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Comparative Analysis of Apriori and FP-Growth for Order Pattern Analysis to Support Sales Strategy at Buya Aqiqah

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Abstract: Intense market competition and suboptimal transaction data management have contributed to declining sales at Buya Aqiqah, a small and medium-sized enterprise (SME) specializing in aqiqah and catering services in Depok, West Java. To address this business challenge, this study conducts a comparative performance and output analysis of the Apriori and Frequent Pattern Growth (FP-Growth) algorithms to extract customer purchasing patterns and formulate data-driven sales strategies. Following the Cross-Industry Standard Process for Data Mining (CRISP-DM) framework, the research processed historical sales transaction records spanning a two-year operational period from April 2024 to April 2026. The dataset was transformed from 749 raw sales entries into 541 tabular transactions comprising 79 distinct menu items. Experimental evaluations conducted in Google Colaboratory using Python across five distinct minimum support and confidence thresholds demonstrated that FP-Growth consistently outperformed Apriori, exhibiting substantially faster execution times and superior memory efficiency due to its compact tree-based representation without repetitive candidate itemset generation. Under the optimal parameter baseline of 2% minimum support and 100% minimum confidence, both algorithms yielded an identical set of 22 valid association rules, differing only in the sequence of rule extraction. The extracted rules identified strong affinity relationships among specific staple and side-dish combinations with significant lift values, particularly involving goat dishes, rice, and complementary menu items. These empirical findings provide actionable strategic guidance for Buya Aqiqah to optimize commercial performance through structured product bundling, cross-selling, up-selling, and targeted promotional discounts tailored to actual customer dining preferences.

Keywords: Apriori; Crisp-Dm; Data Mining; Fp-Growth; Sales Strategy.

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1. Introduction

Transaction records represent vital business assets that enable enterprises to understand consumer purchasing behavior, uncover consumption patterns, and design effective commercial strategies (Sinaga *et al.*, 2021). Within competitive retail environments, the systematic processing of transactional data enables organizations to transition from intuitive management to empirical, data-driven decision-making. Nevertheless, many micro, small, and medium enterprises (MSMEs) continue to treat transactional records merely as administrative archives or passive sales logs rather than extracting actionable intelligence from them (Arinal & Afsari, 2023). This analytical deficiency often leaves business owners unaware of product affinity trends, cross-category purchasing relationships, and shifting customer preferences over time. This operational challenge is evident at Buya Aqiqah, an MSME established in 2003 in Depok, West Java, which provides integrated aqiqah and catering services spanning livestock procurement, religious slaughtering, food processing, and meal package distribution. In recent years, heightened market competition from modern catering providers, aggressive competitor pricing, and evolving consumer buying habits have led to a substantial reduction in business volume. Monthly order volumes that historically reached approximately 100–300 goats experienced a steep downturn to only 10–15 goats per month, creating urgent pressure to formulate corrective commercial measures. This continuous sales contraction highlights the imperative for Buya Aqiqah to reevaluate its conventional marketing and product management paradigms. Historically, the business relied almost exclusively on returning clients and informal word-of-mouth recommendations, an approach that proves increasingly inadequate in capturing modern consumers who actively search, evaluate, and order catering packages through digital channels. Furthermore, the absence of analytical evaluation regarding menu popularity and complementary meal combinations has resulted in static service packages that fail to accommodate modern consumer dietary preferences. Transactional logs gathered from April 2024 to April 2026 preserve valuable historical information regarding customer order compositions that can be analyzed to resolve these business limitations. By systematically extracting frequently co-occurring menu selections, the enterprise can replace generalized pricing models with data-backed sales initiatives, including strategic meal bundling, personalized cross-selling, and targeted promotional discounts designed to stimulate order volume (Kurniana *et al.*, 2023).

Data mining methodologies provide a rigorous framework for identifying implicit patterns, behavioral trends, and structural relationships within historical sales databases. In market basket analysis, association rule mining serves as a standard technique for discovering co-occurrence affinities among items purchased within individual transactions (Amsury *et al.*, 2023). Among the established association algorithms, the Apriori algorithm identifies frequent itemsets using a breadth-first search and a candidate generation-and-test mechanism constrained by minimum support and confidence thresholds. However, Apriori frequently suffers from computational bottlenecks caused by repetitive database scans and an exponential growth of candidate combinations when handling dense datasets. Conversely, the Frequent Pattern Growth (FP-Growth) algorithm addresses these computational constraints by compressing transaction datasets into an FP-tree structure, allowing frequent pattern extraction through conditional tree projections without generating candidate combinations explicitly (Arinal & Rusmarhadi, 2024). To execute this analytical procedure methodically, the Cross-Industry Standard Process for Data Mining (CRISP-DM) provides a robust, multi-phase lifecycle encompassing Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, and Deployment (Fadillah & Wicaksono, 2023). Previous empirical studies have confirmed that association rule mining can effectively reveal consumer buying trends across various commercial contexts. Apriori has been successfully deployed to optimize inventory control, forecast product demand, and assemble meal combos in culinary enterprises, while FP-Growth has demonstrated equivalent analytical capability with superior computational scalability in dense retail transaction environments (Lubis & Lestari, 2023). However, a significant gap persists in the existing literature: most investigations examine a single algorithm in isolation without providing a rigorous comparative assessment of execution speed, memory footprint, and rule consistency under identical transactional conditions. Furthermore, the specialized operational domain of aqiqah catering services—characterized by specific package configurations, traditional livestock dishes, and diverse side menus—remains substantially underexplored in empirical data mining research. Consequently, a direct comparative inquiry evaluating both computational overhead and pattern extraction quality is essential to ascertain the most efficient and practical algorithm for this specialized commercial domain. To address these empirical and operational needs, this study conducts a direct comparative evaluation between the Apriori and FP-Growth algorithms using empirical sales transaction data from Buya Aqiqah. The comparative benchmarking specifically investigates processing time, memory allocation, and the structural integrity of the resulting association rules across multiple parameter scenarios. Guided by the CRISP-DM methodology, historical sales records from April 2024 to April 2026 are processed to extract affinity rules that reflect genuine consumer ordering behavior. The resulting association patterns are expected to furnish verifiable, data-driven guidelines

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for Buya Aqiqah management to revitalize commercial performance through structured menu bundling, complementary cross-selling, and dynamic promotional strategies (Ananda *et al.*, 2023).

2. Related Work

Several empirical studies have implemented data mining and association rule mining on commercial sales records to uncover consumer purchasing patterns and support operational decision-making. Sinaga *et al.* (2021) deployed the Apriori algorithm on coffee shop transaction data at Ucokopi, successfully identifying recurrent beverage and food combinations that informed inventory replenishment schedules and promotional package configurations. In a related study on culinary micro-enterprises, Oktavian and Rumaisa (2022) integrated business intelligence with the Apriori algorithm at UMKM Foodendez, demonstrating that customer transaction logs could delineate distinct market segments and facilitate targeted marketing campaigns. Focusing on the culinary MSME sector, Briliantino and Perdana (2023) applied Apriori to sales logs from Banyu Burgerbar, determining high-demand menu pairings and item interdependencies to establish evidence-based promotional frameworks. Furthermore, empirical investigations across diverse food service businesses have reaffirmed that mining association rules can systematically uncover complementary dish selections to guide product bundling, cross-selling, and dynamic menu pricing (Sudarmo *et al.*, 2025). In addition to Apriori, researchers have investigated the FP-Growth algorithm as an efficient alternative for extracting frequent consumption patterns. FP-Growth is particularly advantageous when transactional databases exhibit high item density and recurring combinations because it constructs a compressed tree representation rather than generating candidate combinations iteratively (Amsury *et al.*, 2023). Prior literature demonstrates that both Apriori and FP-Growth are capable of identifying reliable purchasing associations, although their computational structures and execution efficiency vary substantially depending on dataset scale and parameter constraints. Table 1 summarizes the representative literature applying association rule mining across retail and food service domains.

Table 1. Summary of Related Work on Association Rule Mining in Business Domains

Author (Year)	Business/Domain	Method	Main Result
Sinaga *et al.* (2021)	Ucokopi / Culinary business	Apriori	Identified frequently purchased menu combinations for stock management and promotional packages.
Oktavian & Rumaisa (2022)	UMKM Foodendez	Business Intelligence + Apriori	Identified sales patterns and market segments to support targeted marketing strategies.
Briliantino & Perdana (2023)	Banyu Burgerbar / Culinary MSME	Apriori	Identified high-demand products and purchasing relationships to support promotional strategies.
Kurniana *et al.* (2023)	Cafe Sakuyan Side	Apriori	Generated association rules that supported menu bundling and cross-selling strategies.
Amsury *et al.* (2023)	The Gade Coffee & Gold	Association Rule + Apriori	Extracted association rules utilized for cross-selling initiatives and promotional activities.
Fadillah & Wicaksono (2023)	Commercial sales / MSME	Apriori	Extracted customer purchasing patterns as a basis for promotional and sales strategies.
Arinal & Rusmarhadi (2024)	Raja Geprek / Culinary MSME	Apriori + CRISP-DM	Generated association rules to support menu bundling and promotional pricing strategies.
Lubis & Lestari (2023)	Ayaa Fashion / Retail MSME	Association Rule + FP-Growth	Identified frequent itemsets and purchasing relationships for promotional and inventory planning.

As summarized in Table 1, association rule mining using either Apriori or FP-Growth has established practical efficacy in detecting consumer buying trends across culinary, retail, and general MSME operations. These studies demonstrate that transaction histories can be systematically mined to discover inter-item correlations, supporting strategic initiatives such as combo bundling, cross-selling, and targeted price discounts. Nonetheless, most existing research has focused on deploying a single algorithmic model in isolation, rarely

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conducting a head-to-head empirical comparison between Apriori and FP-Growth under identical transaction logs and uniform experimental parameters. Moreover, analytical investigations specifically addressing aqiqah and traditional catering services remain absent from the published literature. Therefore, this study positions itself as a comparative inquiry that benchmarks both algorithms using empirical sales transaction data from Buya Aqiqah to uncover purchasing affinities and provide a quantitative foundation for commercial revitalization. The fundamental divergence between Apriori and FP-Growth resides in their underlying frequent-itemset mining mechanisms. The Apriori algorithm operates via a candidate generation-and-test paradigm, searching frequent itemsets level by level through a breadth-first search. Candidate itemsets are generated by joining previously discovered frequent itemsets, and each candidate is subsequently validated against the database to prune combinations that fall below the minimum support threshold. This iterative scanning mechanism incurs substantial computational overhead, as the transaction database must be scanned repeatedly at each hierarchical level, generating an exponential volume of candidate combinations in dense datasets. Consequently, the iterative scanning and extensive candidate storage requirements directly increase processing time and memory consumption. Conversely, the FP-Growth algorithm eliminates candidate generation entirely by adopting a divide-and-conquer strategy supported by an FP-tree (Frequent Pattern Tree) structure. The algorithm requires only two complete database scans: the first scan identifies frequent individual items, and the second constructs a highly compressed FP-tree by mapping transaction paths that share common prefixes. Frequent itemsets are subsequently extracted directly from conditional FP-trees projected for each frequent item. By circumventing explicit candidate generation and substantially reducing input/output operations, FP-Growth maintains compact memory utilization and accelerates execution speed. These architectural differences provide the theoretical rationale for benchmarking the computational performance of both algorithms on the Buya Aqiqah transaction dataset. In evaluating the resulting association rules, the quality and statistical strength of the discovered relationships are assessed using three primary metrics: support, confidence, and lift. Support indicates the frequency with which a specific itemset occurs within the overall transaction database. Confidence reflects the conditional probability that a customer purchases a subsequent item given the presence of an antecedent item. Meanwhile, lift measures the strength of the association rule relative to the expected co-occurrence under conditions of statistical independence, where a value strictly greater than one indicates a meaningful positive purchasing affinity. These evaluation principles serve as the theoretical benchmark for analyzing the empirical outputs generated by both algorithms.

3. Methodology

3.1 Research Framework

This study employed a quantitative methodology grounded in the Cross-Industry Standard Process for Data Mining (CRISP-DM) framework to analyze sales transaction records and benchmark the algorithmic performance of Apriori and FP-Growth. CRISP-DM was selected because it provides a systematic, industry-standard process model for converting raw transactional data into actionable business intelligence. The methodology comprises six sequential phases: Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, and Deployment. The structured implementation flow is depicted in Figure 1.

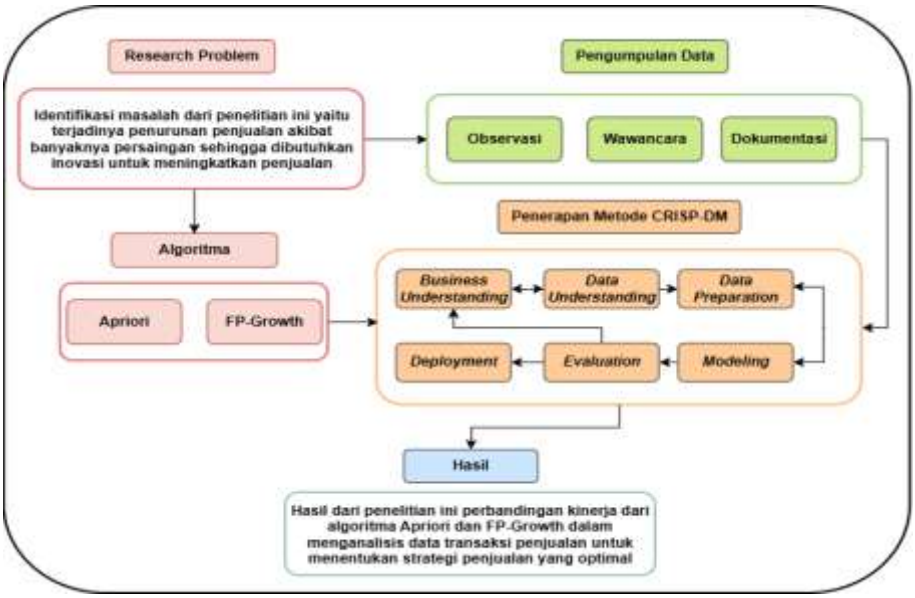


Figure 1. Stages of Methodology Implementation

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The framework commenced with the Business Understanding phase, identifying the persistent order reduction at Buya Aqiqah and establishing the strategic objective of utilizing historical transactions to design data-driven sales packages. The Data Understanding phase involved assessing data distributions, transaction completeness, and attribute integrity. Data Preparation addressed data cleaning, deduplication, metadata standardization, and binary transformation. In the Modeling phase, both Apriori and FP-Growth algorithms were executed across identical parameter constraints. The Evaluation phase benchmarked the computational efficiency in terms of execution time and memory footprint, alongside assessing the validity of the generated association rules. Finally, the Deployment phase formulated commercial strategies—such as bundling combinations, cross-selling schemes, and targeted promotional discounts—based on the empirical findings.

3.2 Dataset Description and Preprocessing

The dataset utilized in this investigation comprises historical sales transaction logs from Buya Aqiqah, an MSME catering enterprise located in Depok, West Java, recorded between April 2024 and April 2026. Sourced from the enterprise's manual sales tracking system, the raw dataset contained 749 transactional records structured across six attributes: order number (*order no*), order date (*order date*), menu item name (*item name*), quantity purchased (*quantity*), unit price (*price*), and total transaction amount (*amount*). Because financial pricing details represent sensitive proprietary data, the *price* and *amount* attributes were excluded from algorithmic processing. For association rule discovery, the analysis retained *order no* as the unique basket transaction identifier and *item name* as the product categorical variable. During data preparation, data hygiene routines were executed to remove null records, rectify typographical inconsistencies in menu names, and eliminate anomalous metadata entries. Subsequently, the normalized transaction records were mapped into a tabular format and converted into a one-hot binary transaction matrix, where a value of 1 indicates the inclusion of an item within a given order basket, and 0 indicates its absence. This encoding consolidated the 749 raw sales entries into 541 unique transaction baskets covering 79 distinct culinary menu items.

3.3 Computational Environment and Software Pipeline

The analytical pipeline was implemented using the Python programming language within the Google Colaboratory cloud environment. Data wrangling and binary matrix structures were constructed using the Pandas library, while frequent itemset mining and association rule generation were executed using the mlxtend (Machine Learning Extensions) library. To ensure rigorous computational benchmarking between Apriori and FP-Growth under identical conditions, algorithmic execution time was quantified in seconds using Python's built-in time module, and peak RAM allocation was measured using the tracemalloc library. Table 2 details the hardware specifications of the local client workstation utilized to access and manage the cloud programming environment.

Table 2. Specifications of Local Workstation Hardware

No.	Hardware Component	Specification
1.	Processor	Intel Core i3-6006U (2.0 GHz)
2.	Internal Storage	Solid State Drive (SSD) 256 GB
3.	Random Access Memory (RAM)	8 GB DDR4
4.	System Architecture	64-bit Operating System, x64-based processor
5.	Operating System	Windows 10 Home

The specifications detailed in Table 2 represent the local terminal environment used to control execution; the underlying parallel computations and matrix operations were hosted on Google Colaboratory cloud virtual instances.

3.4 Testing Scenarios and Evaluation Criteria

To examine algorithmic stability, observe computational resource behavior across expanding search spaces, and extract meaningful purchasing patterns, empirical evaluations were conducted across five parameter scenarios. Each scenario systematically adjusted the minimum support and minimum confidence thresholds: Scenario 1: Minimum Support = 6%, Minimum Confidence = 20%, Scenario 2: Minimum Support = 5%, Minimum Confidence = 40%, Scenario 3: Minimum Support = 4%, Minimum Confidence = 40%, Scenario 4: Minimum Support = 3%, Minimum Confidence = 60%, Scenario 5: Minimum Support = 2%, Minimum Confidence = 100%. The statistical quality, pattern relevance, and associative strength of an extracted rule were evaluated using three standard metrics: support, confidence, and lift ratio. Support indicates the proportion of total transactions in the dataset that simultaneously contain both the antecedent and consequent itemsets. Confidence evaluates the reliability of the rule by measuring the conditional probability that a customer orders the consequent item given that the antecedent item has already been selected. Lift ratio measures the dependency between the antecedent and consequent relative to their

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expected co-occurrence under conditions of statistical independence. A lift ratio strictly greater than 1.0 confirms a statistically valid positive relationship, demonstrating that the presence of the antecedent item substantially increases the probability of purchasing the consequent item. Rules satisfying the conditions in Scenario 5 (minimum support of 2% and minimum confidence of 100%) with high lift ratios were selected for final business strategy recommendations.

4. Results and Discussion

4.1 Results

The empirical evaluation was structured in accordance with the CRISP-DM lifecycle, covering data preparation, algorithmic modeling, computational benchmarking, and rule extraction. In the initial exploratory phase, 749 historical sales records from Buya Aqiqah covering the period from April 2024 to April 2026 were extracted from spreadsheet logs, as shown in Figure 2. Data preparation involved filtering out redundant attributes, correcting typographical inconsistencies in menu naming, and removing invalid metadata, resulting in the cleaned transactional dataset shown in Figure 3. The dataset was subsequently encoded into a one-hot binary transaction matrix, as illustrated in Figure 4. This transformation consolidated the raw logs into 541 distinct customer transactions structured across 79 unique culinary menu items.

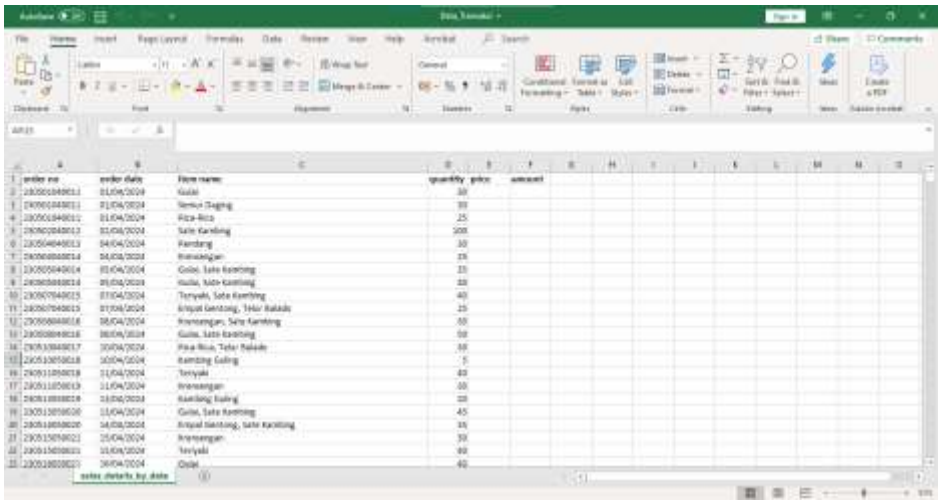


Figure 2. Raw Transaction Data

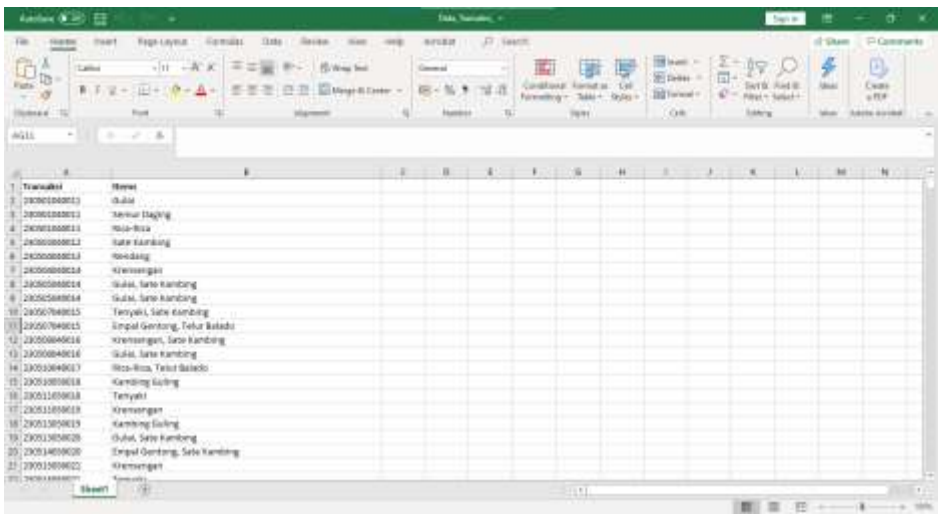


Figure 3. Cleaned Dataset

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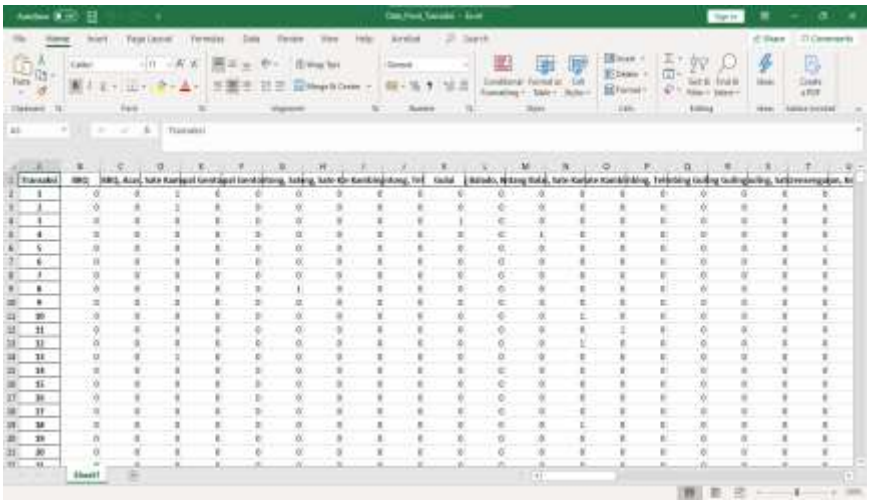


Figure 4. Tabular Data Transformation

In the modeling phase, both Apriori and FP-Growth algorithms were executed on the binary transaction matrix using the mlxtend library within the Python Google Colaboratory runtime environment. The frequent itemset mining and rule generation pipelines were executed across the five experimental scenarios defined in Section 3. Algorithmic efficiency was quantified by measuring execution speed (in seconds) and peak memory allocation (in megabytes). Table 3 summarizes the comparative computational performance of both algorithms across all testing configurations.

Table 3. Computational Performance Benchmarking of Apriori and FP-Growth

Experiment	Algorithm	Minimum Support	Minimum Confidence	Execution Speed (Seconds)	Memory Usage (MB)
1	Apriori	6%	20%	0.2314	1.1122
	FP-Growth	6%	20%	0.0171	0.1510
2	Apriori	5%	40%	0.4228	1.2903
	FP-Growth	5%	40%	0.0155	0.1269
3	Apriori	4%	40%	0.3086	1.1300
	FP-Growth	4%	40%	0.0194	0.1760
4	Apriori	3%	60%	0.2774	1.1300
	FP-Growth	3%	60%	0.0478	0.4393
5	Apriori	2%	100%	0.0659	2.0869
	FP-Growth	2%	100%	0.0268	1.0925

As documented in Table 3 and illustrated in Figure 5, FP-Growth consistently demonstrated superior execution speed compared to Apriori across all tested scenarios. In Experiment 1, FP-Growth completed pattern extraction in 0.0171 seconds, whereas Apriori required 0.2314 seconds, representing a computational speedup exceeding thirteen times. A similar performance gap was observed in Experiment 2, where FP-Growth achieved execution in 0.0155 seconds against 0.4228 seconds for Apriori, delivering a speedup factor of more than twenty-seven times. Across Experiments 3 and 4, FP-Growth maintained its runtime efficiency within a fraction of a second (0.0194 and 0.0478 seconds), whereas Apriori consistently hovered around 0.27 to 0.30 seconds. Even in Experiment 5, where the execution time of Apriori dropped to 0.0659 seconds due to the highly restrictive 100% confidence constraint that aggressively pruned the downstream rule-filtering phase, FP-Growth still executed more than twice as fast at 0.0268 seconds. In addition to processing time, memory allocation patterns underscored substantial architectural differences between the two methods, as shown in Figure 6. Apriori imposed a consistently higher memory footprint across all testing scenarios, consuming over 1.1 MB even at higher support thresholds (6% and 5%). As the minimum support threshold was progressively lowered to 2% in Experiment 5, the search space of potential item combinations expanded considerably, causing Apriori's peak memory allocation to surge to 2.0869 MB. Conversely, FP-Growth exhibited an exceptionally lean memory profile, consuming between 0.1269 MB and 0.4393 MB in Experiments 1 through 4, and only reaching 1.0925 MB in Experiment 5—an allocation roughly half that required by Apriori under the exact same parameters. These empirical trends reveal a clear relationship: lower minimum support thresholds cause exponential growth in candidate itemsets, which severely impacts system overhead. While Apriori must continuously generate, maintain, and scan candidate k-itemsets across multiple database passes, FP-Growth preserves structural compactness through its FP-tree structure, allowing frequent patterns to be extracted via

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conditional tree projection without building exhaustive combinatorial sets. Consequently, FP-Growth proves far more scalable and resource-efficient for handling transaction logs characterized by dense item pairings.

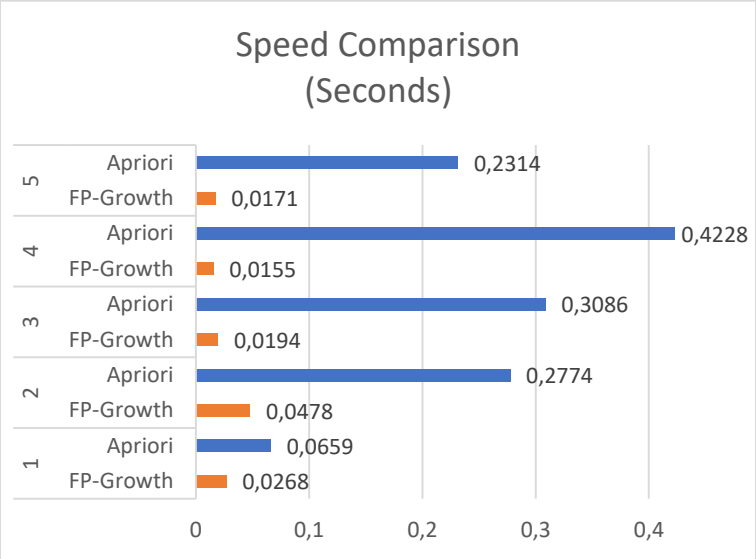


Figure 5. Comparison of Algorithm Processing Speed

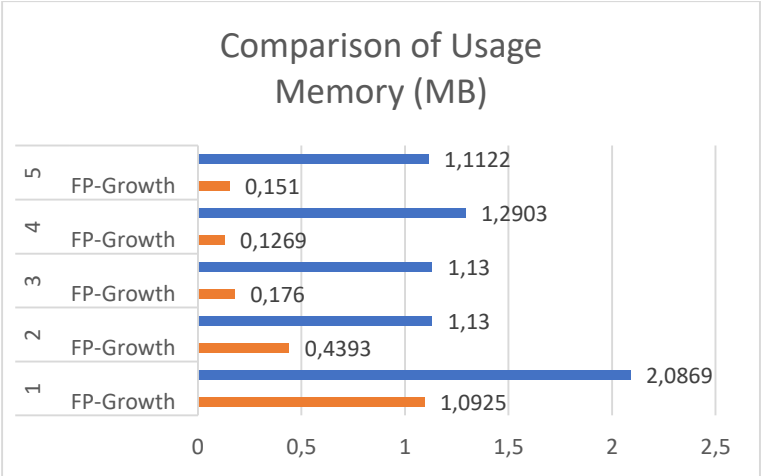


Figure 6. Comparison of Algorithm Memory Usage

In Scenario 5, setting the minimum support threshold to 2% and the minimum confidence threshold to 100% produced 22 valid association rules. Both Apriori and FP-Growth discovered an identical set of association rules, differing only in internal row ordering and index assignments. To highlight the strongest and most actionable commercial affinities, the eight rules exhibiting the highest lift values are detailed in Table 4.

Table 4. Best-Performing Association Rules Based on Lift Values

No.	Antecedents	Consequents	Support	Confidence	Lift
1	Gulai, Telur Balado, Acar	Sate Kambing	0.0347	1.0000	12.3385
2	Nasi, Rica-Rica, Kerupuk Udang	Kentang Balado, Acar	0.0254	1.0000	9.7273
3	Nasi, Rica-Rica	Kentang Balado, Acar	0.0975	1.0000	9.3636
4	Nasi, Semur Daging, Gulai	Sate Kambing	0.0200	1.0000	7.0268
5	Nasi, Sate Kambing, Acar	Gulai	0.0534	1.0000	7.0268
6	Sate Kambing, Krensengan, Telur Balado	Kerupuk Udang	0.0868	1.0000	7.0268
7	Nasi, Sate Kambing, Acar	Telur Balado	0.0200	1.0000	5.8358
8	Rica-Rica, Kerupuk Udang	Kentang Balado	0.0254	1.0000	5.0268

The association rules in Table 4 reveal clear, recurrent purchasing affinities among main livestock dishes and complementary side items. Rule 1 demonstrates that transactions containing *Gulai*, *Telur Balado*, and *Acar* invariably include *Sate Kambing*, with a support of 0.0347 (3.47%), a confidence of 1.0000 (100%), and the

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highest lift value of 12.3385. The 100% confidence level indicates that all historical customers who selected this specific combination of accompaniments also ordered *Sate Kambing*, while the lift value confirms an exceptionally strong positive dependency far beyond chance co-occurrence. Similarly, Rules 2 and 3 highlight robust complementary relationships between *Rica-Rica* preparations and side dishes (*Kentang Balado* and *Acar*), achieving lift values of 9.7273 and 9.3636, respectively. In the deployment stage of CRISP-DM, these extracted rules and computational findings were consolidated into a strategic business report for Buya Aqiqah management, translating empirical association patterns into concrete commercial package configurations.

4.2 Discussion

This study conducted an empirical comparison between the Apriori and FP-Growth algorithms to discover customer purchasing patterns and support the formulation of optimized sales strategies for Buya Aqiqah in Depok, West Java. The experimental findings confirm that FP-Growth achieves substantially faster processing speed and requires less memory allocation than Apriori across all testing scenarios, even though both algorithms produce an identical set of 22 association rules under equivalent support and confidence constraints. This computational divergence stems directly from their structural mechanisms. Apriori employs an iterative candidate generation-and-test approach requiring multiple passes over the dataset, leading to high computational complexity when evaluating multi-item combinations. In contrast, FP-Growth compresses transactional information into a compact FP-tree structure and extracts patterns through conditional tree projection, thereby minimizing input/output overhead and candidate storage. These empirical results corroborate previous findings in commercial data mining literature. Lubis and Lestari (2023) demonstrated that FP-Growth handles retail transactions characterized by recurring item combinations with superior computational efficiency compared to Apriori. Similarly, Arinal and Rusmarhadi (2024) highlighted that Apriori incurs significant computational overhead in larger or denser transaction sets due to repetitive candidate validation cycles. The findings also align with Amsury *et al*. (2023) and Sudarmo *et al*. (2025), confirming that while both algorithms maintain mathematical equivalence in rule discovery accuracy, FP-Growth provides distinct scalability benefits for enterprise transaction processing. From a business perspective, the application of the CRISP-DM framework ensured that analytical procedures directly addressed the underlying operational challenge at Buya Aqiqah, namely counteracting the severe sales decline from 100–300 goats to 10–15 goats per month. As emphasized by Sinaga *et al*. (2021), grounding association models in business realities is crucial for transforming raw transaction logs into targeted commercial interventions. The strong affinity rules identified in Table 4 provide an empirical foundation for revitalizing Buya Aqiqah's sales strategies through structured bundling and targeted promotional frameworks.

Specifically, the high-affinity rules provide clear managerial direction for product restructuring. Rule 1, exhibiting a lift of 12.3385, and Rule 5, with a lift of 7.0268, identify *Sate Kambing* and *Gulai* as the foundational culinary pairing in consumer preferences, consistently accompanied by *Telur Balado* and *Acar*. Buya Aqiqah management can leverage this high correlation to introduce a pre-configured "Standard Aqiqah Box" combining these specific dishes at an attractive bundle price, thereby eliminating choice fatigue and accelerating customer purchasing decisions. In addition to conventional packages, Rules 2, 3, and 8 reveal a prominent cluster centered on *Rica-Rica* paired with *Kentang Balado*, *Acar*, and *Kerupuk Udang*, with lift values ranging from 5.0268 to 9.7273. This empirical pattern justifies the creation of an "Alternative Catering Package" tailored for modern or younger consumer segments seeking flavorful alternatives beyond traditional sate and gulai preparations. Furthermore, the extracted patterns offer actionable guidelines for up-selling and cross-selling initiatives. Rule 6 (lift = 7.0268) and Rule 7 (lift = 5.8358) demonstrate that orders combining meat dishes such as *Sate Kambing* and *Krensengan* frequently prompt the addition of side items, particularly *Kerupuk Udang* and *Telur Balado*. Operational staff and future digital sales interfaces can implement automated cross-selling prompts that systematically suggest these complementary side dishes during order intake, effectively increasing average order value. These operational recommendations strongly support the conclusions of Syahriani (2022) and Kurniana *et al*. (2023), who demonstrated that association-driven bundling and promotional targeting significantly enhance cross-selling efficiency and customer conversion rates in culinary MSMEs.

5. Conclusion and Recommendations

This study successfully applied the Apriori and FP-Growth algorithms within the Cross-Industry Standard Process for Data Mining (CRISP-DM) framework to analyze sales transaction records from Buya Aqiqah in Depok, West Java. Benchmarking across five experimental scenarios confirmed that FP-Growth consistently outperformed Apriori in computational efficiency, achieving execution speeds up to thirteen times faster (0.0171 seconds versus 0.2314 seconds in Scenario 1) and consuming substantially less peak memory (1.0925 MB versus 2.0869 MB in Scenario 5). Despite their computational differences, both algorithms generated an

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identical set of 22 association rules under a minimum support threshold of 2% and a minimum confidence threshold of 100%. The extracted patterns revealed strong purchasing affinities, prominently highlighting the combination of *Gulai*, *Telur Balado*, and *Acar* with *Sate Kambing* (lift = 12.3385), as well as modern meal combinations centered on *Rica-Rica* and complementary side dishes. The primary academic contribution of this research lies in providing a rigorous, empirical head-to-head evaluation of Apriori and FP-Growth under identical transactional constraints within the specialized aqiqah and catering MSME sector. By demonstrating that FP-Growth delivers equivalent rule discovery accuracy with superior computational scalability, this study provides actionable methodological guidance for small enterprise data mining. From a practical perspective, the extracted association rules offer an empirical foundation for overcoming Buya Aqiqah's sales decline through three concrete commercial strategies: configuring pre-packaged core aqiqah meal boxes, establishing alternative catering menus for younger consumer demographics, and implementing automated cross-selling prompts for high-affinity side items. Nevertheless, this study is subject to several limitations. The empirical analysis was confined to a single MSME enterprise with 541 unique transaction baskets over a two-year observation period (April 2024 to April 2026), which may reflect enterprise-specific consumer habits. Future research should expand the empirical scope to multi-enterprise catering datasets and longitudinal observation windows to capture broader seasonal purchasing dynamics. Additionally, prospective studies could benchmark FP-Growth against vertical data format algorithms such as ECLAT or integrate association rule discovery with predictive machine learning models. Finally, embedding these affinity rules into a real-time web-based point-of-sale (POS) or customer-ordering mobile application represents a valuable avenue to automate dynamic menu recommendations and continuously refine commercial strategies.

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