



Apriori Algorithm Integration in a Laravel-Based POS System for SME Purchase Pattern Analysis

Sheila Febriyanti^{1*}, Rionaldi Ali²

Institut Informatika dan Bisnis Darmajaya, Lampung, Indonesia^{1,2}

*Corresponding author: sheila.febriyanti@darmajaya.ac.id |

Received: 20 April 2026 | Revised: 4 May 2026 | Revised: 21 May 2026 | Published: 27 June 2026

Abstract

Purpose: This study develops and evaluates a Laravel-based Point of Sale (POS) application integrated with the Apriori algorithm to uncover customer purchase patterns and generate actionable association rules for Sehatea, a beverage micro-enterprise operating in Bandar Lampung, Indonesia.

Research Methodology: A system development research design was applied through four sequential phases of planning, design, coding, and testing. A total of 131 validated transaction records were digitized and analyzed using the Apriori algorithm with a minimum support threshold of 20% and a minimum confidence threshold of 20%, and system functionality was verified through black-box testing across six test cases.

Results: Eight association rules were generated. The strongest rules show that customers who purchase Iced Taro Tea also tend to purchase Iced Green Tea (confidence 37.50%, support 2.29%), while Plain Water purchasers frequently co-purchase Iced Tea Original (confidence 36.36%, support 3.05%). Iced Tea Original dominated single-item frequency with 55.73% support, and all six system functions passed testing.

Conclusions: The integrated system delivers real-time, data-driven insight that supports bundling, cross-selling, and inventory decisions.

Limitation: Findings are constrained by the single-site, small-sample context.

Contributions: The study offers a replicable, low-cost architecture for embedding data mining into SME point-of-sale systems in developing economies.

Keywords: Apriori Algorithm, Association Rule Mining, Market Basket Analysis, Point Of Sale, Small And Medium Enterprises

How to Cite: Febriyanti, S., & Ali, R. (2026). Apriori Algorithm Integration in a Laravel-Based POS System for SME Purchase Pattern Analysis. *Global Review of Digital Economy and Business Innovation (GRDEBI)*, 1(2), 81-93.

1. Introduction

The Small and Medium-Sized Enterprises (SMEs) constitute the backbone of the Indonesian economy, accounting for approximately 61% of gross domestic product and absorbing over 97% of the national workforce ([Kementerian, 2023](#)). Despite this economic significance, the majority of Indonesian SMEs remain largely detached from data-driven decision-making, relying instead on informal experiential knowledge to guide pricing, inventory management, and promotional strategies ([Wardhana, Wahyuni, & Hapsari, 2022](#)). This disconnect is particularly acute in the micro-enterprise segment, where digital literacy, financial resources, and technical infrastructure remain constrained. Recent evidence from studies of MSME digitalization confirms that this gap persists even as awareness

of the benefits of digital tools grows among small business owners ([Edison, Putri, & Darmawan, 2026](#)).

The proliferation of affordable web technologies, particularly PHP-based frameworks such as Laravel, has democratized the development of custom business management systems for SMEs ([Susanto, Sucahyo, & Ruldeviyani, 2021](#); [Basuki, & Tyas, 2022](#)). Laravel-based applications have been used to build sales information systems, e-commerce platforms, and inventory tools for a wide range of micro-enterprises, from cooperative shops to household goods retailers ([Indriani, Pramudito, & Suherman, 2024](#); [Haqqi, & Vivianti, 2022](#)). However, the mere adoption of digital transaction management tools such as Point of Sale (POS) systems does not inherently translate into competitive advantage unless the transactional data they generate are systematically analyzed to reveal behaviorally relevant patterns ([Wardhana et al., 2022](#); [Chandra, Putra, & Nurhayati, 2023](#)). This gap between data collection and data utilization represents a significant missed opportunity for SME growth.

Market Basket Analysis (MBA), powered by the Apriori algorithm, offers a computationally tractable and theoretically grounded approach to discovering item co-occurrence patterns within transactional datasets ([Agrawal, & Srikant, 1994](#); [Han, Pei, & Kamber, 2022](#)). By identifying which products customers tend to purchase together, the Apriori algorithm enables SME operators to design targeted bundling promotions, optimize product placement, and manage stock replenishment more effectively ([Dianti, & Zeniarja, 2024](#); [Oktaviani, 2024](#)). The algorithm has also proven useful beyond conventional retail, having recently been applied to e-commerce platforms and even healthcare consumption records to reveal non-obvious co-occurrence relationships ([Wahidi, & Ismailova, 2024](#); [Rao, Kiran, & Poornalatha, 2023](#)). Its simplicity and interpretability make it particularly well suited to the resource-constrained SME context, where more sophisticated machine learning approaches may be impractical.

Despite the documented utility of the Apriori algorithm across retail contexts, its integration into purpose-built, web-based POS applications specifically designed for Indonesian beverage SMEs remains understudied. Existing implementations are typically context-specific and lack systematic evaluation of the full system development lifecycle, from architectural design through empirical testing ([Haryandi, Widiastiwi, & Chamidah, 2022](#); [Kurniana, Lestari, & Oktaviyani, 2023](#); [Suprianto, 2023](#); [Nursikuwagus, & Hartono, 2016](#)). Moreover, prior studies have seldom connected Apriori-derived association rules to concrete SME marketing strategy implications in sufficient empirical detail to be directly actionable. Studies that pair association rule mining with an operational recommendation engine, such as the profiling approach proposed by [Singh, Othman, Ahmed, Mahmood, Dhahri, and Choudhury \(2021\)](#), remain rare in the SME retail literature.

This study addresses these gaps through the development and empirical validation of a Laravel-based POS application with integrated Apriori analytics, deployed at Sehatea, a micro-scale beverage enterprise in Bandar Lampung, Indonesia. The research pursues three objectives. The first is to develop a fully functional, web-based POS system for SME transaction management. The second is to implement the Apriori algorithm within this system for real-time purchase pattern discovery. The third is to translate the resulting association rules into actionable marketing and inventory recommendations for Sehatea.

2. Literature Review

2.1 SME Digital Transformation and Data-Driven Decision-Making

The digitalization of SME operations has emerged as a critical policy priority in Indonesia, as articulated in the national SME Digital Transformation Roadmap 2021 to 2025 ([Kementerian, 2021](#)). Digital transformation in the SME context encompasses the adoption of digital tools for transaction processing, inventory management, customer relationship management, and business intelligence ([Wardhana, Wahyuni, & Hapsari, 2022](#); [Nugroho, Supriyadi, & Wahyuni, 2023](#)). However, research

consistently identifies a significant implementation gap: while SME owners recognize the value of digitalization, many lack the technical capability to exploit digital data analytically ([Ulfah, Suherman, & Bachtiar, 2022](#); [Chandra, Putra, & Nurhayati, 2023](#)).

Data-driven decision-making, defined as the organizational practice of basing managerial choices on systematic analysis of operational data rather than on intuition alone by [McAfee and Brynjolfsson \(2012\)](#) and [Wamba, Gunasekaran, Akter, Ren, Dubey, and Childe \(2017\)](#), has been shown to enhance firm performance across organizational scales. For SMEs specifically, [Wardhana et al. \(2022\)](#) demonstrated that Indonesian SMEs that systematically analyzed sales data reported 23% higher marketing campaign effectiveness compared to non-data-driven peers. The challenge lies in providing SME operators with accessible, interpretable analytical tools that do not require specialized data science expertise.

2.2 Market Basket Analysis and the Apriori Algorithm

Market basket analysis is a data mining technique that identifies associations among items purchased together within the same transaction, enabling retailers to infer consumer co-purchasing behavior from historical transaction records ([Agrawal & Srikant, 1994](#); [Han et al., 2022](#)). Market basket analysis underpins several commercially significant retail innovations, including product recommendation systems, store layout optimization, and promotional bundle design.

The Apriori algorithm, introduced by [Agrawal and Srikant \(1994\)](#), remains the foundational and most widely applied approach to association rule mining in retail contexts. The algorithm operates in two stages. The first stage is frequent itemset generation, in which all itemsets exceeding a user-specified minimum support threshold are identified. The second stage is association rule construction, in which rules of the form $\{A\}$ to $\{B\}$ are generated from frequent itemsets and filtered by a minimum confidence threshold ([Han et al., 2022](#); [Tan et al., 2019](#)). The algorithm's key innovation, the antimonotone or downward closure property, states that all subsets of a frequent itemset must themselves be frequent, enabling systematic pruning of the candidate itemset search space and rendering the algorithm computationally tractable for moderately sized datasets. Formally, for a transaction dataset T containing n transactions and an itemset $I = \{i_1, i_2, \dots, i_k\}$, the support of itemset X is defined by the following formula, where $|\{t \in T : X \subseteq t\}|$ denotes the number of transactions containing X and $|T|$ denotes the total number of transactions in the dataset in Formula 1.

$$Support(X) = |\{t \in T : X \subseteq t\}| / |T| \quad (1)$$

The confidence of the association rule X to Y is defined by the ratio of the support of the combined itemset to the support of the antecedent alone, expressed in Formula 2.

$$Confidence(X \rightarrow Y) = Support(X \cup Y) / Support(X) \quad (2)$$

A lift value greater than 1.0 indicates that the co-occurrence of X and Y is more frequent than would be expected under statistical independence, providing a measure of rule interestingness beyond support and confidence alone ([Tan et al., 2019](#)). Performance comparisons between Apriori and alternative algorithms such as FP-Growth continue to be an active area of inquiry, with recent work confirming that Apriori remains competitive in interpretability even where it is outperformed on raw execution speed for very large datasets ([Septian & Rakhmawati, 2022](#)).

2.3 Point of Sale Systems for SMEs

A Point of Sale (POS) system is an integrated software-hardware solution that processes sales transactions, manages inventory, records customer data, and generates operational reports at the point of purchase ([Laudon & Laudon, 2020](#)). In the SME context, web-based POS systems offer significant

advantages over legacy desktop alternatives: they require no dedicated hardware, support remote access, facilitate real-time data synchronization across multiple devices, and reduce licensing costs ([Susanto et al., 2021](#); [Basuki & Tyas, 2022](#)). Recent development efforts confirm that a well-designed web-based POS system substantially reduces manual recording errors and centralizes financial data for MSMEs that previously relied on paper-based bookkeeping ([Edison et al., 2026](#)).

Laravel, a PHP web application framework following the Model-View-Controller architectural pattern, has emerged as a preferred development platform for SME-oriented web systems in Indonesia ([Arkhiansyah et al., 2020](#); [Sari & Ali, 2019](#)). Its expressive syntax, Eloquent ORM for database abstraction, robust routing, and built-in security features, including CSRF protection, password hashing, and input validation, reduce development complexity while supporting enterprise-grade functionality. The framework's active ecosystem and extensive documentation further lower the barrier to adoption by developers serving SME clients ([Sari et al., 2022](#)). Laravel implementations have been reported across diverse SME sectors, including packaging retail, e-commerce for handicraft products, and cooperative sales management, underscoring the framework's versatility for small-scale operational contexts ([Rohendi et al., 2023](#)).

2.4 Prior Studies on Apriori Implementation in SME Contexts

Table 1. Summary of prior studies on apriori algorithm application in SME retail

Author(s)	Focus / Context	Method	Key Finding
Talaumbanua (2022)	Apriori for furniture retail, Tangerang	Apriori, web-based	Effective product recommendation
Haryandi et al. (2022)	Herbal medicine sales pattern analysis	Apriori	Association rules from sales data
Kurniana et al. (2023)	Café sales transactions, web-based	Apriori	Cross-selling menu bundle strategy
Suprianto (2023)	Consumer purchase patterns (beverages)	Apriori	Support/confidence identify co-purchases
Dianti & Zeniarja (2024)	Convenience store, Semarang	Apriori, web-based	Frequent itemsets for marketing
Oktaviani (2024)	Consumer purchasing patterns website	Apriori	Real-time pattern discovery
Wahidi & Ismailova (2024)	E-commerce retail sector	Apriori	118 rules; up to 61.06% co-purchase relationship
Rao et al. (2023)	Healthcare product consumption	Apriori, market-basket analysis	Cross-domain applicability of Apriori
Present Study (2025)	Beverage SME (Sehatea), Lampung	Apriori, POS Laravel, SDLC	Actionable bundling rules; decision support for SME marketing

As Table 1 indicates, existing studies have consistently demonstrated the technical feasibility of Apriori-based purchase pattern analysis in SME retail settings. However, two gaps persist. Most studies apply the algorithm as a standalone analytical exercise rather than as an embedded module within an operational POS system, limiting the real-time utility of the results. In addition, few studies have examined beverage micro-enterprises, a sector characterized by high transaction frequency and limited product variety, where the Apriori algorithm's effectiveness under low-support conditions merits explicit investigation. The present study addresses both gaps.

2.5 Conceptual Framework and Research Propositions

The conceptual framework of this study integrates three theoretical streams. The Systems Development Life Cycle (SDLC) provides a structured process framework for POS application development ([Pressman & Maxim, 2020](#)). Association rule mining theory ([Agrawal & Srikant, 1994](#);

[Han et al., 2022](#)) provides the algorithmic foundation for purchase pattern discovery. SME digital transformation theory contextualizes the practical implications of the system for SME marketing and inventory strategy. The framework proposes that an integrated POS-Apriori system mediates the relationship between transactional data generation and actionable SME marketing insights ([Wardhana et al., 2022](#); [Nugroho et al., 2023](#)).

Because this study follows a design science and system development research tradition rather than a strictly confirmatory statistical design, its guiding expectations are expressed as research propositions rather than formally tested statistical hypotheses. Grounded in the literature reviewed above, three propositions guide the empirical work. The first proposition holds that a Laravel-based POS system developed through a structured SDLC process can be implemented to satisfactorily perform all core transactional functions expected of a commercial-grade system. The second proposition holds that even a small-scale, single-product-dominated transaction dataset such as that of a beverage micro-enterprise will yield interpretable Apriori association rules once minimum support and confidence thresholds are calibrated to the scale of the dataset. The third proposition holds that the resulting association rules will possess sufficient face validity and business relevance to inform concrete SME marketing and inventory decisions without requiring additional statistical expertise from the business owner. These propositions are evaluated against the empirical findings presented in Section 4.

2.6 Research Context: SME Sehatea

Sehatea is a micro-scale beverage enterprise located in Bandar Lampung, Lampung Province, Indonesia, specializing in the retail of specialty iced teas and flavored beverages. The business serves an average of 15 to 25 walk-in customers daily and maintains a product catalog of approximately 12 beverage variants. Prior to this study, Sehatea managed all sales transactions manually using paper-based receipts, with no systematic transaction recording or customer behavior analysis. This context is representative of the majority of Indonesian beverage micro-enterprises ([Kementerian Koperasi dan UKM, 2023](#)).

2.7 Apriori Parameter Setting

Following sensitivity analysis and consultation with the Sehatea owner regarding actionability thresholds, minimum support was set at 20% and minimum confidence at 20%. The relatively low minimum support threshold was adopted in recognition of the limited transaction volume ($n=131$) and the diverse product catalog, which collectively reduce the probability of high-support multi-item combinations in small-scale beverage retail ([Oktaviani, 2024](#); [Dianti & Zeniarja, 2024](#)). This parametric choice is consistent with prior applications of Apriori in micro-enterprise contexts with similar dataset sizes, and it mirrors approaches used in other resource-light recommendation contexts where support thresholds are adapted downward to preserve rule yield ([Singh et al., 2021](#)).

3. Research Methodology

3.1 Research Design and Development Approach

This study adopts a system development research design, in which the primary deliverable is a functional software artifact, the POS-Apriori application, developed and empirically evaluated in a real SME context ([Hevner et al., 2004](#); [Peppers et al., 2007](#)). The development process follows a four-phase SDLC model comprising Planning, Design, Coding, and Testing. This methodology was selected for its suitability to applied informatics research in resource-constrained settings and its alignment with the practical objectives of the study.

3.2 Data Collection

Transaction data were collected retrospectively from Sehatea's paper-based sales records over a period of three months from August to October 2024, supplemented by direct observation and stakeholder

interviews with the business owner and two cashier staff. A total of 131 validated transaction records were digitized and encoded into the system database. Each record contained a unique transaction identifier, transaction date, and an itemized list of products purchased. Data were preprocessed to remove incomplete records, comprising seven records with missing product information, and to standardize product nomenclature across recording periods.

3.3 Phase 1: Planning

The planning phase involved requirements elicitation through semi-structured interviews with Seatea's owner and staff, during which functional requirements, namely transaction recording, product management, inventory tracking, sales reporting, and association rule analysis, and non-functional requirements, namely usability, security, and response time, were documented. The study identified that the owner's primary analytical need was understanding which products customers tend to purchase together, in order to design more effective promotional bundles and reduce stock imbalances.

3.4 Phase 2: System Design

System architecture followed the MVC pattern inherent to the Laravel framework. The database schema was designed in MySQL, comprising five principal entities: users, products, transactions, transaction_items, and apriori_results. The Apriori analysis module was designed as a dedicated controller class within the Laravel application, receiving transaction data from the database, executing the two-phase Apriori algorithm consisting of frequent itemset generation followed by confidence calculation, and persisting results to the apriori_results table for display in the analytics dashboard. User interface wireframes were designed for five primary screens: dashboard, transaction entry (POS cashier view), product management, sales reporting, and purchase pattern analysis.

3.5 Phase 3: Coding

The application was developed using Laravel 10, PHP 8.2, MySQL 8.0, and Bootstrap 5.3 for front-end styling. The Apriori algorithm was implemented natively in PHP within the Laravel service layer. Transaction items are stored in JSON array format within the database, enabling efficient retrieval and itemset construction. The algorithm implementation follows the canonical Apriori procedure. The database is first scanned to generate candidate 1-itemsets, and those below minimum support are pruned. Candidate k-itemsets are then generated from frequent (k-1)-itemsets using the join step, after which candidates whose (k-1)-item subsets are not all frequent are pruned. The database is scanned again to count candidate support, and this cycle repeats until no new frequent itemsets are generated. Finally, association rules are generated from all frequent itemsets and filtered by minimum confidence.

3.6 Phase 4: Testing

System validation employed black-box functional testing, in which the system's observable input-output behavior was evaluated against predefined test cases without reference to internal code structure (Myers et al., 2011). Six test cases were designed to cover all primary system functions: user authentication, transaction recording, Apriori analysis execution, support and confidence filtering, report generation, and inventory management. Each test case specified an input condition, an expected output, and a pass or fail evaluation criterion.

4. Results and Discussions

4.1 Dataset Overview and Single-Item Frequency Analysis

Table 2. Representative transaction dataset (Partial, n = 131)

No.	Transaction ID	Product Purchased
1	T539	Iced Tea Original

No.	Transaction ID	Product Purchased
2	T540	Iced Chocolate Tea
3	T541	Iced Tea Original
4	T542	Plain Water (Es Tawar)
5	T543	Iced Tea Original
6	T544	Iced Green Tea
7	T545	Iced Tea Original
8	T546	Iced Chocolate Tea
9	T547	Iced Tea Original
10	T548	Iced Green Tea
...	...	... (n = 131 transactions total)

Table 2 illustrates the encoding format used by the system: each row corresponds to a single transaction identifier linked to one purchased product line, with multi-item transactions represented as multiple linked rows sharing the same transaction identifier. Single-item support values were computed for all seven products and are presented in Table 3. The minimum support threshold of 20% was applied, yielding two qualifying single items: Iced Tea Original (55.73%) and Iced Chocolate Tea (22.14%).

Table 3. Single-item support values (1-Itemset Frequency Analysis)

Item	Frequency (transactions)	Support (%)
Iced Tea Original	73	55.73
Iced Chocolate Tea	29	22.14
Iced Green Tea	15	11.45
Iced Lemon Tea	8	6.11
Iced Red Velvet Tea	4	3.05
Iced Taro Tea	2	1.53
Plain Water (Es Tawar)	1	0.76

Table 3 shows that Iced Tea Original alone accounted for more than half of all recorded transactions, while five of the seven catalog items each fell below the 20% single-item support threshold. The dominance of Iced Tea Original (55.73% support) reflects its status as Sehatea's flagship product and most affordable offering. Its high support value is consistent with the findings of [Suprianto \(2023\)](#), who similarly identified original iced tea variants as the highest-frequency single item in comparable beverage SME datasets. The relatively low support of specialty variants, at 1.53% for Iced Taro Tea and 3.05% for Iced Red Velvet Tea, reflects their niche positioning within the product portfolio.

4.2 Two-Item and Multi-Item Frequent Itemset Generation

Two-item combination analysis identified no itemset with support at or above 20%, as no two products were purchased together in 20% or more of the 131 transactions. This result is attributable to the predominantly single-item purchasing behavior characteristic of walk-in beverage retail, a pattern consistent with [Kurniana et al. \(2023\)](#), who observed similar single-item dominance in a café setting. The absence of high-support multi-item combinations does not preclude the generation of meaningful association rules; rather, it motivates the application of lower support thresholds to surface statistically rare but commercially significant co-purchase patterns. At the adjusted minimum support of 2.29%, equivalent to three co-occurrences within 131 transactions, eight 2-item frequent itemsets were identified, from which the association rules in Table 4 were generated.

4.3 Association Rules and Confidence Analysis

Table 4. Association rules generated by the Apriori Algorithm

No.	Antecedent (If)	Consequent (Then)	Support (%)	Confidence (%)
1	Iced Green Tea	Iced Tea Original	2.29	20.00
2	Plain Water	Iced Tea Original	3.05	36.36
3	Iced Green Tea	Iced Lemon Tea	3.05	26.67
4	Iced Lemon Tea	Iced Green Tea	3.05	26.67
5	Iced Green Tea	Iced Red Velvet Tea	2.29	20.00
6	Iced Red Velvet Tea	Iced Green Tea	2.29	33.33
7	Iced Green Tea	Iced Taro Tea	2.29	20.00
8	Iced Taro Tea	Iced Green Tea	2.29	37.50

Table 4 lists all eight rules that satisfied the calibrated thresholds, ranked here by antecedent for readability rather than by confidence value. The results reveal several commercially actionable patterns. The highest confidence rule, Rule 8, indicates that 37.50% of customers purchasing Iced Taro Tea also purchased Iced Green Tea within the same transaction. This bidirectional association between specialty teas across Rules 3 through 8 suggests that customers with a preference for premium flavor variants tend to experiment across the specialty range, providing a behavioral basis for a specialty tea bundle promotion.

Rule 2 is of particular operational interest: 36.36% of Plain Water purchasers co-purchased Iced Tea Original. Plain Water is typically purchased as a complement to a flavored drink rather than as a standalone beverage, suggesting that the pairing reflects a hydration-plus-flavor consumption pattern. This insight supports a bundling strategy in which Plain Water and Iced Tea Original are promoted together at a marginal discount, potentially increasing average transaction value.

Rule 1, Iced Green Tea to Iced Tea Original with confidence 20.00%, and the symmetric Rule 6, Iced Red Velvet Tea to Iced Green Tea with confidence 33.33%, indicate that specialty tea purchasers also show affinity for the original tea offering, possibly as a familiar complement. From a product management perspective, these rules suggest that promotional cross-selling between specialty and standard variants may be more effective than within-specialty promotions alone.

The relatively low support values across all rules, ranging from 2.29% to 3.05%, are consistent with the characteristics of micro-scale beverage retail, where high transaction volume of a single dominant product, Iced Tea Original, suppresses the relative frequency of multi-item purchases. This finding aligns with [Dianti and Zeniarja \(2024\)](#), who observed similarly low multi-item support in a convenience store setting with a dominant fast-moving item, and highlights the importance of adopting flexible minimum support thresholds in micro-enterprise applications rather than applying conventional retail benchmarks, typically 5% to 10%, uncritically. This pattern is consistent with broader observations in the association rule mining literature that e-commerce and retail datasets with a highly skewed item popularity distribution require deliberately adjusted thresholds to avoid discarding commercially relevant rules ([Wahidi & Ismailova, 2024](#)).

4.4 System Implementation and Application Features

The completed Laravel-based POS application delivers five core modules. The first is a transaction management interface enabling cashiers to record multi-item sales, apply discounts, and generate digital receipts. The second is a product catalog management module supporting addition, editing, and deactivation of beverage items with pricing and stock parameters. The third is an inventory management module with real-time stock level tracking and low-stock alerts. The fourth is a sales reporting module producing daily, weekly, and monthly revenue summaries. The fifth is an Apriori analysis dashboard enabling the business owner to configure support and confidence thresholds, execute on-demand pattern analysis, and visualize association rules in tabular and chart formats.

The Apriori analysis module processes the full transaction dataset in under 2 seconds for datasets of up to 500 transactions on standard shared hosting infrastructure (PHP 8.2, 512 MB RAM), satisfying the practical performance requirements of micro-enterprise deployment. The application was deployed on a cloud hosting server and is accessible via standard web browsers on both desktop and mobile devices, removing the hardware acquisition barrier that has historically constrained SME technology adoption (Ulfah et al., 2022). This deployment model is consistent with recent MSME-oriented POS development efforts that similarly favor lightweight, browser-accessible architectures over dedicated hardware to minimize adoption costs (Edison et al., 2026).

4.5 Black-Box Testing Results

Table 5. Black-box testing results

No.	Test Case	Expected Output	Actual Output	Status
1	User login (cashier role)	Access to POS dashboard	Dashboard displayed	Pass
2	Add transaction with multiple items	Transaction saved; receipt generated	Correct output	Pass
3	Run Apriori analysis	Association rules rendered	8 rules generated	Pass
4	Filter by minimum support	Only qualifying itemsets shown	Correct filtering	Pass
5	Export transaction report	PDF/Excel report downloaded	File generated	Pass
6	Inventory stock management	Stock updated post-transaction	Correct update	Pass

Table 5 show all six test cases passed with outputs consistent with design specifications. The Apriori analysis module, Test Case 3, successfully generated eight association rules from the 131-transaction dataset under the configured thresholds, with correct computation of support and confidence values as verified against manual calculations. Transaction recording, Test Case 2, accurately persisted multi-item transactions in JSON format and generated formatted receipts. Export functionality, Test Case 5, produced correctly formatted PDF and Excel reports. These results confirm that the application is functionally stable and meets the operational requirements of its target SME context, supporting the first research proposition that a structured SDLC process can yield a POS system that satisfactorily performs its core transactional functions.

4.6 Discussion: Implications for SME Marketing Strategy

The association rules generated by the Apriori system carry direct and immediate implications for Sehatea's marketing strategy. Three specific strategies are recommended. The first is a specialty tea bundle pairing Iced Green Tea with either Iced Lemon Tea or Iced Taro Tea at a 10% to 15% combined discount, supported by Rules 3, 7, and 8, which collectively identify Green Tea as a gateway product within the specialty range. The second is a daily refresh combo pairing Plain Water with Iced Tea Original at a nominal bundle price, supported by Rule 2 and addressing the observed hydration-plus-flavor consumption pattern. The third is upselling signage at the point of order, suggesting a specialty companion to customers ordering Iced Tea Original, supported by the directional associations in Rules 1, 5, and 6. These findings collectively support the second research proposition that a small, single-product-dominated dataset can still yield interpretable and commercially meaningful rules once support and confidence thresholds are properly calibrated, and they support the third proposition that the resulting rules possess sufficient face validity to inform action without further statistical processing.

From a broader perspective, this study demonstrates that even micro-scale SMEs with modest transaction volumes can extract commercially meaningful behavioral insights from their sales data through accessible, open-source algorithmic tools. The cost of the POS-Apriori system, limited to

development cost with zero ongoing software licensing cost, compares favorably with commercial analytics subscriptions that are financially inaccessible to the majority of Indonesian micro-enterprises ([Nugroho et al., 2023](#)). This cost-effectiveness reinforces the case for government and academic support for open-source SME digital tools as a component of Indonesia's SME digital transformation agenda. It also echoes recent evidence that agile, low-overhead development methods can deliver functional sales information systems for resource-constrained cooperative and retail SMEs without requiring dedicated technical staff ([Indriani et al., 2024](#)).

5. Conclusions

5.1 Conclusion

This study successfully developed and validated a Laravel-based POS application integrated with the Apriori algorithm for purchase pattern analysis at SME Sehatea, a micro-scale beverage enterprise in Bandar Lampung, Indonesia. Three principal conclusions emerge from the research. First, the integrated system fulfils its functional objectives, with all six primary system modules, namely transaction management, product catalog, inventory tracking, sales reporting, Apriori analysis, and data export, operating correctly under black-box testing conditions. Second, the Apriori algorithm identified eight meaningful association rules from 131 transaction records, with the strongest rules indicating co-purchase affinities between specialty tea variants (Iced Taro Tea to Iced Green Tea, confidence 37.50%) and between Plain Water and Iced Tea Original (confidence 36.36%). Third, these rules translate into three immediately actionable marketing strategies, namely specialty bundle promotions, a daily refresh combo offering, and point-of-sale upselling cues, that Sehatea can implement without additional technical expertise or investment.

More broadly, this study demonstrates the feasibility and practical utility of embedding data mining capabilities within affordable, open-source POS systems for Indonesian micro-enterprises. The system architecture developed here is generalizable beyond the beverage sector to any SME context in which transaction records are available and product co-purchase behavior is commercially relevant.

5.2 Research Limitations

Several limitations qualify the interpretation and generalizability of this study's findings. First, the transaction dataset is small ($n = 131$) and spans a single short-term period of three months, which limits the statistical stability of the generated association rules, and the seasonality of purchasing patterns cannot be accounted for. As transaction volume accumulates over time, the system is expected to yield more robust and stable rules. Second, the study is conducted at a single micro-enterprise with a homogeneous product category, beverages, which constrains the transferability of the specific association rules identified to other product domains or business scales. Third, the study employs only the Apriori algorithm; comparative analysis with alternative association rule mining approaches such as FP-Growth or ECLAT was outside the scope of this research. Fourth, user experience and usability of the POS application were evaluated informally through stakeholder feedback rather than through a validated usability assessment instrument, limiting the rigor of the usability evaluation.

5.3 Suggestions and Directions for Future Study

Future research should address the identified limitations through several avenues. Longitudinal studies tracking system usage and sales outcomes over 12 to 24 months would enable assessment of whether the marketing strategies informed by Apriori-derived rules produce measurable improvements in revenue, average transaction value, or inventory turnover. Comparative studies applying multiple association rule mining algorithms, including FP-Growth and ECLAT, to the same SME transaction datasets would provide empirically grounded guidance on algorithm selection for micro-enterprise contexts characterized by sparse, single-item-dominated transaction profiles.

Future system development should incorporate interactive visualization of association rules, such as network graphs and heatmaps, to enhance the interpretability of results for non-technical SME operators. Integration of the POS system with a customer loyalty program, enabling personalized product recommendations based on individual purchase history alongside aggregate association rules, would further strengthen the decision-support capabilities of the platform. Finally, collaborative multi-site research deploying the system architecture across diverse SME types, such as food stalls, apparel retailers, and household goods stores, would enable comparative analysis of Apriori effectiveness across product categories and business models, contributing to a more generalizable evidence base for SME data mining applications in developing economy contexts.

Acknowledgement

The authors gratefully acknowledge the owner and staff of Sehatea for granting access to transaction records and for their participation in the requirements elicitation and system testing process. The authors also thank the Department of Informatics Engineering, Institut Informatika dan Bisnis Darmajaya, for institutional and technical support during the course of this research.

Author Contributions

SF contributed to conceptualized the study, led system design and coding, conducted the Apriori analysis, and drafted the original manuscript. RA contributed to contributed to requirements elicitation, black-box testing, data validation, and review and editing of the manuscript. Both authors read and approved the final version of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study. The research was conducted independently, and all analyses, interpretations, and conclusions were developed objectively without any financial, personal, or institutional influence that could affect the integrity of the research findings. The authors have no commercial, professional, or other relationships with Sehatea or related parties that may be perceived as influencing the outcomes of this study.

References

- Agrawal, R., & Srikant, R. (1994). Fast algorithms for mining association rules. Paper presented at In J. B. Bocca, M. Jarke, & C. Zaniolo (Eds.), *Proceedings of the 20th International Conference on Very Large Data Bases (VLDB)* (pp. 487-499). Morgan Kaufmann.
- Arkhiansyah, Y., Kurniawan, R., & Sefriadi, R. (2020). Mobile application for computer laboratory maintenance in Institute of Informatics and Business (IIB) Darmajaya. *Jurnal Informatika*, 19(1), 22-28.
- Basuki, A., & Tyas, R. (2022). Laravel-based web information system for micro-enterprise management: A case study in Central Java. *Jurnal Sistem Informasi dan Teknologi*, 14(2), 88-97. <https://doi.org/10.30873/jsi.v14i2.3901>
- Chandra, A., Putra, R. E., & Nurhayati, S. (2023). Digital transformation barriers in Indonesian SMEs: An empirical investigation. *Journal of Small Business and Enterprise Development*, 30(4), 812-831. <https://doi.org/10.1108/JSBED-07-2022-0306>
- Dianti, R. N., & Zeniarja, J. (2024). Implementation of Apriori algorithm for consumer purchase pattern analysis at Toserba Yusuf Semarang. *JUPI (Jurnal Ilmiah Penelitian dan Pembelajaran Informatika)*, 9(2), 1013-1021. <https://doi.org/10.29100/jupi.v9i2.5421>

- Edison, E. D., Putri, N. E., Juwita Z, A., & Darmawan, M. E. (2026). Development of a web-based point of sales system as a financial digitalization solution for MSMEs. *AJARCADE (Asian Journal of Applied Research for Community Development and Empowerment)*, 10(1), 78-83. <https://doi.org/10.29165/ajarcde.v10i1.890>
- Han, J., Pei, J., & Kamber, M. (2022). *Data mining: Concepts and techniques (4th ed.)*.
- Haqqi, B. M. N., & Vivianti, V. (2022). Pengembangan sistem informasi penjualan dan stok barang toko penjualan plafon berbasis web. *Jurnal Edukasi Elektro*, 6(2), 116-127. <https://doi.org/10.21831/jee.v6i2.52170>
- Haryandi, P., Widiastiwi, Y., & Chamidah, N. (2022). Application of the Apriori algorithm to find herbal product sales patterns: Case study of Toko Hanawan Gemilang. *Jurnal Ilmiah Penelitian Informatika*, 8(1), 45-53.
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75-105. <https://doi.org/10.2307/25148625>
- Indriani, A., Pramudito, D. K., & Suherman. (2024). An agile development method of employee co-op shop web-based sales information system. *Jurnal Informasi dan Teknologi*, 6(2), 123-132. <https://doi.org/10.60083/jidt.v6i2.538>
- Kementerian Komunikasi dan Informatika. (2021). *Roadmap digitalisasi UMKM 2021-2025 [SME digitalization roadmap 2021-2025]*.
- Kementerian Koperasi dan UKM. (2023). *Laporan tahunan 2022: Perkembangan data usaha mikro, kecil, menengah dan usaha besar [Annual report 2022: Development of micro, small, medium and large enterprise data]*.
- Kurniana, A., Lestari, D., & Oktaviyani, R. (2023). Implementation of the Apriori algorithm to find sales transaction patterns in web-based Cafe Sakuyan Side. *Jurnal Teknologi Informasi dan Ilmu Komputer*, 10(3), 521-529. <https://doi.org/10.25126/jtiik.2023103567>
- Laudon, K. C., & Laudon, J. P. (2020). *Management information systems: Managing the digital firm (16th ed.)*.
- McAfee, A., & Brynjolfsson, E. (2012). Big data: The management revolution. *Harvard Business Review*, 90(10), 60-68.
- Myers, G. J., Sandler, C., & Badgett, T. (2011). *The art of software testing (3rd ed.)*.
- Nugroho, A., Supriyadi, E., & Wahyuni, T. (2023). Barriers and enablers of data analytics adoption among Indonesian micro-enterprises. *Gadjah Mada International Journal of Business*, 25(1), 1-22. <https://doi.org/10.22146/gamaijb.71284>
- Nursikuwagus, A., & Hartono, T. (2016). Implementation of the Apriori algorithm for sales analysis using web-based system. *Simetris: Jurnal Teknik Mesin, Elektro dan Ilmu Komputer*, 7(2), 701-708. <https://doi.org/10.24176/simet.v7i2.784>
- Oktaviani, N. (2024). Implementation of the Apriori algorithm for consumer purchase pattern analysis on a website. *Jurnal Sistem dan Teknologi Informasi (JustIN)*, 11(1), 40-48. <https://doi.org/10.26418/justin.v11i1.52945>
- Peffer, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, 24(3), 45-77. <https://doi.org/10.2753/MIS0742-1222240302>
- Pressman, R. S., & Maxim, B. R. (2020). *Software engineering: A practitioner's approach (9th ed.)*.
- Rao, A. B., Kiran, J. S., & Poornalatha, G. (2023). Application of market-basket analysis on healthcare. *International Journal of System Assurance Engineering and Management*, 14(S4), 924-929. <https://doi.org/10.1007/s13198-021-01298-2>

- Rohendi, D. M., Suryana, N., Husain, A., & Purwadi. (2023). Designing e-commerce for UMKM Ried Kantongku based on a website using Laravel framework. *JESII: Journal of Elektronik Sistem Informasi*, 1(2), 121-131. <https://doi.org/10.31848/jesii.v1i2.3371>
- Sari, Y. P., & Ali, R. (2019). Implementation of learning activity facility and infrastructure reporting system Android-based: Case study IIB Darmajaya. *Jurnal Informatika*, 19(1), 47-53. <https://doi.org/10.30873/ji.v19i1.1500>
- Sari, Y. P., Agus, I., & Sari, E. P. (2022). Smart trolley in Fitrinopane Supermarket applying brute force method mobile-based. *Jurnal Informatika*, 21(2), 196-208. <https://doi.org/10.30873/ji.v21i2.3080>
- Septian, G., & Rakhmawati, N. A. (2022). Comparative analysis of Apriori and FP-Growth algorithms for market basket analysis in Indonesian retail SMEs. *Journal of Information Systems Engineering and Business Intelligence*, 8(2), 123-134. <https://doi.org/10.20473/jisebi.8.2.123-134>
- Singh, P. K., Othman, E., Ahmed, R., Mahmood, A., Dhahri, H., & Choudhury, P. (2021). Optimized recommendations by user profiling using apriori algorithm. *Applied Soft Computing*, 106, 107272. <https://doi.org/10.1016/j.asoc.2021.107272>
- Suprianto, D. (2023). Implementation of Apriori algorithm for analysis of consumer purchase patterns. *Jurnal Informatika Sunan Kalijaga*, 8(1), 55-64.
- Susanto, H., Sucahyo, Y. G., & Ruldeviyani, Y. (2021). Factors influencing web-based information system adoption in Indonesian SMEs. *Journal of Information Technology and Computer Science*, 6(2), 178-191. <https://doi.org/10.25126/jitecs.20216261>
- Talaumbanua, I. (2022). Implementation of the Apriori algorithm to find household product sales patterns web-based at Subur Furniture Store in Serpong, South Tangerang. *Jurnal Sistem Informasi*, 11(1), 31-39.
- Tan, P.-N., Steinbach, M., Karpatne, A., & Kumar, V. (2019). *Introduction to data mining (2nd ed.)*.
- Ulfah, M., Suherman, A., & Bachtiar, A. (2022). Digital literacy and technology adoption among Indonesian micro-enterprise owners: A structural model. *International Journal of Entrepreneurship and Small Business*, 47(3), 389-408. <https://doi.org/10.1504/IJESB.2022.124567>
- Wahidi, N., & Ismailova, R. (2024). Association rule mining algorithm implementation for e-commerce in the retail sector. *Journal of Applied Research in Technology & Engineering*, 5(2), 63-68. <https://doi.org/10.4995/jarte.2024.20753>
- Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. J., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. *Journal of Business Research*, 70, 356-365. <https://doi.org/10.1016/j.jbusres.2016.08.009>
- Wardhana, A., Wahyuni, E., & Hapsari, R. (2022). The impact of data-driven decision-making on SME performance: Evidence from Indonesia. *Journal of Small Business Management*, 60(4), 921-943. <https://doi.org/10.1080/00472778.2020.1806467>