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Blockchain for Halal Traceability in Sarawak: Digital Governance and Shariah Compliance to Drive PCDS 2030

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Abstract

Sarawak's Post COVID-19 Development Strategy (PCDS) 2030 envisions a robust, data-driven digital economy, positioning the Halal manufacturing and agricultural sectors as critical drivers of export growth. However, conventional Halal supply chains often struggle with localized traceability and transparency, presenting governance challenges that can risk cross-contamination and undermine consumer trust. To address these vulnerabilities, this conceptual paper proposes a Shariah-compliant blockchain governance framework tailored specifically to Sarawak's Halal ecosystem. By decentralizing supply chain data through an immutable ledger, the proposed model effectively operationalizes the core Islamic ethical principles of *Amanah* (trustworthiness) and *'Adl* (justice) in modern trade. Crucially, this research bridges technological implementation with actionable public policy. To facilitate seamless digital adoption without stifling local economic growth, the paper advocates for the establishment of state-backed "Halal Tech Sandboxes". Under the PCDS 2030 framework, this regulatory sandbox approach allows local SMEs to pilot blockchain traceability in live industrial environments. This mechanism fosters vital cross-agency collaboration between digital regulatory bodies and state Islamic councils. Ultimately, integrating blockchain technology into Sarawak's digital infrastructure will enhance regional data sovereignty, elevate global export competitiveness, and fulfill the PCDS 2030 mandate by establishing a resilient Shariah-compliant governance model in Borneo.

Keywords: *Blockchain, Halal Traceability, PCDS 2030, Digital Governance, Regulatory Sandbox, Shariah Compliance*

1. Introduction

The Post COVID-19 Development Strategy (PCDS) 2030 is a critical strategic document guiding Sarawak's vision to become a thriving, developed state by 2030. PCDS 2030 targets an 8% annual GDP growth to reach a RM282 billion economy, identifying agriculture and manufacturing as key economic sectors for export growth. Within these sectors, the Halal industry holds immense economic potential; globally, the Halal market currently exceeds USD 2 trillion and is anticipated to grow to USD 2.8 trillion. Concurrently, Malaysia's Halal industry contribution to exports is projected to increase to RM75.2 billion by 2030. However, conventional Halal supply chains in Sarawak frequently encounter systemic hurdles, such as limited localized traceability and fragmented data management, presenting governance challenges that risk cross-contamination and undermine consumer trust. These vulnerabilities are not merely theoretical; Malaysia has experienced significant meat fraud scandals involving adulteration, mislabelling and illegal importing, highlighting the severe consequences of opaque supply chains and ineffective traceability. To mitigate these vulnerabilities, the integration of advanced digital technologies specifically blockchain emerges as a viable mechanism to overhaul existing governance structures. Blockchain technology offers an immutable, decentralized ledger that ensures transparent data provenance from farm to fork, promoting traceability through timestamped and signed digital transactions. Within an Islamic context, this decentralized data governance effectively operationalizes the core ethical principles of *Amanah* (trustworthiness) and *'Adl* (justice) in modern trade. The feasibility of this approach in Sarawak is already being demonstrated by local traceability solution providers, such as Sinisana Technologies, which has successfully implemented a Halal blockchain platform at an abattoir facility to modernize operations while maintaining religious compliance. This conceptual paper proposes a Shariah-compliant blockchain governance framework

customized for Sarawak to elevate global export competitiveness, enhance regional data sovereignty, and fulfill the PCDS 2030 mandate.

2. Literature review

The integrity of Halal products is a multidimensional construct that extends beyond the point of slaughter or manufacturing to encompass the entire logistical network, an approach deeply rooted in the concept of *Halalan Toyyiban* (permissible and wholesome) (Zulfakar et al., 2014). In recent years, academic discourse has highlighted that the increasing complexity and globalization of supply chains pose significant risks to this integrity. Ali et al. (2021) argued that localized traceability is often compromised by information asymmetry, fragmented data management, and opaque logistical nodes. These vulnerabilities create structural loopholes that opportunistic entities can exploit, leading to cross-contamination and meat fraud, which ultimately severely undermine consumer trust and religious compliance. Consequently, there is a pressing scholarly consensus on the necessity of robust, end-to-end traceability frameworks to safeguard the Halal food supply chain against such systemic risks. To address the inherent vulnerabilities of conventional supply chains, researchers have increasingly directed their focus toward disruptive digital technologies, with blockchain emerging as a paramount solution. Rejeb et al. (2021) identified blockchain technology as a revolutionary tool for the Halal industry due to its intrinsic attributes: decentralization, immutability, and transparency. By providing a tamper-proof distributed ledger, blockchain effectively eliminates information silos and ensures that every transaction from raw material sourcing to the end consumer is securely recorded and verifiable. Furthermore, the integration of blockchain with Internet of Things (IoT) sensors and smart contracts automates the verification of critical control points, such as storage temperatures and logistical routes, thereby embedding proactive governance directly into the operational workflow (Rejeb et al., 2021). Zahari (2025) corroborated this by positing that a blockchain-enabled SMART certification system offers an optimal, technology-driven solution for maintaining stringent Halal standards systematically across the food industry.

Despite the proven technological efficacy of blockchain, the transition from conventional to digitalized supply chains presents complex socio-economic challenges, particularly for micro, small, and medium enterprises (MSMEs). A comparative study by Hassam et al. (2025) on Malaysian MSMEs revealed that while industry players recognize the potential of blockchain to enhance operational transparency and elevate brand equity, its adoption is heavily constrained by prohibitive initial setup costs, a lack of technical expertise, and an entrenched reliance on traditional paper-based auditing. Similarly, Elfarnawani and Kartiwi (2024) explored stakeholder perspectives within Malaysia's Halal ecosystem and concluded that the successful integration of blockchain cannot rely solely on technological readiness. Rather, it demands cohesive regulatory support, capacity building, and institutional mandates to foster an environment where stakeholders feel confident in transitioning toward decentralized data governance. Within the specific context of Sarawak, the operationalization of blockchain-enabled traceability intersects critically with public policy and state-led digital governance initiatives. The Sarawak Digital Economy Blueprint 2030 (Sarawak Multimedia Authority [SMA], 2023) and the Post COVID-19 Development Strategy (PCDS) 2030 (Economic Planning Unit Sarawak, 2021) both emphasize the establishment of a resilient, data-driven digital economy. These strategic frameworks prioritize the modernization of the agricultural and manufacturing sectors to boost export competitiveness. Bridging the gap between technological capabilities and these policy mandates requires innovative regulatory mechanisms. The literature suggests that integrating advanced technological solutions with state-backed digital governance not only enhances regional data sovereignty but also aligns with the Shariah principles of *Amanah* (trust) and *'Adl* (justice) by promoting fair and transparent trade practices. Therefore, contextualizing these technological advancements within Sarawak's strategic goals is crucial for developing a comprehensive digital governance framework that fulfills the mandate of PCDS 2030.

3. **Conceptual Framework**

The conceptual framework proposed in this study is anchored in the synthesis of advanced digital capabilities, Islamic ethical doctrines, and state-driven public policy to fulfill the mandates of the Post COVID-19 Development Strategy (PCDS) 2030. The first foundational domain of this framework is Shariah-Compliant Blockchain Governance, which acts as the primary technological enabler. By deploying a decentralized and immutable ledger, this domain systematically operationalizes the core Islamic principles of *Amanah* (trustworthiness) and *'Adl* (justice) within modern trade logistics. According to Ali et al. (2021), a sustainable blockchain framework is pivotal in eliminating information asymmetry and mitigating cross-contamination risks across the Halal food supply chain. Furthermore, as posited by Zahari (2025), utilizing a blockchain-enabled SMART certification and traceability system ensures that trust in data integrity and fairness among all supply chain nodes are digitally enforced, effectively transforming theoretical Shariah compliance into a quantifiable digital standard.

The second and third domains of the framework interconnect this technological enabler with actionable policy mechanisms and strategic state outcomes. To transition local micro, small, and medium enterprises (MSMEs) into this digital ecosystem without exposing them to prohibitive compliance burdens, the framework introduces "Halal Tech Sandboxes" as a critical policy mechanism. Hassam et al. (2025) highlighted that while MSMEs acknowledge the operational benefits of blockchain, their adoption is heavily constrained by technical and financial readiness. Therefore, establishing a state-backed regulatory sandbox provides a controlled, live industrial environment for local SMEs to pilot these traceability solutions safely. This approach necessitates vital cross-agency collaboration between digital regulators and state Islamic councils, aligning seamlessly with the data-centric governance prioritized in the Sarawak Digital Economy Blueprint 2030 (Sarawak Multimedia Authority [SMA], 2023). Ultimately, this structured integration targets the specific outcomes of PCDS 2030: enhancing regional data sovereignty, establishing a resilient Shariah-compliant governance model in Borneo, and elevating Sarawak's Halal export competitiveness on the global stage (Economic Planning Unit Sarawak, 2021).

4. **Research Questions**

The research questions formulated are as follow:

1. What are the primary governance challenges and vulnerabilities regarding localized traceability in Sarawak's conventional Halal supply chains?
2. How does a Shariah-compliant blockchain governance framework operationalize the Islamic ethical principles of *Amanah* and *'Adl* in modern trade?
3. To what extent can the establishment of "Halal Tech Sandboxes" facilitate seamless digital adoption among local SMEs and fulfill the economic mandates of PCDS 2030?

5. Significance of Study

The findings and framework presented in this study offer critical strategic value for the realization of Sarawak's Post COVID-19 Development Strategy (PCDS) 2030. The PCDS 2030 envisions transforming Sarawak into a thriving, data-driven society supported by a resilient global supply chain, with the ambitious target of expanding the state's economy to RM282 billion by the end of the decade. By demonstrating the intersection of advanced digital traceability and the Halal sector, this study provides actionable insights on how to digitize and secure supply chain resilience a core economic pillar heavily emphasized in the PCDS 2030 framework. Consequently, investing in blockchain-enabled Halal governance is not merely an operational upgrade, but a strategic economic imperative that can significantly elevate Sarawak's agricultural and manufacturing export capabilities in the global market. Furthermore, this research contributes directly to the state's broader digital governance agenda, which is actively championed by the Sarawak Multimedia Authority (SMA). The SMA has consistently worked to position Sarawak as a digital powerhouse by leveraging emerging, practical technologies such as artificial intelligence and blockchain to drive economic transformation and structural growth. By outlining a tailored, Shariah-compliant blockchain governance framework, this paper provides a concrete roadmap for digital regulatory bodies to implement these advanced technologies specifically within the Halal ecosystem. This strategic alignment ensures that technological adoption in Borneo moves beyond theoretical discourse into scalable, live industrial applications that maximize digital value and deliver secure services for local communities and businesses.

From a religious and socio-ethical perspective, the study provides profound implications for state Islamic regulatory bodies, particularly the Majlis Islam Sarawak (MIS). MIS has already demonstrated a proactive approach toward digitalizing Halal enforcement in the state, such as introducing new mobile applications designed to streamline the verification of Halal statuses for food premises. Integrating an immutable blockchain ledger takes this digitalization effort to a systemic, state-wide level. It empowers MIS to enforce stringent Shariah compliance specifically the ethical principles of *Amanah* (trustworthiness) and *'Adl* (justice) through cryptographically secure and tamper-proof data governance. This technological intervention effectively eliminates localized traceability vulnerabilities and safeguards Muslim consumer trust from the farm to the retail level. Finally, the study's advocacy for state-backed "Halal Tech Sandboxes" serves as a critical policy contribution designed to protect and empower local micro, small, and medium enterprises (MSMEs). By proposing a controlled regulatory sandbox, this research bridges the digital innovation aspirations of SMA with the strict religious compliance mandates enforced by MIS. This proposed cross-agency collaboration mechanism allows local businesses to pilot advanced blockchain traceability systems without facing prohibitive initial regulatory penalties. Ultimately, establishing this inclusive, Shariah-compliant digital governance model will enhance regional data sovereignty, ensure an equitable distribution of technological opportunities, and position Sarawak as a premier, technologically resilient Halal hub in Borneo.

6. Research Methodology

This research adopts a qualitative, conceptual methodology grounded in a comprehensive review of contemporary literature and strategic policy documents. The study primarily relies on secondary data sourced from key governmental frameworks that dictate Sarawak's digital and economic trajectory, notably the Post COVID-19 Development Strategy (PCDS) 2030 (Economic Planning Unit Sarawak, 2021) and the Sarawak Digital Economy Blueprint 2030 (Sarawak Multimedia Authority, 2023). To ensure a robust technological foundation, recent academic discourse (2021–2025) concerning the integration of blockchain within Halal supply chains was systematically reviewed. By synthesizing these diverse governmental and academic sources, the methodology is designed to bridge the gap between advanced technological implementations and actionable public policy, specifically tailoring the approach to the unique socio-economic landscape of Borneo (Ali et al., 2021). Following the data collection phase, a thematic analysis was employed to map the critical intersections between digital governance, Shariah compliance, and localized regulatory mechanisms. The analysis focused on how the immutable and decentralized attributes of blockchain can theoretically operationalize the fundamental Islamic ethical principles of *Amanah* (trustworthiness) and *'Adl* (justice) in modern trade logistics (Elfarnawani & Kartiwi, 2024). Furthermore, the conceptualization of the state-backed "Halal Tech Sandbox" was developed by critically examining the regulatory and financial challenges faced by micro, small, and medium enterprises (MSMEs) during digital transitions (Hassam et al., 2025). This structured analytical approach culminated in the design of a Shariah-compliant blockchain governance framework that is technologically viable, strictly aligned with religious mandates, and directly supportive of Sarawak's overarching PCDS 2030 objectives.

7. Findings

7.1 Vulnerabilities in Conventional Halal Governance

According to the conceptual analysis, conventional Halal supply chains in Sarawak struggle significantly with localized traceability and transparency. These conventional methods often rely on fragmented, paper-based systems or centralized data silos, presenting severe governance challenges that risk cross-contamination. Such systemic vulnerabilities not only compromise the physical integrity of Halal products but also actively undermine consumer trust in local manufacturers. Consequently, the findings emphasize that without structural digital intervention, Sarawak's ambition to position its Halal manufacturing and agricultural sectors as critical drivers of export growth under the PCDS 2030 framework will face significant logistical and compliance barriers.

7.2 Decentralization as a Resilient Governance Solution

To address these identified vulnerabilities, the findings propose the implementation of a Shariah-compliant blockchain governance framework specifically tailored to Sarawak's Halal ecosystem. By decentralizing supply chain data through an immutable distributed ledger, the blockchain framework eliminates single points of failure and prevents unauthorized data manipulation. This technological shift ensures that all logistical nodes from rural agricultural farms in Borneo to urban processing centers maintain verifiable and transparent data provenance. Ultimately, this approach replaces opaque conventional supply chain management with a resilient digital architecture that enhances regional data sovereignty.

7.3 Operationalizing Amanah and 'Adl through Digital Ledgers

A critical conceptual finding of this study is the theoretical mapping of blockchain's technical capabilities directly to Islamic jurisprudence. The proposed digital model effectively operationalizes the core Islamic ethical principles of *Amanah* (trustworthiness) and *'Adl* (justice) in modern trade. Blockchain's cryptographic immutability structurally enforces *Amanah* by guaranteeing that Halal certification and traceability data cannot be forged, altered, or tampered with by opportunistic parties. Concurrently, the decentralized and transparent nature of the ledger promotes *'Adl*, ensuring that consumers, logistics providers, and religious regulatory bodies have fair and equitable access to truthful product history.

7.4 Policy Integration via Halal Tech Sandboxes

Finally, the findings critically bridge this advanced technological implementation with actionable public policy. The study establishes that for seamless digital adoption to occur without stifling local economic growth, state intervention is necessary through the establishment of state-backed "Halal Tech Sandboxes". Under the PCDS 2030 framework, this

regulatory sandbox approach allows local SMEs to safely pilot blockchain traceability in live industrial environments. This mechanism is found to be vital for fostering proactive cross-agency collaboration between digital regulatory bodies and state Islamic councils, ultimately establishing a resilient Shariah-compliant governance model in Borneo that elevates global export competitiveness.

8. Discussion

The transition from conventional traceability to a blockchain-enabled Halal supply chain presents profound implications for public policy and industrial governance in Sarawak. While the technological merits of decentralized ledgers in preventing cross-contamination are well-documented, sudden and rigid regulatory mandates can inadvertently stifle local economic growth, particularly for micro, small, and medium enterprises (MSMEs) that often lack the requisite initial capital and digital literacy to adapt to complex systems (Hassam et al., 2025). To navigate this socio-economic challenge, this research critically bridges technological implementation with actionable public policy. Specifically, to facilitate seamless digital adoption without stifling local economic growth, the paper advocates for the establishment of state-backed "Halal Tech Sandboxes". Under the PCDS 2030 framework, this regulatory sandbox approach allows local SMEs to pilot blockchain traceability in live industrial environments. By operating within this controlled testing environment, local Halal manufacturers can iteratively adopt decentralized data governance without facing immediate, prohibitive regulatory penalties, thereby democratizing access to advanced traceability tools. Furthermore, the successful operationalization of this blockchain framework relies heavily on institutional synergy and structured regulatory support. The implementation of the sandbox mechanism fosters vital cross-agency collaboration between digital regulatory bodies and state Islamic councils. In the specific context of Sarawak, this necessitates cohesive policy alignment between entities such as the Sarawak Multimedia Authority (SMA), which spearheads the state's digitalization agenda, and the Majlis Islam Sarawak (MIS), which oversees rigorous Halal enforcement. Such stakeholder coordination is imperative, as contemporary studies highlight that technological deployment in the Halal sector cannot succeed in a vacuum; it requires cohesive institutional mandates to build stakeholder confidence (Elfarnawani & Kartiwi, 2024). Ultimately, integrating blockchain technology into Sarawak's digital infrastructure will enhance regional data sovereignty, elevate global export competitiveness, and fulfill the PCDS 2030 mandate by establishing a resilient Shariah-compliant governance model in Borneo. This strategic alignment ensures that Sarawak is strongly positioned to meet stringent international compliance standards, driving the state toward its goal of becoming a high-income, developed economy (Economic Planning Unit Sarawak, 2021).

9. Conclusion

Sarawak's Post COVID-19 Development Strategy (PCDS) 2030 envisions a robust, data-driven digital economy, positioning the Halal manufacturing and agricultural sectors as critical drivers of export growth. However, conventional Halal supply chains often struggle with localized traceability and transparency, presenting governance challenges that can risk cross-contamination and undermine consumer trust. To overcome these fundamental vulnerabilities, this conceptual paper proposes a Shariah-compliant blockchain governance framework tailored specifically to Sarawak's Halal ecosystem. By transitioning away from fragmented data silos and decentralizing supply chain data through an immutable ledger, the proposed model effectively operationalizes the core Islamic ethical principles of *Amanah* (trustworthiness) and *'Adl*(justice) in modern trade. This technological integration ensures that the physical and spiritual integrity of Halal products is permanently safeguarded and verifiable throughout the entire logistical network. Crucially, this research bridges technological implementation with actionable public policy to ensure sustainable industry-wide adoption. To facilitate seamless digital adoption without stifling local economic growth, the paper advocates for the establishment of state-backed "Halal Tech Sandboxes". Under the PCDS 2030 framework, this regulatory sandbox approach allows local SMEs to pilot blockchain traceability in live industrial environments, thereby lowering the barriers to entry for digital transformation. Furthermore, this mechanism fosters vital cross-agency collaboration between digital regulatory bodies and state Islamic councils, ensuring that technological governance aligns with religious jurisprudence. Ultimately, integrating blockchain technology into Sarawak's digital infrastructure will enhance regional data sovereignty, elevate global export competitiveness, and fulfill the PCDS 2030 mandate by establishing a resilient Shariah-compliant governance model in Borneo.

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