I J C R M

International Journal of Contemporary Research In Multidisciplinary

*Research Article*

# Market Basket Analysis: Trend Analysis of Association Rules in Different Time Periods

**Jyoti Upadhay [1], Dr. Rajiv Jain [2*], Dr. Anju Bharti [3]**

[1] MBA Student, Maharaja Agrasen Institute of Technology (MAIT), Delhi, India

[2] Assistant Professor, Maharaja Agrasen Institute of Technology (MAIT), Delhi, India

[3] Assistant Professor, Maharaja Agrasen Institute of Technology (MAIT), Delhi, India

**Corresponding Author:** *Dr. Rajiv Jain

**DOI:** https://doi.org/10.5281/zenodo.15333750

## Abstract

Market Basket Analysis (MBA) is a crucial data mining technique used to identify associations between products based on consumer purchasing behavior. This research aims to examine how association rules evolve over different periods, revealing trends that can optimize retail-marketing strategies. Using a dataset from a retail company, the study employs the Apriori algorithm to extract frequent item sets and assess temporal variations in purchasing patterns. Findings demonstrate significant seasonal shifts and promotional effects, underscoring the importance of time-sensitive marketing strategies in retail. The research contributes to the development of dynamic pricing, targeted advertising, and efficient inventory management based on real-time consumer insights.

## Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 09-03-2025
- **Accepted:** 25-03-2025
- **Published:** 29-04-2025
- **IJCRM:**4(S2); 2025: 50-56

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

## How to Cite this Article

Upadhay J, Jain R, Bharti A. Market Basket Analysis: Trend Analysis of Association Rules in Different Time Periods. Int J Contemp Res Multidiscip. 2025;4(S2):50-56.

## Access this Article Online

www.multiarticlesjournal.com

**KEYWORDS:** Market basket analysis, association rules, consumer Behavior, temporal analysis, data mining, retail analytics

## 1. INTRODUCTION

Retail has evolved since the common corner stores of the 1900s, until the new e-commerce, that have shaken the retail world to its core. This changing process has led to a new era of unlimited possibilities for commerce and consumers. Consumers nowadays have a wide range of options, independently in almost every domain. In the past, when the consumer had to buy something, they could only choose a product from the catalogue of the store. However, with the new era of information and globalization, the list of options has increased exponentially. Now, consumers can choose from a huge variety of products and their variations. Limitations as geography, season, and so on are no longer an issue. Products that were considered luxury goods are now considered common products. Previously regarded as luxury

items are now seen as everyday items. Because of all of this, businesses now have countless options. However, a great number of new rivals entered the market as a result of this boundless potential. Retail establishments look for marketing techniques to draw in new clients or retain existing ones. This issue could only be improved by modern marketing techniques that provide effective advertising and appropriate product planning.

Market basket analysis, which has been practiced in other countries, has shown remarkable success. As a result, multinational retail stores such as Walmart and Tesco have been using market basket analysis to achieve higher profits. But to get the insights using market basket analysis, we need to have information about our customers' purchases regarding what they buy and when they buy it. Hence, comes the importance of the data about the customer's purchases, which is based on their behavior.

Although the amount of data has increased dramatically over the past 20 years, not all of it is pertinent. As a result, businesses began using data to find and extract pertinent information. Data mining, commonly referred to as the Knowledge Discovery and Data (KDD) process, is the process of obtaining valuable information. Finding useful information in vast amounts of data is made possible by data mining (Weiss & Indurkhya, 1998). Numerous scientific fields, including manufacturing, marketing, CRM, retail commerce, psychology, and education, make extensive use of it. Numerous data mining approaches are available to assist extract valuable information and solve organisational issues. Neural networks, synthetic data, classification, association, prediction, clustering, regression, sequence finding, and visualisation are a few of these.

**Data Mining**

Data mining, according to David Hand, is the process of analysing (typically enormous) observational data sets in order to uncover unexpected associations and provide new, comprehensible summaries that are beneficial to the data owner. (David Hand, Padhraic Smyth, and Heikki Mannila, 2001)

Up until now, data mining techniques have been applied in a variety of industries with great success. For instance, it may assist healthcare organisations in making decisions about customer relationship management, healthcare insurers in detecting fraud and abuse, doctors in identifying best practices and successful treatments, and patients in receiving better and more reasonably priced healthcare services. (Geral Tan and Hian Chye Koh). Customer segmentation, as used in marketing, is the process of breaking down a large customer base into smaller groups of consumers, each of which is made up of comparable customers (Woo, Bae, & Park, 2005). Customers may be identified and grouped according to their traits and attributes using this segmentation approach.

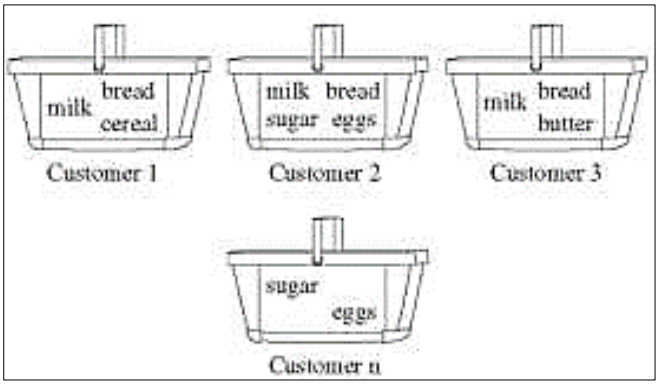
Analysing transactional data is a key area of data mining application. Every transaction in a recorded transactional database is a group of things. Market basket analysis is the most effective method for examining and identifying the connections and trends among products. It is among the most intriguing data mining research topics that scholars are increasingly paying greater attention to.

**Market Basket Analysis**

A market basket is a collection of goods that a buyer purchases at a single retail visit. We frequently purchase many items from various categories on our trips to the supermarket and combine them into a single basket. and is regarded as a single transaction. The examination of such baskets collectively is known as market basket analysis.

The term "market basket analysis" refers to a wide range of analytical methods used to identify relationships and linkages between particular commodities, as well as consumer behaviour and item relationships. It is used in retail with the premise that a client is more (or less) likely to purchase another group of things if they purchase a certain group of items. For instance, it's commonly known that most of the time, customers who purchase beer also purchase chips. The businesses that offer their goods are interested in the behaviours that result in sales. To develop new marketing and sales tactics that can enhance both the company's advantages and the customer experience, supermarket sellers are interested in determining which goods are bought in tandem.

Most of the retail markets are more focused on what their customers buy. But they ignore the fact that when they buy it. Which is also considered to be a huge factor in their purchasing behavior of purchase. This thesis is focused on not just “what” the customer buys but also “when” they buy it. According to Forbes magazine, marketers are constantly looking into the future, trying to predict the next big trend and data-driven marketing is the topmost trend right now in which time plays a highly significant role. So, data-driven marketing with time as a crucial factor will help us predict a better future for the retail company.




According to Chen, Tang, Shen, and Hu (2005), the market basket analysis is an effective technique for putting up-selling, cross-selling, and inventory management tactics into practice. Market basket analysis, often referred to as affinity analysis or association rule mining, has been used to study how consumers behave with relation to the kinds of purchases they make. This data mining method was first applied in the marketing industry

to comprehend consumer purchasing trends by identifying correlations and co-occurrences in a transactional database (i.e., market basket data). When shopping at a supermarket, for instance, customers are much more likely to buy a basket full of items, most of which are from diverse product categories, than to buy a single item. This enables us to find links between objects, goods, or categories that are not immediately apparent, typically concealed, and paradoxical. Additionally, we are able to extract jointly bought items and product categories, and these linkages can be expressed as association rules. Based on two distinct ideas, these association rules allow managers to create marketing tactics such as creating interventions, pushing particular product categories, giving promotions, etc., which ultimately result in customers spending more money. Upselling, which includes adding extra features or purchasing a lot of the same product, adding more items from other categories is known as cross-selling. Additionally, market basket analysis is particularly helpful for item placement and stock management.

## LITERATURE REVIEW

Retailers utilise market basket analysis, a strategic data mining approach, to better understand client purchase habits and increase sales. This approach entails looking at large datasets, including past purchase histories, to find innate product groups and discover products that consumers frequently purchase together. Retailers may optimise inventory management, create successful marketing campaigns, use cross-selling techniques, and even change shop layout for better consumer interaction by identifying these co-occurrence patterns.

For instance, if consumers are purchasing milk, what is the likelihood that they will also purchase bread, and what type of bread, during the same shopping trip? By assisting merchants with cross-selling, ledge space planning for the best possible product placement, and targeted marketing based on forecasts, this information may result in higher sales.

### How Does Market Basket Analysis Work?

1. Collect data on customer transactions, such as the items purchased in each transaction, the time and date of the transaction, and any other relevant information.
2. Clean and preprocess the data, removing any irrelevant information, handling missing values, and converting the data into a suitable format for analysis.
3. To find frequent item sets—sets of things that frequently appear together in a transaction—use association rules mining methods like Apriori or FP-Growth.
4. Determine the confidence and support for each often-purchased item, indicating the probability that one item will be bought in light of the purchase of another.
5. Create association rules using the often occurring itemset and the support and confidence values that go along with them. The probability of buying one item given the purchase of another is indicated by association rules.
6. Examine the market basket analysis's findings to determine which things are frequently purchased, how strongly they are associated, and to find other pertinent information about the tastes and behaviour of your customers.
7. Use the insights from the market basket analysis to inform business decisions such as product recommendations, store layout optimization, and targeted marketing campaigns.

### Types of Market Basket Analysis

1. To predict future consumer behaviour, predictive market basket analysis uses supervised learning. Applications like as customised product suggestions, individualised promotions, and efficient demand forecasts are made possible by the ability to identify cross-selling opportunities through purchasing patterns. Furthermore, it is useful for detecting fraud.
2. By comparing past purchases across various market segments, Differential Market Basket Analysis identifies patterns and identifies purchasing patterns particular to each clientele. Its uses include client segmentation, seasonal trend detection, competitive analysis, and insights into the dynamics of local markets.

Let's look at a market basket analysis example from Amazon, the biggest e-commerce site in the world. From the standpoint of the consumer, Market Basket Analysis is comparable to grocery shopping. It typically tracks every item that a customer purchases in a single transaction. Next, it displays the most similar items that buyers are likely to acquire in a single transaction.

## RESEARCH METHODOLOGY

**Data Collection:** The study utilizes transactional data from a retail company, covering thousands of transactions over multiple periods. Key variables include transaction IDs, timestamps, product IDs, and customer identifiers. The dataset is pre-processed to remove inconsistencies, duplicates, and incomplete records.

**Pre-processing and Data Transformation:** Data cleaning involves handling missing values and standardizing product identifiers. Transactions are converted into a binary matrix format suitable for the Apriori algorithm. The dataset is then segmented into three-month periods to analyse temporal changes.

**Algorithm and Analysis Approach:** The Apriori algorithm is applied to identify frequent itemsets and generate association rules. Three key metrics—support, confidence, and lift—are used to evaluate rule significance. The study also employs time-series analysis to track variations in rule strength over different time frames.

### Evaluation Metrics

- **Support:** Frequency of an itemset appearing in transactions.
- **Confidence:** Likelihood of purchasing an item given another item's presence.
- **Lift:** Strength of the association beyond random chance.

## FINDING AND ANALYSIS

### Strategy for Market Basket Analysis

### 1. Introduction to Market Basket Analysis

Market Basket Analysis (MBA) is a fundamental technique in data mining that seeks to identify associations and patterns within transactional data. This approach is widely applied in retail and e-commerce sectors to enhance sales, optimize product placements, and develop effective marketing strategies.

Businesses like Amazon and Netflix rely on an MBA to produce meaningful product recommendations by analyzing historical purchase data. The insights derived from this method allow companies to create targeted promotions and cross-selling opportunities, ultimately boosting customer satisfaction and revenue.

### 2. Key Concepts and Definitions in Market Basket Analysis

#### 2.1 Association Rules

Association Rule Mining (ARM) is an essential component of MBA, designed to discover relationships between products frequently bought together. These relationships are expressed in the form of IF-THEN statements, which help retailers understand buying patterns.

**For example:** IF customers buy bread, THEN they are likely to buy butter.

**Three key metrics are used to evaluate association rules:**

- **Lift:** Measures the strength of the association rule. A lift value greater than 1 suggests a strong positive correlation.
- **Support:** Represents the proportion of transactions that contain a specific item or itemset.
- **Confidence:** Indicates the probability that a transaction containing the antecedent also contains the consequent.

#### 2.2 Antecedents and Consequents

Every association rule consists of two components:

- **Antecedent (LHS - Left-Hand Side):** The item(s) that serve as the basis of the rule.
- **Consequent (RHS - Right-Hand Side):** The item(s) that are likely to be purchased along with the antecedent.

For example, in the rule **{Milk}** → **{Cookies}**, *Milk* is the antecedent, and *Cookies* is the consequent.

#### 2.3 Causality in Market Basket Analysis

Causality refers to the relationship where one event directly influences another. In the context of MBA, causality is difficult to establish definitively. However, trends can suggest causative behaviors. For instance, if a supermarket lowers the price of diapers and observes an increase in beer purchases, it may imply a causal relationship between these items.

#### 2.4 Frequent Itemsets

Frequent itemsets refer to products that appear together in transactions beyond a certain threshold. The support threshold determines whether an itemset qualifies as *frequent*. Businesses prioritize marketing strategies around these frequently purchased combinations.

### 3. Data Requirements and Collection for MBA

For an MBA to be effective, data must be structured and relevant. Transactions should include:

- **Customer ID** (optional but useful for personalized analysis)
- **Transaction ID** (Invoice ID)
- **Timestamp (Date & Time)**
- **Item Codes (Stock Codes)**
- **Item Descriptions**
- **Quantity Purchased**

The dataset should be large enough to provide meaningful insights, and missing or incorrect values must be addressed before analysis.

### 4. The Apriori Algorithm in Market Basket Analysis

One of the most widely used techniques in MBA is the Apriori Algorithm, introduced by Rakesh Agrawal in 1993. This algorithm follows a two-step approach:

#### 4.1 Frequent Itemset Generation

The algorithm scans the entire dataset to identify itemsets appearing frequently together. It follows these steps:

1. Calculate support for individual items.
2. Generate candidate itemsets through iterative joining of frequent itemsets.
3. Apply pruning to remove non-frequent itemsets.
4. Repeat the process until no further frequent itemsets are found.

#### 4.2 Rule Generation

Once frequent itemsets are established, association rules are derived based on minimum support and confidence thresholds. This ensures that only meaningful relationships are considered for business decisions.

#### 4.3 Example of Apriori Implementation

Step 1: Identify individual item frequencies. Step 2: Formulate item combinations (e.g., {Milk, Bread}). Step 3: Remove combinations below the support threshold. Step 4: Generate association rules from frequent itemsets.

By applying these steps iteratively, retailers can develop insights into product affinities.

### 5. Alternative Algorithms for Market Basket Analysis

While Apriori is commonly used, several other algorithms have been developed to enhance efficiency:

**FP-Growth Algorithm**

- Builds a frequent pattern tree (FP-tree) for more efficient mining.
- Reduces the need for repeated database scans, making it more scalable.

**AIS Algorithm**
- An early approach that generates association rules dynamically.
- Less efficient due to excessive candidate itemset generation.

**CBA (Classification-Based Association)**
- Combines classification techniques with association rule mining.
- Used in applications beyond retail, including medical diagnostics.

**MCAR (Multiple Classification Association Rules)**
- Uses vertical data representation to optimize rule discovery.

**6. Real-World Applications of Market Basket Analysis**
An MBA has numerous applications across industries:
**Retail and E-commerce**
- Personalized recommendations (e.g., Amazon's "Customers who bought this also bought").
- Optimizing store layouts and product placement.

**Healthcare**
- Identifying co-occurring symptoms for disease diagnosis.
- Recommending complementary treatments.

**Finance and Banking**
- Detecting fraudulent transactions by analyzing unusual purchasing patterns.
- Cross-selling financial products (e.g., credit cards with insurance plans).

**7. Advantages and Challenges of Market Basket Analysis**
**7.1 Advantages**
**Enhances Customer Experience**
- Provides personalized recommendations, increasing sales and customer satisfaction.

**Optimizes Inventory Management**
- Helps businesses stock products based on demand correlations.

**Supports Data-Driven Decision Making**
- Provides insights into customer purchasing behavior.

**7.2 Challenges**
- **Data Sparsity**
- Many products have low purchase frequencies, making it challenging to generate meaningful associations.
- **Computational Complexity**
- Large datasets require significant processing power and memory.
- **Interpretation of Rules**
- High-confidence rules may not always be actionable or useful.

**8. Practical Implementation of Market Basket Analysis**
**8.1 Tools Used**
- **Python Libraries**
- pandas (Data handling)
- mlxtend (Association rule mining)
- matplotlib (Data visualization)
- apriori (Frequent itemset generation)

**8.2 Implementation Steps**
1. **Data Preprocessing**
- Load transaction data and handle missing values.
- Convert transactional data into a format suitable for analysis.
2. **Applying the Apriori Algorithm:**
- Identify frequent itemsets using minimum support.
- Generate association rules with confidence and lift metrics.
3. **Interpreting the Results:**
- Analyze the most relevant association rules.
- Visualize patterns using heatmaps or network graphs.

## 9. RESULT AND DISCUSSION

**9.1 Association Rules Across Periods:** The results indicate notable shifts in association rules based on seasonal and promotional influences. For instance, summer transactions reveal strong associations between beverages and snacks, whereas winter transactions emphasize warm clothing and hot beverages.

**9.2 Impact of Promotions and Seasonal Trends:** Promotional campaigns significantly influence association rules. Products on discount frequently appear in high-support itemsets, suggesting a direct impact on purchasing decisions. Seasonal variations also emerge, demonstrating the necessity of time-sensitive marketing approaches.

**9.3 Comparison of Top Association Rules:** A comparison of the top 30 association rules across different periods highlights fluctuations in confidence and lift values. Certain rules remain stable over time, indicating persistent consumer habits, while others shift based on external factors such as holidays and economic trends.

**10. Scope of Future Research**
This research demonstrates the critical role of time in Market Basket Analysis. By analyzing how association rules evolve over different periods, businesses can enhance marketing strategies, inventory management, and promotional planning. Future work could explore finer time granularity, integrate external variables such as economic indicators, and utilize machine learning techniques to improve predictive capabilities. Additionally, applying deep learning models could further refine the accuracy of temporal consumer behavior predictions.

## REFERENCES


1. Liao SH, Chu PH, Hsiao PY. Data mining techniques and applications: A decade review from 2000 to 2011. Expert Systems with Applications. 2012;39(12):11303–11311. https://doi.org/10.1016/j.eswa.2012.02.063
2. Linoff GS, Berry MJA. *Data mining techniques: For marketing, sales and CRM*. 3rd ed. Wiley; 2011.
3. Mushtaq A. Data mining for marketing. Journal of Marketing and Consumer Research. 2015;9:17–29.
4. Ngai EWT, Xiu L, Chau DCK. Application of data mining techniques in customer relationship management: A literature review and classification. Expert Systems with Applications. 2009;36(2):2592–2602. https://doi.org/10.1016/j.eswa.2008.02.021
5. Agrawal R, Imielinski T, Swami A. Mining association in large databases. In: *Proceedings of the 1993 ACM SIGMOD International Conference on Management of Data*. 1993:207–216. https://doi.org/10.1145/170036.170072
6. Gangurde R, Kumar B, Gore D. Building prediction model using market basket analysis. International Journal of Innovative Research in Computer and Communication Engineering. 2017;5(2):294–298. https://doi.org/10.15680/IJIRCCE.2017.0502136
7. Hibino A, Niwa Y. Graphical representation of nuclear incidents/accidents by associating network in nuclear technical communication. Journal of Nuclear Science and Technology. 2008;45(5):369–377. https://doi.org/10.1080/18811248.2008.9711446
8. Gangurde R, Kumar B, Gore D. Optimized predictive model using artificial neural network for market basket analysis. International Journal of Computer Science & Communication. 2017;9(1):44–47. https://doi.org/10.090592/IJCSC.2017.014
9. [Duplicate of #1 – omitted for redundancy]
10. Solnet D, Boztug Y, Dolnicar S. An untapped gold mine? Exploring the potential of market basket analysis to grow hotel revenue. International Journal of Hospitality Management. 2016;56:119–125. https://doi.org/10.1016/j.ijhm.2016.04.013
11. Kamley S, Jaloree S, Thakur RS. An association rule mining model for finding the interesting patterns in stock market dataset. International Journal of Computer Applications. 2014;93(9):1–6.
12. Umbarkar SS, Nandgaonkar S. Using association rule mining: Stock market events prediction from financial news. International Journal of Science and Research (IJSR). 2015;4(6):1274–1278.
13. Raorane AA, Kulkarni RV, Jitkar BD. Association rule – Extracting knowledge using market basket analysis. Research Journal of Recent Sciences. 2012;1(2):19–27.
14. Kapadia G, Kalyandurgmath K. Market basket analysis of consumer buying behaviour of a lifestyle store. In: *International Conference on Technology and Business Management*. 2015:406–412.
15. Chandrakar O. Predicting examination results using association rule mining. International Journal of Computer Applications. 2015;116(1):7–10.
16. Barman D, Chowdhury N. Movie business trend prediction using market basket analysis. International Journal of Computer Applications. 2013;74(9):1–4.
17. Kaur M, Kang S. Market basket analysis: Identify the changing trends of market data using association rule mining. Procedia Computer Science. 2016;85:78–85. https://doi.org/10.1016/j.procs.2016.05.180
18. Tan SC, Lau JPS. Time series clustering: A superior alternative for market basket analysis. In: *Lecture Notes in Electrical Engineering*. 2014;285:241–248. https://doi.org/10.1007/978-981-4585-18-7_28
19. Sirisha GNVG, Shashi M, Raju GVP. Periodic pattern mining – Algorithms and applications. Global Journal of Computer Science and Technology: Software and Data Engineering. 2013;13(13):1–6.
20. Ozden B, Ramaswamy S, Silberschatz A. Cyclic association rules. In: *Proceedings of the 14th International Conference on Data Engineering (ICDE)*. 1998:412–421. https://doi.org/10.1109/ICDE.1998.655804
21. Anderson C. *The long tail: Why the future of business is selling less of more*. New York: Hyperion; 2006.
22. MicroStrategy. *Business Intelligence in the Retail Industry*. MicroStrategy World 2003 Conference, Las Vegas; 2003.
23. Toroslu IH. Repetition support and mining cyclic patterns. Expert Systems with Applications. 2003;25(3):303–311. https://doi.org/10.1016/S0957-4174(03)00072-1
24. Yun CH, Chuang KT, Chen MS. Adherence clustering: An efficient method for mining market-basket clusters. Information Systems. 2006;31(3):170–186. https://doi.org/10.1016/j.is.2004.11.008
25. Agrawal R, Srikant R. Fast algorithms for mining association rules. In: *Proceedings of the 20th International Conference on Very Large Databases (VLDB)*. 1994:487–499.
26. Heydari M, Yousefli A. A new optimization model for market basket analysis with allocation considerations: A genetic algorithm solution approach. Management & Marketing. 2017;12(1):1–11. https://doi.org/10.1515/mmcks-2017-0001
27. Kandelaar J. *A cross-category method comparison for doing market basket analysis* [Master's thesis]. 2016:1–100.
28. Aguinis H, Forcum LE, Joo H. Using market basket analysis in management research. Journal of Management. 2013;39(7):1799–1824. https://doi.org/10.1177/0149206312466147
29. Hamzić D. Market basket analysis: Mining frequent pairs in Python. 2017 Jan 19. Available from: https://dzenanhamzic.com/2017/01/19/market-basket-analysis-mining-frequent-pairs-in-python/
30. Jabeen H. Market basket analysis in R. 2018 Aug 21. Available from: https://www.datacamp.com/community/tutorials/market-basket-analysis-r

31. Yadav M. Apriori algorithm. Available from: https://www.geeksforgeeks.org/apriori-algorithm/
Li S. Market basket analysis in Python. 2017 Sep 24.



**About the Corresponding Author**

**Dr. Rajiv Jain** is an Assistant Professor at the Department of Management, Maharaja Agrasen Institute of Technology (MAIT), Delhi. He holds an MBA and has cleared the GATE examination. Currently, he is pursuing a Ph.D., further enhancing his academic credentials. With over 12 years of teaching experience and more than 17 years in industry, Dr. Jain brings a wealth of practical knowledge to his academic role. His areas of expertise include strategic management, operations, and business analytics. He is actively involved in various academic and administrative responsibilities at MAIT, contributing to the development of management education.