Inventory control using ABC and min-max analysis on retail management information system

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Abstract. Determination of reorder point aims to meet the safety stock. This is a central parameter of inventory control. This study aims to find reorder point based on goods classification and safe stock. This approach is implemented in retail information systems that have been running. The information system has about 15,000 active items with the number of sales transactions around 1,100 per day. The problem in determining the reorder point is the unavailability of the safe stock reference. Lack of safe stock information triggered the ordering goods error. This error causes over stock. It can increase the potential of expired goods. In this study the researcher classifies the goods and determines the amount of safe stock to control the inventory. We used ABC analysis method for goods classification. It divides the group of goods into A, B, C, and D. The amount of safe stock is determined based on the goods sale’s history using Min Max Analysis method. Classification result is used to determine the limits on the inventory of allowed items to be ordered. Limitation safety stock amount refers to the limits from the min max method result. While, testing is done by comparing cost before and after implementation of this method.

1. Introduction

In the face of competition in the retail industry, companies must have various strategies in order to survive. Inventory management is one strategy that needs to be considered by the company. Retail company performance is strongly influenced by inventory. In meeting consumer needs, companies must ensure that the goods needed are always available. On the other hand, items that are not needed should not meet the warehouse. Unnecessary goods accumulate in the warehouse resulting in high inventory costs. One of the causes of excessive accumulation of goods is that there is no information about the maximum inventory limit. This must be a concern of the company in order to control inventory costs.

The application of information technology is one strategy that can be used to overcome inventory problems. Information technology that needs to be applied is not only limited to recording incoming and outgoing goods [1]. Further mathematical models need to be applied in the inventory management system. Without the right mathematical model, the rule of thumb method can cause excess inventory and excess inventory [2]. From the results of the right mathematical calculations, companies can arrange rules systematically. Rules that are implemented in the information system can control reorder. Controlled reorder values can reduce excess or lack of stock.

This paper describes the results of the application of mathematical methods in inventory control. The study was conducted on retail companies that have implemented computerized information systems. Ayunadi Supermarket is a retail company located in Denpasar City, Bali, Indonesia. In the current...
information system, there are 15,000 records of goods and 1,100 transaction data per day. Information generated in the information system used includes the remaining stock of goods, data on sales, purchases, returns and orders. The company's strategy in controlling inventory is determining the minimum and maximum stock of goods. Stock limit data is updated within a period of 3 months. Too many items don't allow the company to list all items. So that there is often a problem of over stock on goods that are slow moving. This paper proposes the development of management information systems in controlling inventory. Inventory control is carried out on the return order module. Sales transaction data in the database are analyzed to get the priority class of goods, minimum values, and maximum stock. In the reorder module, restrictions are made on ordering items based on class and the number of items allowed to be ordered. The method applied to search for goods class is ABC Analysis. ABC analysis can be used to find items that contribute greatly to sales [3-5]. The second method is min-max analysis, used to determine the minimum and maximum values of stocks based on sales transactions [6,7]. The results of ABC and Min-Max Analysis are implemented on the item data. In the goods ordering module, the rules for ordering restrictions are based on class of goods, minimum stock, and maximum stock. This paper consists of 5 sections. Section 1 Introduction, Section 2 Related Work, Section 3 Proposed Methods, Section 4 Result and Discussions, and Section 5 Conclusion.

2. Related work
Research on inventory control with computer applications has been done before. Sugianto et al, has conducted research on scheduling systems on good order using economic order quantity [1]. In the study, Sugianto et al designed a web-based application to determine the schedule of returning goods. The method used to determine the amount of goods ordered is economic order quantity. The output of the designed system is a schedule of the amount of raw material that must be ordered back to meet the needs of raw materials. Research on scheduling reordering [1], is an inspiration in this paper. Only in this paper, the data used is retail company data. In the retail data the number of items sold is a concern. The amount of goods sold in this paper will be grouped to find out the priority level of the goods. The resulting group is used to find fast moving items and slow-moving items. The method applied in giving classes is ABC. Research on ABC analysis has been done previously on [3-5]. ABC analysis is used to get a collection of items that have a high value on sales transaction data. Labels for class A, B, C can provide priority information for handling inventory based on the value of an item. So that efficiency can be done in terms of inventory [5]. The determination of the number of re-orders will be adjusted to the class of goods. The number of orders for each item is determined based on the minimum stock and maximum stock. Research on the number of orders to meet minimum and maximum stock has been carried out in the study [6,7]. The combination of class of goods with minimum and maximum stock standards, can overcome over stock which results in high costs.

3. Proposed methods
In this study proposed stock control methods using ABC Analysis and Min-Max Analysis. The proposed method is implemented in the Ayunadi Swalayan retail management information system. The first stage was carried out data transformation in the retail management application database structure. The transformation process uses the Extract, Transform, Load (ETL) method. The output of the ETL process is Data Mart. In the Data Mart, the search for goods classes per sub category is carried out using the ABC Analysis calculation method. Furthermore, in the Data Mart, the search for maximum and minimum stock values is based on the Min-Max Analysis calculation method. The resulting maximum and minimum grade and stock values are then implemented into the goods data table in the retail management information system database. The last stage is to arrange the order amount that is allowed in the order module in the retail management information system. Rules that are made based on the class of goods along with the minimum and maximum stock values.
3.1. Extract, Transformation and Load (ETL)

**Figure 1. Proposed methods.**

**Figure 2. Database retail management system of Ayunadi swalayan.**
The initial stage in the proposed method is the separation of operational data into a data warehouse. This stage is carried out so that the analysis process does not interfere with system operations. The data separation process is carried out using the Extract, Transform, Load (ETL) method. ETL is a data integration function that involves the process of extracting data from an outside source (operational system), changing it to suit business needs, and finally loading it into a data warehouse. Data is loaded on the data warehouse which is then exploited to get the desired information. The data used in the ETL process can come from sources such as mainframe applications, ERP applications, CRM tools, flat files or Excel spreadsheets [8]. The output of the ETL stage is Data Mart. Data Mart is a data warehouse that contains specific information from departments within an organization. Data Mart is part of the data warehouse. Less data sources are needed in Data Mart compared to Data Warehouse [9]. In this paper the data used is sales data. In addition to sales data is not used in this paper, so the data warehouse that is made is only limited to Data Mart.

Extract is the process of filtering data from source data, or selecting the required data from source data to be included in the Data Warehouse. In the extraction process, there are selected tables and fields in the POS Ayunadi database. Based on the needs of pareto and min-max analysis, the tables needed are tables of items, tbbarangkeluar, tbbarangkelilil, and categories. Table items are tables that are used to store and manage item data. Tables of outbound and non-standard items are used to store sales transaction data. The table of categories is a table that is used to store data on the subcategory of items that exist in the Supermarket Self Service. Based on the table that has been determined in the extraction process, the next step is to transform or transform data. In the transformation process is carried out the determination of data types from the fields used and joining (merging) tables. Joining is carried out on the categories of categories, outbound, and default. Load is the end result of the ETL process, load displays data that has been through the extraction and transformation process. In the Load process, dimensions and fact tables can be seen and processed further to implement ABC and Min-Max Analysis.

![Figure 3. Data mart.](image)

### 3.2. ABC analysis

ABC analysis is a method of inventory control based on the principle found by Vilfredo Pareto. The principle found by Vilfredo Pareto is known as the Pareto law. Initially the Pareto law observed that 20% of the Italian population had 80% of the land used. Pareto found the same distribution in other economic and natural processes [3]. As a general rule he formulated this finding as: "in any set of elements, trying to achieve small amounts in small amounts will have the greatest effect [10]. In the
1940s, General Electric's Ford Dickie developed this Pareto concept to create ABC concept in classifying inventory items. Based on Pareto law, ABC analysis can classify items based on the value rating from the highest to the lowest, and then divided into priority major classes, usually classes named A, B, C, and so on sequentially from rank highest to lowest value, therefore, this analysis is called ABC analysis.

Generally, class A has a small number of items, but has a very high value. Class A is 15-20% of the total goods, but represents 75-80% of the total value of money. Class B in the number of units ranges from 20-25% of the total number of items, but represents 10-15% of the total value of money. Class C the number of units ranges from 60-65% of the total goods, but represents 5-10% of the total value of money. ABC analysis is done on the history of the sale of goods. The transaction period used in ABC analysis can be tailored to the needs of each company. There are no industry standards that determine the analysis period and are determined based on convenience [4]. In this paper ABC is used to classify items based on the history of sales of goods in the last 3 months. The classification process is done by finding the sales value of each item. The sales value of each item is then compared to the total sales during the specified period. The data is then sorted by the largest sales value. From the data presentation, the labels A, B, C and D are given according to the number of items that contribute to the sales value.

In the ABC analysis method that applies Pareto Law, the priority category of goods consists of A, B, and C. While in this paper, the class of goods is divided into A, B, C, and D, this is related to Ayu Nadi Swalayan's need for control inventory. A state that the group is Very Fast-Moving Items, which are items that are very fast selling or most consumers buy. Class B, is a group of Fast-Moving items that sell quickly under group A. Class C is the category of Slow-Moving Items, items that are not too salable. D is a Very Slow-Moving Item which is an item that is very rarely purchased by consumers. This Class D is a recommendation for the removal of items from display because they are not selling well or are not active. Inactive goods classes are also applied to other studies [4]. Determination of the class of goods is carried out based on sub categories of goods, priority of goods is measured based on the value of money between items in the sub-category, so that there is no imbalance in the sale value of goods that are too high in the pareto calculation process.

### 3.3. Min-max analysis

Min-Max analysis in this paper is used to find the minimum stock and maximum stock. The maximum and minimum stock amounts are calculated based on the needs of the goods in a certain period. In addition to the need for goods, the maximum and minimum stock quantities are determined based on lead times and safety stock. Lead time is the grace period needed between when ordering goods with the arrival of the item [6]. Safety stock is a security stock to prevent the stock from running out. Security stock is determined to overcome delays in delivery or other things that can cause stock to run out [11]. Calculating safety stock can be used with calculations:

\[
\text{Safety stock} = \text{Average period consumption} \times \text{Replenishment lead time in days}
\]

Average period consumption is an average merchandise requirement. In this paper the average requirement is calculated based on average sales per day in one week. The minimum stock is then calculated to find out the amount of merchandise that must be available. The minimum amount of stock becomes a reference number of orders during the reorder period. In this paper the minimum stock is calculated by the following equation:

\[
\text{Min. inventory} = (\text{Average period consumption} \times \text{Reorder period}) + \text{Safety stock}
\]

The reorder period is determined according to the sales visit in taking the order note to the store. Maximum stock is the maximum amount of inventory that is allowed to be stored in the warehouse. Maximum inventory is needed so that the quantity of inventory in the warehouse is not excessive so that there is no waste of working capital [6]. To calculate the maximum stock can be calculated by:
Max. inventory = 2 * (average period consumption * reorder period) + safety stock

Determination of maximum inventory is based on inventory management at the company. At Ayunadi Supermarket, the maximum stock is determined based on safety stock and 2 times the inventory requirements in the reorder period. The results of the minimum stock and maximum stock values are combined with results from ABC analysis. Goods with class A are permitted to be ordered in excess of the maximum stock. Goods with class B are only permitted to meet the maximum stock. Goods with Class C are allowed to exceed the minimum stock and below the maximum stock. Lastly for goods with class D is only allowed to meet the minimum stock. The rule was then implemented in the retail management information system that existed at the Ayunadi Supermarket.

4. Results and discussions
The proposed supply control method has been tested on Ayunadi Swalayan sales data. In the ABC analysis method, the priority category of goods consists of A, B, and C. While in the development carried out, the priority of goods is divided into A, B, C, and D, this is related to Ayu Nadi Supermarket's needs in controlling inventory. A state the Very Fast-Moving Item group, which is a very fast selling item / most consumers buy in the Men’s Health Care Sub Category. Category B, is a group of Fast-Moving items that sell quickly under group A. Group C is the category of Slow-Moving Items, items that are not too well sold. D is a Very Slow-Moving Item which is an item that is very rarely purchased by consumers. Determination of categories of goods is carried out based on sub categories of goods, priority items are measured based on the value of money between items in the sub-category, so that there is no imbalance in the sale value of goods that are too high in the pareto calculation process.

In Figure 4, the results of the analysis of the sale of goods at the Supermarket in the period of 3 months. Categories are distinguished by color, pink for category A, orange for category B, blue for category C, and white for D. Sales column shows the value of money for each item, the cumulative sales column is the total accumulated value of goods, contribution is the column that displays percentage of goods contribution to the total value of sales money. Control column. The cumulative (%) is the percentage contribution of the value of goods from the total value of money in the sub-categories analyzed, namely Men Bath Care. Because the number of items is too much in the Supermarket, the determination of the goods is focused on the percentage of the contribution of the value of the goods in the Counter Column. Cumulative (%). Categories A and B are items that represent 80% of the total value of money. A is the first 40% and B is more than 40% to 80%. C is an item category that represents 10% after B and D are item categories that represent 10% after category C.

Figure 4. ABC analysis implementation in men bath care sub categories.
Figure 5 is another result of the implementation of the Pareto Analysis in the Face Care sub category. In the Face Care sub category, the number of items is more, so that members of category A items are more than in the Men’s Health Care sub category.

Implementation of Min Max Analysis in the Ayunadi Swalayan datamart is done to find the minimum and maximum number of stocks that must be available at Ayunadi Swalayan to serve the needs of consumers. At Ayunadi, self-service orders are made on average once a week according to the sales distributor’s schedule. Minimum stock calculation is calculated for 1 week. Goods need in a period of 1 week is calculated based on 3 months sales, namely January - March 2018. So that the maximum and minimum stock values can change according to the next 3 months period in the current year. Figure 6 shows the results of the implementation of the Min Max Analysis which produces data on goods requirements in a day and minimum stock, and maximum stock.
Figure 6. Implementation of min max analysis.

The results of sales data analysis with Pareto and Min-Max Analysis are then implemented on the Ayunadi Supermarket self-service profile. Linkages from classification A, B, C, D, minimum stock, and maximum stock are the number of orders that are allowed when issuing a Purchase order. With restrictions based on the priority of goods, inventory of goods will be in accordance with the needs of goods according to the history of consumer transactions. So that the number of goods with over stock status can be reduced and of course can reduce the inventory cost of goods that are not sold on the company's cash flow. Implementation of goods classification and maximum minimum stock can be seen in Figure 7.

Figure 7. Implementation of classification of goods, minimum maximum stock in POS modules for purchase order.
The impact of the proposed inventory control method showed in Table 1 and Table 2. 2017 is the transaction data before the inventory control is applied. Year 2018 is transaction data after implementing the proposed inventory control method. Table 1 is a comparison of sales data, table 2 is the data on the purchase of goods which constitutes inventory costs.

**Table 1.** Sales comparation after proposed method implemented.

|       | 2017       | 2018       |
|-------|------------|------------|
| Jan   | 3.146.949.207 | 3.326.843.535 |
| Feb   | 2.908.880.659  | 3.044.643.794  |
| Mar   | 3.316.330.845  | 3.584.264.873  |

Table 1 shows the increase in sales in 2018. The data shows that the restrictions on orders made have a positive impact. This can indicate that the items needed are still available. Table 2 shows the value of the purchase of goods decreased in 2018. The value of purchases increased only in February 2018, but this was in line with increased sales. Based on Table 2 data, inventory controls implemented are effective in reducing inventory costs. In this case it can be stated there is no excess stock of the slow-moving item.

**Table 2.** Purchase Comparation after Propose Method Implemented.

|       | 2017       | 2018       |
|-------|------------|------------|
| Jan   | 3.193.184.871 | 2.801.656.862 |
| Feb   | 2.390.945.823  | 2.594.487.305  |
| Mar   | 3.108.301.460  | 3.059.440.562  |

Based on the data in table 1 and table 2, the average difference in sales and purchases in 2017 is 7.53%. In 2018 the average value of sales and purchase differences was 15.07%. The comparison states that there is a decrease in inventory costs after implementing inventory control.

5. **Conclusion**

In this paper has successfully implemented inventory control with ABC and Min Max. The large number of items in the analysis process with ABC Analysis cannot produce the right accumulated results 20% of items represent 80% of the value on sales. classification and stock limits on the goods can be used as a parameter in giving warnings to operators in ordering goods. The results of the application of the proposed method indicate that it has been successful in suppressing inventory costs. Decrease in inventory costs does not have a negative impact on sales value. In further research, it is necessary to add external parameters in the control of goods. External parameters can be in the form of holidays or other national events. So that the order limit can be flexible following the needs of goods because there are certain events.
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