



Inventory management for essential oil UMKM: enhancing business performance with data mining

Luky Fabrianto¹, Johan Hendri Prasetyo², Novianti Madhona Faizah³, Susi Solichatun⁴

^{1,2}Digital Business, Universitas Nusa Mandiri, Indonesia

³Computer Science, Universitas Tama Jagakarsa, Indonesia

⁴Information System, Universitas Nusa Mandiri, Indonesia

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ABSTRACT

Micro, small, and medium enterprises (UMKM) play a critical role in driving economic growth and employment opportunities in Indonesia. PT Sukacita Kokoh Bersama (SKB), a company specializing in essential oil sales, exemplifies the dynamic nature of UMKM by embracing technological advancements to thrive in the competitive market. To address the challenge of optimizing inventory management, SKB implemented data mining techniques, specifically the Apriori algorithm, to uncover hidden relationships among different oil types and gain insights into consumer preferences and purchasing behavior. The study aimed to identify relevant sales patterns and predict demand for each oil type. With a threshold of 30%, several rules were generated, including "If customers purchase Lavender Oil and Lemon Oil together, there is a 53% confidence that they will also purchase Peppermint Oil". This research showcases the importance of data mining in enhancing inventory management and decision-making processes for UMKM like SKB.

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Corresponding Author:

Luky Fabrianto,

Bisnis Digital,

Universitas Nusa Mandiri,

Jl. Raya Jatiwaringin No.2, RT.8/RW.13, Cipinang Melayu, Kec. Makasar, Kota Jakarta Timur,

Daerah Khusus Ibukota Jakarta 13620

luky.lfb@nusamandiri.ac.id

1. INTRODUCTION

In today's rapidly evolving business landscape, the advancement of information technology and communication has significantly impacted all sectors, including micro, small, and medium enterprises (UMKM). In the past five years, UMKM in Indonesia have witnessed a remarkable increase in their contribution to the Gross Domestic Product (GDP), rising from 57.8% to 61%. This makes UMKM a crucial safety net and an engine of economic growth (Riskita, 2022). The development of UMKM in Indonesia is characterized by fast transaction cycles, with their products directly addressing the essential needs of society (Pratama et al., 2022). Furthermore, data from the Ministry of Cooperatives and Small and Medium Enterprises in 2018 indicates that there are 64.2 million UMKM players, accounting for 99.99% of the total number of businesses in Indonesia. UMKM provide employment opportunities for around 117 million workers, representing 97% of

the labor force in the business sector. Meanwhile, UMKM contribute 61.1% to the national economy's GDP, with the remaining 38.9% contributed by large enterprises, which account for only 5,550 or 0.01% of the total number of business players (Sasongko D., 2020). These figures underscore the pivotal role of UMKM in driving economic progress and creating widespread employment opportunities in Indonesia (Wahyudi et al., 2019)(Santosa & Budi, 2017).

PT Sukacita Kokoh Bersama (SKB) has embarked on a transformative journey by embracing data mining techniques to enhance their inventory management of essential oils. As customer demand continues to rise, SKB faces the challenge of maintaining adequate stock levels and preventing inventory imbalances. By leveraging the power of data mining, SKB can uncover valuable associations between different oil types, enabling them to optimize stock allocation, reduce waste, and meet customer needs more effectively. This strategic approach not only boosts profitability but also strengthens customer satisfaction, positioning SKB as a dynamic player in the ever-evolving UMKM landscape (Najib, 2020).

With the significant role of micro, small, and medium enterprises (UMKM) in empowering the Indonesian economy, it comes as no surprise that the integration of technology within these enterprises is essential. PT Sukacita Kokoh Bersama (SKB) operates in the field of essential oil sales and therapy oils [molecules]. Initially starting as a reseller and dropshipper in 2018, the company transitioned into an UMKM in 2020 and eventually became a legalized Limited Liability Company with VAT-registered status in 2021. SKB offers 50 different types of essential oils, encompassing a diverse range of ingredients such as Black Pepper Oil, Cajuput Oil, Cananga Oil, Cardamom Oil/Kapulaga, Cedarwood Oil, and more. Some of these oils are blends or carrier oils (Sharmeen et al., 2021), serving as a neutral base (Rezaenia et al., 2020). The journey of SKB exemplifies the dynamic nature of UMKM in embracing technological advancements and transforming their business models to thrive in today's competitive market (Nosiel et al., 2021).

The urgency of research on implementing data mining techniques in inventory management for SKB lies in its potential to address the pressing challenge of stocking the right oil types to meet customer demand effectively using sales data from the inception of the business in 2019 until 2022, comprising more than 14.000 transactions. By utilizing data mining methods, SKB can uncover valuable associations and interrelationships between oil types, allowing them to optimize stock allocation, reduce waste, and prevent stockouts. This research contributes to the field of science by demonstrating the practical application of data mining in enhancing inventory management for UMKM, specifically in the essential oil industry. It provides insights and best practices that can be applied to similar businesses, fostering advancements in inventory management strategies and improving overall business performance.

The aim of this research is to evaluate whether the application of data mining methods can be beneficial in managing the inventory of essential oil sales for SKB (Utami et al., 2022). The research will focus on identifying relevant sales patterns, predicting demand for each oil type, and making more effective decisions in inventory management (Gandhmal & Kumar, 2019). Therefore, the objective of this study is to determine whether data mining methods can serve as an effective tool to assist SKB in maintaining optimal stock availability of essential oils and avoiding undesirable inventory issues[gandhmal]. This endeavor is expected to optimize the stocking of different oil types, resulting in more effective and efficient inventory management while enhancing profitability and better fulfilling customer needs (Padma & Mishra, 2022).

The research approach adopted in this study utilizes the Apriori algorithm (Nurhidayanti et al., 2022)(Fabrianto, 2022) to uncover associations among various types of essential oils (*Essential Oil Safety: A Guide for Health Care Professionals - Robert Tisserand, Rodney Young - Google Books, n.d.*). By employing this approach, it is

anticipated that it will assist SKB in identifying patterns or associations within their sales transaction data, thereby revealing which oil types are frequently purchased together. This identification will enable SKB to strategically enhance their sales and ultimately contribute to the overall economic growth of the nation.

By employing the Apriori algorithm, SKB aims to unravel hidden relationships among different oil types, providing valuable insights into consumer preferences and purchase behavior (Sudrajat & Ermatita, 2021). This knowledge will empower SKB to make informed decisions on inventory management, marketing strategies, and product bundling. By understanding the associations between oil types, SKB can optimize their product offerings and ensure a more personalized and tailored experience for their customers (Quispe, 2023).

Data mining is an iterative and interactive process of discovering accurate, useful, and understandable patterns or models within massive databases (Nurhidayanti et al., 2022). It involves the search for desired trends or patterns in large databases to aid in future decision-making. In the field of data mining, several stages need to be performed, starting from data cleaning, data selection, data transformation, data mining, pattern evaluation, knowledge presentation, and the Apriori algorithm (Saputra & Sibarani, 2020). The Apriori algorithm involves the analysis of associations. Association rule mining is a data mining technique used to discover rules based on item combinations. One intriguing stage in association analysis, which has garnered much attention from researchers in developing efficient algorithms, is frequent pattern mining (Fadhli et al., 2018). Support refers to the measure or percentage of an item combination in the database (Fabrianto et al., 2021), while confidence represents the certainty or strength of the relationship between items in an association. Confidence can be determined once the frequent pattern of an item has been identified. The significance of an association can be evaluated using two criteria: support and confidence (Fabrianto, 2022). Support measures the percentage of the item combination in the database, while confidence reflects the strength of the relationship between items in the association (Fadhli et al., 2018).

In the context of SKB's challenges, data mining methods are crucial for establishing connections between different types of oils based on sales data since the inception of the business. As a further development, it is essential to delve into the details of what data mining entails, how to apply it in business settings, and the benefits derived from its usage. Previous research has shown that the Apriori algorithm can be employed to process sales transaction data and derive new insights regarding the associations between products (Fabrianto et al., 2021). Furthermore, through the Apriori algorithm, we can uncover relationships between different products (Masrani Afrianti, 2023).

2. RESEARCH METHOD

The research started by gathering sales data from the year 2019 until 2022. The dataset, as shown in Table 1, contained various attributes that held the key to unlocking valuable insights. This data exploration journey aimed to uncover patterns and trends that could enhance our understanding of sales dynamics.

Table 1. Sales Data Attribute

Attribute	Description
id_penjualan	Unique sales ID
tanggal	Transaction date
nama_pelanggan	Customer name
Propinsi	Destination province for shipment
qty	Quantity of purchased items
nama_barang	Type of oil item/package (with volume in milli liter)
total	Total amount paid

nama_kurir Name of the courier service used

This research focused on analyzing sales data to anticipate the demand for different types of single oil products. The goal was to uncover patterns and associations between these oil types using association rules. The dataset consisted of 28.507 items sold and 14.117 transactions recorded. To simplify analysis, we only considered two attributes: 'id_penjualan' (Unique sales ID) and 'nama_barang' (Type of oil item/package). By examining these attributes, we aimed to gain insights into the inventory needs for each oil type and identify potential combinations that customers frequently purchased together. This research aimed to provide a clear understanding of customer preferences and aid in strategic decision-making for inventory management and product offerings.

2.1. Pre-Processing

In the dataset, the attribute 'nama_barang' combines the type of oil with its corresponding volume in milliliters. To facilitate further analysis, we separated the oil type and volume, as shown in Table 2 below. This separation allows us to examine the oil types independently and explore their relationships with other variables in the dataset more effectively.

Table 2. Change of 'nama_barang' attribute

Before	After
10ml Citronella Oil	Citronella
20ml Clove Bud Oil	Clove Bud
50ml Citronella Oil	Citronella
100ml Lemongrass Oil	Lemongrass
1000ml Patchouli	Patchouli

The purpose of the aforementioned modification was to narrow down the focus of the research to solely the oil types, disregarding their respective volumes. By streamlining the variety of items sold under the attribute 'nama_barang', a significant reduction in the number of item types was achieved. Specifically, the dataset initially consisted of 346 item types, but after the refinement process, it was narrowed down to just 42 types, specifically single essential oils. Table 3, provides a comprehensive list of these 42 single essential oils that are sold within the dataset. This refinement enables a more targeted analysis of the individual oil types and their respective patterns, facilitating a deeper understanding of their significance in the research context.

The consolidation of oil types was also carried out based on merging several oil types that share similar base ingredients. For example, Bergamot oil, Kaafir Lime oil, and orange oil were combined into a single oil type called Orange (The Heart of Aromatherapy by Andrea Butje | Aromatics.Com – Aromatics International, n.d.). Additionally, carrier (Alhasso et al., 2022) oils such as Almond, Argan (EBSCOhost | 155102021 | Nanostructured Lipid Carriers (NLCs) Composed of Argan Oil, the Potential Novel Vehicle for Caffeine Delivery to Stratum Corneum and Hair Follicles., n.d.), and VCO (Essential Oil Safety: A Guide for Health Care Professionals - Robert Tisserand, Rodney Young - Google Books, n.d.) were eliminated from the dataset, as the focus of the research was solely on single essential oils. This consolidation aimed to ensure that only single essential oils remained in the inventory, aligning with the research objective.

As a result of this consolidation, the dataset was further reduced in terms of data size. The number of transactions decreased to 12.628, and the number of items sold amounted to 24.576. This streamlining process not only facilitates a more manageable dataset but also enables a more focused analysis of the specific single essential oil types and their associated patterns.

Table 3. 42 Types of single essential oil sold

Agarwood	Clove Bud	Gurjun	Patchouli
Alpinia Galangal	Coriander	Orange	Piper Battle Leaf
Aniseed	Cubeb	Juniper Bery Organic	Rose
Basil	Eucalyptus	Lavender	Rosemary
Black Pepper	Fennel	Lemon	Sandalwood
Cananga	Frangipani	Lemongrass	Tea Tree
Cardamom	Frankincense	Magnolia	Tuberose
Cedarwood	Geranium	Peppermint	Turmeric
Chamomile	Ginger	Myrrh	Vanilla
Cinnamon	Grapefruit	Nutmeg	Veytver
Citronella	Green Tea		

After reducing the data, the dataset was transformed into a new format where each instance contains a sales ID and the ordered oil. This simplified format, as shown in Table 4, includes the sales ID and the corresponding type of oil ordered in each transaction.

Table 4. Instances change format

id_penjualan	Oil order
4600	Gurjun, Rosemary, Basil, Peppermint
4613	Gurjun, Clove Bud, Basil
4616	Citronella, Basil, Gurjun

Based on the dataset format in Table 4, binary tabulation was performed to calculate the support value for each type of oil. Table 5, illustrates examples of the binary tabulation (Wayan Suparta & Pembangunan Jaya, n.d.), showing the presence or absence of each oil type in the transactions.

Table 5. Binary Tabulation

id_penjualan	Gurjun	Rosemary	Clove Bud	Basil	Peppermint	Citronella
4600	1	1	0	1	1	0
4613	1	0	1	1	0	0
4616	1	0	0	1	0	1

2.2. Association rule

Association rule mining is a data mining technique used to uncover hidden patterns and relationships between items in a large dataset. It helps identify co-occurrence and association between different items in a transaction. By analyzing transactional data, association rule mining allows us to understand how likely it is for one item to be purchased along with another item, enabling businesses to make informed decisions and optimize their operations (Kaur & Kang, 2016). Table 4. is an example of Oil order.

Interesting relationships can be represented in the form of associative rules 'Gurjun \rightarrow Basil', which reveal patterns and connections between different items in a dataset. These rules consist of an antecedent (Gurjun) and a consequent (Basil). By analyzing the support (frequency of occurrence) and confidence (likelihood of the consequent given the antecedent), we can identify meaningful associations and uncover valuable insights (Fabrianto, 2022).

a. High frequent analysis

This formula acts as a compass, pointing towards those valuable patterns that can revolutionize business strategy. The secrets hidden within the numbers and business transactions for an item, searching for products that meet the minimum support, shown in the following formula:

$$\text{Support } (A) = \frac{\text{Transactions Contains } A}{\text{Total Transactions}} \quad (1)$$

To find support value for two items, the following formula is used:

$$\text{Support } (A \cap B) = \frac{\text{Transactions Contains } A \text{ and } B}{\text{Total Transactions}} \quad (2)$$

b. Association Rule Formation

Once all the frequent patterns have been discovered, the next step is to find the associative rules that meet the minimum confidence requirements. This is like unraveling the hidden connections between different items in a fascinating puzzle. By calculating the confidence value of the rule $A \Rightarrow B$, we can determine how strongly item A is associated with item B in the dataset (Fabrianto et al., 2021). This valuable information allows us to make informed decisions and take strategic actions to optimize sales and customer satisfaction. Get ready to unlock the power of associative rules and uncover hidden insights that will drive the success of business, shown in the following formula:

$$\text{Confidence} = P(A | B) = \frac{\text{Number of transactions contains } A \text{ and } B}{\text{Number of transactions contains } A} \quad (3)$$

3. RESULTS AND DISCUSSIONS

Tabel 6, provides a summary of the dataset before and after the pre-processing steps. This is to ensure that the research utilizes a dataset that has undergone pre-processing. The table compares the number of transactions and the total number of oils before and after the pre-processing stage.

Table 6. Before and after dataset pre-processing

	Before	After
Jumlah Item terjual	28,507	24,576
Jumlah Transaksi	14,117	12,628
Jumlah Jenis Item	346	42

3.1. Exploration Data Analysis

To obtain candidate essential oils with sufficient support, we calculate the support value for each essential oil. This process helps us identify the oils that are frequently purchased together, allowing us to find association rules among them. By selecting the oils with high support, these research focus on those that have a significant impact on customers purchasing decisions. Table 7, is a recapitulation of the support values of 42 types of oil.

Table 7. Support values of 42 types of oil

Single oil type	Support	Single oil type	Support
Agarwood	1.70%	Green Tea	1.28%
Alpinia Galangal	0.80%	Gurjun	0.35%
Aniseed	0.09%	Juniper Bery Organic	0.27%
Basil	1.61%	Lavender	24.57%
Black Pepper	0.42%	Lemon	6.29%
Cananga	11.30%	Lemongrass	16.85%
Cardamom	0.60%	Magnolia	3.65%
Cedarwood	4.95%	Peppermint	28.41%
Chamomile	1.59%	Myrrh	0.03%
Cinnamon	1.65%	Nutmeg	1.73%
Citronella	9.98%	Orange	9.49%
Clove Bud	7.02%	Patchouli	6.38%
Coriander	0.06%	Piper Battle Leaf	0.20%

Cubeb	0.10%	Rose	0.92%
Eucalyptus	12.60%	Rosemary	6.92%
Fennel	1.16%	Sandalwood	0.40%
Frangipani	2.01%	Tea Tree	5.20%
Frankincense	5.46%	Tuberose	0.13%
Geranium	0.70%	Turmeric	1.12%
Ginger	3.80%	Vanila	4.78%
Grapefruit	0.79%	Veytver	3.96%

To address the issue of numerous oils having relatively low support values, a minimum support threshold of $\leq 6\%$ is applied in this research. Figure 1, presents a graphical representation of the selected oils that will be used to obtain the best rules. This visualization allows for a clearer understanding of the specific oils that are included in the analysis and will contribute to the identification of the most significant associations.

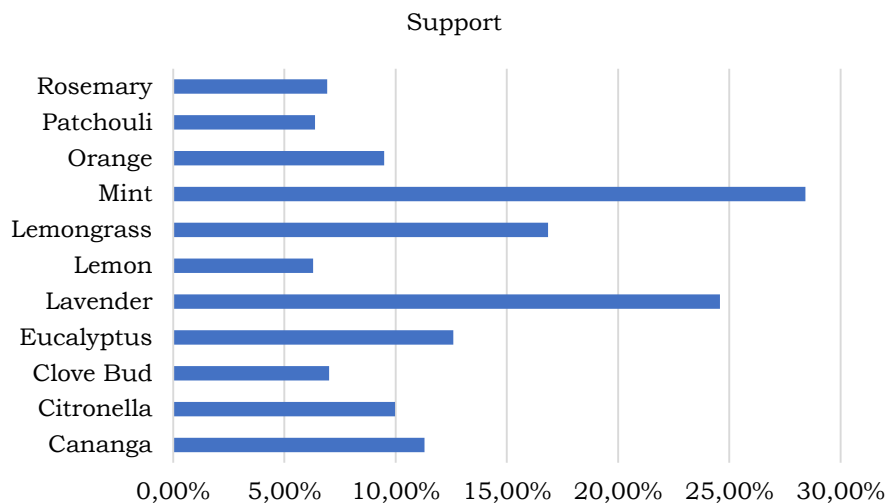


Figure 1. Types of oil that surpasses the threshold

3.2. Implementation of Association Rules

Based on the total number of transactions and the selected oils, as shown in Figure 1, this research aims to obtain the best rules using a confidence threshold (θ) of $\geq 30\%$. The Weka software version 3.8.4 is utilized for this purpose. Setting the threshold value aims to focus on the most significant rules and reveal strong relationships among the oils in the dataset. This approach enables valuable insights and facilitates decision-making based on the identified patterns in the data. Table 8, presents the support values of each oil that surpasses the threshold, providing a clearer understanding of the level of support for each oil in the analysis.

Table 8. Support value of each oil type

Oil Type	Number of Transaction	Support
Cananga	1427	11.30%
Citronella	1260	9.98%
Clove Bud	886	7.02%
Eucalyptus	1591	12.60%
Lavender	3103	24.57%
Lemon	794	6.29%
Lemongrass	2128	16.85%
Peppermint	3588	28.41%
Orange	1198	9.49%
Patchouli	806	6.38%

Rosemary

874

6.92%

The results obtained for the combination of 2 types of oils, which form an association rule, can be seen in Table 9, from the table, it can be interpreted as follows: "If purchasing Lemon Oil, there is a 43% confidence that Peppermint Oil will also be purchased". It's means that if customers buy Lemon Oil, there is a 43% likelihood that they will also purchase Peppermint Oil.

Table 9. Best Rules for 2 types of oil

Oil Type	Number of Transaction	Oil Type	Number of Transaction	Confidence
Lemon	794	Peppermint	340	43%
Lemon	794	Lavender	321	40%
Lavender	3103	Peppermint	973	31%

The rules obtained for the combination of 3 types of oils, which can also be considered as association rules, can be seen in Table 10, these rules provide insights into the relationships between different types of oils.

Table 10. Best Rules for 3 types of oil

Rules for 2 types of oil		Number of Transactions	Type 3 Oil	Number of Transactions	Confidence
Lavender	Lemon	321	Peppermint	170	53%
Lemon	Peppermint	340	Lavender	170	50%
Cananga	Peppermint	363	Lavender	141	39%
Eucalyptus	Lavender	320	Peppermint	124	39%
Lavender	Lemongrass	443	Peppermint	169	38%
Cananga	Lavender	376	Peppermint	141	38%
Lemongrass	Peppermint	528	Lavender	169	32%

The rule states: "If a customer purchases Lavender Oil and Lemon Oil together, there is a 53% confidence that they will also purchase Peppermint Oil". This means that when customers buy Lavender Oil (Masrani Afrianti, 2023)(Sharmeen et al., 2021) and Lemon Oil together, there is a 53% likelihood that they will also purchase Peppermint Oil. This rule provides valuable information about customer preferences and associations between different types of oils.

4. CONCLUSION

This research showcases the benefits of data mining for UMKM by uncovering valuable insights that go beyond traditional inventory and sales analysis. By leveraging data mining techniques, UMKM owners can identify sales patterns, customer behaviors, product relationships, and marketing strategies to optimize their business operations. Additionally, analyzing additional attributes such as shipping address, total payment, courier name, and delivery service level can provide further valuable insights for targeted marketing, customer spending behavior, and logistics optimization. By utilizing data mining, UMKM can make data-driven decisions, improve customer satisfaction, and enhance overall business performance in a competitive market.

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