The 2nd International Conference on Multidisciplinary Commodity Distribution In Central Aceh Through An Integrated Auction Market System Using The Android-Based Association Rule Mining (ARM) Method

Data Mining Analysis Of

Abstract
Commodity distribution in Central Aceh faces inefficiencies due to lengthy distribution chains and limited price control, which often leads to higher costs for consumers and lower profits for farmers. To address these issues, this study develops an integrated auction market system based on Android, utilizing the Association Rule Mining (ARM) method to optimize the distribution and pricing of commodities. ARM is a data mining technique that uncovers high-frequency patterns in transaction data. By applying ARM with the apriori algorithm, the system identifies key associations among commodities, allowing for more efficient and targeted price recommendations. The system calculates the highest bid for each commodity and recommends optimal pricing strategies to sellers based on frequent pattern analysis, improving transparency and reducing distribution inefficiencies. Testing and implementation of this system indicate that it successfully reduces distribution costs while increasing the effectiveness and speed of the auction process. Overall, the Android-based auction market system shows promise as a tool for enhancing distribution efficiency, optimizing bid values, and supporting local economies in Central Aceh through more equitable commodity pricing.

Keywords: Data Mining, Association Rule Mining (ARM), Commodity Distribution, Android-Based Auction Market System, Apriori Algorithm.

Introduction

The research addresses inefficiencies in commodity distribution within Central Aceh. The Indonesian Ministry of Trade, through BAPPEBTI, established the Commodity Auction Market under Law No. 7 of 2014, Ministerial Decision No. 650/MPP/Kep/10/2004, and Bappebti Regulations Nos. 5, 6, and 7 of 2018. These regulations support three auction methods: offline, online, and hybrid. However, the online auction method has limitations, including restricted auction times and unclear verification processes for commodities being sold online (Permendag 65/2021)

The distribution chain in Central Aceh is long, raising consumer costs and causing low farm-level selling prices due to overproduction. To address this, the study applies Association Rule Mining (ARM) to optimize distribution. ARM is a data mining method that identifies associative rules between item combinations, frequently using high-frequency pattern analysis (Frequent Pattern Mining) [1]. In the proposed Integrated Auction Market System (SPLT), ARM, implemented with the apriori algorithm, determines the highest bids, helping to improve farmer sales values and optimize commodity distribution.

The study aims to build an efficient SPLT on Android using ARM to enhance the distribution of staple commodities in Central Aceh. This system is expected to provide pricing transparency, reduce costs, and benefit low-income families by improving distribution quality and efficiency [2].

Literature Review

A. Data Mining

Data mining is the analytical process of examining large datasets to uncover hidden relationships and summarize data into useful information. This includes techniques to recognize patterns, classifications, and associations that can be used for decision-making [2]. In the context of commodity distribution, data mining helps understand distribution patterns and market behavior for commodities in Central Aceh. Data mining is defined as a set of processes useful for exploring and searching for values in the form of information, as well as complex relationships that have been stored within a database. By extracting information patterns from data, it becomes possible to manipulate data into new, more useful information obtained by extracting and recognizing valuable or interesting patterns found within the database [3]. From various perspectives, data mining is a field of knowledge that can be divided into characteristics, discrimination, association, classification, clustering, trends, and outliers. Techniques in data mining include databases, machine learning, statistics, and visualization. The types of data that can be used include relational, transactional, multimedia, web, and text data [4].

B. Association Rule Mining (ARM)

Association Rule Mining is a data mining method aimed at finding associative rules between items that frequently appear together in transactions. ARM is crucial for identifying item relationships, which helps in generating pricing and bidding recommendations within the auction system [1]. Association analysis, or association rule mining, is a data mining technique aimed at discovering patterns of association rules between combinations of items. The primary step in association rules is identifying how often item combinations appear in the database, commonly referred to as frequent patterns. There are two references in association rules:

1. Support: the number of transactions containing a particular itemset or the frequency of occurrence of the itemset.
2. Confidence: the certainty value, which indicates the strength of the relationship between itemsets. Confidence can be determined once the frequent pattern of an itemset's occurrence is found [5].

C. Apriori Algorithm

The apriori algorithm is a key algorithm in ARM that identifies frequent itemsets by utilizing minimum support and confidence thresholds to establish associations between items. This algorithm is highly efficient for high-frequency pattern analysis, especially in transaction data analysis within auction markets [6]. The main concepts in the Apriori algorithm are frequent itemsets (sets of items that meet the minimum support value), the Apriori property (any subset of a frequent itemset is also frequent), and the join operation. This algorithm was initially designed to be applied to purchase transaction data in a store; however, its usage has recently extended beyond that scope. The inputs for the Apriori algorithm are the min_sup (minimum support value) and transaction data. Apriori generates all frequent itemsets from the transaction data available in the database [7].

D. Previous Research

Several previous studies have applied ARM in various contexts. For instance, Sabna, used ARM for arranging books in libraries based on borrowing patterns [8], while Amalia & Evicienna applied data mining to determine decision patterns in childbirth processes . These studies provide a foundation for applying ARM in commodity distribution and auction contexts [9].

Methods And Research

The methodology of this research includes data collection conducted in February 2024 at the Cooperative and UMKM Office as well as the Agricultural Office of Central Aceh to support the development of an Android-based Integrated Auction Market System (SPLT) using the Association Rule Mining (ARM) method. The research steps consist of direct data collection, a literature review to deepen understanding of ARM, and data analysis aimed at identifying association patterns. A system needs analysis was carried out to determine hardware and software specifications, with the primary software being Android Studio and XAMPP. SPLT enables users, such as buyers, sellers, and quality controllers, to log in, input auction data, and use ARM to analyze patterns and identify associative rules that generate the highest bids and optimal price recommendations. The ARM process involves setting support and confidence thresholds to generate frequently occurring itemsets and rules within transactions, which contributes to enhancing the efficiency of commodity distribution in Central Aceh.

1. High-Frequency Pattern Analysis for Support

The support value of an item is obtained using the following formula:

$$\textit{Support}\ (A) = \frac{\sum \text{Jumlah Transaksi Yang Mengandung A}}{\sum \text{Total Transaksi}} X100 \tag{1}$$

The support value for two items is calculated using the following formulas:

$$\textit{Support}\ (A,B) = P\ (A \ \Pi\ B)$$

$$\textit{Support}\ (A,B) = \frac{\sum \text{Jumlah Transaksi Yang Mengandung A dan B}}{\sum \text{Total Transaksi}} X100 \tag{2}$$

2. Formation of Confidence in Association Rules

The confidence value for forming an association rule is calculated using the formula:

$$\textit{Confidence}\ (A,B) = \frac{\sum \text{Jumlah Transaksi Yang Mengandung A dan B}}{\sum \text{Transaksi Mengandung A}} X100 \tag{3}$$

A. System schematic

The following diagram provides a comprehensive overview of the system workflow, detailing each phase from system initiation to completion. Starting with user login based on roles (buyer, seller, or quality assurer), the process involves entering auction data to form a dataset. This dataset undergoes analysis through association rule mining to discover patterns in commodity distribution. Subsequent stages include rule evaluation to verify the mined patterns, optimization of commodity distribution based on identified rules, and rigorous testing and validation to ensure system accuracy and reliability. Finally, the highest bid result is displayed, marking the end of the process.

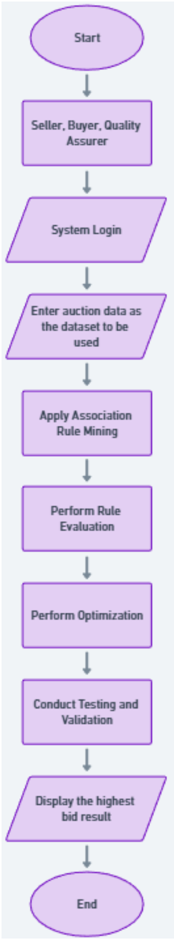

Figure 1. System schematic

Description :

1. Start the system.
2. Log in to the system, with three roles available: buyer, seller, and quality assurer.
3. Enter auction data that has been collected, including details like commodity type, price, location, time, etc., which will be used as a dataset.
4. Apply association rule mining to identify patterns in commodity distribution.
5. Perform rule evaluation to assess the rules generated from the association rule mining.
6. Conduct optimization to enhance commodity distribution based on the generated rules.
7. Carry out testing and validation to test the application and validate the optimization results.
8. Display the highest bid result after all processes are completed.
9. End

Results and Discussion

This section provides a comprehensive overview of the findings obtained from the implementation of the Association Rule Mining (ARM) algorithm using data derived from 100 auction transactions within the integrated market system in Aceh Tengah. Each transaction includes critical information such as transaction ID, product name, buyer name, final price, and transaction date. The data is sourced from the Department of Cooperatives and SMEs and the Department of Agriculture in Aceh Tengah, aimed at uncovering purchasing patterns and providing actionable insights for optimizing commodity distribution.

Table 1. Transaction data

Transaction ID	Product Name	Buyer Name	Final Price	Transaction Date
1	Ubi Kayu	Buyer 1	50,000.00	07/10/202400:00
2	Bawang Merah	Buyer 1	30,000.00	20/09/2024 00:00
3	Tomat Cherry	Buyer 1	25,000.00	23/09/2024 00:00
4	Telur Ayam	Buyer 1	35,000.00	04/10/2024 00:00
5	Kapulaga	Buyer 1	45,000.00	29/09/2024 00:00

6	Wortel	Buyer 1	20,000.00	17/10/2024 00:00
7	Kentang	Buyer 1	15,000.00	19/09/2024 00:00
8	Bawang Merah	Buyer 1	30,000.00	22/09/2024 00:00
9	Wortel	Buyer 1	20,000.00	28/09/2024 00:00
10	Tomat Cherry	Buyer 1	25,000.00	13/10/2024 00:00
...	...	...	...	...
100	Telur Ayam	Buyer 1	40,000.00	26/09/2024 00:00

(Above is a representative sample of the total 100 transactions)

Support Calculation Results

The ARM process began with calculating the support value for each product-price combination based on the transaction data. The support metric reflects the frequency with which a specific product-price pair occurs within the total transaction volume.

Support Formula:

$$\text{Support (Product , Price)} = \frac{\text{Number of Transactions with the same Product and Price}}{\text{Total Number of Transactions}} \times 100$$

Example Calculation: For Wortel priced at Rp 20,000:

- Number of Transactions: 15
- Total Transactions: 100

$\text{Support (Wortel, 20,000)} = \frac{15}{100} \times 100 = 15\%$

The calculated support for various commodities is summarized in the following table:

Table 2. calculated support

Product Name	Final Price	Count	Support (%)
Bawang Merah	30,000.00	9	9.0
Gula Aren	60,000.00	7	7.0
Kapulaga	45,000.00	8	8.0
Kentang	15,000.00	9	9.0
Susu Bubuk	55,000.00	11	11.0
Telur Ayam	35,000.00	6	6.0
Telur Ayam	40,000.00	12	12.0
Tomat Cherry	25,000.00	14	14.0
Ubi Kayu	50,000.00	9	9.0
Wortel	20,000.00	15	15.0

The results indicate that Wortel at a price of Rp 20,000 possesses a support of 15%, meaning that this combination accounted for 15% of total transactions, while Susu Bubuk at Rp 55,000 reflects a support of 11%.

Confidence Calculation Results

Following the support analysis, the next phase involved calculating the confidence for each association rule correlating product names with their respective prices. The confidence metric is computed by comparing the support of the product-price combination to the overall support of the product itself.

Confidence Formula:

$$\text{Confidence (Product, Price)} = \frac{\text{Support (Product, Price)}}{\text{Support (Product)}} \times 100$$

Example Calculation: For Telur Ayam at Rp 35,000:

- Support for the combination: 6
- Support for Telur Ayam (any price): 18

$$\text{Confidence (Telur Ayam, 35,000)} = \frac{6}{18} \times 100 = 33.33\%$$

The results of the confidence calculations are summarized in the table below:

Table 3. Results of the confidence calculation

Product Name	Final Price	Count	Support	Support (Item Only)	Confidence (%)
Bawang Merah	30,000.00	9	9.0	9.0	100.0
Gula Aren	60,000.00	7	7.0	7.0	100.0
Kapulaga	45,000.00	8	8.0	8.0	100.0
Kentang	15,000.00	9	9.0	9.0	100.0
Susu Bubuk	55,000.00	11	11.0	11.0	100.0
Telur Ayam	35,000.00	6	6.0	18.0	33.33
Telur Ayam	40,000.00	12	12.0	18.0	66.67

Tomat Cherry	25,000.00	14	14.0	14.0	100.0
Ubi Kayu	50,000.00	9	9.0	9.0	100.0
Wortel	20,000.00	15	15.0	15.0	100.0

The confidence results indicate that certain products exhibit a perfect confidence level of 100%, suggesting that the price is consistently applied whenever the product appears in the data. Examples include "Bawang Merah" at Rp 30,000 and "Gula Aren" at Rp 60,000. Conversely, products like "Telur Ayam" display variable pricing, with confidence levels of 33.33% for Rp 35,000 and 66.67% for Rp 40,000, indicating that the product is sold at different prices in some instances.

Analysis of Results

The findings from the ARM implementation provide valuable insights into the relationships between commodities and their prices within the auction market. The analysis highlights certain commodities that maintain consistent pricing patterns, which can be recommended as standard prices for future transactions. Conversely, some commodities demonstrate significant price variability, reflecting fluctuations in demand and supply dynamics in the market.

The outcomes of this research empower auction organizers and sellers with a deeper understanding of purchasing behaviors, enabling them to set more informed pricing strategies based on historical data analysis. By recognizing and analyzing these purchasing patterns, stakeholders can enhance their sales strategies and optimize commodity distribution, ultimately contributing to greater efficiency in commodity management in Aceh Tengah.

This research demonstrates the effectiveness of the ARM algorithm in the context of market auction data, offering a systematic approach to derive actionable insights from historical transaction data, thus enhancing decisionmaking processes in commodity pricing and distribution.

Conclusions

The research on the implementation of Association Rule Mining (ARM) within the commodity auctions in Aceh Tengah revealed significant insights into market dynamics and pricing strategies through the analysis of 100 auction transactions. By calculating *support* values, the study identified consistent product-price combinations, such as Wortel and Susu Bubuk, while also highlighting variability in prices for certain commodities like Telur Ayam. The *confidence* calculations demonstrated that products like Bawang Merah and Gula Aren maintained a perfect confidence level of 100%, indicating reliable pricing, whereas the variability in Telur Ayam suggested the need for adaptive pricing strategies. This research underscores the effectiveness of ARM as a data-driven tool for enhancing decision-making in the auction market, empowering sellers to establish informed pricing and optimize commodity distribution, ultimately contributing to greater efficiency in the agricultural sector. Future studies may extend these findings by incorporating additional data sources or advanced analytical techniques to further refine market strategies.

References

[1] M. F. F. Roji and I. Irhamah, “Topic Discovery pada Dokumen Abstrak Jurnal Penelitian di Science Direct Menggunakan Association Rule,” *Inferensi*, vol. 2, no. 2, p. 97, 2019, doi: 10.12962/j27213862.v2i2.6824.

[2] S. Widaningsih, “Perbandingan Metode Data Mining Untuk Prediksi Nilai Dan Waktu Kelulusan Mahasiswa Prodi Teknik Informatika Dengan Algoritma C4,5, Naïve Bayes, Knn Dan Svm,” *J. Tekno Insentif*, vol. 13, no. 1, pp. 16–25, 2019, doi: 10.36787/jti.v13i1.78.

[3] L. Irawan, L. H. Hasibuan, and F. Fauzi, “Analisa Prediksi Efek Kerusakan Gempa Dari Magnitudo (Skala Richter) Dengan Metode Algoritma Id3 Menggunakan Aplikasi Data Mining Orange,” *J. Teknol. Inf. J. Keilmuan dan Apl. Bid. Tek. Inform.*, vol. 14, no. 2, pp. 189–201, 2020, doi: 10.47111/jti.v14i2.1079.

[4] A. Pangestu and T. Ridwan, “Penerapan Data Mining Menggunakan Algoritma K-Means Pengelompokan Pelanggan Berdasarkan Kubikasi Air Terjual Menggunakan Weka,” *JUST IT J. Sist. Informasi, Teknol. Inf. dan Komput.*, vol. 11, no. 3, pp. 67–71, 2022, [Online]. Available: https://jurnal.umj.ac.id/index.php/just-it/article/view/11591

[5] E. Umar, D. Manongga, and A. Iriani, “Market Basket Analysis Menggunakan Association Rule dan Algoritma Apriori Pada Produk Penjualan Mitra Swalayan Salatiga,” *J. Media Inform. Budidarma*, vol. 6, no. 3, p. 1367, 2022, doi: 10.30865/mib.v6i3.4217.

[6] A. Prasetyo, R. Sastra, and N. Musyaffa, “Implementasi Data Mining Untuk Analisis Data Penjualan Dengan Menggunakan Algoritma Apriori (Studi Kasus Dapoerin’S),” *J. Khatulistiwa Inform.*, vol. 8, no. 2, 2020, doi: 10.31294/jki.v8i2.8994.

[7] G. I. Marthasari, Y. Azhar, and D. K. Puspitaningrum, “Perlengkapan Pesta Menggunakan Collaborative Filtering Dan Penggalian,” *J. Ilm. SimanteC Vol. 5, No. 1 Desember 2015 PENDAHULUAN*, vol. 5, no. 1, pp. 1–8, 2015.

[8] E. Sabna, “Pemanfaatan Data Mining Untuk Penempatan Buku Di Perpustakaan Menggunakan Metode Association Rule,” *J. Ilmu Komput.*, vol. 8, no. 2, pp. 59–63, 2019, doi: 10.33060/jik/2019/vol8.iss2.127.

[9] bambang; suharjito; Widodo, “Jurnal Sistem Informasi (Journal of Information Systems). 1/13 (2017), 67-77,” *J. Sist. Inf. (Journal Inf. …*, vol. 13, pp. 49–66, 2017, [Online]. Available: https://pdfs.semanticscholar.org/3c69/e03dad02e4d4b2be800e3833ba32305bba5e.pdf