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Product Stock Supply Analysis System with FP Growth Algorithm

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Abstract

This study explores the application of Data Mining in deciphering consumer purchasing patterns at Tani Heritage Shop, a retailer specializing in agricultural products. Facing the challenge of managing a high volume of daily sales transactions, the shop often encounters difficulties in tracking which products are frequently purchased together. This lack of insight leads to a critical issue: popular products running out of stock unexpectedly. To address this, the research focuses on developing a product stock supply analysis system, utilizing the FP Growth Algorithm. The FP Growth Algorithm, a powerful tool in Data Mining, is employed to analyze sales transaction data and identify consumer purchasing trends, particularly products bought simultaneously. This approach is designed to provide insights into optimal stocking strategies, ensuring the availability of in-demand products. The research methodology involves applying the FP Growth Algorithm to model the product stock supply system, using specific sales data attributes. The results of this study are significant. By setting parameters such as a minimum support value of 30%, a confidence value of 70%, and targeting the highest lift ratio value of 3.67, the research successfully derives several key association rules from the FP Growth algorithm. These rules are instrumental in optimizing the product stock supply analysis system.

Keywords: Association Rule, FP-Growth, Supply Analysis

1. INTRODUCTION

In the dynamic landscape of today's business world, where competition is fierce, companies are incessantly innovating to differentiate themselves from their rivals. A pivotal aspect of this innovation is the strategic deployment of employee skills and insights to cater to the diverse needs of customers [1]. A crucial element in contemporary business strategy lies in the effective utilization of transaction data. Often, this data is plentiful but not optimally used, merely stored in archives. When analyzed judiciously, this data can be a rich source of insights, crucial for decision-making, particularly in shaping marketing strategies by decoding consumer buying patterns [2].

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Pusaka Tani, a retailer catering to agricultural needs such as fertilizers, rice seeds, and plant medicines, confronts the challenge of aligning its product stock with consumer demand. The company grapples with accurately predicting restocking requirements, hampered by a limited understanding of the purchasing patterns of its consumers. This situation underscores the need for an approach rooted in data analysis for efficient inventory management.

Enter Data Mining, the technique of extracting valuable insights from extensive datasets [3]. This method offers a beacon of hope for Pusaka Tani. By dissecting sales transaction data, the company can formulate a knowledge model that accurately reflects consumer purchasing trends. This model is instrumental in devising a system that optimizes product stock in line with these identified patterns, thereby ensuring that supply is in sync with genuine demand.

Within the realm of Data Mining, the FP Growth Algorithm emerges as a particularly beneficial tool [4]. It excels in identifying itemsets that frequently appear in datasets, making it an invaluable asset for scrutinizing sales data [5], [6], [7]. By calculating support and confidence values, it unveils the products that consumers most commonly purchase. This information is vital for Pusaka Tani, enabling the company to make well-informed decisions about which products to restock and in what quantities. This research is geared towards developing a system that utilizes the FP Growth Algorithm for analyzing product stock supply and customizing inventory management to align with consumer purchasing habits. This strategy is poised to significantly improve Pusaka Tani's inventory management, enhancing efficiency and customer satisfaction.

The overarching aim of this study is to create and implement an advanced system for Pusaka Tani that harnesses the FP Growth Algorithm to interpret sales transaction data effectively. The objective is to convert this data into practical insights, empowering Pusaka Tani to more precisely forecast consumer demand and manage inventory with greater proficiency. Understanding the nuances of product purchase patterns and frequencies, the system is designed to facilitate more informed decisions regarding stock replenishment. Beyond addressing Pusaka Tani's immediate inventory challenges, this research also aims to demonstrate the wider applicability and effectiveness of data mining techniques in retail inventory management. The successful application of this system could serve as a paradigm for other retailers facing analogous challenges, underscoring the transformative power of data-driven strategies in optimizing business operations and enhancing customer contentment.

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2. METHODS

2.1. Research Methods

The research conducted has a research flow that is used to facilitate the research flow of the Product Stock Provisioning Analysis System using the FP Growth Algorithm for the research flow shown in Figure 1.

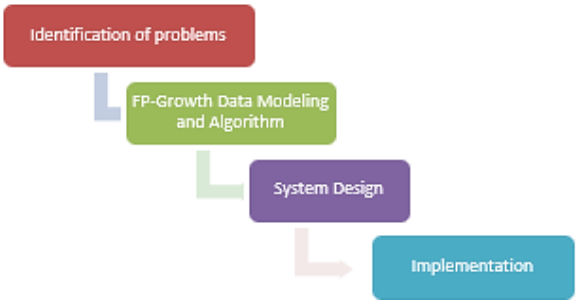

Figure 1. Research Stages

1) Problem Identification Stages
   At this stage, identify problems that occur related to the provision of product stock.
2) Data Modeling Stages and FP Growth Algorithm
   At this stage, data modeling is carried out based on the data that has been obtained, namely sales data and modeling using the FP Growth Algorithm
3) System Design Stages
   At this stage, modeling will be carried out to explain the system being developed visually through system modeling. In the research conducted, the design was carried out using Unified Modeling Language (UML) modeling. UML uses different diagrams to depict various views of a developing system.
4) Implementation Stages
   At this stage, the implementation of the system will be web-based, so the development uses the PHP programming language, and the database will use MySQL by implementing the FP Growth algorithm in the system being built.

3. RESULTS AND DISCUSSION

3.1 Problem Identification Stages

This stage focuses on identifying problems related to the provision of product stock that is less than optimal because many products are overstocked or understocked. Because they don't know the products that consumers frequently buy at the same time, the products that are frequently purchased are in short supply while the products that are rarely purchased are overstocked.

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3.2 Data Modeling Stages and FP-Growth Algorithm

1) Transaction Data

This research uses sample data of 60 product sales transaction data with sales transaction attributes. The transaction data used can be seen in Table 1.

Table 1. Transaction Data

Code Transaction	Transaction
001	Jaya Seed Chili, Urea Fertilizer, Mutiara NPK Fertilizer 16-16-16
002	Jaya Seed Bitter Gourd, Urea Fertilizer, Phonska Plus Fertilizer
003	Jaya Seed Bitter Gourd, Urea Fertilizer, Kempo, Boom Flower
……	
060	EM4 Yellow, Filia 25SE, Regent 50EC

2) Determination of Support Value and Confidence Value Parameters

The support value is used as a probability value for a transaction or a measure of value that shows how big the level of dominance of an item or item is in the entire transaction[8]and the confidence value is used as a value of confidence or certainty between combinations[9][10][11]. To measure the value that has been produced, we will also use the Lift Ratio. The Lift Ratio is used to measure whether the resulting combination has a good combination value[12]. If the lift ratio value is more than 1 then this combination is the best. The minimum support value used is 30% and the minimum confidence value used is 70%. The results of FP Growth are shown in Figure 2.

0.079	Pupuk NPK ...	Ripcoro	
0.149	Pupuk Urea	Plenum	
0.105	Pupuk Urea	Balistic	
0.114	Pupuk Urea	EM4 Kuning	
0.123	Pupuk Urea	Primasil	
0.096	Pupuk Urea	Kempo	
0.105	Plenum	Primasil	
0.544	Jaya Seed ...	Pupuk NPK ...	Pupuk Urea

Figure 2. Results of FP Growth Calculation Modeling

3) Association Rules

In Figure 3, you can see the association rule results from the FP Growth calculation modeling.

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Association Rules
[Pupuk Urea, Primasil] --> [Plenum] (confidence: 0.714)
[Pupuk Urea, Primasil] --> [Jaya Seed Cabai, Plenum] (confidence: 0.714)
[Jaya Seed Cabai, Pupuk Urea, Primasil] --> [Plenum] (confidence: 0.714)
[Pupuk Urea, Primasil] --> [Pupuk NPK Mutiara 16-16-16, Plenum] (confidence: 0.714)
[Pupuk NPK Mutiara 16-16-16, Pupuk Urea, Primasil] --> [Plenum] (confidence: 0.714)
[Pupuk Urea, Primasil] --> [Jaya Seed Cabai, Pupuk NPK Mutiara 16-16-16, Plenum] (confidence: 0.714)
[Jaya Seed Cabai, Pupuk Urea, Primasil] --> [Pupuk NPK Mutiara 16-16-16, Plenum] (confidence: 0.714)
[Pupuk NPK Mutiara 16-16-16, Pupuk Urea, Primasil] --> [Jaya Seed Cabai, Plenum] (confidence: 0.714)
[Jaya Seed Cabai, Pupuk NPK Mutiara 16-16-16, Pupuk Urea, Primasil] --> [Plenum] (confidence: 0.714)
[Sumo] --> [Jaya Seed Cabai] (confidence: 0.769)
[Sumo] --> [Pupuk NPK Mutiara 16-16-16] (confidence: 0.769)
[Sumo] --> [Jaya Seed Cabai, Pupuk NPK Mutiara 16-16-16] (confidence: 0.769)
[Jaya Seed Cabai, Plenum] --> [Pupuk Urea] (confidence: 0.773)
[Pupuk NPK Mutiara 16-16-16, Plenum] --> [Pupuk Urea] (confidence: 0.773)
[Jaya Seed Cabai, Plenum] --> [Pupuk NPK Mutiara 16-16-16, Pupuk Urea] (confidence: 0.773)
[Pupuk NPK Mutiara 16-16-16, Plenum] --> [Jaya Seed Cabai, Pupuk Urea] (confidence: 0.773)
[Jaya Seed Cabai, Pupuk NPK Mutiara 16-16-16, Plenum] --> [Pupuk Urea] (confidence: 0.773)
```

Figure 3. Association Rule Results

Based on the results of the Association Rule association modeling, one of the results is that if consumers buy UREA FERTILIZER and JAYA SEED CHILI, they will also buy NPK MUTIARA 16-16-16 confidence 0.714, it can be concluded that they have a simultaneous purchase confidence value of 71.4%.

3.3 System Design Stages

The design process in this research is modeled in the form of UML (Unified Modeling Language). UML is used in the industrial world to define requirements, make analysis, and design. One of the UML diagrams created is a use case diagram[13]. Use case diagrams to describe interrelated interactions between actors and systems. The analysis system process modeling consists of 2 actors, namely admin and owner. Where the admin can manage transaction data, and FP Growth process data. Meanwhile, the owner can see the results of the FP Growth process so that he can see the results of the analysis. The design of the stock provision analysis system process using FP Growth in the form of a use case diagram can be seen in Figure 4.

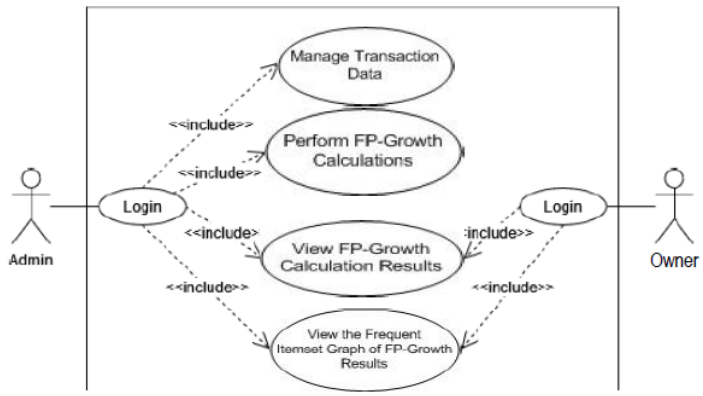

Figure 4. Use Case Analysis System Diagram

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3.4 Implementation Stages

The stock supply analysis system was built on a web basis, so the system was coded using PHP programming. Data storage uses MySQL as a database. The result of coding is an application with a user interface that makes it easier for users to use the application. Interface display in the product stock supply analysis system using FP Growth. The following is the interface for the product stock supply analysis system.

1) Data interface modeling

The data page is used to display transaction data that will be used for the fp growth calculation process as seen in Figure 5.

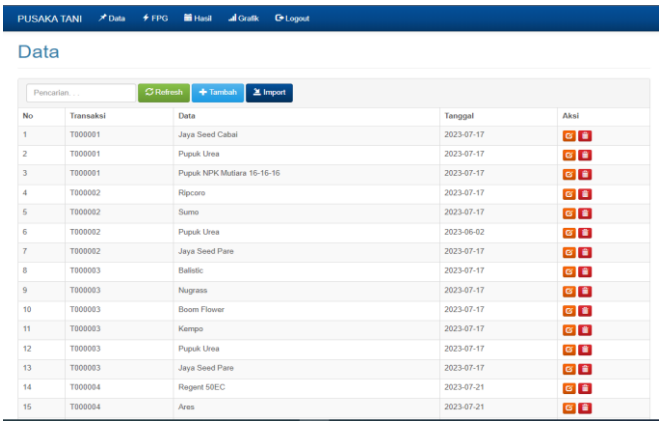

Figure 5. Data Interface Page

2) FP Growth Calculation Modeling

The FP Growth calculation page will display the FP Growth calculation process which will be calculated based on the date period by determining the support and confidence values, which can be seen in Figure 6.

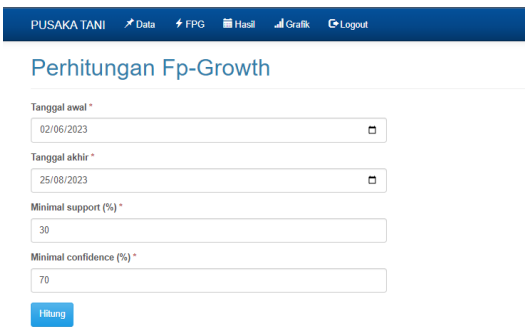

Figure 6. FP Growth Calculation Interface Page

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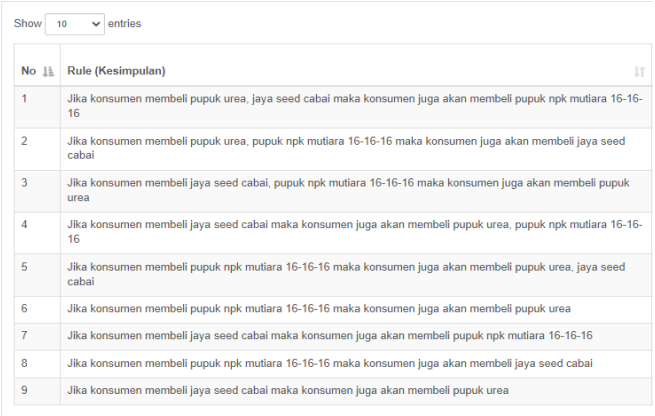
3) FP Growth Results Interface

The FP Growth results page will display the results of the FP Growth calculation so that the results of FP Growth can be seen in Figure 7.


Show 10 entries

No	Rule (Kesimpulan)
1	Jika konsumen membeli pupuk urea, jaya seed cabai maka konsumen juga akan membeli pupuk npk mutiara 16-16-16
2	Jika konsumen membeli pupuk urea, pupuk npk mutiara 16-16-16 maka konsumen juga akan membeli jaya seed cabai
3	Jika konsumen membeli jaya seed cabai, pupuk npk mutiara 16-16-16 maka konsumen juga akan membeli pupuk urea
4	Jika konsumen membeli jaya seed cabai maka konsumen juga akan membeli pupuk urea, pupuk npk mutiara 16-16-16
5	Jika konsumen membeli pupuk npk mutiara 16-16-16 maka konsumen juga akan membeli pupuk urea, jaya seed cabai
6	Jika konsumen membeli pupuk npk mutiara 16-16-16 maka konsumen juga akan membeli pupuk urea
7	Jika konsumen membeli jaya seed cabai maka konsumen juga akan membeli pupuk npk mutiara 16-16-16
8	Jika konsumen membeli pupuk npk mutiara 16-16-16 maka konsumen juga akan membeli jaya seed cabai
9	Jika konsumen membeli jaya seed cabai maka konsumen juga akan membeli pupuk urea

Figure 7. FP Growth Results Page

Based on Figure 7, the results of FP Growth are shown based on the minimum support value and confidence value. The association results show a combination of item sets that are often purchased by consumers together, making it easier to provide product stock.

4. CONCLUSION

The conclusion drawn from the analysis and testing using the FP Growth method provides insightful revelations into consumer purchasing behaviors. By employing this method, the study successfully deciphers association rules that are pivotal in predicting the products most frequently bought by consumers. This understanding directly informs and enhances the stock supply analysis system, making it more responsive to actual consumer needs.

A key finding from the application of data mining to transaction data, processed through the FP Growth algorithm, is the identification of specific purchasing patterns. For instance, the analysis revealed a pattern wherein the purchase of UREA FERTILIZER and JAYA SEED CHILI often leads to the subsequent purchase of NPK MUTIARA 16-16-16. Such insights are invaluable for retailers in optimizing stock levels, effectively preventing situations of overstocking or understocking.

In essence, the application of the FP Growth method in analyzing product purchase transaction patterns proves to be a powerful tool. It enables retailers to maintain an optimal stock level, ensuring the right balance between supply and

demand. This approach not only streamlines inventory management but also aligns it more closely with consumer preferences and behaviors, ultimately leading to more efficient and customer-centric retail operations. The success of this method in the study offers a promising avenue for other retailers to adopt similar data-driven strategies for their inventory management challenges.

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