

SME Halal Raw Material Supply Chain Management System for White Space Resources

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Abstract

This study develops a Halal Raw Material Supply Chain Management System to enhance traceability, transparency, and operational efficiency for SMEs in Batu Pahat's halal poultry sector. Implementing QR code technology for item tracking alongside Extreme Programming (XP) methodology, the system integrates inventory control, halal certification verification, and logistics management. Findings demonstrate improved stakeholder coordination and supply chain visibility, strengthening consumer trust in halal compliance. The digital solution addresses critical SME challenges in certification maintenance and market responsiveness. Future research will explore a reverse marketplace model where SMEs publicly post quotations for broiler farmers, alongside blockchain integration to enhance security and transactional efficiency in halal supply chains.

1. Introductions

A robust halal supply chain is vital for SMEs to comply with Islamic dietary laws, improve product quality, and foster consumer trust. However, SMEs like White Space Resources face challenges such as high certification costs, complex processes, and limited technology, hindering effective supply chain management [1][2][3].

The objective is to develop a web-based Halal Supply Chain Management System integrating certified suppliers and central kitchens to enhance traceability and compliance [4]. This system will address inefficiencies and support halal certification transparency [5]. Its scope includes the halal poultry supply chain in Batu Pahat, aiming to improve operational efficiency, consumer confidence, and SME competitiveness in halal markets [6].

2. Literature Review

This review explores SMEs role in halal supply chains, emphasizing digital technologies, sustainability, and lessons from White Space Resources to enhance transparency, compliance, and community-focused halal supply chain systems.

2.1 White Space Resources

White Space Resources is a social enterprise based at Batu Pahat Johor, who help single mothers and low-income individuals through the production of traditional Johorean cuisine. White Space Resources concentrates on creating job opportunities and training entrepreneurship to uplift the community and create sustainable livelihoods. Under the esteemed banner of Jands & Co, the organization is in the business of empowering community development, improving food security and driving sustainability. White Space Resources does this by

building on economic growth and resilience in the community via initiatives such as the Johor Entrepreneurship Lab, that provides cooking, packaging, and marketing skill sets to the participants.



Fig. 1 Naqibah binti Azman, Founder and Manager of White Space Resources

Based on Fig 1, the company are founded and managed by Naqibah Binti Azman. The company, White Space Resources is dedicated to avoiding halal compromised in its suppliers' supply chain to assure consumer trust and meet stipulated regulatory standards. But, because the company relies heavily on manual data management, it finds it difficult to maintain transparency. The problem of this method is that it complicates the verification of halal status in the ingredients and tracking the raw materials through different stages of the supply chain. And this makes it difficult for the company to meet Islamic dietary laws on a regular basis, and to build the trust it needs with consumers.

2.2 Supply Chain Management System

Industry 4.0 technologies like blockchain, IoT, and AI revolutionize SCM by enhancing traceability, real-time monitoring, and predictive analytics [7][8][9]. These innovations drive efficiency, transparency, and responsiveness, making web-based solutions pivotal for modern supply chains. Web technology integrates partners, enabling seamless collaboration across geographies [10][11], fostering transparency, trust, and resilience against disruptions. By streamlining operations and automating tasks, it boosts efficiency and strategic resource allocation which critical in today's fast-paced environment.

2.2.1 Halal Supply Chain Importance

For SMEs targeting halal markets, maintaining halal supply chain integrity is vital for consumer trust and market access [2]. Compliance enhances brand reputation and loyalty [12], while meeting growing demand for ethically compliant products.

Furthermore, digital integration is essential for maintaining halal integrity, with technologies like blockchain enhancing traceability and transparency [3]. This not only ensures compliance but also improves operational efficiency, enabling SMEs to better meet market demands.

Research highlights the critical role of halal supply chains in sustainability, with [6] demonstrating their dual compliance and operational benefits for SMEs. [13] further shows how effective halal SCM enhances SME competitiveness in global markets.

2.2.2 SMEs in Halal Supply Chains

SMEs are considered more and more important as a vital role in halal supply chains to achieve economic growth and sustainability. The halal industry is emerging to provide growth because of the rapid rising customer demand for halal products [2]. Nevertheless, SMEs struggle with scarce resources and expertise exploiting the halal supply chain management which restricts them from the competitive standpoint in the market. A literature review shows that digital technology, R&D, financing and regulatory support are important for performance of halal value chain among MSMEs [3].

In addition, the integration of digital solutions, like blockchain and QR technology has potential to significantly enhance transparency as well as traceability of products flowing through halal supply chains. We discuss for example the FoodSQRBlock project, which shows how digitising food production and supply chains can improve halal integrity assurance [5]. Such adoption of such technologies by SMEs is not only about halal certification but it also helps in building consumer trust and loyalty, hence leading to better competition against the market [14].

2.3 Web Technology

Today, Web technology enhances supply chain efficiency, transparency, and responsiveness. QR codes, two-dimensional barcodes, enable real-time data tracking and traceability across the supply chain. By storing extensive information, they improve product monitoring from production to consumption. Integrating QR codes boosts operational visibility, enhances control, and increases performance, leading to higher customer satisfaction [5]. This technology is vital for modern, data-driven supply chain management.

QR codes enhance supply chain management through real-time product tracking, enabling stakeholders to monitor goods efficiently, critical in food and pharmaceutical industries. They improve traceability with digital records, boosting consumer trust and regulatory compliance [13]. Additionally, QR codes streamline inventory management, reducing errors and increasing operational efficiency.

Web technologies like blockchain, big data analytics, and IoT enhance supply chains. Blockchain ensures secure records, big data optimizes decisions, and IoT enables real-time monitoring. Combined with QR codes, they create a transparent, efficient ecosystem—blockchain secures transactions, while big data identifies trends [7][8].

2.3.1 QR Code Technology

QR code technology implementation is a practical solution that SMEs have been facing when it comes to challenges in halal supply chain. QR codes enable traceability and record keeping by tracking states of halal across the supply chain. Unique QR code is given to each product with the halal certification details, product date of productions and supplier's details [5].

The QR code is scanned by different stakeholders like suppliers, retailers, and consumers and provides real time information when scanned on a product's journeying through the supply chain. This transparency ensures that products meet halal standards and that there was compliance with halal integrity that builds trust with consumers [2].

This makes using QR Codes a cheaper and easier solution for SMEs, as it does not require a large investment in complex technology, but instead only utilizes capabilities on the existing smartphone [6]. For the project objectives of this technology, operational efficiency, product traceability, and halal compliance are improved. SMEs will be able to overcome operational barriers and achieve performance and market success by using a QR code-based tracking system [6].

2.3.2 Cloud Technology

Cloud technology is transforming supply chain management by enhancing operational efficiency and responsiveness. Cloud-based solutions enable real-time data access and stakeholder collaboration, critical in fast-paced business environments. This technology streamlines food production and supply chain digitization, ensuring seamless data flow from production to consumption [5]. Such integration improves transparency, traceability, and consumer trust while optimizing operational workflows. Cloud-based supply chain management facilitates real-time data sharing among stakeholders, enhancing coordination and reducing lead times. As noted by [15], web-enabled integration improves business performance. By leveraging cloud platforms, organizations collaborate more effectively with suppliers, manufacturers, and retailers, optimizing overall supply chain efficiency.

In addition, Cloud technology enables advanced analytics, allowing organizations to process vast supply chain data, identify trends, and optimize operations. As noted by [10], cloud-based analytics enhance forecasting, inventory management, and decision-making for greater efficiency. Beyond these benefits, cloud technology enables Industry 4.0 adoption, integrating IoT and blockchain to create circular, sustainable supply chains. As [11] highlights, this synergy enhances resilience to meet market demands and environmental challenges while optimizing operations for long-term growth.

2.4 Tyson Foods

Tyson Foods, <https://www.tysonfoods.com/news/news-releases/2018/8/tyson-foods-selects-foodlogiq-connect-supply-chain> one of the world leaders in production of poultry, beef and pork, uses FoodLogiQ Connect to reach the next level of supply chain transparency, compliance and efficiency. Being a vertically integrated corporation, Tyson can control every supply chain link, starting with breeding and ending with distribution, which guarantees the constancy of quality and operational control.

FoodLogiQ centralizes food safety documentation, enables real-time inventory tracking, and optimizes logistics for data-driven decisions. It enhances traceability by collecting production data, ensuring compliance, and facilitating rapid quality issue resolution. Tyson leverages its demand forecasting and logistics tools to improve delivery reliability while maintaining stringent safety standards, demonstrating operational excellence and market adaptability. The platform's analytics further reduce waste and reinforce Tyson's industry leadership.

2.5 Hormel Foods

Hormel Foods, <https://www.hormelfoods.com/inspired/story/inside-the-hormel-foods-supply-chain-revolution/> a multinational company that manufactures meat and shelf-stable products, has gone through digital transformation, implementing the O9 platform to foster supply chain revolution. O9 uses AI and machine learning to connect legacy data systems, providing real-time analytics, demand planning, and inventory optimization. Such

transformation enables Hormel to move toward proactive operations instead of reactive ones and reduce forecasting errors and increase efficiency.

The platform integrates the market trends, production, and logistics data, enhance decision-making and resource allocation. Hormel can respond nimbly to consumer demand through optimization of production schedules and inventory management, without compromising on strict standards of food safety and quality. O9 implementation demonstrates that Hormel values innovation, operational excellence, and competitiveness in the food industry. This strategic action helps not only simplify the processes within the supply chains but also empowers Hormel to respond to the fluctuating market conditions with the accuracy of the data.

2.6 Kersia

Kersia, <https://www.kersia-group.com/> a worldwide leader in food safety solutions, uses Oracle Fusion Cloud SCM to optimize biosecurity and hygiene processes throughout the poultry supply chain. The purchased system is an integrated platform that comprises ERP and manufacturing modules and allows real-time tracking of inventory, supplier management and optimisation of logistics processes.

Oracle SCM centralizes financial and operational data to give Kersia end-to-end visibility of its supply chain and respond more effectively to food safety risks. Advanced analytics help to make data-driven decisions, guaranteeing the adherence to high standards of quality and increasing operational efficiency. This digitalization empowers Kersia in providing novel contamination prevention solutions, which keeps it competitive in the food safety industry. The installation is an indication of Kersia striving to excellence in technology and its mission to protect the world food supply chain using the latest digital technology.

2.7 HalalLink

HalalLink is a halal supply chain management system designed to improve compliance, traceability, and transparency for SMEs, logistics providers, broilers, and slaughterhouses. Key features include User Management for role-based access control and Inventory Tracking for broilers to list poultry by weight and assign slaughterhouses. SMEs can browse products and place orders via an integrated marketplace, ensuring halal integrity throughout the supply chain.

HalalLink enhances halal supply chains through real-time order tracking, automated logistics coordination, and QR-based verification at each transfer point. Its reporting module generates compliance audits without QR-certification links, while integrated payment/document management centralizes contracts and invoices. This end-to-end visibility strengthens operational efficiency, transparency, and trust among all stakeholders in the poultry supply chain.

2.8 Comparison with the Existing Systems

The following table 1 is a brief comparison of four supply chain management systems including Tyson Foods, Hormel Foods, Kersia, and the HalalLink which is proposed in this paper. This comparison shows the general ability of each system in performing various critical operations.

Table 1 System Comparison

Features/System	Tyson Foods	Hormel Foods	Kersia	HalalLink
Log In and User Management	✓	✓	✓	✓
Process Order	✓	X	✓	✓
Inventory Tracking	✓	✓	✓	✓
Real-Time Tracking	✓	✓	X	✓
Halal Certification Compliance	X	X	X	✓
Payment Management	✓	✓	✓	✓
Document Management	✓	✓	✓	✓
Demand Forecasting	✓	✓	✓	X
Supplier Management	✓	✓	✓	✓
Traceability via QR Code	X	X	X	✓

3. Methodology

The Extreme Programming (XP) methodology is particularly advantageous for solo developers, enhancing communication, simplicity, and feedback, which allows for rapid adaptation and high code quality through practices like TDD and continuous integration [16], [17].

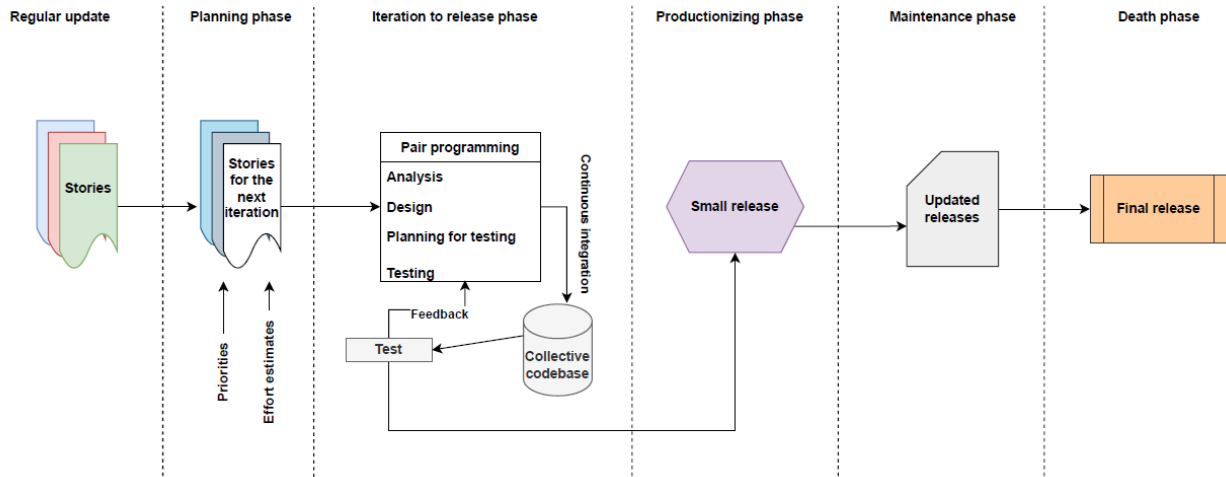


Fig. 2 Extreme Programming (XP) Phases [20]

XP is well-suited for solo development, guiding continuous improvement through phases like Exploration, Planning, and the iteration cycle shown in Fig 2. Its emphasis on simplicity and regular code reviews helps maintain high quality and adaptability throughout the process [17],[18]. Conducting unit and acceptance tests early enhances reliability without requiring extensive collaboration [19]. Frequent releases and feedback loops enable solo developers to quickly adapt to changing requirements, supporting disciplined, agile progress [20]. This approach fosters high-quality software by enabling early defect detection and iterative refinement which key features of XPs structured methodology.

Table 2 Software development activities and their task

Phase	Task	Output
Exploration	<ul style="list-style-type: none"> Collaborate with halal authorities and SME operators. Create simple system structure and sample code. Validate architecture with technical experts. Define user story criteria, goals, and priorities. Validate architecture with technical experts 	<ul style="list-style-type: none"> Collected regulatory and operational data. Basic architecture supporting gradual change. Prioritized clear and detailed user stories.
Planning	<ul style="list-style-type: none"> Develop system architecture focused on traceability and inventory tracking Create UML diagrams to represent data structure and system interactions Analyze user stories and estimate tasks 	<ul style="list-style-type: none"> Project proposal List of prioritized functionalities Gantt chart UML diagrams and Flowchart Design System architecture diagram, Database schema and data dictionaries. UX/UI design mockups.

Table 2: (Cont.)

Phase	Task	Output
Iteration	<ul style="list-style-type: none"> Develop and implement system modules for inventory tracking, reporting, and document management Integrate QR code functionality for traceability Implement frontend and backend components Write and optimize database queries Implement user authentication and role-based access control 	<ul style="list-style-type: none"> Functional codebase Developed system modules (inventory tracking, reporting, document management) QR code-based traceability system User authentication system Working database integration
Production	<ul style="list-style-type: none"> Perform unit and integration tests to verify individual components and their interactions. Conduct user acceptance testing for usability feedback Refactor code based on test outcomes. 	<ul style="list-style-type: none"> Testing results User feedback on system usability Improved system performance
Maintenance	<ul style="list-style-type: none"> Deploy the functional web system to end-users Continuously improve and update software 	<ul style="list-style-type: none"> Web system accessible to users
Death	<ul style="list-style-type: none"> Collect stakeholder feedback to refine system and align with industry standards Implement improvements and add new features based on feedback 	<ul style="list-style-type: none"> Refinement plan Updated system with enhancements

4. Analysis and Design

The system ensures halal compliance with role-based access, inventory tracking, reporting, and workflow integration, backed by a robust database and intuitive UI for supply chain efficiency.

4.1 Software Requirement Specification

The functional requirements are outlined in Table 3 and centre on particular functions, features, and procedures that the system must have in order to satisfy user demands.

Table 3 *Functional Requirements*

Num	Module	Description
1	User Management	<ol style="list-style-type: none"> Admins (all roles): Manage user accounts (register, view delete). All users: manage their own profile. All users: Authenticate accounts during login and reset passwords via email verification. Admin Logistic: Assign delivery tasks to logistic employees, including task details and deadlines.
2	Inventory Tracking	<ol style="list-style-type: none"> Admin White Space Resources, Employee White Space Resources: create poultry as categories for items. Admin Broiler, Employee Broiler: Create items into marketplace. Admin Broiler, Employee Broiler: Display QR codes for tracking items at broiler stages.

Table 3: (Cont.)

Num	Module	Description
		4. Admin White Space Resources, Employee White Space Resources: create poultry as categories for items.
		5. Admin Broiler, Employee Broiler: Create items into marketplace.
		6. Admin Broiler, Employee Broiler: Display QR codes for tracking items at broiler stages.
		7. Admin Logistic, Employee Logistic: Scan QR codes for tracking items during delivery.
		8. Admin Slaughterhouse, Employee Slaughterhouse: Display QR codes for tracking items.
		9. Admin SME, Employee SME: Display QR codes for tracking items at final stages.
		10. Admin Slaughterhouse, Employee Slaughterhouse: Update task statuses start or complete.
3	Reporting	1. Admin White Space Resources: Generate halal compliance reports for audits and reviews. 2. Admin SME, Employee SME: download halal compliance reports for audits and reviews. 3. Admin White Space Resources: View performance reports across all linked stakeholders.
4	Marketplace	1. Admin Broiler, Employee Broiler: Add halal-certified items (e.g., chicken) to the marketplace for SME kitchens. 2. Admin SME, Employee SME: Place orders for items listed in the marketplace. 3. Admin SME, Employee SME: Make payments to broilers using payment gateway. 4. Admin Broiler: notify via email for items sold to SME kitchens.
5	Document Management	1. Admin Broiler, Employee Broiler: Upload halal certification documents for compliance. 2. Admin Slaughterhouse, Employee Slaughterhouse: Upload processing reports and quality assurance documents. 3. Admin SME, Employee SME: Download invoices from purchase order records.

Table 4 shows the non-functional requirements that describe the system's performance criteria and operational characteristics. These requirements provide a complete blueprint for system development.

Table 4 *Non-functional Requirements*

Num	Requirements	Description
1	Performance	The system response time are less than 2 seconds for key operations.
2	Security	The system must ensure secure access through authentication and authorization mechanisms, encrypted data transmission (HTTPS), and protection against SQL injection.
3	Usability	The system must have an intuitive and user-friendly interface, with clear navigation and accessibility features for all stakeholders.
4	Data Integrity	All data stored in the system must be consistent, accurate, and protected against corruption through validation rules and regular backups.
5	Auditability	The system should maintain a comprehensive audit trail for critical actions, including user logins, task assignments, and payment transactions, for traceability.

4.2 System Analysis

The Appendix A, B and C provide critical insights into the systems design. Appendix A, illustrates the functional requirements, highlighting the roles and tasks performed by different actors. Appendix B, presents the database structure, showing entities and their relationships to support system functions. Appendix C, outlines the proposed workflow, detailing the processes for effective module integration.

4.3 System Architecture

The provided diagram in Fig 3, represents the system architecture for the halal supply chain management system, which is designed to ensure seamless traceability and halal compliance from Broilers to SMEs.

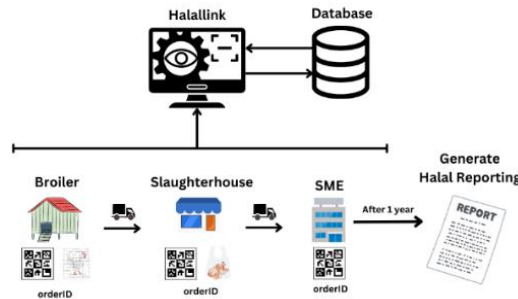


Fig. 3 System Architecture Halallink

The system architecture in Fig 3 facilitates broiler procurement through a QR-enabled workflow: SMEs place orders by weight (e.g., 100kg), triggering logistics collection with QR-scanned verification (orderID/checkID). At slaughterhouses, QR codes track arrival, queuing, and processing. Post-packaging, QR-tagged shipments undergo inspection before delivery, where final scans complete the chain. SMEs generate annual halal certification reports via White Space Resources, supported by the relational schema in Table 5.

Table 5 Relational Schema

Num	Table Name	Attributes
1	Users	userID, companyID, fullname, email, password, role, status, tel_number, image, remember_token, email_verified_at, created_at, updated_at
2	Companies	companyID, formID, company_name, company_image, company_type, created_at, updated_at
3	Locations	locationID, companyID, company_address, location_type, created_at, updated_at
4	Certs	certID, companyID, cert_type, cert_file, created_at, updated_at
5	Vehicles	vehicleID, companyID, vehicle_plate, vehicle_load_weight, created_at, updated_at
6	Orders	orderID, userID, locationID, paymentID, order_timestamp, deliver_timestamp, order_status, created_at, updated_at
7	Items	itemID, poultryID, userID, locationID, slaughterhouse_locationID, measurement_type, item_image, measurement_value, price, stock, created_at, updated_at
8	Poulties	poultryID, poultry_name, poultry_image, created_at, updated_at
9	Checkpoints	checkID, orderID, locationID, companyID, arrange_number, item_record, created_at, updated_at
10	Verifies	verifyID, deliveryID, checkID, verify_status, verify_comment, created_at, updated_at

Table 5: (Cont.)

Num	Table Name	Attributes
11	Carts	cartID, itemID, orderID, quantity, price_at_purchase, item_cart_delivered, created_at, updated_at
12	Payments	paymentID, payment_amount, payment_status, payment_reference, bill_code, transaction_id, payment_timestamp, created_at, updated_at
13	Deliveries	deliveryID, userID, vehicleID, scheduled_date, start_timestamp, end_timestamp, created_at, updated_at
14	Trips	tripID, deliveryID, start_checkID, end_checkID, orderID, created_at, updated_at
15	Delivery_Location_Token	id, deliveryID, locationID, token, expired_at, created_at, updated_at
16	Tasks	taskID, checkID, userID, task_type, task_status, start_timestamp, finish_timestamp, created_at, updated_at
17	Reports	reportID, companyID, reportValidityID, created_at, updated_at
18	Report_Validities	reportValidityID, userID, start_timestamp, end_timestamp, approval, created_at, updated_at

Furthermore, the user interface is designed to simplify the workflow, and increase efficiency by considering the needs and preferences of the users. The design ensures ease of use for all, including older users. Below are the main user interface screens for White Space Resource, Broiler, Slaughterhouse, Logistic, and SME users.

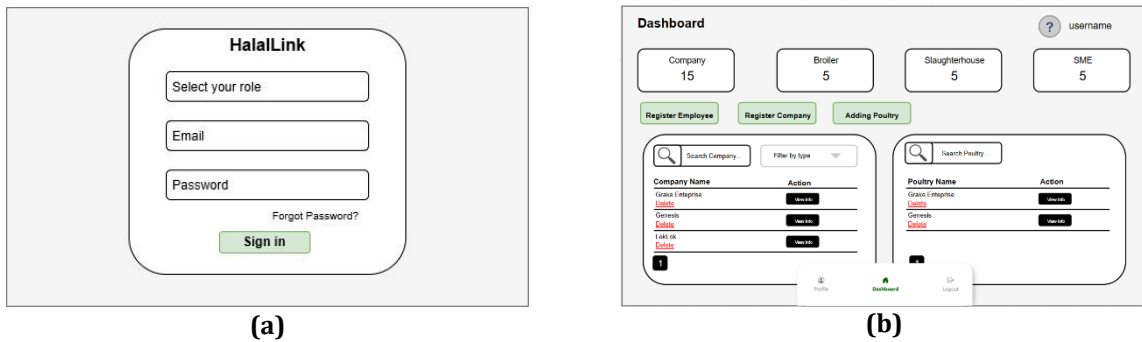


Fig. 4 (a) Login Page (b) White Space Resource Dashboard Page

This is the initial mockup wireframe created based on what the company does. The login and index page shown in Fig 4(a) can be reached by every user of the system. The White Space Resource Admin dashboard in Fig 4(b) is used to add, edit and remove employees, companies and poultry entries.

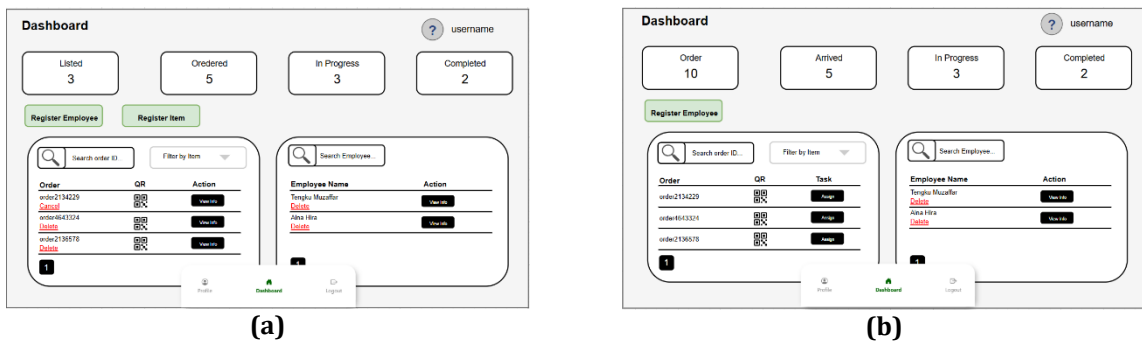


Fig. 5 (a) Broiler Dashboard Page (b) Slaughterhouse Dashboard Page

The wireframe sketches out dashboards that are used by Broiler and Slaughterhouse Admins. Broiler Admins can track and handle orders using the tools in Fig 5(a). As shown in Fig 5(b), Slaughterhouse Admins use this system to add employees and change the status of their processing tasks.

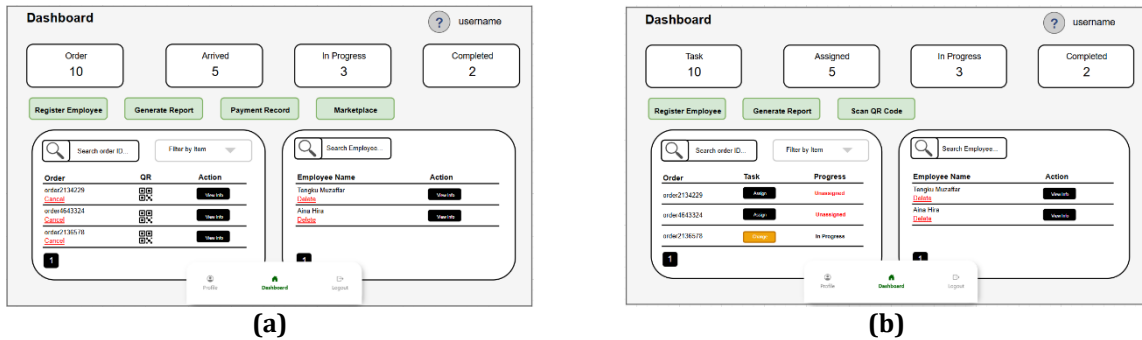


Fig. 6 (a) SME Dashboard Page (b) Logistic Dashboard Page

The following dashboards are featured in Fig 6, one for SME and one for Logistic Admin. Fig 6(a) points out that SME Admin includes functions for orders, payment and the marketplace. Fig 6(b) offers help to Logistic Admins via task tracking, various assigning tasks and tools for employee management.

5. Implementation

The development, completed on the authentication module. This stage includes the design of the user interface, which is functional and allows for initial interactions. It comes with secure options for logging in and signing up, as well as password recovery, to maintain control over who has admin access.

5.1 User Management

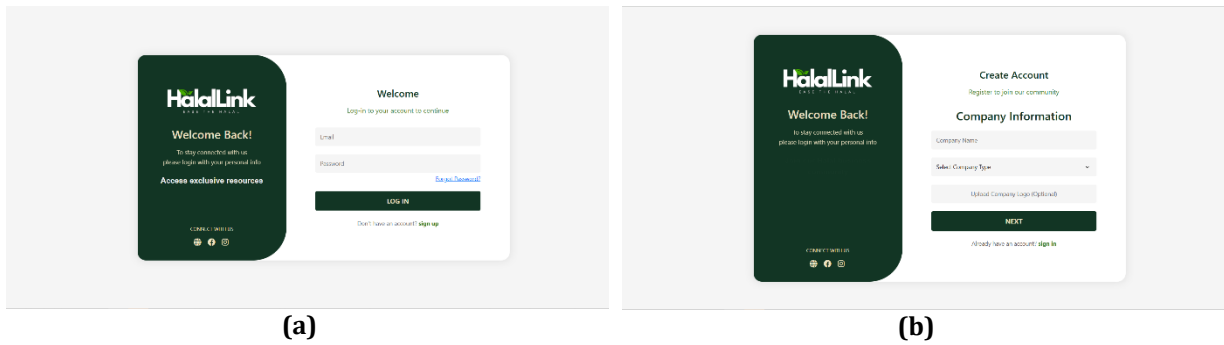


Fig. 7 (a) Login Page (b) Sign Up Page

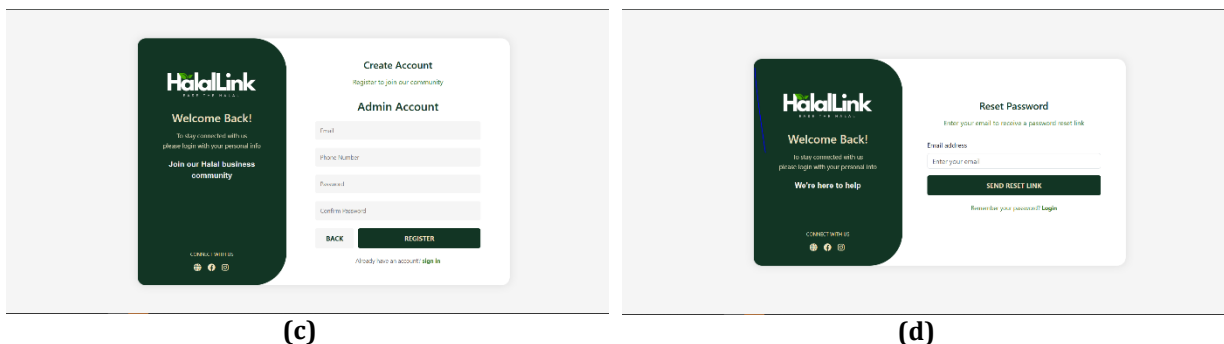
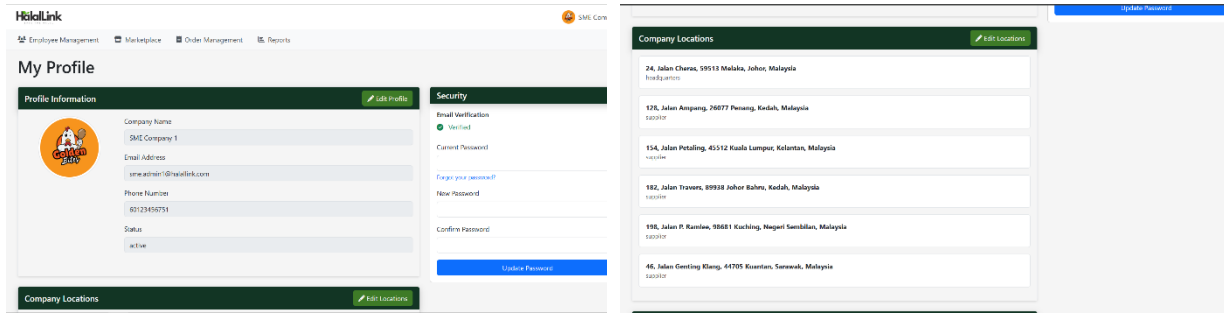
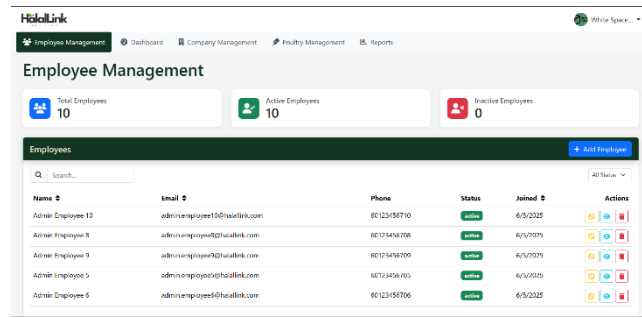


Fig. 7 (c) Cont. of Sign-Up Page (d) Forgot Password Page

This module, illustrated in Fig 7(a-d), ensures secure admin access through a streamlined interface. It includes user authentication, registration, and password recovery functionalities. The design prioritizes usability while enforcing robust security protocols. For Fig 8 illustrate profile page for company type broiler, logistics, SME, and slaughterhouse.

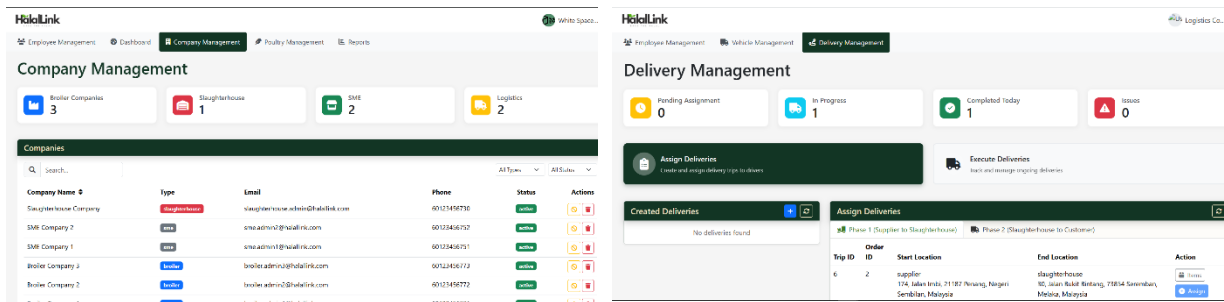


(a) (b)
Fig. 8 (a) Profile Info and Security Section (b) Company Location Section



(c)
Fig. 8 (c) Employee Management Page

The profile management system is structured into three to four sections based on company type and user role. As shown in Fig 8(a), the "Profile Info and Security Section" contains user details and security settings, while Fig 8(b) displays the "Company Location Section" with address data. Employees view a simplified version (Fig 8a only), whereas admin roles access Fig 8(c) for employee management, with restricted authorization for non-admin users.



(d) (e)
Fig. 8 (d) Company Management Page (e) Delivery Management Page: Assignment

Fig 8(d) shows White Space Resources' company management interface, where new registrations from Fig 7(c) are reviewed and activated. Fig 8(e) streamlines logistics workflows: staff assign delivery dates, vehicles, and drivers to ensure coordination. Together, these interfaces enhance operational efficiency in onboarding and delivery management.

5.2 Inventory Tracking

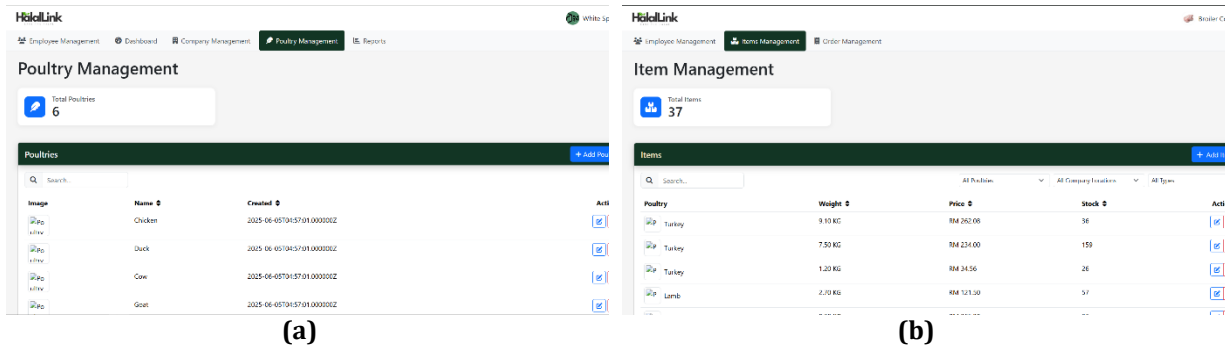


Fig. 9 (a) Poultry Management Page (b) Item Management Page

For page on Fig 9(a) are only accessed by White Space Resources which used for managing poultry which categories that will be used for Fig 9(b) to add items into marketplace by broiler.

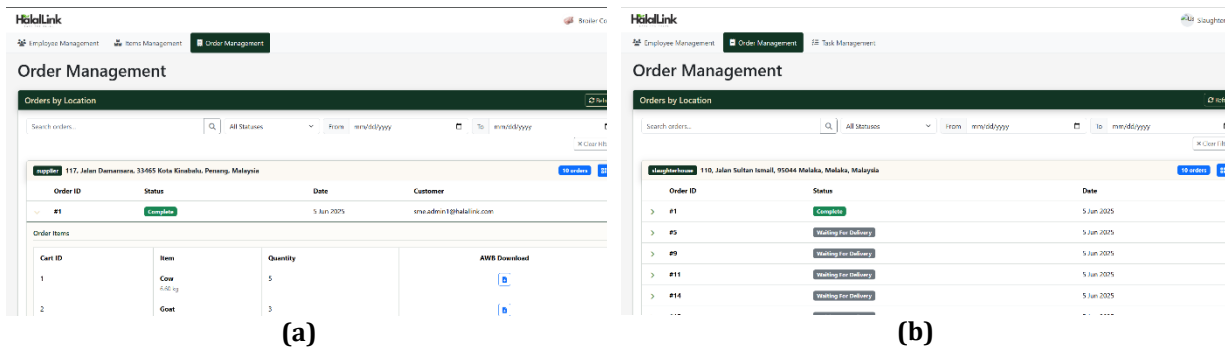


Fig. 10 (a) Order Management Page: Broiler (b) Order Management Page: Slaughterhouse

Figs 10(a)-(b) show order management interfaces for Broiler and Slaughterhouse systems. Broiler staff scan QR codes to track supplies and print AWB documents, while slaughterhouse teams monitor operations via QR codes, ensuring traceability and efficiency in both production stages.

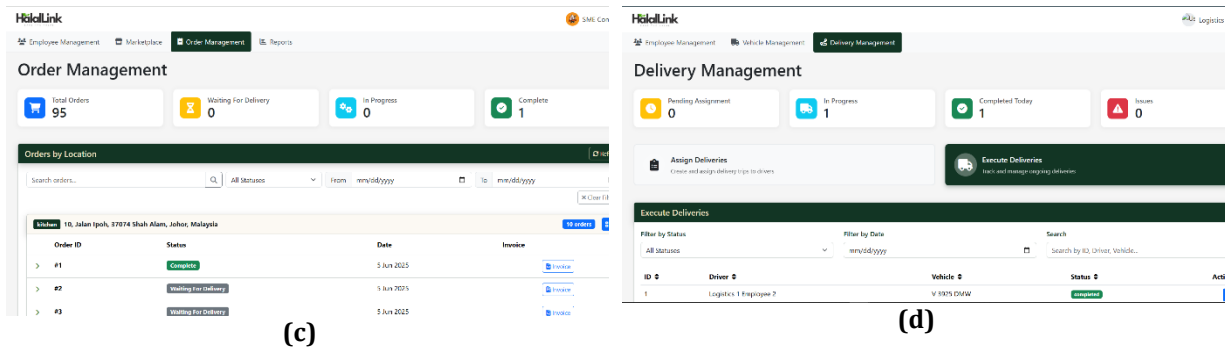
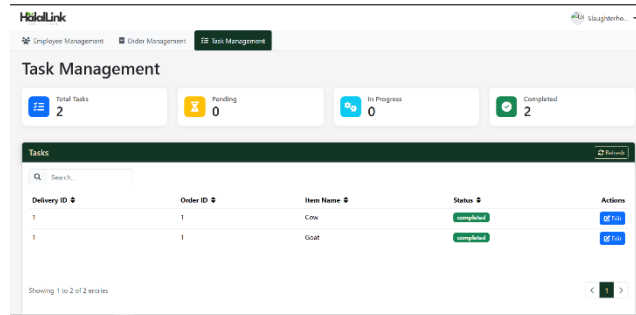


Fig 10 (c) Order Management Page: SME (d) Delivery Management Page: Execution

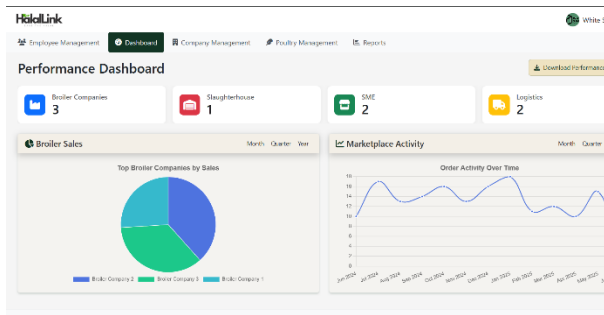


(e)

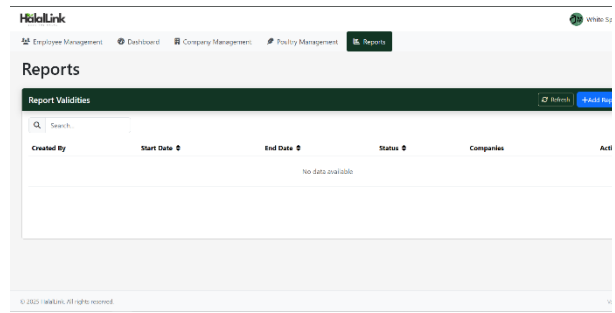
Fig 10 (e) Task Management Page

Fig 10(c)-(e) show SME, logistics, and slaughterhouse interfaces using QR codes for traceability, delivery tracking, and real-time task updates, streamlining production and operations.

5.3 Reporting



(a)

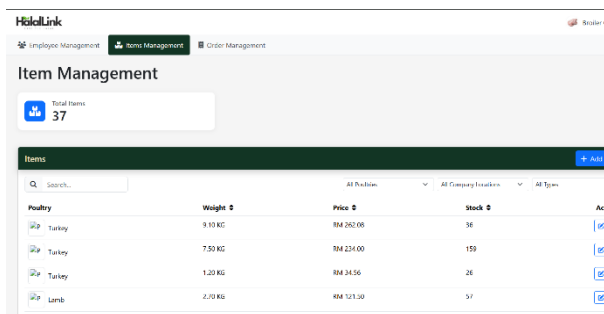


(b)

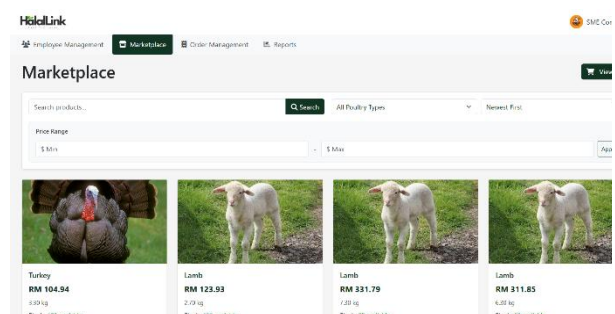
Fig. 11 (a) Poultry Management Page (b) Reports Issued Page: White Space Resources

Both Fig 11(a)-(b) show interfaces for White Space Resources personnel. Fig 11(a) lets administrators monitor metrics, manage orders, and download operational reports. Fig 11(b) provides tools for creating, checking, and authorizing halal certification reports, with SMEs accessing signed documents. Both interfaces streamline compliance oversight and secure document distribution.

5.4 Marketplace



(a)



(b)

Fig. 12 (a) Item Management Page (b) Marketplace Page: Broiler

The marketplace functionality is illustrated across Fig 12(a)-(d), demonstrating the complete transaction workflow between broiler producers and SME kitchens. Fig 12(a) shows the interface where Broiler administrators and employees list halal-certified products (such as poultry) in the marketplace for SME procurement. Subsequently, Fig 12(b) presents the SME ordering interface where kitchen administrators and staff can select and request these certified products.

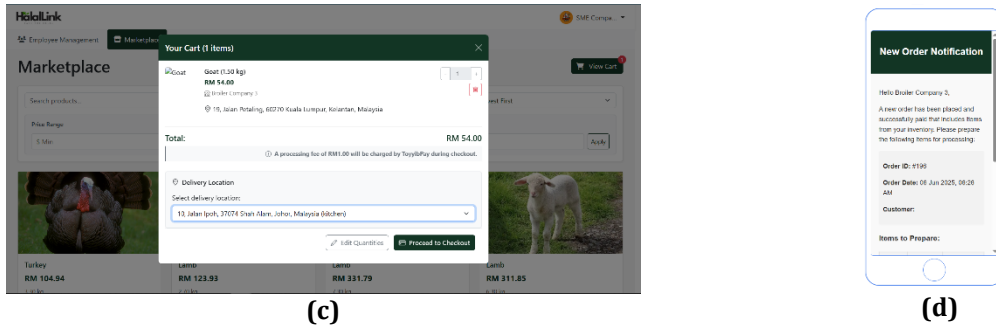


Fig. 12 (c) Marketplace Page: Cart (d) ToyyibPay Payment Gateway Page

The transaction process continues in Fig 12(c), which displays the integrated payment gateway that enables SME users to complete financial transactions directly with broiler suppliers. Finally, Fig 12(d) reveals the automated notification system that alerts Broiler administrators via email upon successful sales to SME kitchens.

5.5 Document Management

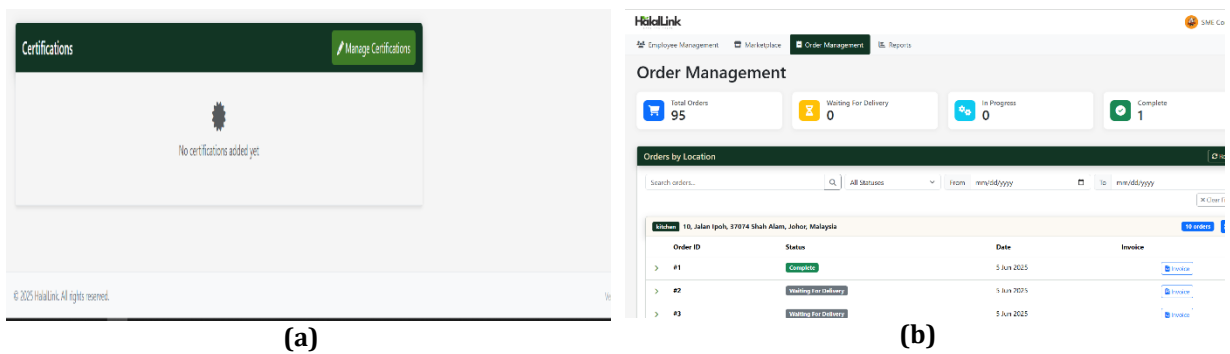


Fig. 13 (a) Profile Page: Certification Section (b) Order Management Page: SME

Fig 13(a) presents the "Certification Section," where users can manage their certifications, though this section is unavailable for White Space Resources as they do not require certification display for audits.

The SME portal, shown in Fig 13(c), lets SME administrators and their employees download formal invoices linked to their purchase orders. It helps ensure that businesses follow regulations, control quality and look after their financial records throughout the supply chain industry.

6. Result and Discussion

This section covers Functional and UAT testing to validate Halallink system features, usability, and overall user satisfaction.

6.1 Functional Testing

This Functional Testing verifies system features using test accounts. Results are recorded as Pass/Fail and displayed in a summary table.

Table 6 User Management Module

Test	Expected Result	Actual Result
Admins can manage user accounts (register, view, delete)	Admins can add, view, and delete users from the system successfully	PASS
Users can manage their own profiles	Users can update their own profile details such as name, email, and password	PASS
Users can authenticate and reset passwords via email	Users can log in and reset password using email verification	PASS
Admin Logistics assigns delivery tasks	Logistic Admin can assign delivery tasks with deadlines and view assigned tasks	PASS

Table 6 shows that all User Management Module functions, including user account management, profile updates, authentication, and delivery task assignment by Admin Logistics, were successfully tested and passed.

Table 7 *Inventory Tracking Module*

Test	Expected Result	Actual Result
White Space Resources users create poultry categories	Poultry categories are created and saved in the system	PASS
Broiler users create items in marketplace	New items are listed in the marketplace under the correct poultry category	PASS
Broiler users display QR code for tracking	QR codes are generated and displayed for each item	PASS
Logistics users scan QR code during delivery	QR codes are scanned and delivery status is logged	PASS
Slaughterhouse users display QR code	QR codes are displayed for slaughterhouse items	PASS
SME users display QR code for final stages	Final-stage tracking QR codes are visible to SME users	PASS

Table 7 confirms all Inventory Tracking Module features function correctly, including poultry creation, item tracking with QR codes, and task updates across all roles, with every test case marked as PASS.

Table 8 *Reporting Module*

Test	Expected Result	Actual Result
White Space Admin generates halal compliance reports	Reports are generated and available for download	PASS
SME users download halal compliance reports	Reports can be downloaded successfully without corruption	PASS
White Space Admin views stakeholder performance reports	Performance data is shown in charts or tables accurately	PASS

Table 8 shows that all Reporting Module functions performed as expected. Halal compliance reports and stakeholder performance data were generated, viewed, and downloaded successfully by the respective users.

Table 9 *Marketplace Module*

Test	Expected Result	Actual Result
SME users place orders	Order request is saved and inventory updated	PASS
SME users make payments	Payment gateway processes transaction successfully	PASS
Broiler Admin receives email notification	Email is sent automatically after item is sold to SME kitchen	PASS

Table 9 confirms all Marketplace Module functions are working correctly. SME users successfully placed orders, completed payments, and Broiler Admins received automatic email notifications after each sale.

Table 10 *Document Management Module*

Test	Expected Result	Actual Result
Broiler users upload halal certification	Uploaded documents are stored and retrievable	PASS
Slaughterhouse users upload QA reports	Reports are uploaded, timestamped, and secured	PASS
PSME users download invoices	Invoices can be downloaded as PDF or viewable format	PASS

Table 10 demonstrates that all Document Management Module features function properly. Users successfully uploaded halal and QA documents, and SME users downloaded invoices without any issues.

6.2 User Acceptance Testing (UAT)

User acceptance testing was conducted using test accounts across various roles in the Halallink system. Five respondents from the White Space Resources module completed the feedback form, evaluating five key modules. Results (presented from Fig 14 onward) are based on a 5-point scale.

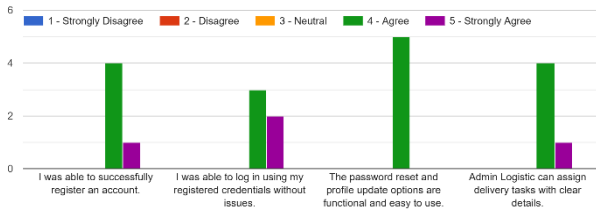


Fig. 14 User Management Module

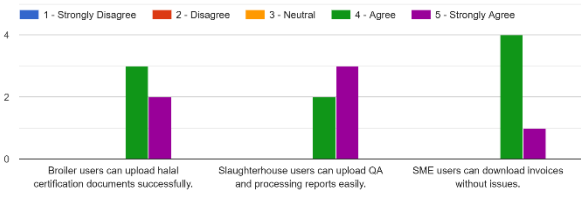


Fig. 15 Document Management Module

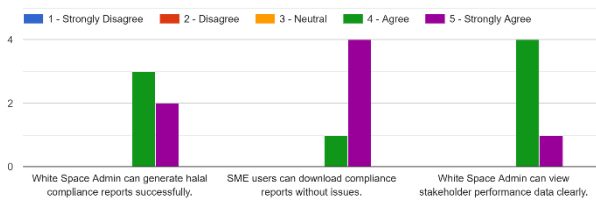


Fig. 16 Reporting Module

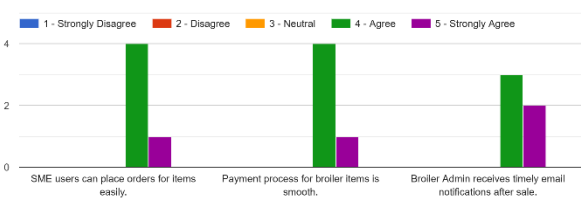


Fig. 17 Marketplace Module

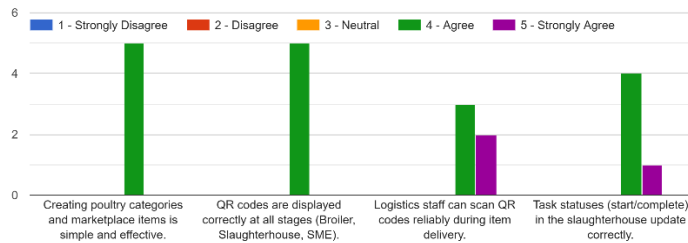


Fig. 18 Inventory Tracking Module

Based on the results presented in Fig 14 onward, the Halallink system demonstrates a high level of acceptance and usability across all tested modules. The majority of responses were rated 4 (Agree) and 5 (Strongly Agree), indicating positive feedback from the designated test account users. Modules such as user registration, login, task assignment, inventory tracking with QR codes, report generation, and payment processes all received consistently high scores.

7. Conclusion

The HalalLink system significantly improves halal poultry supply chain operations by offering transparent halal verification, efficient web-based ordering, QR code traceability, and secure payments. These features build trust and support market expansion. However, the system currently depends on internet access, limits negotiation as brokers control listings, faces occasional transaction issues, and focuses only on poultry. Future improvements include reversing the transaction model so SMEs can post their product needs publicly, allowing broilers to respond like a marketplace. Plans also include expanding halal certification to other food sectors, using blockchain for traceability, and improving mobile access and user training to enhance flexibility, transparency, and stakeholder participation.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

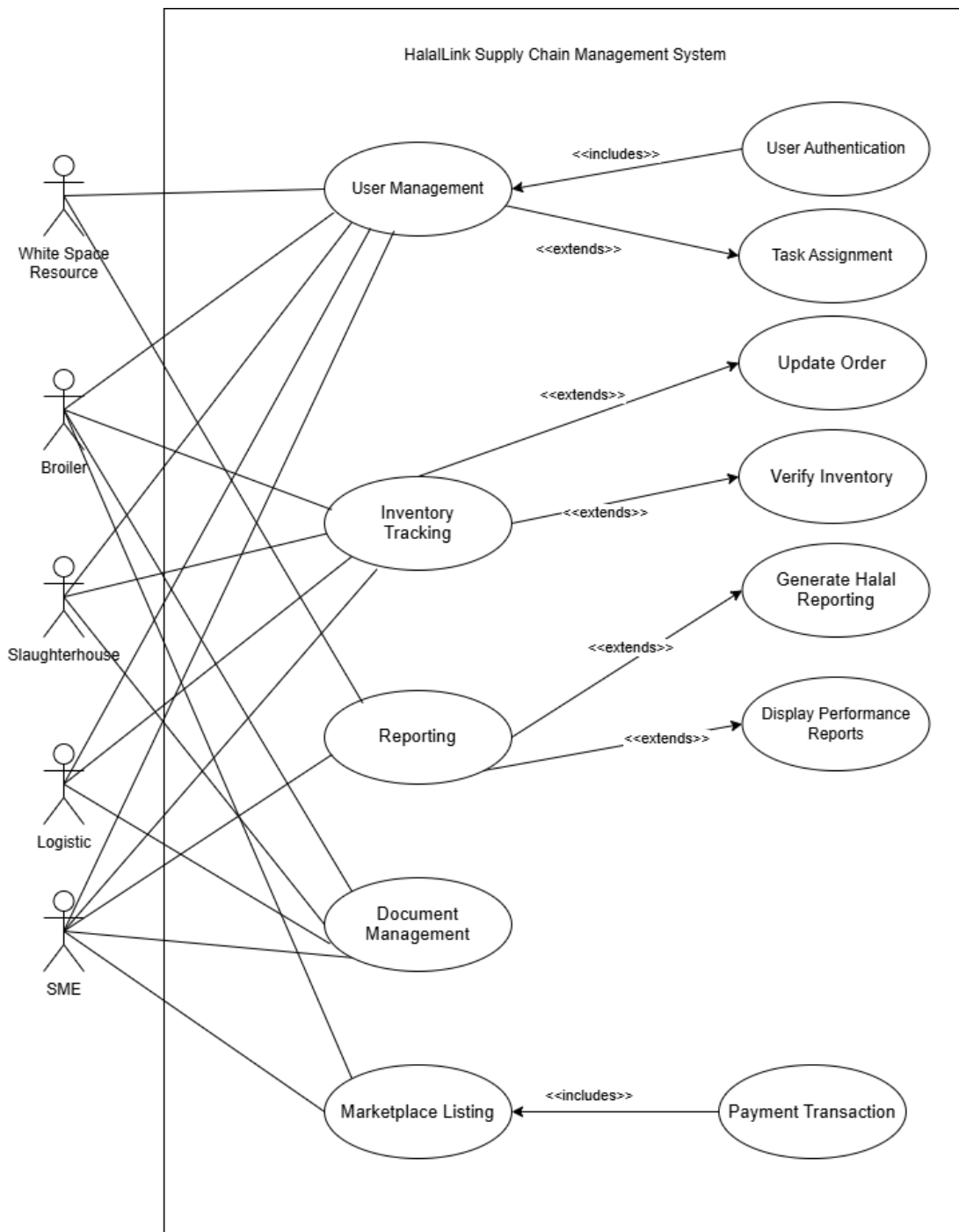
The author confirm contribution to the paper as follow: **study conception and design:** Tengku Muhammad Muzaffar Tengku Masly Mohd Gadafi, Azizul Azhar Ramli; **data collection:** Tengku Muhammad Muzaffar Tengku Masly Mohd Gadafi; **analysis and interpretation of results:** Tengku Muhammad Muzaffar Tengku Masly Mohd Gadafi, Azizul Azhar Ramli. All authors reviewed the results and approved the final version of the manuscript.

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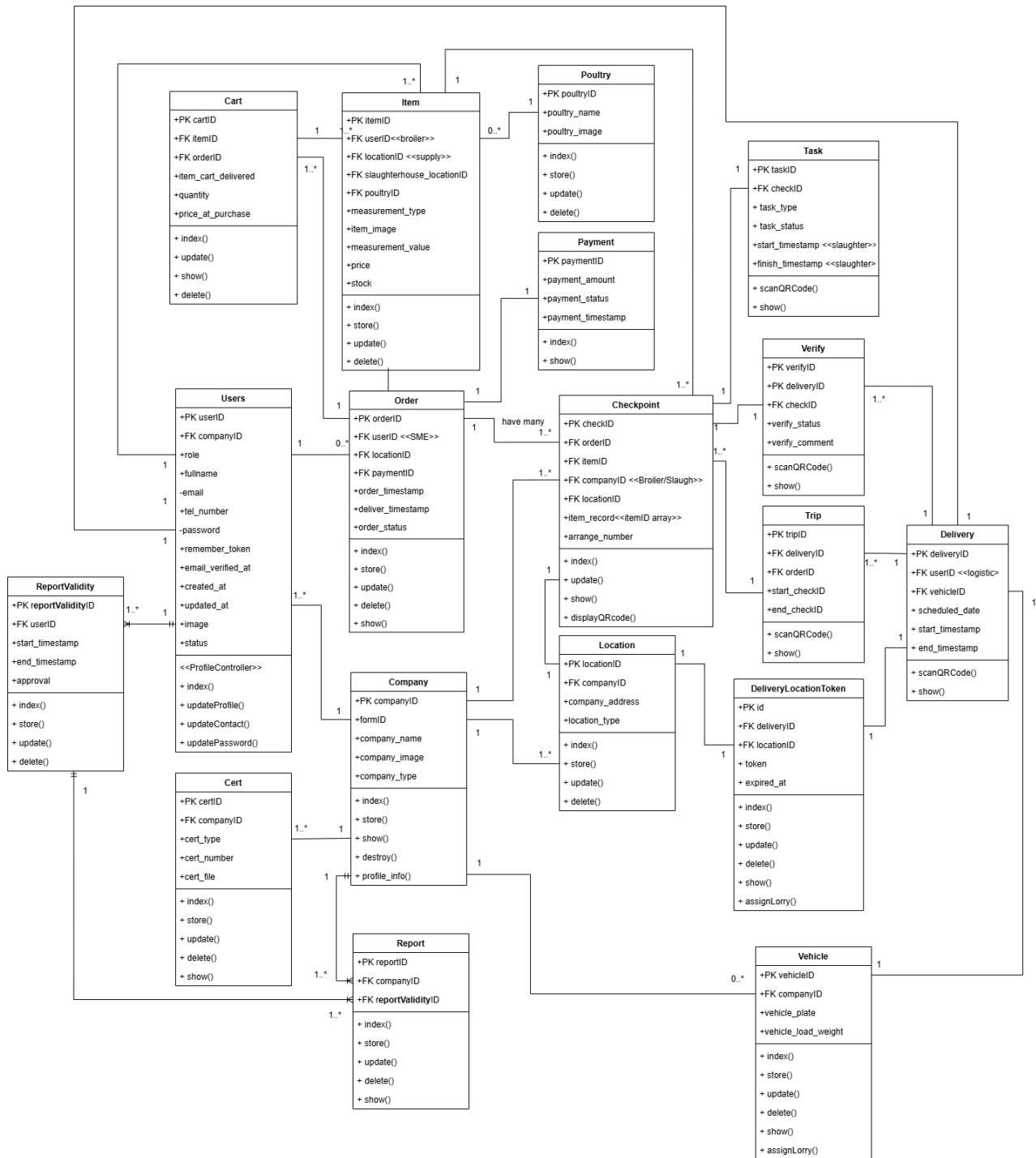
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Appendix A: Use Case Diagram



Appendix B: Class Diagram



Appendix C: Flow Chart

