



Translating Halal Control Requirements into BPMN Business Rules for QR Code Traceability

Keny Rahmawati¹, Nurul Retno Hapsari¹, Puji Handayani Kasih², Riza Prapascatama Agusdin³, Dian Indri Purnamasari⁴, Rifki Indra Perwira³, Hanif Afifudin³, Muhammad Ruhul Jadid^{3*}, Tanasya Zalza², Muhammad Nugroho Prasetyo¹

¹ Department of Business Administration, UPN "Veteran" Yogyakarta, Indonesia

² Department of Industrial Engineering, UPN "Veteran" Yogyakarta, Indonesia

³ Department of Informatics, UPN "Veteran" Yogyakarta, Indonesia

⁴ Department of Accounting, UPN "Veteran" Yogyakarta, Indonesia

Received : August 22, 2026

Revised : August 24, 2026

Accepted : August 25, 2026

Online : October 7, 2026

Abstract

Halal supply chain integrity in poultry slaughterhouses (Rumah Pemotongan Ayam, RPA) is often compromised by manual, fragmented record-keeping, which enables practices such as informally using another RPA's halal certificate. This study addresses a gap in existing halal traceability research, which has largely focused on technology selection (blockchain, RFID, QR code) without explicitly documenting the underlying business rules that operationalize halal-specific critical control points. Using a Design Science Research approach, this paper reports the problem identification, design and development, and demonstration stages for the BPMN-based business process design of "Sistem Jejak Halal," a QR code-based halal traceability system developed with a Type C RPA partner. Field observation, interviews, and focus group discussions were used to elicit halal control requirements, which were then modeled as four interrelated BPMN processes: RPA registration, breeder data management, JULEHA (Halal Slaughterer) data management, and halal QR code generation, and validated through iterative walkthroughs with the partner. The results show that BPMN can translate halal-specific risks, including certificate and Veterinary Control Number (NKV) validity and JULEHA (Halal Slaughterer) active-status verification, into explicit, auditable business rules embedded directly in the process design, rather than relying solely on the accuracy of consumer-facing information. This design provides an implementation-ready specification for the RPA partner and serves as the requirements basis for the subsequent Rapid Application Development phase of the broader research initiative. Findings are context-bound to a single Type C RPA case study; transferability to other medium-scale poultry slaughterhouses is proposed as future work.

Keywords: *Business Process Model and Notation, Halal Traceability, QR Code, Halal Critical Control Point, Poultry Slaughterhouse*

INTRODUCTION

The global halal industry has expanded rapidly, driven by rising consumer demand for transparent, verifiable food production (Tieman, 2011; Tieman et al., 2012). As halal compliance shifts from religious formality toward systematic supply chain governance, digital technologies increasingly enable end-to-end halal assurance rather than administrative record-keeping (Harsanto et al., 2024). Indonesia, home to the world's largest Muslim population, has reinforced this shift through its national halal certification authority (BPJPH) and its digital platform, SIHALAL, intended to centralize certificate issuance and verification (Kurniawan et al., 2025; Umam et al., 2026).

Within the poultry supply chain, the slaughterhouse (Rumah Pemotongan Ayam, RPA) is a critical halal control point, where process lapses can compromise the halal integrity of the entire downstream product (Myløstvyi et al., 2025). Established frameworks identify control points

Copyright Holder:

© Rahmawati, Hapsari, Kasih, Agusdin, Purnamasari, Perwira, Afifudin, Jadid, Zalza & Prasetyo. (2026)
Corresponding author's email: mruhulj@gmail.com

This Article is Licensed Under:



across pre-slaughter, slaughter, and post-slaughter stages, such as animal welfare, slaughterer competency, and post-mortem inspection, each requiring consistent, verifiable documentation (Shahdan et al., 2017).

In practice, however, medium-scale RPAs (Type C) often lack resources for fully integrated digital documentation. Field observations at the partner RPA revealed that halal-related records, including animal origin, health certificates, slaughterer identity, and packaging data, were still recorded manually across disconnected documents.

This fragmentation creates a structural vulnerability: without a centralized, verifiable record linking each RPA to its own valid halal certificate and Veterinary Control Number (NKV), an unlicensed RPA could informally use another RPA's certificate to access markets requiring halal assurance, undermining the credibility of the halal label.

Digital traceability technologies, particularly blockchain, RFID, and QR code-based systems, have been proposed to close this gap (Sidarto & Hamka, 2021; Susanty et al., 2024). QR code-based traceability is especially attractive for medium-scale actors such as Type C RPAs, as it requires comparatively low technical investment while allowing consumers to verify product provenance by scanning a printed code (Abdul Wahab et al., 2025; Ilahiya et al., 2026).

However, before implementing such a system, organizations must explicitly model its underlying business processes. This includes which actors are involved, what data must be validated, and under what business rules a traceability record and its QR code may be generated. Business Process Model and Notation (BPMN), an internationally standardized notation for business process modeling (International Organization for Standardization, 2013; Object Management Group, 2013), offers a structured way to represent these flows in a form legible to non-technical stakeholders yet precise enough to guide system development (Geambaşu, 2012).

BPMN has been applied to traceability in food supply chains generally (Pizzuti & Mirabelli, 2015) and meat traceability specifically (Meidayanti et al., 2019), but its application to halal-specific control requirements, such as certificate validity, JULEHA status verification, and QR code generation logic, for a Type C poultry slaughterhouse remains largely undocumented.

This paper addresses that gap by presenting the BPMN-based business process design of "Sistem Jejak Halal," a QR code-based halal traceability system developed for a Type C RPA partner. This study models four interrelated business processes: RPA registration, breeder data management, JULEHA data management, and halal QR code generation. It examines how each embedded business rule operationalizes a halal control requirement identified from the partner RPA's operational context.

This process design is part of a broader initiative integrating Design Thinking and Rapid Application Development; this paper isolates the business process modeling component and aims to provide a replicable BPMN-based reference for halal traceability system design in medium-scale poultry slaughterhouses.

LITERATURE REVIEW

Prior studies on halal traceability have largely emphasized technology selection over business process documentation. Susanty et al. (2024) designed a blockchain-based halal traceability system for the chicken meat supply chain; Sidarto & Hamka (2021) examined blockchain adoption in Indonesia's poultry industry; and Abdul Wahab et al. (2025) and Ilahiya et al. (2026) explored QR code-based approaches.

However, these studies emphasize technology architecture and consumer-facing information rather than the business rules, such as certificate validity or slaughterer status, that determine when a traceability record may legitimately be created. This study addresses this gap using Business Process Model and Notation (BPMN) as the modeling instrument.

BPMN is an internationally standardized graphical notation developed by the Object Management Group ([Object Management Group, 2013](#)) and certified as ISO/IEC 19510:2013 ([International Organization for Standardization, 2013](#)), designed to bridge business and technical stakeholders through elements such as events, tasks, gateways, and data objects. Compared with UML Activity Diagrams, BPMN offers greater readability for non-technical users and more explicit representation of cross-actor interaction through pools and lanes ([Geambaşu, 2012](#)), making it well suited to early-stage design involving RPA staff, the halal regulator (BPJPH), and system developers.

BPMN has previously modeled food supply chain traceability generally and beef supply chain traceability specifically ([Meidayanti et al., 2019](#)), but it rarely addresses halal-specific control points, such as certificate validity and slaughterer status, explicitly.

As part of the broader research initiative, the system's UI/UX design draws on Design Thinking, a human-centered method proceeding through empathize, define, ideate, prototype, and test stages ([Brown, 2008](#)), previously applied to interface design evaluated using the System Usability Scale ([Ashari & Muharram, 2022](#)).

Translating these outputs into a functional system follows the Rapid Application Development (RAD) framework ([Martin, 1992](#)), whose success depends on active end-user involvement across iterative cycles. Interface validity is subsequently measured using the System Usability Scale (SUS) ([Adhiwibowo et al., 2025](#)), developed by [Bangor et al. \(2008\)](#) and empirically validated as a quick, reliable usability instrument.

Taken together, prior halal traceability research emphasizes technology selection without explicitly documenting the underlying business process through a standard notation. In contrast, BPMN applications in food traceability have not been extended to halal-specific critical control requirements in resource-limited, medium-scale (Type C) RPAs. This study positions BPMN as the instrument that translates critical halal control requirements into a digital workflow design, then validates it for usability through Design Thinking, RAD, and SUS.

RESEARCH METHOD

This study follows the Design Science Research (DSR) paradigm, concerned with creating and evaluating purposeful IT artifacts for identified organizational problems ([Hevner et al., 2004](#)), applying the Design Science Research Methodology (DSRM) of [Peppers et al. \(2007\)](#): problem identification, solution objectives, design and development, demonstration, evaluation, and communication. This paper reports the problem identification, design and development, and demonstration stages for the BPMN-based business process design component of a broader initiative integrating Design Thinking and Rapid Application Development to build the "Sistem Jejak Halal" system.

Problem identification (DSRM stage 1-2), corresponding to Design Thinking's Empathize stage, was conducted at a single Type C RPA partner through field observation, semi-structured interviews, and focus group discussions (FGD) with the RPA owner/administrator, the certified halal slaughterer (JULEHA), and a halal regulator informant familiar with BPJPH requirements. Informants were selected purposively until thematic saturation was reached regarding operational practices, documentation gaps, and halal-related risks, particularly informal certificate borrowing and the absence of an integrated record linking a certificate to its Veterinary Control Number (NKV).

The design and development stage (DSRM stage 3) translated these findings into an explicit BPMN 2.0 process model ([International Organization for Standardization, 2013](#); [Object Management Group, 2013](#)), modeled using Camunda Modeler. Four processes were designed as separate pools with dedicated swimlanes representing the RPA, the Sistem Jejak Halal platform, and the Super Admin: RPA registration and certificate/NKV verification, breeder data management,

JULEHA data management, and halal QR code generation. Explicit business rules were coded (e.g., BR-REG, BR-PET, BR-JUL, BR-QR) to represent validation logic such as certificate validity, JULEHA active-status verification, and prerequisite master data availability.

The demonstration stage (DSRM stage 4) consisted of iterative walkthrough sessions with the RPA partner, corresponding to Design Thinking's Ideate and Prototype stages, in which process flows were reviewed against operational practice and revised accordingly. The evaluation stage (DSRM stage 5), comprising usability testing following technical implementation, is documented in the project's final research report and will be discussed in a forthcoming journal publication; this paper itself constitutes the communication stage (DSRM stage 6). As a single case study of one Type C RPA, the resulting design is context-bound to that partner's operational conditions; the Conclusion qualitatively discusses transferability to other Type C or Type D RPAs.

FINDINGS AND DISCUSSION

The BPMN-based design produced four interrelated processes: RPA registration, breeder data management, JULEHA data management, and halal QR code generation, all validated with the RPA partner. This section reports the RPA Registration and Halal QR Code Generation processes in full detail, as they most directly operationalize the halal-critical risks identified earlier; the breeder and JULEHA processes, which follow a structurally similar input-validate-store pattern, are summarized at the end.

RPA Registration Process

Figure 1 presents the BPMN diagram of the RPA registration process, modeled across three pools representing the RPA, the Sistem Jejak Halal platform, and the Super Admin. The process begins when an RPA submits its halal certificate and NKV to the Super Admin, who enters the data for automated validation before creating an account. Table 1 lists the governing business rules.

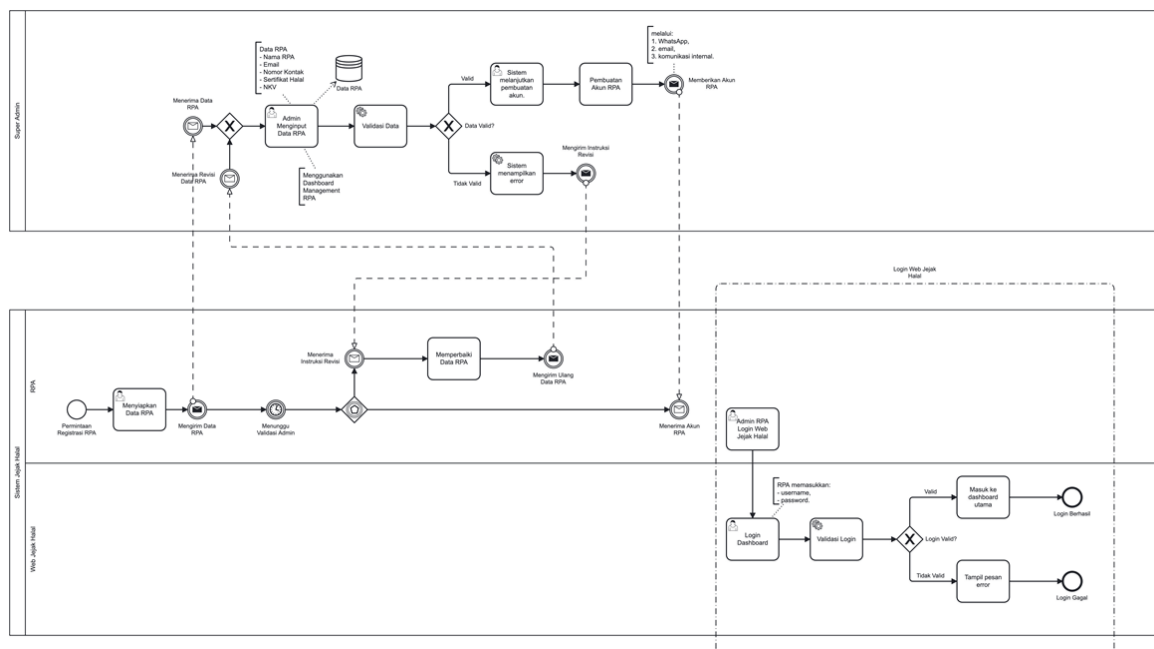


Figure 1. BPMN diagram of the RPA Registration Process.

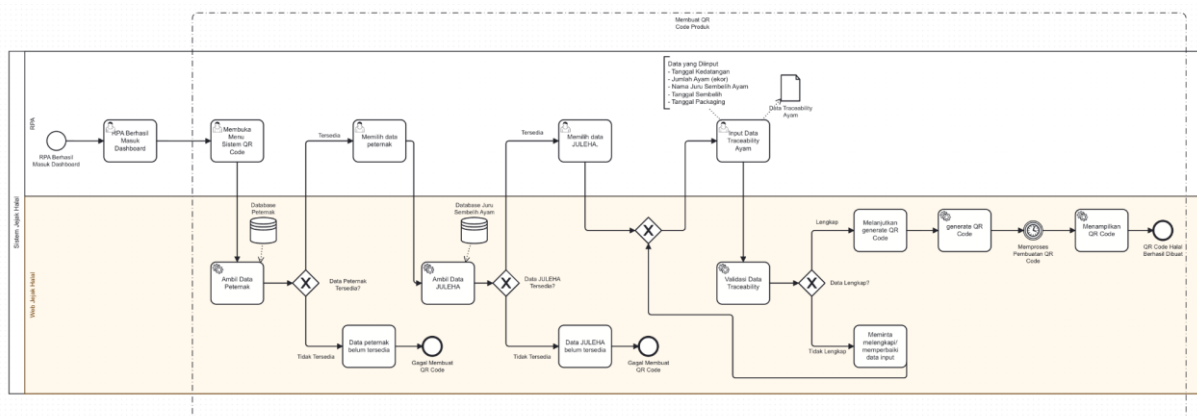
Table 1. Business Rules of the RPA Registration Process

Code	Business Rule
BR-REG-01	All registration data fields must be completed before the data can be processed.
BR-REG-02	The email used must be valid and not already registered in the system.
BR-REG-03	The NKV number must be present and consistent with the RPA's administrative data.
BR-REG-04	The uploaded halal certificate must still be active and verifiable.
BR-REG-05	Incomplete data cannot proceed to the account creation stage.
BR-REG-06	The Super Admin may request revision of, or reject, non-conforming data.
BR-REG-07	The RPA may resubmit data after making corrections.
BR-REG-08	The system creates an RPA account only after all data has been declared valid.
BR-REG-09	The system must store every created account in the system database.
BR-REG-10	An RPA may only access system features after its account is active.

These rules directly operationalize the halal certificate misuse risk identified in the field. Because BR-REG-03 and BR-REG-04 require the NKV and halal certificate to be validated and linked to a specific account before that RPA can access any system feature (BR-REG-10), the design structurally prevents an unlicensed RPA from generating a traceability record under another RPA's certificate. This shows how a halal-specific risk can be embedded directly into a BPMN business rule at the process design stage, prior to technical implementation.

Halal QR Code Generation Process

Figure 2 presents the BPMN diagram of the halal QR code generation process, the core process of Sistem Jejak Halal. This process can only begin once breeder and JULEHA master data are available, enforced through two exclusive gateways that check data availability before allowing data entry. Table 2 lists the governing business rules.

**Figure 2.** BPMN Diagram of the Halal QR Code Generation Process**Table 2.** Business Rules of the Halal QR Code Generation Process

Code	Business Rule
BR-QR-01	The RPA administrator must be logged in before accessing the QR code generation feature.
BR-QR-02	A QR code can only be created if breeder data already exists in the system.
BR-QR-03	A QR code can only be created if JULEHA data already exists in the system.

BR-QR-04	The selected JULEHA must have an active status.
BR-QR-05	All traceability data fields must be completed before the system can create a QR code.
BR-QR-06	The system must validate the data before the generation process proceeds.
BR-QR-07	The system creates a QR code only if all data is valid.
BR-QR-08	Every QR code must be linked to that batch's traceability data.
BR-QR-09	The system must store traceability data in its database.
BR-QR-10	A generated QR code can be scanned to display the product's halal information.

BR-QR-04 operationalizes a halal-specific control point: only a certified halal slaughterer with active status may be recorded as having performed the slaughter for a given batch, which corresponds to the JULEHA competency and certification control point identified in halal poultry slaughter frameworks ([Shahdan et al., 2017](#)). Unlike prior QR code-based halal traceability studies, which primarily describe the resulting consumer-facing information display ([Abdul Wahab et al., 2025](#); [Ilahiya et al., 2026](#)), the BPMN model in this study makes explicit the precondition logic, BR-QR-02 through BR-QR-04, that must be satisfied before a QR code can be generated at all.

This distinction is significant because it shows how the traceability guarantee is enforced structurally at the point of data entry, rather than relying solely on the accuracy of information subsequently displayed to the consumer.

Breeder and JULEHA Data Management Processes

These processes follow a structurally comparable input-validate-store pattern: data entered by the RPA administrator (farm name and health certificate for breeders; slaughterer name and certification for JULEHA) is automatically validated, then stored as reusable master data or returned for correction. Both processes prohibit duplicate records and require that deleting a master data record does not retroactively affect any QR code already generated from it (BR-PET-09, BR-JUL-10), preserving auditability as master data is updated.

Together, these four process models show that BPMN can operationalize halal-specific critical control points, certificate and NKV validity, JULEHA status verification, and prerequisite data availability as explicit, auditable business rules embedded in the system design, addressing the gap identified in the Literature Review. These validated rules serve as the requirements basis for the RAD phase, in which they will be elaborated into Use Case Diagrams, an ERD, and Activity/Sequence Diagrams for implementation.

CONCLUSIONS

This paper presented the BPMN-based business process design of "Sistem Jejak Halal," a QR code-based halal traceability system developed for a Type C RPA partner. Following the problem identification, design and development, and demonstration stages of the Design Science Research Methodology, four business processes- RPA registration, breeder data management, JULEHA data management, and halal QR code generation- were modeled and validated with the RPA partner, with the registration and QR code generation processes elaborated in full detail.

The findings show that BPMN can translate halal-specific critical control requirements into explicit, auditable business rules. The registration process's certificate and NKV validation rules structurally address halal certificate misuse. In contrast, the QR code generation process's prerequisite checks embed JULEHA competency and active-status control directly into the workflow before any traceability record can be issued, addressing the gap identified in the Literature Review regarding limited business process documentation in halal traceability research.

For the RPA partner, this validated design provides an implementation-ready specification.

It serves as the requirements basis for the subsequent RAD phase, in which the same processes will be elaborated into Use Case Diagrams, an ERD, and Activity/Sequence Diagrams.

LIMITATIONS & FURTHER RESEARCH

This study has two main limitations. As a single case study of one Type C RPA, the resulting design is context-bound to that partner's conditions; transferability to other Type C or Type D RPAs should be empirically verified rather than assumed. Second, this paper reports only the design and demonstration stages; the evaluation stage, comprising usability testing following implementation, is documented in the project's final research report and will be discussed in a forthcoming journal publication.

Future research should proceed in two directions. First, the validated design will be technically implemented through the RAD phase, after which the prototype will be revised based on feedback from a second focus group discussion involving external stakeholders, including academics, Halal Inspection Agencies (LPH), halal centers, MUI, BPJPH, LPPOM, and consumers, before being tested for usability using the SUS. Second, apply the same BPMN-based approach to other Type C and Type D RPAs to assess how far the identified business rules generalize across medium-scale poultry slaughterhouse contexts in Indonesia.

REFERENCES

- Abdul Wahab, R., Mohamad, U. H., & Ahmad, M. N. (2025). A dual approach to halal meat traceability through QR codes and blockchain. *International Journal on Advanced Science, Engineering and Information Technology*, 15(2), 654–660. <https://doi.org/10.18517/ijaseit.15.2.20509>
- Adhiwibowo, W., Widayat, W., & Syafei, W. A. (2025). Design of dual blockchain-based with point of authority for halal traceability system application on fresh meat-based supply chain. *Results in Engineering*, 26, 105133. <https://doi.org/10.1016/j.rineng.2025.105133>
- Ashari, I. F., & Muharram, R. R. (2022). Pengembangan antarmuka pengguna Kolepa mobile app menggunakan metode design thinking dan System Usability Scale [Development of the Kolepa mobile app user interface using design thinking and the System Usability Scale]. *JSiI (Jurnal Sistem Informasi)*, 9(2), 168–176. <https://doi.org/10.30656/jsii.v9i2.4993>
- Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the System Usability Scale. *International Journal of Human-Computer Interaction*, 24(6), 574–594. <https://doi.org/10.1080/10447310802205776>
- Brown, T. (2008). Design thinking. *Harvard Business Review*, 86(6), 84–92. <https://hbr.org/2008/06/design-thinking>
- Geambaşu, C. V. (2012). BPMN vs. UML activity diagram for business process modeling. *Accounting and Management Information Systems*, 11(4), 637–651.
- Harsanto, B., Farras, J. I., Firmansyah, E. A., Pradana, M., & Apriliadi, A. (2024). Digital technology 4.0 on halal supply chain: A systematic review. *Logistics*, 8(1), 21. <https://doi.org/10.3390/logistics8010021>
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75–105. <https://doi.org/10.2307/25148625>
- Ilaheya, K. N., Fajrusshodiq, M., Dealova, D., & Rokhman, F. (2026). Designing a simple QR code based digital traceability system for halal product transparency. *Journal of Artificial Intelligence and Engineering Applications*, 5(3), 4646–4653. <https://doi.org/10.59934/jaiea.v5i3.2389>
- International Organization for Standardization. (2013). *Information technology — Object Management Group Business Process Model and Notation* (ISO/IEC Standard No. 19510:2013). <https://www.iso.org/standard/62652.html>
- Kurniawan, M., Suparno, & Vanany, I. (2025). Conceptual framework for halal supply chain

- traceability and food safety in Indonesia based on blockchain technology and Internet of Things to support sustainable development. *Engineering Proceedings*, 84(1), 27. <https://doi.org/10.3390/engproc2025084027>
- Martin, J. (1992). *Rapid application development*. Macmillan.
- Meidayanti, K., Arkeman, Y., & Sugiarto. (2019). Analysis and design of beef supply chain traceability system based on blockchain technology. *IOP Conference Series: Earth and Environmental Science*, 335(1), 012012. <https://doi.org/10.1088/1755-1315/335/1/012012>
- Mylostyvyi, R., Lykhach, V., Gutyj, B., Marenkov, O., & Mylostyva, D. (2025). Halal poultry slaughter technology: A critical review of control points. *Animal Science and Food Technology*, 16(2), 55–76. <https://doi.org/10.31548/animal.2.2025.55>
- Object Management Group. (2013). *Business Process Model and Notation (BPMN)* (Version 2.0.2). <https://www.omg.org/spec/BPMN/2.0.2/>
- Peppers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, 24(3), 45–77. <https://doi.org/10.2753/MIS0742-1222240302>
- Pizzuti, T., & Mirabelli, G. (2015). The Global Track&Trace System for food: General framework and functioning principles. *Journal of Food Engineering*, 159, 16–35. <https://doi.org/10.1016/j.jfoodeng.2015.03.001>
- Shahdan, I. A., Regenstein, J. M., & Rahman, M. T. (2017). Critical limits for the control points for halal poultry slaughter. *Poultry Science*, 96(6), 1970–1981. <https://doi.org/10.3382/ps/pew427>
- Sidarto, L. P., & Hamka, A. (2021). Improving halal traceability process in the poultry industry utilizing blockchain technology: Use case in Indonesia. *Frontiers in Blockchain*, 4, Article 612898. <https://doi.org/10.3389/fbloc.2021.612898>
- Susanty, A., Puspitasari, N. B., Rosyada, Z. F., Pratama, M. A., & Kurniawan, E. (2024). Design of blockchain-based halal traceability system applications for halal chicken meat-based food supply chain. *International Journal of Information Technology*, 16(3), 1449–1473. <https://doi.org/10.1007/s41870-023-01650-8>
- Tieman, M. (2011). The application of halal in supply chain management: In-depth interviews. *Journal of Islamic Marketing*, 2(2), 186–195. <https://doi.org/10.1108/17590831111139893>
- Tieman, M., Van der Vorst, J. G. A. J., & Che Ghazali, M. (2012). Principles in halal supply chain management. *Journal of Islamic Marketing*, 3(3), 217–243. <https://doi.org/10.1108/17590831211259727>
- Umam, M. K., Herlina, E., Riyan, A. B., & Sigit, W. (2026). *Digital governance and fraud risk management in SIHALAL-based halal certification in Indonesia: Towards a Sharia-compliant information system framework and artificial intelligence (AI)-assisted verification*.