
Bond and sukuk structure	Chen and Wang (2020)*, Khan et al.(2020), Hamza (2020), Mounira (2020), Al-Hajjar (2020), Mohamed (2019)*, Muneeza and Mustapha (2019), Shukri et al. (2019), Mat Rahim et al. (2018)
Benefit and advantages	Kunhibava et al. (2021), Chen and Wang (2020), Hamza (2020), Mounira (2020), S&P Global Ratings (2020)*, Al Subaei (2019)*, Alam et al.(2019), Mat Rahim et al. (2018)
Challenges	Kunhibava et al (2021), Chen and Wang (2020), Hamza (2020), Khan et al.(2020), Mathias (2018)
Green bonds	Malamas et al. (2020), Sanderson (2018)
Credit rating	Iyer and Ravi Kumar (2021)
Financial inclusion	Al Mahmoood (2019)*

*denotes grey literature

Chen and Wang (2020) provides an in-depth analysis of the current inefficiencies in the entire bond issuance value chain in Europe and proposes a potential blockchain solution using tokenization. Khan et al. (2020) introduces a novel, exploratory analysis of sukuk tokenization based on a case study by implementing a basic smart contract for sukuk *murabaha* on Ethereum

and provides a conceptual analysis of feasibility concerns of sukuk issuance with tokenization. Other papers also expound on the potential of smart contracts such as Hamza (2020), presenting a proposal for a blockchain sukuk model for the largest bank in Turkey, Mohamed (2019), using blockchain to structure impact sukuk, and Mat Rahim et al. (2018), illustrating the use of smart contracts to support various Islamic financial products including sukuk. Mounira (2020) presents a case study of the Blosoom Finance model. Al-Hajjar (2020) proposes smart sukuk issuance through the "Initial Coin Offering" (ICO) which is a type of cryptocurrency powered by blockchain technology. Muneeza and Mustapha (2019), discuss the Shariah compliant structure of blockchain. Shukri et al. (2019) briefly suggests the use of blockchain to facilitate the issuance of perpetual *waqf* sukuk.

The purported superior traceability feature of blockchain makes it ideal to support verification, which is a critical process in validating sustainable instruments. Malamas et al. (2020) propose a blockchain-enabled green bond issuance architecture that reduces the intermediary costs and offers compliance, scalability, confidentiality, and security where the funds of qualified, environmentally friendly projects could be traced. The potential application of blockchain to improve traceability of carbon emissions verification of green bonds is also concurred by Sanderson (2018). From a bond credit rating perspective, Iyer and Ravi Kumar (2021) propose an innovative blockchain-based system enabling implementation of a bond-pays model in credit rating industry that could mitigate the conflict of interest issue arising from the existing issuer-pays model resulting in rating shopping and inflation. Al Mahmoood (2019) presents the case for using blockchain to issue retail sukuk to address financial inclusion.

At this stage, there obviously exists significant room for future research in various themes as the blockchain application in the capital market matures. This is consistent with the observation made by Ali et al.(2020) that there is a lack of theoretical orientation and longitudinal study of the overall value of blockchain to the financial sector, demonstrating the lack of maturity in this research area. In particular, we would be interested to study the impact of blockchain adoption in bond and sukuk issuances on improvements in efficiency and performance of the bond and sukuk, level of risks and improvements in compliance including Shariah compliance.

3. Research Methodology

The paper primarily applies a qualitative approach and literature review as a research method. According to Snyder (2019), literature reviews are useful when the aim is to provide an overview of a certain issue or research problem, to identify gaps in research, or simply discuss a particular matter. Due to the limited availability of empirical academic studies, the paper also includes review of any available grey literature as defined in Table 3.

Table 3 Defining Aspects and Examples of 'Grey Literature', 'Grey Data', and 'Grey Information' (Adams et al., 2016)

Term	Defining aspect	Examples
Grey literature	Not controlled by commercial publishing organizations	Internal reports, Working papers, Newsletters
Grey data	User-generated, web-based	Tweets, Blogs, Facebook status updates
Grey information	Informally published or not published at all	Meeting notes, Emails, Personal memories

4. Discussion

4.1 Sukuk on Blockchain Issuance Process

This section will firstly provide a primer on a sukuk issuance process and lifecycle of a sukuk blockchain and secondly a summary of available sukuk on blockchain. A typical sukuk issuance process involves the creation of a special purpose vehicle (SPV) by the issuer. According to Kunhibava et al. (2021), the following parties will be present:

1. the issuers, typically a SPV that issues sukuk and protects the underlying assets for the sukuk holders;
2. sukuk holders, who are the owners of the sukuk;
3. the obligor, who is in need of funding and is responsible for paying the sukuk holders;
4. Shariah advisors, who ensure Shariah compliance of the sukuk structure;
5. the regulator, that is the approving body for the capital market;
6. legal advisors, who ensure the structure is legally sound;
7. an investment bank, either individually or as part of a group, that acts as the lead arranger, rating advisor, book runner or lead manager who underwrites and arranges the offering and advises the obligor; and
8. a facility agent that manages the operational aspects of the sukuk structure.
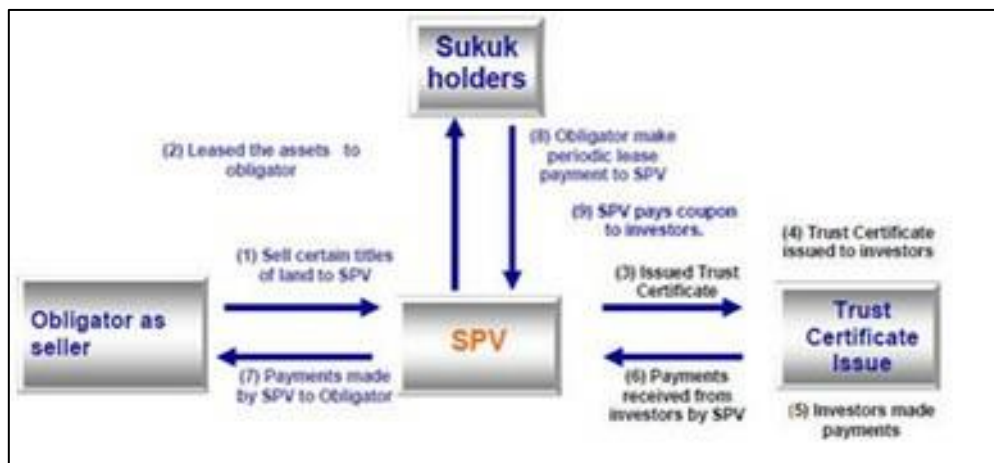

Figure Transaction Flows in A Sukuk *Ijarah*

(Malaysia International Islamic Finance Centre, n.d.)

Step 1. SPV purchases property from obligator. Step 2. SPV rents property to the obligator for specified period. Step3. The assets purchased by the SPV is funded by the issuance of sukuk (trust certificates) which represents beneficial ownership in the assets and the lease. Step 4. Trust certificates are issued to the investors. Step 5. Investors make payments for the trust certificates. Step 6. SPV receives payments from investors. Step 7. SPV transfers payments to obligator. Step 8. Obligator makes periodic lease payments to SPV. Step 9. SPV pays profit payments to investors. At maturity, SPV sells the property to the obligator and pays the investors for sukuk redemption.

The main characteristics of blockchain technology are trust and decentralization (Seebacher and Schüritz, 2017) as presented in Figure 3.
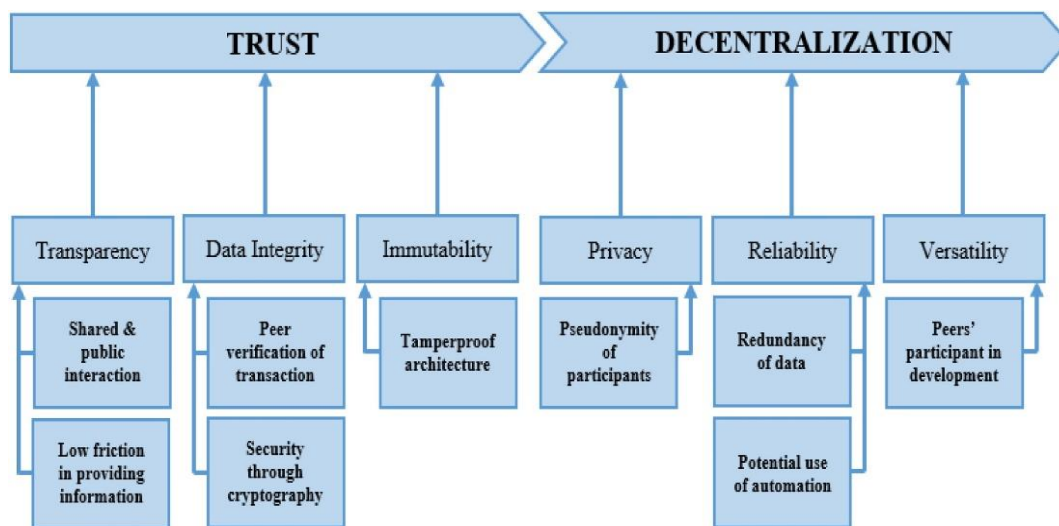

Figure 3 Blockchain technology characteristics

(Seebacher & Schüritz, 2017)

Blockchain is essentially a decentralized ledger that maintains transaction records on many computers simultaneously (Ali et al., 2020). Blockchain technology comprises of three concepts: distributed ledger, cryptography and smart contracts (Muneeza & Mustapha, 2019). Distributed ledger technology (DLT), most famously used in the development of Bitcoin, is a computer code or protocol that allows many participants of the same network to record information on a single shared ledger, where every participant can see the same data and information inserted (Hamza, 2020). Cryptography is the practice of developing protocols that prevent third parties from viewing private data and is an integral part of blockchain technology (Crushcrypto, n.d.). "Smart contracts" is a term used to describe computer code that automatically executes all or parts of an agreement and is stored on a blockchain-based platform (Levi & Lipton, 2018). In the blockchainised version of the sukuk, the papers (trust certificates) issued to the primary subscribers and investors are distributed to them as (crypto) tokens which represents their portion/ ownership of the underlying asset and/ or dividend payment (Mohamed, 2019).

The blockchain solution for sukuk issuance essentially transposes the entire lifecycle of the sukuk from a paper-based system onto distributed ledgers or online blockchain platform. In addition, the transaction flows of both cash and underlying asset are "tokenized", by employing smart contracts for its execution. From a Shariah perspective, there is no difference regarding the requirements of the underlying Shariah contract used to issue a traditional sukuk and blockchain sukuk. The difference lies in the use of blockchain technology itself which is used through smart contracts to carry out functions in a transparent and reliable manner (Kunhibava et al., 2021). Blockchain is viewed as an enabling tool much like how commodity trading platforms are used currently to transact *tawarruq* or commodity *murabahah* contracts. Blockchain is permissible provided the end-to-end design complies with the Shariah requirements of the underlying Shariah contract applicable for the respective sukuk. This is reflected in the AAOIFI standards (2017) which states that "(t)he certificates may be traded through any known means, that do not contravene the rules of the Shariah, such as registration, electronic means or actual transmission by the bearer to the purchaser". Hence, just as Shariah advisors review and approve the design of commodity trading platforms, so must the design of blockchain platforms to ensure Shariah compliance.

The design of the blockchain solution may vary according to the blockchain platform operators. Since the application of blockchain in bond and sukuk issuances is limited, there is yet to be any standardization. Potential designs and proof-of-concepts have been a subject of academic research and grey literature as will be discussed in section 3. Figure 3 illustrates one of the blockchain solution design for sukuk issuance.
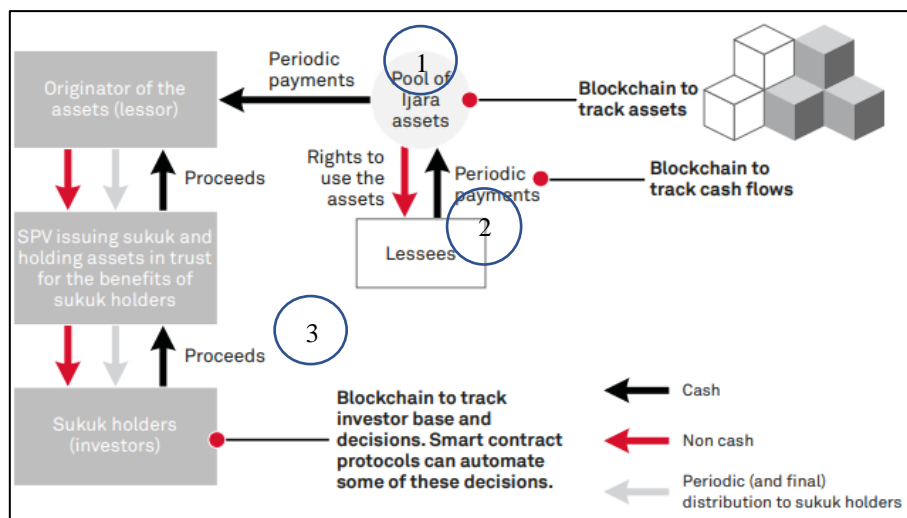

Figure 4 Blockchain Sukuk

(S&P Global Ratings, 2020)

Component 1. Originator of the asset or issuer tokenizes the sukuk into the asset ledger and the SPV holds the tokens on behalf of the investors. Investment banks or the lead manager initiate a digital term sheet and receive sign-off from the issuer. Lead manager has individual single view on the master book regarding bids and orders from the potential investors.

Component 2. Cash payments for the purchase of the sukuk, periodic profit payments and redemption are tokenized (wallets) in the cash ledger. During settlement, custodians or banks will act as token keepers and transfer money/sukuk instrument to the beneficiary accounts based on an instruction.

Component 3. Smart contracts document unique identifiers for the various participants i.e. issuer, investor, SPV, regulator etc., Know-your-customer (KYC) details and automate the execution of contractual terms such as profit payment, redemption etc. Observation nodes can allow regulators to access directly the detailed transaction data and provide a live audit trail.

Based on available information, there have been very limited issuances of sukuk on blockchain and these are as follows:

1. In 2018, Al Hilal Bank became the first Islamic bank in the world to leverage blockchain to transact a secondary market deal in Al Hilal Bank's USD500 million Senior Sukuk maturing in September 2023 (Al Hilal Bank, 2018).
2. In 2019, an Indonesian Islamic microfinance cooperative, BMT Bina Ummah, raised 710 million rupiahs (USD50,000) through a primary sukuk issuance through the Smart Sukuk platform of Blossom Finance (Santiago, 2019).
3. In 2019, Dubai-based blockchain fintech Wethaq in partnership with a blockchain company, R3, issued its first pilot Sukuk on its securities market platform for Islamic capital markets (Ledger Insights, 2019).

Table 4 provides a summary of the blockchain design by Blossom Finance and Wethaq based on available information. No information was found on the blockchain design for the Al Hilal Bank's issuance, which was supported by a fintech company, Jibrel Network.

Table 4 Blockchain Design of Available Sukuk Issuances

Name of platform	Blossom Finance[1]	Wethaq[2]
Network	Ethereum	Corda Protocol[3]
Private transaction by network (Zhang, 2019)	Public	Inherently all transactions are private. The entire transaction is visible to a validating notary.
Control information sharing by network (Binance Research, 2019)	No	Yes
Payment	Ethereum wallet (ERC20 standard)	SWIFT gpi (global payments innovation)
Regulatory supervision	No information on the use of a "supervisory node".	"Supervisory node" available to allow certain access to regulators and Shariah Board for regulatory/ Shariah compliance purposes.

[1] *Information sourced from Blossom Finance (2019) and Mounira (2020).*

[2] *R3 (2019).*

[3] *Corda started first as a closed-source project within R3, which is a consortium invested by financial companies, dedicated to developing DLT for the financial industry. Corda architecture design is heavily influenced by requirements from the financial industry, mainly privacy and regulation compliance. Key aspects include using a UTXO (Unspent Transaction Output) transaction model, and all transactions*

4.2 Advantages and Challenges

4.2.1 Advantages

Simplifying process and cost efficiencies

Using blockchain technology can eliminate the use of physical documents and automation can mitigate common issues arising from physical form, such as delays, inefficiencies, tampering and errors (Chen and Wang, 2020). The new technology could help to eliminate counterparty risk, reducing the administrative cost of holding assets, and driving the process more transparent with layers that are more streamlined (Chen and Wang, 2020 and Mohamed, 2019). Mat Rahim et al. (2018) note that the use of smart contracts reduces the need for participation from banks, lawyers and middlemen (Al Subaei, 2019) and works on minimizing errors in the organization and data management. Because blockchains can eliminate the need to rely on banks as a third party to verify the payment process, blockchain reduces the time needed to complete a transaction while cutting costs (Hamza, 2020; Mounira, 2020 and Al Subaei, 2019) of sukuk issuances and hence increasing the price competitiveness of sukuk compared to bonds. Smart contract as explained in section 3 simplifies the process of issuing and trading sukuk (Hamza, 2020), facilitating regulatory oversight where legal and automatic accounting aspects are brought together to overcome the challenges of identification of assets and structure, negotiation (Shariah and legal) and documentation (S&P Global Ratings, 2020).

Transparency

The use of unique identifiers for all participants, which can be shared and viewed in the network in a real-time manner (Al Subaei, 2019), can streamline the transaction flow more seamlessly and overcome any data mismanagement (Chen and Wang, 2020). Providing accurate information is very useful for sukuk holders to facilitate investment advisory and decision-making process (Kunhibava et al., 2021 and S&P Global Ratings, 2020). This also allows for more

effective Shariah audit and reconciliation system (Hamza, 2020) helps to reduce risks related to transaction security or identity theft (Mounira, 2020).

Investor diversification and market growth

Investing in traditional bonds and sukuk is usually conditioned on a minimum investment amount, which may restrict the participation of retail investors, beyond the sophisticated investor types. According to Alam et al. (2019), smart contact can widen the access to investors which can be retail, corporate or financial institutions. Furthermore, traditional issuances may also be physically constrained by geographical barriers thus limiting the pool of investors. By adopting blockchain, issuers could enjoy better access to a broader range of target investors and face reducing obstacles for cross-border transactions (Chen and Wang, 2020). The access to global capital allows investor diversification and the opportunity to attract a larger group of investors (Mounira, 2020 and Mohamed, 2019) who are also interested in the social impact of the sukuk (S&P Global Ratings, 2020) and spurring growth in the sukuk market (Hamza, 2020)

4.2.2 Challenges

Regulatory and legal

Currently most financial regulators already have some form of integration with regards to regulation of fintech solutions. However, in order to encourage growth in the novel sector, fintech solutions are subject to some form of regulatory sandbox that is typically less onerous compared to the regulatory regime imposed on traditional brick and mortar financial institutions. One of the characteristics of blockchain sukuk is that parts of the issuance process are decentralized thus raising regulatory issues particularly in respect of the possibility of breaching some of the current consumer protection standards used in capital markets (Kunhibava et al., 2021). Another main issues regarding blockchain usage is about how network operators will comply with national provisions on professional confidentiality and secrecy (Chen and Wang, 2020). Another issue is the legal enforceability of smart contracts (Khan et al., 2020; Mathias, 2018). Perhaps the challenges that are facing smart instruments and smart contracts in general are to find legislation that will regulate their work and adapt to the use of this technology in daily life (Hamza, 2020). In the blockchain set-up, many other complexities need to be tackled to establish more sophisticated solutions for multi-regional and multi-time zone accessibility and governance structure while in compliance with different regulations.

Shariah

To ensure that the sukuk issued is in accordance with Shariah, issuers need to employ a competent Shariah advisor to inspect the blockchain algorithm/ programming in order to ensure that it is in accordance with the requirements of the underlying Shariah contracts (Kunhibava et al., 2021). For example, in a *mudaraba* contract, the profit is shared between the investor and issuer whilst lost is borne by the investor. Hence, the algorithm has to be properly coded to ensure that the smart contract is able to distinguish between the profit and loss scenarios and compute the profit distribution according to each scenario. Smart sukuk can be the solution of these obstacles related to the conventional sukuk issuances in terms of its compliance to the Shariah (Hamza, 2020). Where the design involves the use of cryptocurrency, there will be additional complexities since Shariah scholars are still debating the permissibility of using cryptocurrency.

Cyber risks

Being an online application, blockchain solutions are exposed to cyber risks such as hacking (Kunhibava et al., 2021). In addition, there exist vulnerabilities in smart contracts where potential coding errors and any undetected errors have the potential to be exploited. Hence, more extensive security analysis is needed before issuance of sukuk to help conceptualize a framework for their secure deployment in the Islamic finance sector (Khan et al., 2020).

5. Conclusions and Recommendations

Technology adoption needs to win massive support if it aims to change the market infrastructure or behavior. In order to maintain the stability of the debt capital market, market participants have urged that technology should focus on creating efficiencies and value for the current set-ups and infrastructure instead of completely replacing them. Hence, blockchain adoption should not cause a complete disintermediation since human interactions in the advisory functions are still necessary, especially for the deal negotiation in the pre-issuance process. Most importantly, blockchain should not be considered as a single solution to improve issuance efficiencies, but rather interoperate with other innovative technology such as artificial intelligence and cloud computing (Chen and Wang, 2020).

Smart sukuk has the potential of becoming the future for sukuk issuances and may contribute to the spread of sukuk more widely, leading to the expansion of Islamic funding. The advantages of smart contracts could facilitate transactions in convenient way and hence would contribute to wellbeing of the ummah, thus achieving the *maslaha*. The use of smart contracts designed to protect against fraud is also consistent with *maqasid al-Shariah* (purposes of Shariah), which is the protection of *al-mal* (property). The Prophet (PBUH) said, *"Make things easy and do not make them difficult, cheer the people up by conveying glad tidings to them and do not repulse (them)"* (Al-Bukhari).

Recommendations

The various studies suggest that the potential of blockchain in sukuk is significant. Currently the implementation of blockchain is largely driven by conventional players due to the cost of technology and availability of expertise that may not be afforded by many of the Islamic finance jurisdictions. The Islamic Development Bank and OIC should play a more progressive role and collaborate to develop the necessary infrastructure for the issuance of blockchain sukuk for cross-border transactions. This innovation could be the cornerstone in broadening capital market participation amongst OIC members and retail investors in the region. By extension, central banks of OIC members can develop a sovereign sukuk infrastructure to facilitate liquidity management and raise funding to support development in the post-COVID-19 world. To achieve wider acceptance, smart contracts could be utilized to facilitate some level of standardization of contracts across the Islamic finance jurisdictions, which have long been an outstanding issue.

Reference

AAOIFI. (2017). In *Shari'ah Standards* (p. 468). Retrieved from http://aaoifi.com/shariaa-standards/?lang=en

Adams, J., Hillier-Brown, F.C., Moore, H.J. et al. (2016). Searching and synthesising 'grey literature' and 'grey information' in public health: critical reflections on three case studies. Syst Rev 5, 164 https://doi.org/10.1186/s13643-016-0337-y

Alam, N., Gupta, L., & Zameni, A. (2019). *Fintech and Islamic Finance*. Springer International Publishing. https://doi.org/10.1007/978-3-030-24666-2

Ali, O., Ally, M., Clutterbuck, & Dwivedi, Y. (2020). The state of play of blockchain technology in the financial services sector: A systematic literature review. In *International Journal of Information Management,* Vol. 54, p. 102199). Elsevier Ltd. https://doi.org/10.1016/j.ijinfomgt.2020.102199

Al Hilal Bank. (2018, November 26). *https://www.alhilalbank.ae/en/news/2018/november/al-hilal-bank-executes-the-worlds-first-blockchain-sukuk-transaction.aspx*. Retrieved from Al Hilal Bank: https://www.alhilalbank.ae/en/news/2018/november/al-hilal-bank-executes-the-worlds-first-blockchain-sukuk-transaction.aspx

Al Mahmoood, D. (2019). *Promoting retail sukuk using blockchain technology*. Hamad bin Khalifa University. Thesis submitted in partial fulfilment of the requirements for the Degree of Master of Science Islamic Finance. https://search.proquest.com/openview/5ca60f7f50fc8ca6707be3c6479fcb62/1?pq-origsite=gscholar&cbl=2026366&diss=y

Al Subaei, F. (2019, December). Blockchain Application in the Gulf States. *Policy Paper 2019-22*. Retrieved from https://www.mei.edu/sites/default/files/2019-12/Blockchain%20in%20the%20Gulf.pdf

Al-Hajjar, M. A. (2020). An Outlook for Employing the "Initial Coin Offering" (ICO) for the Issuance of "Islamic Smart Sukuk" Across the Blockchain. *Journal Sharia and Law,* 82(5). Retrieved from https://scholarworks.uaeu.ac.ae/sharia_and_law/vol2020/iss82/5

Chen, W., & Wang, Q. (2020). *The Role of Blockchain for the European Bond Market* (FSBC Working Paper, Issue July). Retrieved from https://fsblockchain.medium.com/the-role-of-blockchain-for-the-european-bond-market-ce4ca0362f67

Binance Research. (2019, September 19). *Case Study: Santander's Latest Bond Issuance on Ethereum.* Retrieved from Binance Research: https://research.binance.com/en/analysis/santander-bond

Blossom Finance. (2019, October 16). *World's First Primary Sukuk Issuance on Blockchain Closes*. Retrieved from Blossom Finance: https://blossomfinance.com/posts/worlds-first-primary-sukuk-issuance-on-blockchain-closes

Crushcrypto. (n.d.). *What is Cryptography*. Retrieved from Crushcrypto: https://crushcrypto.com/cryptography-in-blockchain/

Hamza, O. (2020). Smart Sukuk Structure from Sharia Perspective and Financing Benefits: Proposed Application of Smart Sukuk through Blockchain Technology in Islamic Banks within Turkey. *EJIF – European Journal of Islamic Finance*, 1–8. Retrieved from https://doi.org/10.13135/2421-2172/3983

Iyer, K.V. & Ravi Kumar, V.V. (2021), "Using blockchain technology in credit rating industry to promote an innovative bond-pays model", *International Journal of Innovation Science*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/IJIS-10-2020-0200

Khan, N., Kchouri, B., Yatoo, N. A., Kräussl, Z., Patel, A., & State, R. (2020). Tokenization of sukuk: Ethereum case study. *Global Finance Journal*, 100539. https://doi.org/10.1016/j.gfj.2020.100539

Kunhibava, S., Mustapha, Z., Muneeza, A., Sa'ad, A. A., & Karim, M. E. (2021). Ṣukūk on blockchain: a legal, regulatory and Sharī'ah review . *ISRA International Journal of Islamic Finance*, *ahead-of-p*(ahead-of-print). https://doi.org/10.1108/ijif-06-2020-0120

Ledger Insights. (2019, Novermber 28). *R3's partner Wethaq issues its first blockchain sukuk*. Retrieved from Ledger Insights: https://www.ledgerinsights.com/wethaq-blockchain-sukuk/

Levi, S. D., & Lipton, A. B. (2018, May 26). *An Introduction to Smart Contracts and Their Potential and Inherent Limitations*. Retrieved from Harvard Law School Forum on Corporate Governance: https://corpgov.law.harvard.edu/2018/05/26/an-introduction-to-smart-contracts-and-their-potential-and-inherent-limitations/

Malaysia International Islamic Finance Centre. (n.d.). *Sukuk Using Al-Ijarah Structure*. Retrieved from MIFC: http://www.mifc.com/index.php?ch=ch_kc_definitions&pg=pg_kcdf_sukuk&ac=305

Malamas, V., Dasaklis, T., Arakelian, V., & Chondrokoukis, G. (2020). A Block-Chain Framework for Increased Trust in Green Bonds Issuance. *SSRN Electronic Journal*, *September*. https://doi.org/10.2139/ssrn.3693638

Mathias, A (2018). Blockchain 8 main legal issues. Retrieved from https://www.avocats-mathias.com/wp-content/uploads/2018/04/LB-GM-Blockchain-Janvier-2018.pdf.

Mat Rahim, S. R., Mohamad, Z. Z., Abu Bakar, J., Mohsin, F. H., & Md Isa, N. (2018). Artificial Intelligence, Smart Contract and Islamic Finance. *Asian Social Science*, *14*(2), 145. https://doi.org/10.5539/ass.v14n2p145

Mohamed, H. (2019). Blockchain-Based Impact Sukuk. In S. E. Hidayat, Y. F. Aryani, B. A. Fianto, S. A. Rusmita, N. Laila, & Haryadi (Eds.), *Blending Islamic Finance and Impact Investing for the SDGs, 4th Annual Islamic Finance Conference* (p. 107). Fiscal Policy Agency, Minister of Finance, The Republic of Indonesia. https://www.academia.edu/41300047/Blending_Islamic_Finance_and_Impact_Investing_for_the_Sustainable_Development_Goals

Mounira, B. (2020). Blockchain Technology Applications in the Islamic Financial Industry - The Smart Sukuk of Blossom Finance's Platform in Indonesia Model. *Economic Sciences, Management and Commercial Sciences, 13*(2), 309-325.

Muneeza, A., & Mustapha, Z. (2019). Blockchain and Its Shariah Compliant Structure. In M. M. Billah (Ed.), *Halal Cryptocurrency Management*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-10749-9

R3. (2019, June). *Innovating in Sukuk Capital Markets.* Retrieved from https://talkingtech.cliffordchance.com/content/micro-cctech/en/emerging-technologies/blockchain---distributed-ledger-technology/innovating-in-sukuk-capital-markets/_jcr_content/text/parsysthumb/download/file.res/Sukuk%20Capital%20Markets.pdf

S&P Global Ratings. (2020). *Islamic Finance Outlook 2020 Edition.* Retrieved from https://www.spglobal.com/_assets/documents/ratings/research/islamic_finance_2020_screen.pdf

Sanderson, O. (2018). How to Trust Green Bonds: Blockchain, Climate, and the Institutional Bond Markets. Blockchain, Climate, and the Institutional Bond Markets. In *Transforming Climate Finance and Green Investment with Blockchains* (pp. 273–288). Elsevier. https://doi.org/10.1016/B978-0-12-814447-3.00020-3

Santiago, C. (2019, October 17). *Indonesian microfinance cooperative issues world's first blockchain sukuk*. Retrieved from Theasset.com: https://www.theasset.com/article/38966/indonesian-microfinance-cooperative-issues-worlds-first-blockchain-sukuk-

Seebacher, S., & Schüritz, R. (2017). Blockchain Technology as an Enabler of Service Systems: A Structured Literature Review. In S. Za, M. Drǎgoicea, & M. Cavallari (Ed.), *Exploring Services Science. IESS 2017. Lecture Notes in Business Information Processing. 279.* Springer. doi:https://doi.org/10.1007/978-3-319-56925-3_2

Shukri, N., Zamri, S., Muneeza, A., & Ghulam, H. (2019). Waqf Development in Marawi City via Issuance of Perpetual Waqf Sukuk. *International Journal of Management and Applied Research*, 6(2), 68–80. https://doi.org/10.18646/2056.62.19-005

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Tan, V. (2020, December 15). *Bursa Malaysia keen to explore blockchain Sukuk*. Retrieved from IFNFintech: https://ifnfintech.com/bursa-malaysia-keen-to-explore-blockchain-sukuk/

Zhang, J. (2019, October 24). *Enterprise Blockchain Protocols: A Technical Analysis of Ethereum vs Fabric vs Corda*. Retrieved from Kaleido: https://www.kaleido.io/blockchain-blog/enterprise-blockchain-protocols-a-technical-analysis-of-ethereum-vs-fabric-vs-corda