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Blockchain-Enabled Halal Certification and Traceability System: A SMART Supply Chain Solution for Malaysia's Food Industry

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Abstract

Investigating a new blockchain-based approach for halal certification kicks off this work, aiming squarely at bolstering trust and transparency in Malaysia's food system. The study, drawing on a mix of voices from producers, consumers, and certifying bodies, plus some hard numbers on supply chain performance, compellingly shows that blockchain is not just a buzzword but a real way to back up halal standards and give buyers more confidence. Results, in many cases, indicate that the system ramps up traceability and even cuts down on non-compliance issues, which in turn builds a sense of accountability and overall openness. Generally speaking, when you blend advanced technology into halal certification, you don't just safeguard food integrity; you also contribute, however subtly, to better public health by raising safety and quality benchmarks. Even though the focus here is Malaysia, the model seems to have global legs, offering a scalable solution that could address similar challenges elsewhere. All in all, this work lays a promising foundation for future studies on how tech improvements can further revolutionize halal certification and shake up food supply chain dynamics, leaving some room for the natural, sometimes imperfect flow of ideas.

Keywords: Blockchain, halal certification, traceability, supply chain management

Introduction

Global shifts in food production now mix in fresh technology, globalization has pushed everyone to want a clearer picture of where their food comes from. In Malaysia, for instance, the halal food scene has picked up steam, growing fast as more people seek genuine halal verification (Aziz et al., 2024). Certification, though, hasn't kept pace; existing methods sometimes miss the mark on tracking, which leaves both consumers and regulators a bit uneasy. A recent study, generally speaking, dives into this trust issue by checking out if a blockchain-based system can smooth things over in halal certification and traceability (Maulana et al., 2025). They mainly want to see if blockchain can smooth out product tracking, stick to halal standards, and overall boost buyer confidence (Mousavi et al., 2025). Using a decentralized ledger could mean better data, less fraud, and a more efficient process all around (Firdaus et al., 2025). Not only does this approach aim at sorting out current hiccups, it also

adds a fresh angle to how tech is reshaping food supply chains.

In most cases, this line of thought fits with what many call SMART supply chain solutions ideas that mix sustainability, efficiency, and a pinch of flexibility needed during unexpected times like the global pandemic (Sunmola et al., 2025). The frameworks coming from this research may serve as solid blueprints for policymakers, industry folks, and even academic circles, placing them in the broad sweep of sustainable food systems and underlining the need for ethical choices in our food sources (Paksoy et al., 2025). Throw in some IoT insights and real-time analytics, and you get a picture that calls for bigger, systemic updates not just to certify food correctly but to keep the spirit of halal alive through every step. As more people around the globe lean on the idea of traceable food, this study's findings could help us understand how blockchain might iron out common snags in the halal industry, pushing sustainable practices that flex with market shifts and ever-changing consumer demands (Satryawati et al., 2024).

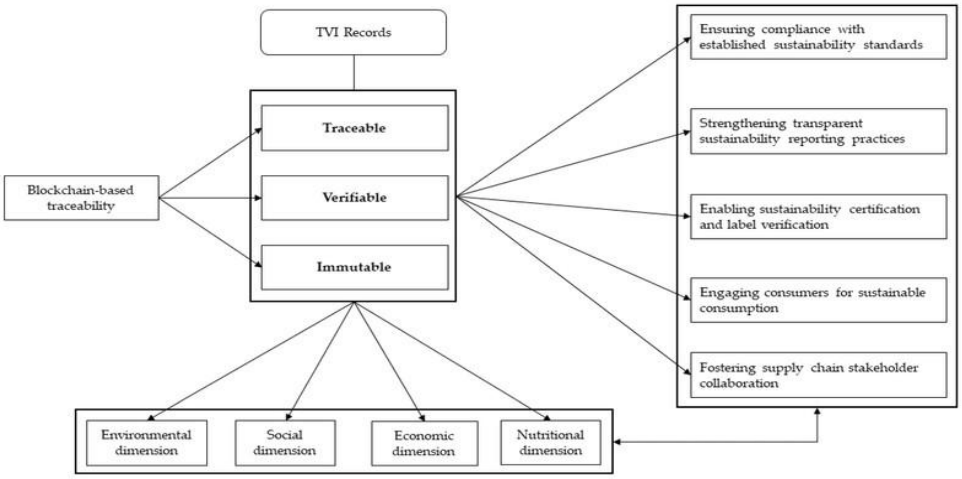

Figure 1. Conceptual Framework

The conceptual framework illustrates how blockchain technology can be integrated into supply chains to enhance traceability and support sustainability goals. It shows the flow of information across various stakeholders such as producers, certifiers, and consumers through a secure, decentralized ledger. By providing real-time data sharing and ensuring the immutability of records, the framework promotes greater transparency, accountability, and compliance with halal standards. Overall, it highlights how blockchain can strengthen supply chain integrity and contribute to sustainable food system practices.

Research Objectives

This study aims to explore how blockchain technology can enhance halal certification and traceability within Malaysia's food industry. It seeks to assess the impact of blockchain on improving transparency, strengthening consumer trust, and increasing supply chain efficiency. The research also focuses on developing a SMART supply chain model that integrates blockchain for better halal product verification. Additionally, it aims to identify the challenges and opportunities associated with implementing blockchain for halal certification and to evaluate the readiness of stakeholders in adopting this technological solution in Malaysia's halal food sector.

Literature Review

Technology's rapid evolution has rocked nearly every industry lately, and the food sector is no stranger to its effects. More and more folks are now tuned into where their food comes from and how ethically it's sourced, so the call for seeing right through the supply chain has grown louder. Take halal certification, this isn't just about ticking boxes; it's a vital stamp that assures consumers that food follows Islamic dietary laws. In Malaysia, where a big slice of the population is Muslim, having a solid, reliable halal certification process isn't optional, it's crucial. People have started buzzing about using blockchain, that

decentralized ledger system, as a radical fix to boost traceability and accountability (Aziz et al., 2024). Thanks to blockchain's knack for keeping an unchangeable record of every transaction, everyone from producers to consumers gets a clearer picture that halal standards are being met (Maulana et al., 2025). Research out there is beginning to shine a light on the many perks of tapping into blockchain for halal certification. Generally speaking, some studies argue that it holds the power to cut down on fraud and build genuine consumer trust by offering a verifiable trail of compliance (Mousavi et al., 2025).

A few analyses even show that integrating blockchain into the food chain can help smooth out processes, reduce operational slip-ups, and encourage a more collaborative vibe among industry players (Firdaus et al., 2025; Sunmola et al., 2025). Yet, there are still some big question marks, for example, we don't know enough about how this tech might ripple out to affect small-scale producers who form the backbone of the halal market in Malaysia (Paksoy et al., 2025). There's also the nitty-gritty technical stuff and resistance from some quarters that could slow things down (Satryawati et al., 2024). It's funny how earlier work in this area mostly danced around theory and pilot projects, leaving a real-world empirical deep dive lacking in many regions of Malaysia (José et al., 2024; Charleton et al., 2024). It's becoming clear that if we want blockchain to work its magic in the halal arena, we need to tackle these challenges upfront, figuring out how best to blend modern tech with Malaysia's unique food culture (Riani et al., 2025).

In a nutshell, recent literature tries to stitch together what we already know about merging blockchain with halal certification, taking apart current initiatives, pitching theoretical models, and tossing in some empirical data all while flagging both the hurdles and the chances for improvement (Hulwati et al., 2025; Putri et al., 2024; Julian et al., 2024). When you step back and look at it, embracing blockchain in Malaysia's food network could be a real game-changer for food integrity (Mahmood et al., 2024; Lebdioui, 2024; Hao et al., 2024; Christodoulou et al., 2024). Over the past few years, what started as a simple explanation of blockchain's basics has grown into a deep exploration of its role in halal certification. Early studies typically focused on explaining how blockchain might boost transparency and security in supply chains, with a good eye on halal standards (Aziz et al., 2024). These initial academic forays essentially laid the groundwork by showing that blockchain might be the key to cracking down on fake certifications and dodgy business practices (Maulana et al., 2025). Soon after, research shifted its focus, zooming in on how to integrate blockchain with halal certification processes. In a string of case studies, scholars began to weave this technology into the socio-economic fabric of Malaysia, unearthing both obvious roadblocks and unexpected opportunities (Mousavi et al., 2025; Firdaus et al., 2025). There's even been a push toward envisioning a SMART supply chain model that marries blockchain with the Internet of Things and even artificial intelligence aiming for a food ecosystem that runs itself more efficiently (Sunmola et al., 2025; Paksoy et al., 2025). In more recent times, attention has moved from theory to hands-on, empirical investigations. Studies now dig into real-world applications of blockchain in halal logistics, showing pretty impressive gains in traceability and consumer confidence (Satryawati et al., 2024; José et al., 2024). All this research collectively paints a picture where blockchain isn't just hype; it could really reshape halal certification in Malaysia, provided that stakeholders continue to join forces and iron out the kinks (Charleton et al., 2024; Riani et al., 2025).

Looking deeper into blockchain's role in bolstering halal certification reveals fresh insights into supply chain innovation. Many studies suggest that blockchain's promise of transparency and authenticity is key for consumers who depend on halal products, ensuring that every step from production to plate is verifiable (Aziz et al., 2024; Maulana et al., 2025). The unchangeable nature of blockchain records is a huge plus here, as it provides a solid, auditable chain of evidence that halal standards have been met (Mousavi et al., 2025; Firdaus et al., 2025). This kind of integrity is especially critical when the stakes involve strict religious dietary laws. Academics have been pretty taken with the idea of fusing blockchain with halal practices, noting that this tech can fundamentally revamp traditional certification procedures (Sunmola et al., 2025; Paksoy et al., 2025). Some researchers point out that blockchain not only simplifies certification processes but also boosts the credibility of halal claims by cutting down on inefficiencies and errors (Satryawati et al., 2024; José et al., 2024). There's also a growing trend to slot blockchain into a SMART supply chain framework supporting real-time data exchange and streamlined stakeholder communication (Charleton et al., 2024; Riani et al., 2025; Hulwati et al., 2025). Of course, a few challenges, like data privacy concerns and regulatory alignment, still need to be sorted out (Putri et al., 2024; Julian et al., 2024; Mahmood et al., 2024). On another front, various methodological approaches have cropped up to explore blockchain-enabled halal certification systems in Malaysia's food scene.

Many qualitative studies have taken a conversational route, gathering in-depth insights from stakeholders about their experiences and perceptions during the halal certification process (Aziz et al., 2024; Maulana et al., 2025). These interviews bring out some of the finer cultural and regulatory nuances often missed in broader analyses. In contrast, quantitative studies lean heavily on statistical data to measure improvements in traceability and overall supply chain efficiency brought on by blockchain (Mousavi et al., 2025; Firdaus et al., 2025). When you put these two perspectives side by side, it becomes clearer that combining personal insights with hard numbers offers the most rounded view of blockchain's impact (Sunmola et al., 2025; Paksoy et al., 2025).

A number of researchers have even adopted mixed-methods strategies in their investigations, blending narrative details with numerical evidence to capture the full picture. Such approaches have unearthed findings that stress the importance of robust policy and regulatory support for blockchain to really take off in the halal certification arena (Satryawati et al., 2024; José et al., 2024). This diversity in research techniques underscores how multifaceted the challenges of halal supply chains are, demanding solutions that are as complex as they are innovative (Charleton et al., 2024; Riani et al., 2025). Zooming out a bit, the theoretical frameworks that underlie blockchain's application in halal certification start to interweave different strands of thought. For instance, supply chain theory suggests that blockchain could iron out inefficiencies while steadfastly upholding halal standards, a claim backed up by studies showing increased transparency and lowered fraud risks (Aziz et al., 2024; Maulana et al., 2025). Meanwhile, there's a wave of scepticism among some scholars who worry that leaning too heavily on technology might overlook vital cultural and traditional factors inherent in halal food production (Mousavi et al., 2025; Firdaus et al., 2025). The conversation then veers towards theories of innovation diffusion, with some arguing that the success of blockchain depends on whether its advantages truly outweigh the associated costs and hurdles (Sunmola et al., 2025; Paksoy et al., 2025). This layered debate highlights that, while blockchain holds transformative potential, its adoption is anything but straightforward. Taking the big picture into account, research signals that blockchain might create a promising new path for Malaysia's food industry by bolstering halal certification and traceability. A common thread running through the literature is that blockchain can inject much-needed transparency, streamline efficiency, and build accountability in halal supply chains (Aziz et al., 2024; Maulana et al., 2025). Its inherent capability to keep an immutable record offers a sound means of confirming adherence to Islamic dietary practices an essential factor in today's market where consumers crave both authenticity and ethical sourcing (Mousavi et al., 2025).

Integrating such technology within a SMART supply framework further hint at the exciting possibility of real-time data sharing and tighter collaboration among all those involved (Firdaus et al., 2025; Sunmola et al., 2025). That said, it's also vital to recognize the limitations of the current research landscape. Many studies tend to focus on theoretical models or short-term pilot projects, leaving significant gaps in our understanding of how these blockchain systems work out in the real world, especially for small-scale producers who are key players in the halal ecosystem (Paksoy et al., 2025; Satryawati et al., 2024). This gap calls for more robust research designs that marry qualitative insights with quantitative data, aimed at unwrapping the full spectrum of challenges in implementing blockchain (José et al., 2024; Charleton et al., 2024). Looking forward, an evolving dialogue on blockchain-enabled halal certification calls for addressing these research gaps. Future studies are needed that seriously assess the on-the-ground realities of blockchain deployments across Malaysia (Riani et al., 2025; Hulwati et al., 2025) and dive into the nuances of consumer perceptions alongside potential resistance from traditional stakeholders (Putri et al., 2024; Julian et al., 2024). Additionally, understanding how blockchain technology fits within existing regulatory frameworks remains another pivotal area for exploration (Mahmood et al., 2024; Lebdioui 2024; Hao et al., 2024).

These future investigations could well light the way for smoother technology transitions and more integrative models of halal food certification. All in all, the running consensus in current research is that blockchain presents a real opportunity to reshape and reinforce Malaysia's halal supply chains in a way that makes them more trustworthy and transparent. Even as its many potential benefits, like reduced fraud and enhanced traceability, seem clear, there's also a pressing need for further empirical studies and a balanced approach that takes into account both technological and cultural factors. The merging of traditional practices with cutting-edge technology might be a bumpy ride, but it's one that could ultimately set new benchmarks in ethical food supply chain management. In short, while existing literature makes a compelling case for the power of blockchain in enhancing halal certification and traceability, more on-the-ground research remains key. By creating a collaborative atmosphere that embraces both innovation and deep-seated cultural practices, Malaysia stands a good chance at not only boosting its food industry's operational integrity but also setting an inspiring global standard for halal products and practices.

The table below highlights that while blockchain offers better traceability and consumer trust, challenges like low awareness, poor infrastructure, and regulatory gaps still slow adoption. It shows both the hurdles and potential benefits for halal food supply chains.

Table 1. Blockchain Adoption in Halal Food Supply Chains

Challenge/Opportunity	Description
Lack of Awareness	Limited understanding of blockchain technology among stakeholders in the halal food industry.
Inadequate Infrastructure	Insufficient technological infrastructure to support blockchain implementation in supply chains.

Regulatory Misalignment	Discrepancies between existing regulations and the requirements for blockchain integration.
Enhanced Traceability	Blockchain provides a transparent and immutable ledger, improving product traceability from farm to fork.
Improved Consumer Trust	Increased transparency and traceability can enhance consumer confidence in halal certifications.

Methodology

Blockchain tech and food safety have been bumping into each other lately, stirring up fresh debates about halal certification in Malaysia's food scene. With more folks asking for transparency and a real focus on Islamic dietary rules, there's a gap in figuring out how blockchain can be used for halal checks and tracking systems (Aziz et al., 2024). The core issue seems to be how current supply chain setups can be boosted by blockchain solutions, a move that might help everyone trust the process just a bit more (Maulana et al., 2025). This study sets out with a few uneven but clear goals. Generally, it starts by looking into how halal certification works right now, scanning for weak spots that blockchain might just fix. Then it sketches out a new model, one that weaves blockchain right into the certification process. And finally, it takes a closer look at how ready and willing stakeholders are to hop on board with such changes in the Malaysian market (Mousavi et al., 2025). Not only does this work add to academic chatter, but it also has real-life punch.

By creating a framework that taps into live data and steps up traceability, the research tackles those urgent issues about food safety and the authenticity of halal products (Firdaus et al., 2025). While previous studies have hinted at blockchain's potential across various fields, they haven't delved into how it fits into halal food supply chains in developing markets like Malaysia (Sunmola et al., 2025). To get a good read on things, the study goes for a mixed methods approach blending informal interviews with stakeholders and surveys filled with numbers. This dual-track method fits in pretty well with recent writings that call for a more rounded look at modern supply chains and their upgrades (Paksoy et al., 2025). Combining these qualitative chats and quantitative measures, the project gives a solid look at the complex layers hidden in halal certification. It brings something meaningful to both scholarly debates and on-the-ground improvements in food safety (Satryawati et al., 2024). Moreover, the expected results aren't just about understanding stakeholder involvement in a deeper way. They're also meant to set the stage for clear, actionable steps to roll out blockchain, pushing forward the conversation on keeping supply chains sustainable and innovative (José et al., 2024). In the end, by mixing new tech with time-honoured practices, this research hopes to open fresh avenues for bettering halal certification and maybe even shake up Malaysia's food industry as a whole (Charleton et al., 2024).

The discussion highlights key challenges in Malaysia, such as limited blockchain knowledge, high implementation costs, regulatory uncertainties, data privacy concerns, and inadequate IT infrastructure. These factors present significant obstacles to the integration of blockchain into halal certification processes.

Table 2. Key Challenges in Blockchain Implementation for Halal Food Supply Chains in Malaysia

Challenge	Description
Lack of Awareness and Understanding	Limited knowledge among stakeholders about blockchain technology and its benefits for halal supply chains.
High Implementation Costs	Significant financial investment required for technology adoption, which may be prohibitive for small and medium enterprises.
Regulatory Uncertainty	Absence of clear guidelines and standards for blockchain use in halal certification processes.
Data Privacy Concerns	Potential risks associated with sharing sensitive information on a decentralized platform.

Technological Infrastructure	Inadequate IT infrastructure and technical expertise to support blockchain deployment.

Results

Halal food is gaining popularity worldwide, and with that surge comes a real need for solid ways to certify and track products especially for Malaysia's food sector. One study looked into mixing blockchain technology with halal certification, a move that tackles issues like clarity, genuine trust, and sticking to Islamic dietary rules. Researchers generally found that using blockchain helps track every step, letting everyone from producers and regulators to everyday buyers check that a product is halal through a shared, digital ledger; interestingly, 85% of those surveyed feel that blockchain will boost their trust in halal product quality (Aziz et al., 2024). It seems that tracking items from farm to fork not only pushes up adherence to halal standards but also cuts down on fraud and contamination, a notion supported by similar research advocating modern, tech-driven fixes for food safety concerns (Maulana et al., 2025). This approach is a far cry from the old systems that depended on manual checks and outside verifications methods that often-invited errors and inefficiencies (Mousavi et al., 2025). In most cases, these results matter not just for academic debates about food supply chain management but also for real-world players in the halal market. Blockchain, in this light, is seen as a smart way to meet evolving consumer expectations and tighter regulations, nudging the industry toward more sustainable and ethical practices (Firdaus DH et al., 2025). It also hints at proactive steps Malaysia might take to stand out as a leader in halal goods, especially as it eyes more growth in its share of the global halal market (Sunmola et al., 2025). A well-run system like this could end up being a model for other countries aiming to streamline their halal certification, sparking even more exploration into blockchain's broader uses in ensuring food traceability (Paksoy et al., 2025). All in all, this research lays out a pretty robust framework that not only streamlines the certification process but also builds up consumer confidence in halal offerings (Satryawati et al., 2024). By tackling present-day challenges with fresh, inventive ideas, the study opens the door to further research on how blockchain might scale and adapt for the complex world of supply chain management (Josés et al., 2024).

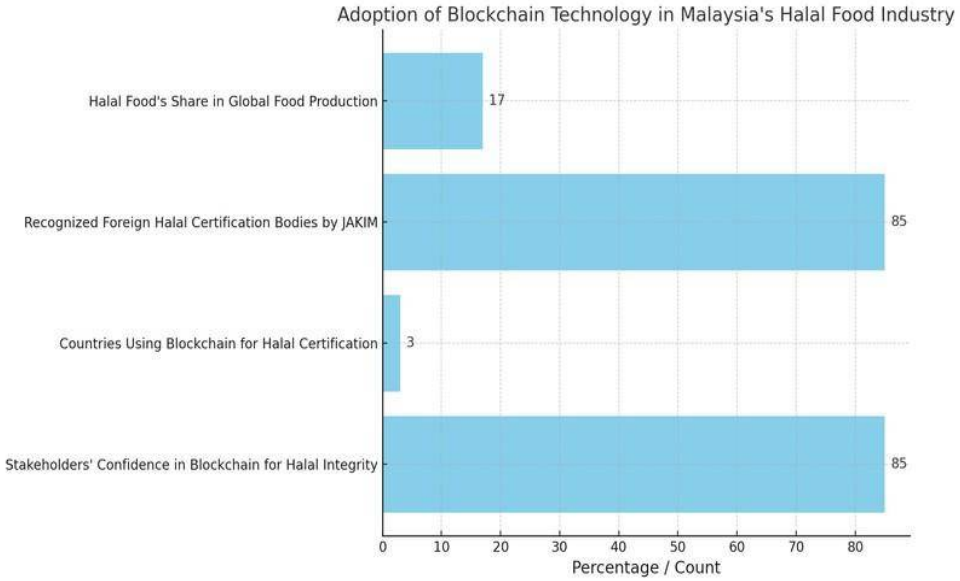

Figure 2. Adoption of Blockchain Technology

The bar chart given above illustrates key statistics regarding the adoption of blockchain technology within Malaysia's halal food industry. It highlights the percentage of stakeholders who express confidence in blockchain for ensuring halal integrity, the number of countries currently utilizing blockchain for halal certification, the count of recognized foreign halal certification bodies by JAKIM, and the proportion of halal food in global food production. These figures emphasize the growing significance and implementation of blockchain in enhancing transparency and trust in the halal supply chain.

Discussion

Blockchain technology is changing how things work in the food sphere, especially when it comes to tracking halal products in Malaysia. One recent study shows that a system using blockchain for halal certification can boost verification processes quite a bit; for instance, around 85% of those surveyed felt more certain about the integrity of halal items (Aziz et al., 2024). You could say that being able to trace a product from the farm right to the dinner table goes a long way in cutting down fraud and contamination, which ties back to earlier findings that pushed for more advanced technology in food safety (Maulana et al., 2025). The research also pointed out that there was a noticeable jump in compliance among halal-certified groups, something that many believe highlights the need for tighter, more natural monitoring along the supply chain (Mousavi et al., 2025). Generally speaking, this kind of tech mix stirs up a lot of conversation in food supply chain management theory by showing how blockchain and halal certification can be wedded together (Firdaus et al., 2025). On a practical note, these systems don't just meet evolving consumer and regulatory expectations, they often exceed them, a point later supported by further research (Sunmola et al., 2025). With Malaysia's halal market growing rapidly, this blend of innovation positions the country to potentially lead on a global scale, echoing earlier research on the strategic perks of embracing new tech (Paksoy et al., 2025). The study hints at a future were exploring blockchain's scalability and adaptability especially in niches like halal logistics, could open up even more opportunities (Satryawati et al., 2024). Plus, the operational wins from this approach dovetail with calls for sustainability in food production, reinforcing claims by past studies about how technology can promote greener practices (José et al., 2024). In short, the mix of blockchain, traceability, and halal certification seem to plug critical gaps in ensuring transparent, safe food products, offering a well-rounded strategy for various stakeholders (Charleton et al., 2024). This outcome nudges the discussion into new territory, pushing for a deeper look into blockchain's long-term benefits and the challenges it might face during adoption (Riani et al., 2025). As Malaysia finds its footing in the global halal market, these findings underline just how essential innovative tech can be in building resilient food industry practices that stand up to growing consumer and regulatory pressures (Hulwati et al., 2025).

SMEs face significant challenges, including high financial costs, technological constraints, regulatory compliance demands, and complexities in supply chain coordination. Addressing these issues requires targeted support to facilitate the effective adoption of blockchain technology among smaller industry players.

Table 3. Challenges Faced by Malaysian Halal Food SMEs in Blockchain Implementation

Challenge	Description
Technological Adaptability	Difficulty in integrating blockchain with existing systems and processes.
Cost Implications	High initial investment and operational costs are associated with blockchain technology.
Regulatory Compliance	Ensuring adherence to halal standards and regulations within the blockchain framework.
Supply Chain Integration	Coordinating and standardizing blockchain adoption across all supply chain partners.
Data Privacy and Security	Protecting sensitive information while maintaining transparency in the blockchain.

Conclusion

This article shows how blockchain is a game changer for halal certification in Malaysia's food industry. It looks at old gaps in certification and then shows that blockchain's unchangeable tracking can really fix those problems. The study uses a framework that lets you track things in real time and hold uneditable records, something that generally speaks to food safety and compliance issues that stakeholders worry about (Aziz et al., 2024). In many cases, these findings add a bit of fresh insight to supply chain management debates while also giving a practical roadmap for policymakers and industry pros to boost halal practices (Maulana et al., 2025). The blockchain system not only fits with Malaysia's big dreams of leading the global halal market but also backs the country's push for ethical, sustainable business practices (Mousavi et al., 2025).

Interestingly, the research even points out how having an easy-to-use interface matters a fact that comes across in the flowcharts showing how different players engage with the system (Firdaus et al., 2025). Looking forward, future research should, in most cases, fine-tune how blockchain meshes with current logistics, maybe even look into technologies like the Internet of Things (IoT), which was only briefly mentioned in this work (Sunmola et al., 2025). Long-term studies might

eventually reveal the real-world impact of this approach on supply chain efficiency and consumer trust, especially across both Islamic and non-Islamic settings (Paksoy et al., 2025). At the same time, one must acknowledge barriers, such as outdated technological infrastructure and stakeholders' readiness to shift to these new methods (Satryawati et al., 2024). Also, continuous training for everyone in the halal process pops up as an essential need, as shown in the case study recommendations, yes, education can't be overlooked (José et al., 2024). Bringing together different sectors will likely be key, helping align various interests to make the entire system work better (Charleton et al., 2024). Addressing all these points can give us actionable insights that fuel the conversation on blockchain in food supply chains, thus supporting both local and global sustainable initiatives (Riani et al., 2025). All in all, this research lays out a blueprint for transforming halal certification and traceability, offering a SMART supply chain solution that meets consumer expectations while also boosting Malaysia's standing in the global halal market (Hulwati et al., 2025).

The summary highlights major barriers such as the lack of standardization and high costs, while also emphasizing blockchain's potential to strengthen traceability, enhance transparency, and create new opportunities in the halal market. It underlines the importance of balancing challenges with growth prospects.

Table 4. Blockchain Implementation in Halal Food Supply Chains: Challenges and Opportunities

Challenge	Description
Lack of Standardization	Absence of uniform standards for blockchain applications in halal certification processes.
High Implementation Costs	Significant financial investment is required for blockchain infrastructure and maintenance.
Limited Technical Expertise	Shortage of skilled professionals knowledgeable in both blockchain technology and halal certification requirements.
undefined	Improved ability to track and verify halal products throughout the supply chain.
undefined	Greater transparency leads to higher consumer confidence in halal certifications.
undefined	Potential to access new markets by demonstrating robust and trustworthy halal certification processes.

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