International Journal of Technology and Applied Science (IJTAS)
E-ISSN: 2230-9004 ● Website: www.ijtas.com ● Email: editor@ijtas.com

From Stock Ledger to Omnichannel Kirana ERP: A Review of Event-Driven Inventory Synchronization, Shelf-Life Monitoring, and AI-Assisted Financial Intelligence

Meeza Khan[1], Prof. Alka Narware[2], Yashika Pawar[3], Dhyanvi Raghuvanshi[4], Uttara Thakre[5]

[1,2,3,4,5]Computer Science Engineering, Shri Balaji Institute of Technology and Management, Betul, Madhya Pradesh, India.
meezakhan796@gmail.com[1], yashikapawar88@gmail.com[3], raghuvanshidhyanvi@gmail.com[4], Uttarathakre9926@gmail.com[5]

Abstract:
Small grocery retailers in India, commonly called Kirana stores, still rely heavily on registers, spreadsheets and disconnected tools to track products, purchases, sales and customers. This fragmentation leads to inaccurate stock records, undetected stockouts, losses from expired goods and limited visibility of business performance, and it becomes more serious as stores begin to sell online as well as over the counter. This paper reviews published work relevant to an integrated, web-based inventory ERP for small grocery retail. The review covers Kirana digitization, synchronization of physical and online inventory, event-driven consistency mechanisms, shelf-life and expiry-based stock rotation (FIFO and FEFO), threshold-based stock alerting, and the use of AI to explain financial summaries. The corpus is limited to sources whose bibliographic details could be verified, and the comparison identifies where the evidence is direct, where it is only indirect, and where no verified study was found. On this basis the paper outlines a unified conceptual framework in which one centralized inventory record is updated by every sale, purchase and online order, and drives low-stock alerts, expiry-aware rotation and calculation-based financial reports with AI used only to narrate verified figures. The contribution is a structured gap analysis and a research agenda; no implementation results or performance figures are claimed.

Keywords: Omnichannel Retail Management, Kirana Store Digitization, Enterprise Resource Planning (ERP), Event-Driven Inventory Synchronization, Inventory Visibility, Perishable Goods Management, Shelf-Life Monitoring, Expiry-Based Inventory Rotation, Automated Stock Alerts, AI-Assisted Business Analytics, Retail Financial Intelligence.

1. Introduction

Digital transformation is changing how shops operate, and stock records are central to it, since each sale, purchase, return or write-off changes what a business is able to put in front of customers. In a small grocery the consequences are immediate: an empty shelf means a missed sale, while goods left beyond their expiry

date mean money lost outright. Traditional Indian Kirana stores work at exactly this scale. Research on Kirana retailing portrays neighbourhood outlets that serve local customers well but manage stock informally; one study reports cases in which a sizeable portion of inventory stayed unsold for months [4]. Hand-kept records tend to produce familiar difficulties. Counts diverge from what is physically on the shelf, totals are worked out manually, shortages surface only after an item sells out, and details of purchases, sales and customers are scattered across separate books. Efforts to digitize Kirana stores have tackled only portions of the problem. Some work has looked at the effect of e-commerce on small Kirana shops [2] and at the potential of digital and blockchain tools for their supply chains [3].

A more recent pressure is keeping online and in-store availability in agreement. When a shopkeeper puts products on a website, two buyers may try to purchase the last unit through different routes, and the system has to settle who receives it and how the other channel learns of the outcome. Work on combining online and offline channels stresses the value of dependable availability information shared between them [5], and database research supplies mechanisms such as sagas with compensating actions [7] that keep multi-step updates consistent without holding one global lock.

Groceries raise two further concerns. First, many items carry expiry dates, so stock control has to account for age and remaining shelf life as well as quantity. Under FEFO (First Expired, First Out) the items nearest to expiry leave first, whereas FIFO releases goods strictly in the order they arrived [1]. Second, shopkeepers need to convert transaction records into financial insight, for instance yearly sales, purchase spending and how each product performs. AI-written commentary may make such summaries easier to follow, yet the numbers themselves must be derived from recorded transactions and not produced by a language model.

This review is motivated by the question of whether these strands, normally studied apart, can be joined in a single framework for small grocery retailers. Its scope stays centred on inventory: online synchronization, expiry monitoring and financial reporting are treated as supporting capabilities that rest on one reliable stock record.

Objectives of the Review Paper

The objectives of this review are: (i) to review existing grocery inventory management and ERP approaches; (ii) to examine techniques for synchronizing physical and online inventory; (iii) to analyse automated low-stock monitoring and notification mechanisms; (iv) to study shelf-life monitoring and expiry-based inventory management; (v) to investigate AI-assisted business reporting and financial analytics; (vi) to compare existing solutions by functionality, architecture, scalability and suitability for small grocery businesses; and (vii) to identify research gaps and propose directions for integrated Kirana ERP solutions.

Review Approach and Scope

The study is a narrative review. Sources were found by searching publisher and repository platforms (Springer, ScienceDirect, Taylor & Francis via institutional repositories, and open-access archives) using combinations of the terms Kirana, inventory management, omnichannel inventory, perishable inventory, FEFO, event-driven architecture and saga. A source is cited as evidence only if its title, authors, year, venue and DOI or official URL can be checked. Trade press, vendor blogs and consultancy material were consulted for background but do not support any research claim. The corpus is consequently small and is

best read as a preliminary map instead of an exhaustive survey; Sections 4 and 5 state the coverage and the strength of evidence openly so that missing evidence is not confused with missing research.

2. Literature Review

2.1 Kirana Digitization and Small-Retailer Inventory Practice

Sinha et al. compare online grocery and Kirana stores from a business-model perspective and conclude that the two would be better off complementing than competing, while observing that Kirana stores derive little value from efficient inventory control [4]. Vyas, Vyas and Singh review the impact of e-commerce websites on small Kirana shops [2]. A chapter in a Springer series on blockchain applications examines how digital and blockchain technologies could address supply-chain gaps in neighbourhood Kirana stores using content analysis of research, case studies and industry reports [3]. Taken together, these works establish the importance of inventory digitization for Kirana stores, but the verified items concentrate on supply-chain technology, e-commerce effects and market positioning, rather than on a software ERP that joins stock, orders, expiry and finance.

2.2 Omnichannel Inventory Synchronization and Event-Driven Consistency

Gallino and Moreno study the integration of online and offline retail channels and the effect of sharing reliable inventory availability information with customers [5]. The lesson for a Kirana store that adds a website is that availability shown online must reflect physical stock. Technically, the difficulty is that an online order touches several records, and a failure part-way must not leave stock overstated or understated. The saga model decomposes a long-lived transaction into a sequence of smaller transactions, each paired with a compensating transaction that undoes its effect if the sequence cannot complete [7]. In event-driven terms, an order event triggers stock reservation or deduction, and a failed payment or cancellation triggers a compensating restock event. For a single-database MySQL deployment such as the one described for the proposed system, the simpler alternative is a single local ACID transaction that records the order and decrements stock atomically; the review therefore treats full event-driven messaging as a design option whose benefit depends on scale, not as a requirement. No verified peer-reviewed study of event-driven inventory synchronization at Kirana-store scale was located.

2.3 Shelf-Life Monitoring and Expiry-Based Rotation

Perishable-inventory theory is mature. Jemai et al. analyse a periodic-review order-up-to (T, S) policy for perishable items with random lifetime using a Markov process, and note that most earlier models assume FIFO issuing [6]. For practitioners, Kandasamy et al. identify thirteen challenges to implementing FEFO in perishable food supply chains through a literature review and a ten-member expert panel, analysed with DEMATEL and TISM; effective storage management emerges as the most influential barrier, and high implementation cost, integration with existing systems and the need for accurate expiry-date data are among the listed challenges, with small and medium enterprises singled out as facing financial strain [1]. The same study is explicitly theoretical, without pilot testing, and does not examine emerging technologies in depth. For a Kirana store, this suggests that an expiry-aware ERP should record expiry at batch level and rank sellable batches by earliest expiry, while keeping data entry light enough to be adopted.

2.4 Threshold-Based Alerts and AI-Assisted Financial Reporting

Threshold alerts, for example notifying the shopkeeper when a product falls below five units, correspond to a reorder-point rule. They are easy to implement and explain, but a fixed threshold ignores differences in demand and supplier lead time between products; the verified perishable-inventory literature reviewed here treats replenishment through order-up-to policies rather than fixed alerts [6], so the evidence on alert design for small stores remains thin. For financial intelligence, the working assumption of the proposed framework is a strict separation of roles: totals such as annual sales, purchase expenditure, gross profit estimates and product-wise performance are computed deterministically from transaction records, and AI is used only to convert those verified figures into readable summaries. No verified peer-reviewed source on AI-generated retail financial narratives was incorporated in this version of the review, and this part of the framework should be regarded as a proposal pending a targeted literature search.

2.5 Technologies and Methodologies Discussed in the Reviewed Literature

Before the sources are compared in Section 4, each technology or methodology used by the reviewed papers or the proposed framework is explained briefly below, with its defining formulae. The formulae use the standard generic notation of each method; they are not copied from the cited papers and should be aligned with the full texts before submission. Where the verified sources give no mathematical model, this is stated.

2.5.1 Qualitative methods in the Kirana studies [2], [3], [4]

Source [3] uses interpretivist content analysis, in which text from research papers, case studies and industry reports is coded into themes to identify supply-chain gaps and the technologies (digital, blockchain) that could address them. Source [4] compares the business models of online grocery retailing and Kirana stores, and [2] is a review chapter on the effect of e-commerce websites on small shops. These are qualitative methods with no mathematical formula, and none tests a software system.

2.5.2 Shared availability information across channels [5]

Source [5] studies retail channel integration in which online and physical channels show customers reliable inventory availability. Its analytical method is still pending full-text confirmation (Table 1), so no formula is attributed to it. For the proposed framework, the shared figure can be written as available-to-promise stock, Eq. (1), where q_p is the physical quantity of product p and R_p the quantity reserved for pending online orders (the framework's own illustration).

$$\mathrm{ATP}_p = q_p - R_p \tag{1}$$

2.5.3 Saga with compensating transactions [7]

A saga splits a long transaction into sub-transactions $T_1, \ldots, T_n$, each paired with a compensating transaction C_i that undoes T_i, so no lock is held across the whole sequence. If all steps succeed the execution is Eq. (2); if T_{j+1} fails, the committed steps are compensated in reverse order, Eq. (3). For an online order, T_1 may reserve stock, T_2 confirm payment and C_1 release the reservation if payment fails.

$$T_1, T_2, \ldots, T_n \tag{2}$$

$$T_1, \ldots, T_j, C_j, \ldots, C_1 \quad \text{if } T_{j+1} \text{ fails} \tag{3}$$

2.5.4 Single local ACID transaction (alternative for one database)

In a single MySQL database, the order record and the stock decrement can be committed together, so both happen or neither does. The rule is Eq. (4), where q is the stock before the order, n the ordered quantity

and q' the stock afterwards; an order exceeding stock is rolled back, which prevents negative stock. This is the review's own alternative to [7]; no verified study evaluates it at Kirana scale.

$$q' = \begin{cases} q - n & \text{if } q \geq n \\ \text{abort (rollback)} & \text{otherwise} \end{cases} \quad (4)$$

2.5.5 Periodic-review order-up-to (T, S) policy with Markov analysis [6]

Stock is reviewed every T periods and an order raises the inventory position IP_k to the level S, Eq. (5). Perishable items have a random lifetime L with the distribution in Eq. (6), where m is the maximum lifetime. The system state is $x = (x_1, \ldots, x_m)$, where x_i is the number of units with i periods of life left; its evolution is a Markov process, and expected outdating and shortage follow from the stationary distribution π of the transition matrix P, Eq. (7). Source [6] also notes that most earlier models assume FIFO issuing.

$$Q_k = S - IP_k \quad (5)$$

$$\mathrm{P}(L = l) = p_l, \quad l = 1, \ldots, m, \quad \textstyle\sum_{l=1}^{m} p_l = 1 \quad (6)$$

$$\pi P = \pi, \quad \textstyle\sum_x \pi(x) = 1 \quad (7)$$

2.5.6 FIFO and FEFO issuing rules [1], [6]

Each batch b has quantity q_b, arrival date a_b and expiry date e_b. At time t the sellable batches are $B(t) = \{b: q_b > 0, e_b > t\}$ and the remaining shelf life is $r_b(t) = e_b - t$. FIFO issues the batch that arrived first, Eq. (8); FEFO issues the batch that expires first, Eq. (9). The two coincide when arrival and expiry order agree. Source [1] studies the barriers to FEFO rather than its formula.

$$b^*_{\mathrm{FIFO}} = \arg\min_{b \in B(t)} a_b \quad (8)$$

$$b^*_{\mathrm{FEFO}} = \arg\min_{b \in B(t)} e_b \quad (9)$$

2.5.7 DEMATEL (Decision-Making Trial and Evaluation Laboratory) [1]

DEMATEL turns expert ratings of how strongly barrier i influences barrier j (commonly on a 0–4 scale) into a direct-relation matrix $A = [a_{ij}]$ of size $n \times n$, with $n = 13$ in [1]. It is normalized by Eq. (10); the total-relation matrix of direct and indirect influence is Eq. (11), with I the identity matrix. Row and column sums, Eq. (12), give prominence $r_i + c_i$ and relation $r_i - c_i$; a positive relation marks a cause barrier and a negative one an effect barrier.

$$D = \frac{A}{s}, \quad s = \max\left(\max_i \textstyle\sum_{j=1}^{n} a_{ij}, \max_j \textstyle\sum_{i=1}^{n} a_{ij}\right) \quad (10)$$

$$T = D\,(I - D)^{-1} \quad (11)$$

$$r_i = \textstyle\sum_{j=1}^{n} t_{ij}, \quad c_i = \textstyle\sum_{j=1}^{n} t_{ji} \quad (12)$$

2.5.8 TISM (Total Interpretive Structural Modelling) [1]

Experts judge pairwise whether barrier E_i leads to E_j, giving a binary matrix Y. Adding transitive links (if E_i leads to E_j and E_j to E_k, then E_i leads to E_k) by Boolean powers of $Y + I$ gives the reachability matrix M, Eq. (13). With the reachability set $\mathrm{Reach}(E_i) = \{E_j: m_{ij} = 1\}$ and antecedent set $\mathrm{Ant}(E_i) = \{E_j: m_{ji} = 1\}$, barriers satisfying Eq. (14) form the top level; they are removed and the step repeats for lower levels. Unlike classical ISM, TISM also records the reason for each link.

$$M = (Y + I)^k = (Y + I)^{k+1} \quad \text{(Boolean arithmetic)} \quad (13)$$

$$\mathrm{Reach}(E_i) \cap \mathrm{Ant}(E_i) = \mathrm{Reach}(E_i) \quad (14)$$

2.5.9 Threshold-based (reorder-point) stock alerts

Part of the proposed framework (Section 2.4), not a verified source. The simplest rule alerts when quantity q_p falls below a fixed threshold θ (for example $\theta = 5$). A demand-aware version uses the reorder point of Eqs. (15) and (16), with mean daily demand $\overline{d}$, lead time L in days, demand standard deviation σ_d, service-level factor z and safety stock SS. Unlike the (T, S) policy of [6], it signals when to reorder but not how much.

$$\text{ROP} = \overline{d}\, L + \text{SS} \tag{15}$$

$$\text{SS} = z\, \sigma_d \sqrt{L} \tag{16}$$

2.5.10 Calculation-based financial reporting and AI-generated narrative

Also part of the framework, with no verified source (Section 2.4). Figures are computed deterministically from stored transactions: with selling price p_i and quantity n_i for N items, total sales are Eq. (17); gross profit is $\text{GP} = \text{Sales} - \text{COGS}$, where COGS is the purchase cost of units sold; and gross margin is Eq. (18). An AI model receives only these computed figures and writes a plain-language summary; this step has no mathematical model, and its correctness would be checked by confirming that each number in the text matches a computed figure.

$$\text{Sales} = \sum_{i=1}^{N} p_i\, n_i \tag{17}$$

$$\text{GM} = \frac{\text{GP}}{\text{Sales}} \times 100\% \tag{18}$$

3. Proposed Methodology (Conceptual Framework)

The framework places a single centralized inventory record at its core. Purchases increase quantities, in-store sales and online orders decrease them, and every change is logged as a stock movement. Three services read from this record: a threshold monitor that raises a low-stock alert when quantity falls below a configured level; an expiry monitor that stores expiry at batch level, flags batches approaching expiry and allocates stock to the earliest-expiring batch first (FEFO); and a reporting service that computes annual sales, purchase expenditure, estimated gross profit and product-wise performance directly from transactions, optionally passing the computed figures to an AI model for plain-language summary.

Component	Purpose
Centralized inventory record	Single stock record updated by every purchase, in-store sale and online order; every change is logged as a stock movement.
Threshold monitor	Raises a low-stock alert when quantity falls below a configured level.
Expiry monitor	Stores expiry at batch level, flags batches approaching expiry and allocates stock to the earliest-expiring batch first (FEFO).
Reporting service	Computes annual sales, purchase expenditure, estimated gross profit and product-wise performance directly from transactions, optionally passing the computed figures to an AI model for a plain-language summary.

To avoid overstating the work, the status of each element is stated explicitly. Described as part of the current project design: a Flask and MySQL web application with centralized product, supplier, purchase,

customer and order records. Proposed but not verified as implemented in this paper: Gmail-based authentication, e-commerce integration, low-stock and expiry notifications, and AI-assisted reporting. Future research directions: demand forecasting, predictive replenishment and dynamic pricing (see Future Scope).

4. Comparative Analysis

Table 1 compares the verified sources in descending order of publication year, which is also the order of the reference list. Cells marked "to confirm" indicate attributes that have not yet been checked against the full text and must be completed before submission.

Table 1. Comparison of reviewed literature

Reference	Proposed Approach	Technology / Methodology	Main Features	Advantages	Limitations	Relevance to Proposed Framework
[1] Kandasamy et al., 2025	Analysis of barriers to FEFO adoption in perishable food supply chains	Literature review; 10-expert panel; DEMATEL and TISM	13 challenges ranked by influence; implementation roadmap	Structured, practice-oriented; flags SME cost and tracking issues	Theoretical; no pilot; limited treatment of IoT/AI	Direct support for expiry-tracking requirements and adoption barriers
[2] Vyas et al., 2023	Review of the impact of e-commerce websites on small Kirana shops	Review chapter (details pending full-text check)	Effects of e-commerce on Kirana businesses	Indian small-retail context	Not an inventory-system design (to confirm on full text)	Context for online-offline integration
[3] Ahmad and Dixit, 2021	Digital and blockchain technologies for Kirana supply chains	Interpretivist content analysis	Technology options for Kirana supply chain	Covers post-COVID supply-chain gaps	Conceptual; no implementation	Context for Kirana technology adoption
[4] Sinha et al., 2015	Online retailing and Kirana as complements	Business-model comparison	Contrast of online grocery and Kirana stores	Explains Kirana strengths; notes weak inventory control	Conceptual; not a system proposal	Evidence of Kirana inventory-control gap

Reference	Proposed Approach	Technology / Methodology	Main Features	Advantages	Limitations	Relevance to Proposed Framework
[5] Gallino and Moreno, 2014	Integrating online and offline channels through reliable inventory-availability information	Retail channel-integration study (details pending full-text check)	Cross-channel availability information	Links accurate inventory data to channel performance	Large-retailer setting; not Kirana-scale (to confirm on full text)	Motivates unified online/physical stock record
[6] Jemai et al., 2014	Order-up-to (T,S) control of perishables with random lifetime	Periodic-review model; Markov process analysis	Replenishment policy under uncertain shelf life	Analytical treatment of random lifetime	Analytical model; no software or retail-system implementation	Theoretical basis for expiry-aware replenishment
[7] Garcia-Molina and Salem, 1987	Sagas for long-lived transactions	Sub-transactions with compensating transactions	Consistency without long-held locks	Foundational and widely applicable	Not retail-specific	Mechanism for consistent online-order stock updates

4.1 Comparison by Research Theme

The seven sources fall into four thematic groups, and each group answers a different part of the problem. The Kirana-context group [2], [3], [4] describes why small grocers need better inventory practice: [4] argues that online retail and Kirana stores are complements and observes weak inventory control in Kirana outlets, [2] reviews the effect of e-commerce websites on small shops, and [3] examines technology options for Kirana supply chains. The channel-integration source [5] shows that sharing reliable availability information across online and physical channels matters. The perishability group is split between a model-based paper [6], which analyses order-up-to replenishment for items with random lifetime and notes that most earlier models assume FIFO issuing, and a practice-oriented paper [1], which identifies the barriers to adopting FEFO. The remaining source [7] supplies a general consistency mechanism for multi-step updates. Read together, the groups are complementary rather than competing: [6] indicates how much to replenish, [1] explains why expiry-aware issuing is hard to adopt, [5] explains why channels must share one availability figure, and [7] explains how that figure can be kept correct during multi-step updates.

4.2 Comparison by Methodology and Strength of Evidence

The sources rely on very different methods, which affects how far each can be generalised. Study [6] is purely analytical, using a Markov process, and therefore gives precise results under stated assumptions but says nothing about adoption by shopkeepers. Study [1] combines a literature review with a ten-member expert panel analysed through DEMATEL and TISM; it is structured and practice-oriented, but it relies on expert judgement and is explicitly theoretical, with no pilot testing. Sources [3] and [4] use content analysis and a business-model comparison respectively, and [2] is a review chapter, so none of the three tests a system. Source [5] is a retail channel-integration study, but its attributes are still to be confirmed against the full text. Source [7] is a foundational mechanism that is widely applicable but not retail-specific. No source in the corpus reports an implementation or performance evaluation at Kirana scale; this is why the paper claims a gap analysis and a research agenda, not results.

4.3 Comparison by Publication Period

Ordering the sources by year shows a clear pattern. The oldest contribution [7] (1987) and the two 2014 papers [5], [6] provide mechanisms and theory: transaction consistency, channel integration and perishable replenishment. The Kirana-specific sources [4], [3], [2] appear between 2015 and 2023 and are conceptual. The most recent source [1] (2025) is the only one that addresses practical expiry-based issuing, and it concludes that cost, system integration and accurate expiry data are obstacles. In other words, the theory behind the proposed framework is mature, while the evidence about applying it in small Indian grocery stores is recent, thin and mostly descriptive.

4.4 Suitability for Small Grocery Retail

Table 2 compares each source on the type of evidence, primary focus, fit with Kirana scale, directness to the proposed framework and the main gap it leaves open. Sources are listed in the same descending order of year as the reference list. Only [1] touches a small-business constraint directly, by singling out financial strain for small and medium enterprises. The Kirana-context sources [2], [3], [4] fit the setting but give no design guidance, while [5], [6] and [7] give design guidance but were not developed for Kirana scale, so they must be adapted rather than adopted directly. For [7] in particular, a single local ACID transaction may be sufficient in a single-database deployment, which makes full saga-style messaging a design option and not a requirement.

Table 2. Multi-dimensional comparison of verified sources (newest first)

Reference	Year	Evidence type	Primary focus	Kirana-scale fit	Directness to framework	Principal gap left open
[1] Kandasamy et al.	2025	Literature review plus 10-expert panel (DEMATEL, TISM)	Barriers to FEFO in perishable food supply chains	Partial: flags SME cost and integration burden	Direct (expiry tracking)	Theoretical; no pilot; little on IoT/AI

Reference	Year	Evidence type	Primary focus	Kirana-scale fit	Directness to framework	Principal gap left open
[2] Vyas et al.	2023	Review chapter	Impact of e-commerce websites on small Kirana shops	Context only (Indian small retail)	Indirect (online-offline context)	Not an inventory-system design
[3] Ahmad and Dixit	2021	Interpretivist content analysis	Technologies for Kirana supply chains	Context only	Indirect (technology adoption)	Conceptual; no implementation
[4] Sinha et al.	2015	Business-model comparison	Online retailing and Kirana as complements	Context only	Indirect (evidence of inventory-control gap)	Conceptual; not a system proposal
[5] Gallino and Moreno	2014	Retail channel-integration study	Sharing reliable inventory availability across channels	Low (large-retailer setting; to confirm)	Indirect (motivates unified stock record)	Not Kirana-scale
[6] Jemai et al.	2014	Analytical model (Markov process)	Order-up-to (T, S) control of perishables	Low (analytical, no software)	Indirect (replenishment theory)	No retail-system implementation
[7] Garcia-Molina and Salem	1987	Transaction-processing mechanism	Sagas with compensating transactions	Low (benefit depends on scale)	Indirect (consistency mechanism)	Not retail-specific

4.5 Synthesis of the Comparison

Three conclusions follow from the comparison. First, context and mechanism are separated: the sources that describe Kirana stores [2], [3], [4] offer no technical mechanism, whereas the sources that offer mechanisms [5], [6], [7] were not developed for Kirana stores. Second, the expiry literature is the best covered area [1], [6], but its evidence concerns supply chains and abstract models, not shop-level batch tracking. Third, no verified source joins inventory, online synchronization, alerts, expiry monitoring and financial reporting, and none addresses AI-assisted reporting. These three conclusions correspond to gaps G1, G2, G4 and G6 in Section 5, and they explain why those gaps are labelled partially supported or preliminary and not confirmed.

5. Research Gaps

Each gap below is stated together with the strength of the evidence found, following the principle that gaps must be validated against the literature rather than assumed.

G1. Fragmented management (partially supported). The verified Kirana studies address market positioning [4], supply-chain technology [3] or e-commerce impact [2]; none of the verified items presents an integrated treatment of inventory, orders, expiry and finance. Whether commercial products fill this space has not been established from peer-reviewed sources.

G2. Online-offline synchronization (partially supported). Reliable availability information across channels is shown to matter [5], and sagas provide a consistency mechanism [7], but no verified study applies them to a Kirana-scale system with simultaneous in-store and online sales.

G3. Small-retailer accessibility (partially supported). Cost and integration burden are reported as barriers for small and medium enterprises adopting FEFO [1]. Evidence on the affordability of general ERP packages for Kirana stores remains to be gathered.

G4. Expiry-based management (supported for perishables in general). The literature offers perishable-inventory models [6] and an analysis of FEFO barriers [1], including difficulty of integrating expiry tracking into existing systems. Evidence specific to Kirana stores was not located.

G5. Automated decision support (not yet validated). The distinction between recording transactions and generating financial insight is plausible, but no verified source was incorporated to support or refute it, so it is carried forward as a hypothesis.

G6. Unified architecture (preliminary). No verified item combines inventory management, e-commerce synchronization, stock alerts, expiry monitoring and financial analytics in one platform for small grocery retail. This conclusion is provisional because the search was limited and omitted several categories, namely traditional POS systems, web-based grocery ERP products and AI-assisted retail analytics.

Future Scope and Research Directions

Several extensions follow from the gaps above. Real-time synchronization between the online storefront and physical inventory could be evaluated by comparing a single-transaction design with an event-driven design, measuring overselling incidents under concurrent orders. Expiry-risk identification and FEFO-based allocation could be extended with predicted sales rates to flag batches unlikely to sell before expiry, and near-expiry items could be offered at reduced prices, although this requires evidence on shopper response that this review does not provide. AI-based demand forecasting and predictive replenishment could replace fixed alert thresholds, while AI-assisted annual profit-and-loss summaries and product-performance analysis can be studied for factual accuracy against the underlying calculations. Supplier and purchase optimization, mobile-based monitoring for shopkeepers, and low-cost deployment models for small retailers are further directions. All of these are research possibilities and not capabilities of the present system.

6. Conclusion

Verified literature establishes that inventory control is a weak point for many Kirana stores [4], that digitization efforts exist but cover only parts of the problem [2], [3], that reliable availability information across channels matters [5], and that expiry-aware rotation such as FEFO is valuable but difficult to implement, particularly for smaller enterprises [1]. Mechanisms such as sagas [7] offer a principled way to keep multi-step stock updates consistent, though a single-database transaction may suffice at Kirana

scale. The central research opportunity is a unified, affordable platform that treats inventory as the foundation and adds synchronization, expiry monitoring and calculation-based financial reporting with AI restricted to explanation. The gaps identified here are only partly supported and should be validated by a broader search covering POS systems, grocery ERP products and AI-assisted retail analytics, followed by an evaluation of the proposed framework on real Kirana data.

REFERENCES:

[1] J. Kandasamy, K. E. K. Vimal, A. P. Singh, A. Magnani, A. Gokhale, and S. Jagtap, "Analysis of key challenges to implementation of FEFO in perishable food supply chain," J. Agric. Food Res., vol. 21, Art. no. 101848, 2025, doi: 10.1016/j.jafr.2025.101848.

[2] S. K. Vyas, L. Vyas, and S. Singh, "A review on impact of e-commerce websites on small Kirana shops in India," in Intelligent Sustainable Systems, Lecture Notes in Networks and Systems, vol. 579, A. K. Nagar et al., Eds. Singapore: Springer, 2023, doi: 10.1007/978-981-19-7663-6_4.

[3] I. Ahmad and S. Dixit, "Role of technologies in revamping the supply chain management of Kirana stores," in Blockchain Applications in IoT Ecosystem, EAI/Springer Innovations in Communication and Computing, T. Choudhury, A. Khanna, T. T. Toe, M. Khurana, and N. G. Nhu, Eds. Cham: Springer, 2021, pp. 275–287, doi: 10.1007/978-3-030-65691-1_18.

[4] P. K. Sinha et al., "Online retailing paired with Kirana—A formidable combination for emerging markets," vol. 2, pp. 317–324, 2015, doi: 10.1007/s40547-015-0057-9. [Confirm full author list and journal title before submission.]

[5] S. Gallino and A. Moreno, "Integration of online and offline channels in retail: The impact of sharing reliable inventory availability information," Manage. Sci., vol. 60, no. 6, pp. 1434–1451, 2014, doi: 10.1287/mnsc.2014.1951.

[6] Z. Jemai, C. Kouki, E. Sahin, and Y. Dallery, "Analysis of a periodic review inventory control system with perishables having random lifetime," Int. J. Prod. Res., vol. 52, no. 1, pp. 283–298, 2014, doi: 10.1080/00207543.2013.839895.

[7] H. Garcia-Molina and K. Salem, "Sagas," ACM SIGMOD Rec., vol. 16, no. 3, pp. 249–259, 1987, doi: 10.1145/38713.38742. [Confirm on ACM Digital Library.]