Digital Food Traceability Technologies for Enhancing Quality and Safety in Saudi Arabia's Poultry Supply Chain.

Abstract

Poultry is the main source of animal protein in Saudi Arabia, and its supply chain combines domestic farms and slaughterhouses with large volumes of imported frozen product, all of which must meet both food safety and halal requirements. Recent studies have found Salmonella and multidrug-resistant Campylobacter in retail chicken and Salmonella in retail eggs in the Kingdom, which raises the question of how contamination and fraud can be traced and prevented. This paper reviews how digital traceability technologies can enhance quality and safety in the Saudi poultry chain. Thirty refereed journal articles from 2020 to 2025 were synthesised through systematic integrative review methods, covering blockchain architectures, radio frequency identification (RFID), Internet of Things (IoT) sensing, quick response (QR) codes, data standards, halal traceability, food safety risk and HACCP, adoption and governance, and consumer valuation. The evidence shows that blockchain combined with RFID, IoT and standard event data can create tamper-resistant records from farm to consumer, support product recall and strengthen halal assurance. Most studies, however, are prototypes, conceptual models or single cases; the accuracy of data entering the system remains a problem; costs, interoperability and governance limit adoption; and consumers value credible certification more than the technology itself. Because no study evaluates digital traceability in Saudi poultry, evidence from the Kingdom itself is thin. A layered traceability framework is proposed that links identification, data capture, shared records, assurance and governance, with propositions for regulators, producers, importers and retailers. No primary data were gathered for the review.

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1. Introduction

Chicken and eggs are staples of the Saudi diet, and the poultry market is large and growing; one recent study noted that it may double by 2030 (Aljasir & Allam, 2025). The chain that serves this market is long and varied. Birds are raised on farms of very different sizes, processed in domestic slaughterhouses or abroad, and sold fresh or frozen through supermarkets, traditional

butchers, restaurants and online platforms. Every step must satisfy two sets of requirements: food safety, enforced through hygiene and temperature control, and halal integrity, which concerns how animals are slaughtered and how products are handled and labelled.

Evidence from the Kingdom shows that safety cannot be taken for granted. In 212 retail chicken samples from producers of different sizes, Salmonella was found in 9.3% and Campylobacter in 35.8%, with multidrug resistance in all Campylobacter jejuni isolates and with higher prevalence among small producers (Aljasir & Allam, 2025). The Saudi Food and Drug Authority (SFDA) found Salmonella in 7% of retail eggs sampled in Riyadh during a pilot risk assessment (Alsufyani et al., 2025). Elsewhere, cross-contamination has been traced from farm to final product in a poultry chain (Gwida et al., 2020), and the COVID-19 pandemic showed that imported frozen meat packages can become a public health concern (Iftekhar & Cui, 2021).

When a problem is found, the ability to trace affected products quickly to their source and to their customers determines how far harm spreads and how much product must be withdrawn. Traceability also underpins halal assurance and protects against fraud such as mislabelling of origin. Digital technologies promise faster and more trustworthy traceability than paper records: RFID tags and QR codes identify products, IoT sensors record conditions, and blockchain provides a shared, tamper-resistant record (Wang et al., 2022; Azevedo et al., 2023). This review examines what the evidence shows about these technologies, how they can be applied to the Saudi poultry chain and under which conditions they are likely to raise quality and safety.

2. Review Aim, Objectives and Questions

The review weighs published findings on digital food traceability and interprets them for the quality and safety of poultry moving through Saudi Arabia's supply chain. To that end, the review sets out (1) to identify the quality, safety and halal risks in poultry chains that traceability must address, with attention to Saudi evidence; (2) to assess the capabilities and limitations of identification, sensing, blockchain and data standard technologies for food traceability; (3) to examine the organisational, governance and consumer factors that shape adoption and value; and (4) to propose a framework and propositions for traceability in the Saudi poultry chain.

Three research questions structure the analysis. RQ1: Which quality, safety and halal risks in poultry supply chains create the need for digital traceability in Saudi Arabia? RQ2: What

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capabilities and limitations do digital traceability technologies show in food and meat supply chains? RQ3: Which organisational, governance and consumer conditions determine whether these technologies improve quality and safety, and how can they be combined in a framework for Saudi poultry?

3. Methodology

The review adopted a systematic integrative design. The literature on food traceability is methodologically diverse, ranging from system prototypes and smart contract tests to case studies, microbiological surveys, choice experiments, multi-criteria models and reviews. An integrative synthesis allows these forms of evidence to be interpreted together, which a meta-analysis could not do. The review proceeded through identification, screening, eligibility and synthesis, each of which was recorded.

3.1 Sources and Selection

Searching took place in November 2026 in an openly available index of scholarly records, and the metadata of each candidate article were verified against its registered record. Technology terms (blockchain, distributed ledger, smart contract, RFID, Internet of Things, QR code, EPCIS, traceability system, e-traceability) were combined with domain terms (poultry, chicken, broiler, meat, halal, food safety, food fraud, recall, HACCP, Salmonella, Saudi Arabia). After title and abstract screening, the remaining articles were assessed in full against the inclusion rules.

The inclusion rules required a refereed journal article written in English, a final publication year no earlier than 2020 and no later than 2025, and a focus on food traceability technologies, their adoption or value, or the safety and halal risks of poultry and meat chains, including Saudi studies of poultry safety. Conference proceedings, items without an abstract, retracted articles and papers on non-food traceability without transferable findings were not admitted. Where possible, studies of meat, poultry and halal chains were preferred over those on other foods.

The corpus is anchored by the blockchain-enabled traceability framework of Wang et al. (2022), which combines a consortium blockchain with RFID tags at packaging level, and by the blockchain traceability design of Azevedo et al. (2023), which links actor and product identities through digital certificates. The resulting corpus of 30 articles is summarised in Table 1.

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Table 1. Composition of the reviewed literature (n = 30)

Theme	Studies	Representative studies	Contribution
Blockchain platforms and halal traceability	10	Wang et al. (2022); Azevedo et al. (2023); Sidarto and Hamka (2021)	Shared records, smart contracts, recall, halal assurance
Identification, sensing and QR	4	Qiao et al. (2023); Urbano et al. (2020); Rotsios et al. (2022)	RFID, IoT temperature tags, consumer access
Adoption, scope and governance	7	Ahmed and MacCarthy (2023); Vu et al. (2023); Lai et al. (2025)	Drivers, barriers, granularity, governance models
Consumer valuation	3	Shew et al. (2022); Suhandoko et al. (2021); Tran et al. (2024)	Willingness to pay and trust
Food safety and halal risk	6	Aljasir and Allam (2025); Alsufyani et al. (2025); Wahyuni et al. (2025)	Pathogens, HACCP, critical control points

3.2 Coding, Rating and Synthesis

For each article, the coding recorded the food product, the stage of the chain, the technology, the type of evidence (prototype or design, case or pilot, survey or experiment, model, or review) and the main findings. The body of evidence for each capability was rated as supportive, mixed or limited according to the number of studies, the type of evidence and the consistency of results. All attributions were checked against the original articles, and findings from other countries are identified as such. The review produced no new data; its framework and propositions are intended to be tested empirically.

4. Quality, Safety and Halal Risks in Poultry Chains

Traceability is valuable only in relation to the risks it helps to manage. The corpus documents microbiological, process, halal and consumer-side risks.

4.1 Pathogens in the Saudi Poultry Chain

Saudi data on poultry pathogens are limited but concerning. Aljasir and Allam (2025) observed that information on the prevalence of Salmonella and Campylobacter in Saudi retail chicken is scarce, and their sampling found all Salmonella isolates to be Salmonella Enteritidis, with resistance to nalidixic acid in 90% of them and multidrug resistance in 70%. The higher prevalence among small-scale producers suggests that risks vary by supplier, which makes it important to know which producer supplied each batch. In the egg chain, the pilot by the Saudi Food and Drug Authority used the Poultry Food Assess Risk Model, combining retail sampling

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with a survey of 125 consumers; 34.4% of consumers had low resistance to salmonellosis, and home storage time was rated as a high-risk behaviour (Alsufyani et al., 2025). These studies indicate that contamination enters at production and that risk continues through retail and the home.

4.2 Contamination Pathways

Tracing pathogens requires linking samples across stages. In an Egyptian poultry chain, Listeria innocua was found at 11% to 28% of samples at the farm, slaughterhouse and food product stages, and the close genetic relatedness of isolates indicated cross-contamination along the whole chain; the authors argued that surveillance should not be restricted to pathogenic species (Gwida et al., 2020). Genomic tracing of this kind is a laboratory method, but it depends on knowing which flock, batch and processing line each sample came from. Digital traceability records provide that link and so make laboratory findings actionable.

4.3 Halal Integrity and HACCP

Halal integrity introduces risks that are not visible in the product. In the Indonesian broiler chain, a study combining interpretive structural modelling and Bayesian networks identified 19 halal and food safety risks, estimated the combined risk at 30.92% and found knife sharpness and vehicle storage temperature to be the two critical control points (Wahyuni et al., 2025). The fact that one critical point concerns halal slaughter and the other the cold chain shows that halal and safety assurance can be managed within one system. A review of HACCP and food safety management described the main chemical, biological and physical contaminants and identified modern technologies, including artificial intelligence, that can strengthen traditional HACCP systems (Awuchi, 2023). Traceability records can document that critical control points were monitored at each batch.

4.4 Imported Frozen Poultry

A substantial share of the poultry consumed in the Kingdom is imported frozen, which adds risks that domestic controls cannot see directly. Information about the farm, slaughter method, halal certification and storage history of an imported consignment usually arrives as documents, and its accuracy depends on the exporter and the certifying body. The COVID-19 experience described by Iftekhar and Cui (2021), in which the virus was detected on imported frozen meat

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packages, showed how quickly concern about imported products can arise and how difficult it is to reconstruct their history from paper records. Digital records that travel with each consignment, and that can be checked by the importer, the regulator and the halal authority, would reduce reliance on documents alone. None of the reviewed studies, however, examines import traceability for Saudi Arabia or the Gulf.

4.5 Consumers and Food Safety Knowledge

Safety also depends on how consumers handle products. A cross-sectional survey of 309 Saudi adults found generally good food safety practices, no regional differences in knowledge and an influence of gender, age and education on knowledge, and recommended educational programmes in public places (Ayad et al., 2022). Traceability information delivered through labels and QR codes could support such education by providing storage and handling advice alongside origin details. In answer to RQ1, the need for traceability in Saudi poultry arises from pathogen contamination that varies by producer, cross-contamination across stages, halal and cold chain control points, import-related concerns and consumer handling risks; but Saudi evidence covers prevalence and consumer behaviour rather than traceability itself.

5. Digital Traceability Technologies

The technologies in the corpus can be grouped into identification and data capture, shared ledgers, standards and data integrity, and halal-specific applications.

5.1 Identification and Data Capture

Product identification is the foundation of any traceability system. Qiao et al. (2023) designed a meat traceability system using an ultra-high-frequency RFID reader with multiple connection options and an anti-collision algorithm, linking farm, slaughter, logistics and sales modules through a traceability code that consumers can query; they described the system as low cost and widely applicable. Urbano et al. (2020) integrated temperature sensors into RFID tags and connected them through IoT services, addressing high initial investment through a billing scheme in which users pay for the data they consume rather than for the equipment, and validated the system in laboratory conditions and in a shipment of oranges from Spain to Ireland. A review of RFID and IoT integration in supply chain management identified challenges and proposed a conceptual framework covering four perspectives, namely product manufacturing,

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shipping and distribution, inventory and the retail shop (Tan & Sidhu, 2022). The authors described the aim of such integration as automated, seamless, interoperable and highly secure sensing, which matches the requirements of a poultry chain in which products pass through many hands within a short time.

QR codes provide a low-cost link between product and information. In a two-phase study of a Greek dairy brand, 308 of 537 consumers scanned a QR code on the bottle, and enriched content accessed through the code increased usage intention, comprehension and self-confidence (Rotsios et al., 2022). For Saudi poultry, RFID at crate and pallet level combined with QR codes on consumer packs would allow both operational tracking and consumer access.

5.2 Blockchain Architectures

Blockchain creates a record that is shared among participants and cannot easily be altered. Wang et al. (2022) built a decentralised system on a consortium blockchain using Hyperledger Fabric, with a data structure inside a battery-free RFID tag so that each scan adds a block linked to previous ones while the information is also recorded on the platform; it was designed for shipment, stocking and storage. Casino et al. (2021) developed a distributed architecture with smart contracts and a private blockchain and tested its feasibility in a dairy company, while Azevedo et al. (2023), following a design science approach, used an Ethereum smart contract and public key infrastructure to link supply chain actors and products through digital certificates. Iftekhar and Cui (2021) proposed a blockchain-enabled architecture to provide a tamper-proof audit trail for frozen meat, motivated by the detection of COVID-19 on imported frozen meat packages.

Recall is a particularly important function. Kravenkit and So-In (2022) designed a blockchain-based system that brings supply chain participants, the food safety regulator, an administrator and end customers into one chain, and tested three smart contracts on an Ethereum test network. Deployment costs on the main Ethereum network were estimated at 30.23 dollars for the regulator and 111.54 dollars for the manufacturer, against 0.022 and 0.083 dollars on a Polygon network, which shows that platform choice strongly affects cost. For the Saudi poultry chain, a recall function that includes the regulator could shorten the time needed to locate affected batches.

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5.3 Standards, Data Integrity and the Oracle Problem

Shared ledgers do not by themselves ensure that the data are correct or usable. Li et al. (2022) noted that uploading all traceability data to a blockchain can reduce efficiency and cause data growth, that the reliability of data from many IoT devices is hard to guarantee and that different storage structures raise data-sharing costs. Their system combined on-chain and off-chain storage, authenticated IoT devices through the blockchain and complied with the Electronic Product Code Information Services (EPCIS) and Core Business Vocabulary standards to improve interoperability. Caldarelli et al. (2020) addressed the oracle problem, that is, the challenge of ensuring that information entering the blockchain from the real world is accurate, and argued that it must be solved before the effectiveness of blockchain can be judged. The Indonesian poultry case reported by Sidarto and Hamka (2021) reached a similar conclusion: the system recorded data permanently and made tampering difficult, but it could not prevent incorrect information from being recorded, although immutability ensures that fraud discovered during an audit remains on record.

5.4 Halal Traceability

Halal applications are especially relevant to Saudi Arabia. The Indonesian poultry company examined by Sidarto and Hamka (2021) used blockchain to promote farm-to-fork transparency in response to concerns about misleading halal labels. In Malaysia, Tan et al. (2022) identified traceability challenges in complying with halal requirements, interpreted them through institutional and agency theory and proposed a blockchain framework derived from implementations in three halal supply chains with input from three software providers. Alamsyah et al. (2022) argued that current Indonesian halal assurance lacks transparency, traceability and granularity of information and proposed a blockchain-based traceability model for the meat industry that could become a national standard. In answer to RQ2, the technologies can identify products, capture conditions, share tamper-resistant records, support recall and document halal processes; the evidence is supportive for technical feasibility and limited for performance at scale, because most studies are prototypes or single cases and none addresses the accuracy of data at the point of entry conclusively.

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5.5 Combining Technologies Along the Poultry Chain

The studies suggest how these technologies could fit together across the stages of a poultry chain. At the farm, flock identifiers would record placement dates, feed, veterinary treatments and test results. At the slaughterhouse, batch codes would link each flock to slaughter sessions, halal supervision and processing lines, which corresponds to the slaughter management module in the system of Qiao et al. (2023) and to the knife and temperature control points identified by Wahyuni et al. (2025). In processing and packing, RFID tags of the kind used by Wang et al. (2022), which need no battery and can be attached to paper packaging, would identify cartons and pallets. In cold storage and transport, sensor-equipped tags such as those of Urbano et al. (2020) would add temperature histories. At retail, QR codes would give consumers access to selected information, as in the study of Rotsios et al. (2022). Each of these components has been demonstrated separately; what the corpus lacks is evidence of an integrated system operating across all stages of a meat chain at commercial scale.

6. Adoption, Governance and Value

Whether a traceability system delivers benefits depends on how it is scoped, adopted and governed.

6.1 Scope and Granularity

Ahmed and MacCarthy (2023) analysed cross-industry cases and an expert workshop and proposed a framework that defines the scope of blockchain traceability through five identification levels and five levels of information granularity, chosen according to the purpose of traceability. The framework implies that a Saudi poultry chain need not trace every bird individually; flock, batch, carton and pallet levels may be sufficient for safety and recall, while halal assurance may require records at the level of each slaughter session.

6.2 Drivers and Barriers

A systematic review of 69 articles on blockchain adoption in food supply chains identified drivers, barriers, applications and implementation stages, raised issues of scalability, regulation, privacy and incentives, and proposed a three-stage implementation framework (Vu et al., 2023). A fuzzy multi-criteria analysis found supply chain efficiency, technology development and sustainability to be the most important drivers of electronic traceability in agri-food chains

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(Krstić et al., 2023). Using game theory, Gupta et al. (2023) showed that each actor's traceability decisions influence those of others so that complexity grows with every additional actor in the chain. In meat production, a scoping review of 14 empirical studies found that blockchain improves traceability, trust and regulatory compliance, particularly when integrated with IoT, but that interoperability, high costs and the lack of standard protocols remain obstacles (Ahmadi Kaliji et al., 2025). A review of blockchain against food fraud similarly identified scalability, interoperability and data accuracy as challenges and stressed collaboration among stakeholders (Duan et al., 2024).

6.3 Governance

Governance determines how traceability functions in practice. Based on 28 interviews in five Italian food chains, Lai et al. (2025) found that governance models shape adoption: captive systems ensured compliance but limited flexibility, whereas modular or relational systems supported differentiation and decentralised coordination. Fully integrated systems were found in only 30% of firms, integration between upstream and downstream stages remained weak, particularly in agriculture, and fixed costs were largely unaffected, although some sectors reported lower variable costs and better quality. The Saudi poultry chain, which includes large integrated producers, many small farms and importers, is likely to require a hybrid model in which large firms and the regulator define common data requirements while smaller actors join through simple tools such as mobile applications and QR codes.

6.4 Costs and the Business Case

Costs appear throughout the corpus as a barrier. The scoping review of Ahmadi Kaliji et al. (2025) listed high implementation costs among the main obstacles in meat chains, and Lai et al. (2025) found that digital traceability left fixed costs largely unchanged, with savings limited to variable costs and quality in some sectors. Design choices can reduce costs: the recall study of Kravenkit and So-In (2022) showed differences of more than a thousandfold in transaction costs between blockchain networks, and the data-as-a-service model of Urbano et al. (2020) shifts spending from equipment to use. The game-theoretic analysis of Gupta et al. (2023) adds that adoption depends on what other actors do, which suggests that regulation or coordinated industry action may be needed to overcome reluctance by individual firms. For Saudi poultry, the

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business case is likely to rest less on direct savings than on avoided recall costs, protection of halal reputation, access to premium segments and compliance with regulatory requirements.

7. Consumer Valuation of Traceability

Consumer response affects the commercial case for traceability. In the United States, a choice experiment found that consumers valued official certification more than blockchain traceability for beef, and the authors advised that business and consumer education should stress what product data are worth instead of the technology that manages them (Shew et al., 2022). In Taiwan, 80% of 1,420 shoppers in traditional markets were willing to pay more for traceability information on pork, especially those who were aware of food safety or valued grading (Suhandoko et al., 2021). A choice experiment with 715 Greek consumers found that consumers with stronger ethnocentric attitudes placed a higher value on blockchain-based traceability of a cheese and were more likely to scan QR codes, but that spending more time reading the information did not raise willingness to pay; the modest willingness to pay and low familiarity with blockchain suggested a need for consumer education (Tran et al., 2024).

These results suggest that Saudi consumers are likely to respond to traceability information that confirms trusted attributes, such as halal certification by a recognised authority, national origin and safety approval, rather than to the technology itself. Studies of Saudi consumers' valuation of poultry traceability are absent from the corpus, which is a priority gap. In partial answer to RQ3, the value of traceability depends on credible certification, appropriate scope, collaboration among actors, interoperable standards and information that consumers find relevant.

8. A Layered Traceability Framework for Saudi Poultry

Figure 1 sets out a five-layer framework that integrates the findings. The identification layer assigns codes to flocks, batches, cartons and pallets, using RFID for logistics units and QR codes for consumer packs. The data capture layer records critical events and conditions, including farm treatments, slaughter details relevant to halal compliance, processing line, test results, and storage and transport temperatures from IoT sensors. The shared record layer stores event data in a standard format based on EPCIS, with hashes or summaries anchored on a permissioned blockchain and full data held off-chain, as Li et al. (2022) proposed. The assurance layer uses these records for HACCP verification, halal certification, laboratory follow-up and rapid recall

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involving the regulator. The governance layer sets data-sharing rules, scope and granularity, access rights, costs and audit of data quality, addressing the oracle problem through inspection and device authentication.

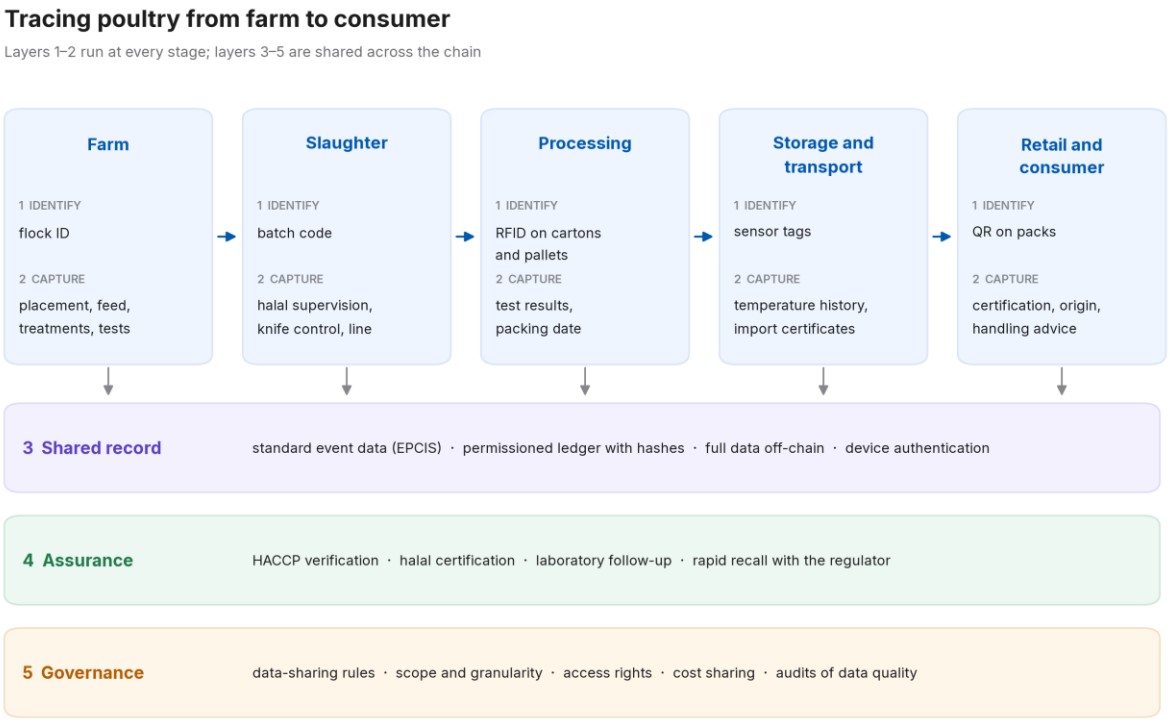


Figure 1. Five-layer digital traceability framework for the Saudi poultry supply chain.

Table 2 summarises the evidence for each layer and its implications for Saudi actors. Five propositions follow. P1: Batch-level digital records linking farms, slaughterhouses and retail reduce the time needed to trace and recall contaminated poultry compared with paper records. P2: Recording halal and cold chain critical control points in the same system improves both halal assurance and food safety. P3: Systems based on common event standards achieve higher participation by small producers and importers than proprietary platforms. P4: Data quality controls at the point of entry determine the safety benefit of blockchain more than the choice of ledger. P5: Consumer packs that display certification, origin and handling advice through QR codes raise trust more than messages about the technology. Figure 2 shows how the evidence divides by theme and type of study.

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Table 2. Evidence by framework layer and implications for Saudi poultry actors

Layer	Key evidence	Evidence status	Implication for Saudi actors
Identification	UHF RFID meat system; QR codes on packs	Supportive	Codes for flocks, batches, cartons and packs
Data capture	RFID temperature tags; IoT device authentication	Mixed	Log halal and cold chain control points
Shared records	Consortium and private blockchains; EPCIS off-chain	Limited	Permissioned ledger with standard events
Assurance	Recall smart contracts; halal blockchain cases	Limited	Link records to SFDA recall and testing
Governance	Scope framework; governance models; adoption drivers	Mixed	National data standard; support for small farms
Consumer interface	Choice experiments; willingness to pay	Mixed	Show certification and handling advice

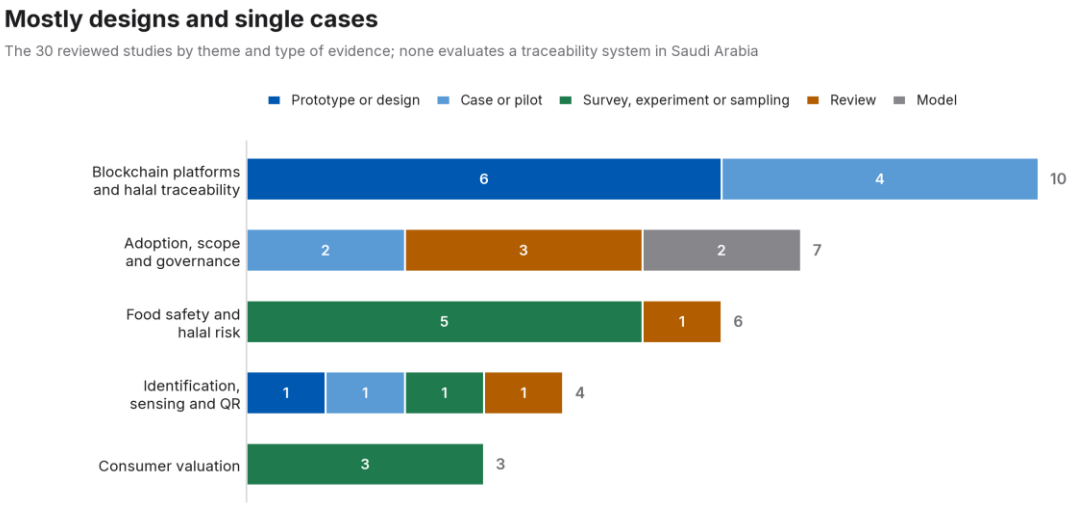


Figure 2. The 30 reviewed studies by theme and type of evidence.

9. Discussion, Implications and Limitations

Turning to RQ3, the evidence indicates that digital traceability can improve quality and safety only when technology, governance and data quality are aligned. Technical designs are plentiful, but field evidence is scarce, and the case studies emphasise that blockchain makes records permanent without making them correct (Sidarto & Hamka, 2021; Caldarelli et al., 2020). Costs

depend heavily on platform choice, as the recall study showed (Kravenkit & So-In, 2022), and integration across stages remains weak even in mature food sectors (Lai et al., 2025).

For Saudi Arabia, several implications follow. The regulator could define a national data standard for poultry traceability events, based on international standards, and link it to recall procedures and laboratory surveillance, so that findings such as those of Aljasir and Allam (2025) can be traced to specific producers. Integrated producers could pilot batch-level traceability with RFID and IoT temperature logging, extending it to contract farms. Importers of frozen poultry could be required to provide event data for each consignment, linking foreign slaughter and halal certification to domestic distribution. Retailers could use QR codes to give consumers certification and handling information, supporting the educational aims identified by Ayad et al. (2022). Small farms, where pathogen prevalence was higher, will need low-cost tools and support to participate.

Adoption is also likely to proceed in stages. The implementation framework of Vu et al. (2023) and the scope framework of Ahmed and MacCarthy (2023) both imply that firms should begin with a clear purpose and a limited scope before extending traceability to more stages or finer granularity. A sensible sequence for the Kingdom would start with batch-level records for domestic integrated producers and with digital certificates for imported consignments, then add temperature data from storage and transport, and only later extend consumer-facing information and links to smaller farms. Each stage would generate evidence on recall times, data quality and costs that could inform the next. Halal certification bodies, both in Saudi Arabia and in exporting countries, would need to take part from the start, because halal status depends on records created at the point of slaughter, often outside the Kingdom. International cooperation on data formats would therefore be as important as domestic regulation.

Several barriers must be addressed. Costs are a concern for small producers, and data-as-a-service models such as that of Urbano et al. (2020) could reduce initial investment. Interoperability requires agreement on standards across firms and with exporting countries. Data privacy and commercial confidentiality need to be protected through permissioned access. Finally, the reliability of data entered manually or by sensors must be verified through audits and device authentication.

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The review is subject to limitations. It includes only 30 journal articles from 2020 to 2025 and does not cover conference papers, standards documents or industry reports, which contain much practical experience. Most technology studies are prototypes or cases from other countries and other foods, such as dairy, and their transferability to Saudi poultry is uncertain. The Saudi studies in the corpus address pathogens and consumer knowledge, not traceability systems. A single reviewer performed the coding, and the propositions have not been tested.

Future research should evaluate pilot traceability systems in Saudi poultry chains and measure recall times, data quality and costs; examine how halal certification bodies can use shared records; study the willingness of Saudi consumers to use and pay for traceability information; and assess how small farms and importers can be included at reasonable cost.

10. Conclusion

Saudi Arabia's poultry chain faces documented risks from Salmonella and Campylobacter, halal integrity concerns and the challenges of a large import supply. Digital traceability technologies, including RFID, IoT sensors, QR codes, standard event data and blockchain, can provide shared and tamper-resistant records that support recall, HACCP verification and halal assurance. The evidence base is dominated by prototypes and single cases from other countries, and it shows that data accuracy, costs, interoperability, governance and consumer trust determine whether these technologies deliver benefits. The proposed five-layer framework offers a basis for pilot projects and research that test digital traceability in the Saudi poultry chain.

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