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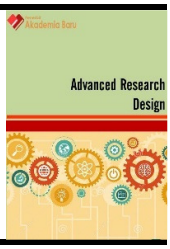

Inventory Management Improvement Suggestion through Time-Series Forecasting for Financial Service Company

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ABSTRACT

Management is consistently facing fast-flowing and lots of changes in business, including in the inventory management. Especially for fast-moving inventories, the correct stocking, controlling, checking and safety stock calculation is highly needed to have an exquisite inventory management and to reduce the possibility of running out of inventory which leads to unavailability to meet the demand. One of the ways to overcome this is by doing an excellent and appropriate forecasting. Therefore, the objective of this concept paper is to analyse and recommend tools to improve inventory management using the appropriate time-series forecasting method. The firm studied in this study is serving its employees as customers that demand the routine items including stationeries and other routine products to support their job as auditors and consultants for its client. However, there are occasions when there is out-of-stock situation for fast-moving items, especially in the peak season period. Furthermore, the firm is only applying replenishment based on the used inventories from the previous month. Therefore, this study suggests to eliminate out-of-stock items situation by applying precaution initiatives such as time-series forecasting. This study is planned to employ 10 time-series forecasting methods such as moving average, exponential smoothing, regression analysis, Holt-Winters analysis, Seasonal analysis and Autoregressive Integrated Moving Average (ARIMA) using Risk Simulator Software. By simulating those methods, the most appropriate method is selected based on the forecasting accuracy measurement.

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1. Introduction

Management is consistently faced with the fast-flowing and highly dynamic changes in business, including the inventory management. Inventory management is the arrangement of approaches and controls that monitor levels of inventory and figure out what levels ought to be maintained, when stock ought to be replenished, and how substantial orders should be managed [1]. Those inventories

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are often being categorized using FSN Analysis. It is an analysis to classify inventories based on the rate of consumption where F stands for Fast-moving, S stands for Slow-moving and N stands for Non-moving items [2]. The items that are categorized as fast-moving, slow-moving and non-moving items are different between companies. The classifications for each type are commonly shown as in Table 1 below.

Table 1
FSN Analysis Characteristics

Indicators	Fast-Moving	Slow-Moving	Non-Moving
Stock	High	Intermediate	Low
Control	High	Intermediate	Low
Check	Tight	Intermediate	No
Safety Stock	High	Low	Rare

For fast-moving inventories, the correct stocking, controlling, checking and safety stock calculation is highly needed to have an exquisite inventory management and to reduce the possibility that the inventory runs out that made the demand cannot be met. Thus, an excellent forecasting is needed. Forecasting itself is utilized as a basis to address on how many inventory to be kept and when to reorder whereby, the more accurate the forecasts, the better the result of the planning and decisions [3]. Indeed, inventory optimization can better address demand volatility and supply variability, and consequently diminishing the risk of both under-stocks and over-stocks for organizations to optimize their inventory through appropriate forecasting [4]. Many organizations that utilize better forecast for inventory optimization had managed to reduce their inventory levels up to 25 percent in one year and delighted a mark down cash flow of over 50 percent in under two years [5].

On the downside, it is not possible to say that forecasting is 100 percent accurate because of the future uncertainties [6]. There are several methods that can be used for forecasting which includes qualitative forecasting, which is based on experts view and appropriate for new industry; time-series forecasting, which is appropriate if the historical data is considered reliable and good factor; causal forecasting; which is appropriate to know the cause-and-effect for business decisions; and simulation forecasting, which is appropriate for simulating the consumers' choices that have the possibility to rise demand [7].

If data is abundant and readily available, time-series forecasting is the most appropriate to forecast future demand. Time-series forecasting can be done by employing simple averages, moving average methods, seasonality, ARIMA and exponential smoothing to name a few [8]. Those methods are applied to know which is the most appropriate to be employed to forecast the inventory needed on a certain period which usually are decided based on the Root Mean Square Error (RMSE) as deviation differences.

Even though there are previous studies which cover the similar topic like in this study, there are several differences as this study employs more thorough time-series forecasting methods available to determine the most accurate time-series forecasting method to be used. Moreover, from the result of previous studies, it can be concluded that there is no certain forecasting method that can be universally applied to any inventory items, as it is based on the current situation and environment for the observed inventory item. To summarize, Table 2 below shows the overall differences as compared to previous studies.

Table 2
Comparison to previous studies

Author(s)	Year	Case Study	Methods	Software Used	Findings
Bon and Ng [4]	2017	Panadol 650mg as fast-moving inventory item forecast at University Health Care Centre of *Universiti Tun Hussein Onn Malaysia*	• Simple Moving Average • Simple Exponential Smoothing • Double Moving Average • Double Exponential Smoothing • Regression Analysis • Holt-Winter's Additive • Seasonal Additive • Holt-Winter's Multiplicative • Seasonal Multiplicative • ARIMA	Risk Simulator Software	Regression Analysis is the most proper forecasting method for University Health Care Centre with the lowest RMSE of 1,334.7793
Monahan [9]	2016	Aircraft orders and delivery successfulness forecast at aircraft manufacturer	• Naïve Method • Double Exponential Smoothing • Holt-Winter's Multiplicative • Seasonal Multiplicative • Regression Analysis • ARIMA	Excel	Seasonal Multiplicative is the most proper forecasting method for aircraft orders, while regression analysis is more accurate.
Matsumoto and Ikeda [10]	2015	Three Alternators and Three Starters remanufacturing forecast at Shin-Etsu Denso, Co.	• Single Exponential Smoothing • Double Exponential Smoothing • ARIMA	Excel	The result from ARIMA for every product improved the forecasting accuracy with only 21.5% error
Bon and Jun [11]	2016	Steel production forecast at John Hee MICRON Sdn. Bhd.	• Simple Moving Average • Simple Exponential Smoothing • Double Exponential Smoothing • Regression Analysis • Time-Series Decomposition • ARIMA	Risk Simulator Software	Seasonal Additive is the most appropriate to be used with RMSE of 105,065.22
Karmaker *et al*., [12]	2017	Jute yarn demand forecasting in Bangladesh	• Single Moving Average • Single Exponential Smoothing • Regression Analysis • Time-Series Decomposition • Holt-Winter's Additive • Holt-Winter's Multiplicative	Minitab 17	Holt-Winter's Additive method gave the best performance with lowest error determinants

Generally, forecasting is usually used by manufacturing organizations since it affects the decisions and activities in that organization including capacity planning, inventory planning, make-or-buy decisions and finally the strategic resource planning which may lead to plant expansion and capital equipment purchase [11,13,14]. Furthermore, the importance of forecasting application for

inventory management is not limited only to manufacturing organization, it also includes organizations that are focusing its business in merchandising. For example, there was a study that simulated forecasting for predicting the future freight truckload demand in the US so that they could facilitate the capacity planning, pricing strategies and marketing efforts [15]. Another example is that Bon and Ng [4] had studied to find the appropriate forecasting method for University Healthcare Centre in Johor which virtually has no manufacturing and selling process. This study was conducted to facilitate the inventory management improvement through forecasting for one of the financial service company located in Indonesia which is discussed further in the next sub-section.

2. Background

As discussed in the introduction, the need for excellent inventory management is not limited to manufacturing company. Failure in maintaining high quality inventory management may lead to high delivery cost for urgent restocking, even missed revenues altogether since the scheduled service to be delivered cannot be performed accordingly [16]. Therefore, good and systematic inventory management is crucial to be established by companies that maintain stock, regardless of the company's nature of business.

This also includes the firm that is being analysed in this study. As an introduction, this firm is located in Indonesia and is a subsidiary of one of the well-known financial service company which has operations in 150 countries of all five continents in the world [17]. This firm provides auditing and advisory services for companies operating in Indonesia to comply with the local financial regulations. Thus, this firm is not doing any merchandise selling to the customers as in the normal market. However, this firm is serving its employees as customers which demand the routine items including stationeries, papers, binders and other routine products to support their job as auditors and consultants for its client. Therefore, as this firm employs more than 2,000 employees [18], this is causing high demand for those routine products and good inventory management practice is highly needed.

Most of the time, companies that are not focusing on selling the products they manufacture will use their own judgement and experience to build up the decision on inventory management, which implies that there is little to none proper and systematic way to forecast its inventory [4]. This situation is also applicable to the financial company that is being studied in this study. Based on an interview with one of the officers from that particular firm, there is a repetitive problem in inventory management, especially for routine products such as stationeries and papers which are considered as fast-moving inventories, while slow-moving inventories such as binder rings, CD-Rs and report boxes; and non-moving inventories like mops, cutters and scissors are giving no problem since the flow of those type of inventories are not rapid. Other than that, the firm's regulation is only allowing one time of ordering in each month and there is no forecasting done at all in the stock management, since they are only replenishing items that have been consumed in the previous month. Thus, there were out of stock before those items are being replenished, especially during peak season when it is in a report-making season, mainly around March and April every year.

Moreover, most of the processes from stock audit until purchase order issuance are still being done manually and the process itself took a while to be completed. Therefore, this problem could slow down the activities of the firm's core business and might negatively affect the employees' satisfaction on the internal service since they could not perform the job properly.

3. Methodology

Basically, the methodology of this study can be divided into three major parts as illustrated in Figure 1. The initial step is collecting raw data from inventory and procurement database that has been verified. The next procedure involves data pre-processing to select or identify two fast-moving items using filtering and pivoting approaches followed by FSN analysis. Subsequently, the trend and seasonality of the selected items will be determined and consequently narrow down the options for time-series forecasting methods applicable for the items by employing time-series components verifications. Finally, data analysis is conducted using suitable time-series forecasting methods. Their performance will be assessed and compared to select the best time-series forecasting method for the selected fast-moving inventories of this study.

Fig.1. Research Framework

3.1 Data Collection

As briefly introduced in the previous sub-sections, the data is collected by data review that has been documented by the company under study. The data being considered are those that has been verified and reported to the regional head which are ranging from Fiscal Year (FY) 17 to 18 (24 months) as confirmed with the procurement department. In this case, it is ranged from July 2016 until June 2018. The data taken is the inventory and procurement database and any other relevant documents that can help the author to complete this study.

The exported data from the database itself is still a raw data in Comma-Separated Value (CSV) format with data for Purchase Order (PO) number and date, Purchase Requisition (PR) number, appointed vendors, items ordered along with quantity and price as well as the delivery and payment terms. Therefore, the data itself should be converted to excel file to ensure that every cell represents one information as stated above. Lastly, the next step to be executed is to pre-process the data first before the data analysis can be conducted.

3.2 Data Pre-processing

In this data pre-processing stage, there are several steps that need to be conducted. The process is started by filtering and pivoting the data, followed by executing FSN analysis to select the top two fast-moving inventory items and lastly, conduct time-series components verification by plotting data to graph to identify trend and seasonality characteristics on the data for each selected inventory items. Below is the detailed explanation for each step to be executed in the data pre-processing stage.

3.2.1 Filtering and pivoting

The first step in doing the pre-processing phase is to add month categorization based on the PO date so that the monthly order and demand can be determined. For this process, the month is being

sorted from 1 to 12 to indicate the number of months in FY 17 and from 13 to 24 to indicate the number of months in FY 18. For the second step, the naming of the items ordered needs to be categorized and standardized. This is required since the PO details are still being keyed in manually; therefore, there are some typos and dissimilarities on typing the item name (i.e. Toner Canon NPG – 35 (Black) and Toner Canon NPG-35 Black) which cause the data to be scattered and could not be categorized correctly.

After those data has been filtered, the database now contains the monthly categorization and standardized items description. The data is then pivoted using pivot table function in excel to summarize the number of orders, order quantity and average price. This step aims to determine two inventories that can be categorized as top two fast-moving inventory items that will be analysed.

3.2.2 FSN analysis

Using the data that has been filtered and pivoted, the next step of data pre-processing is conducted using FSN Analysis. As explained by Chronos Process Integration Sdn Bhd [19] and Investopedia [20], fast-moving inventories are low-priced inventories that are frequently issued and used as well as those with high risk of out-of-stock. Referring to the FSN analysis guideline as instructed by Ben Hmida and Parekh [21], the steps are shown below:

1. Obtain the total demand or order for each inventory in a given period. For the case of this study, the period is 24 months
2. Compute the first quartile (Q1) and third quartile (Q3) from the total demand or order data
3. Classify the inventories using this following logic:
    a. If the total demand or order is higher than Q1, it is considered as Fast-Moving
    b. If the total demand or order is lower than Q3, it is considered as Non-Moving
    c. Everything in between is considered as Slow-Moving

For this study, another indicator for fast-moving inventory items is when the number of order exceeds 24 times which means there was more than once order per month. This process concludes the FSN Analysis and the last step of pre-processing data can be executed.

3.2.3 Time-series characteristics verification

After the top two fast-moving inventory items have been identified, graphs are being plotted. The objective of this step is to determine whether the data has trend and seasonality or not. If the data has no trend nor seasonality nor both, some methods that account seasonality and trend cannot be used since there is no significant effect on the calculation [4]. Using the common pattern of time-series forecasting that had been explained by Waters [22], the trend and seasonality pattern is analysed. For trend, it is easy to be analysed since it can be done automatically through excel function, while for seasonality, it is needed to analyse the data plotting in which it has fluctuated in certain period [7,23].

Consequently, the outcome of this step may limit the number of time-series methods that can be employed. Based on the arguments from Bon and Ng [4], Box and Jenkins [24], Chopra and Meindl [7], Heizer and Render [25], Lawrence and Klimberg [26], and Ord and Fildes [27], if there is no trend in the data, methods such as (1) regression analysis, (2) Holt-Winters method and (3) ARIMA have no significant effect to the forecasting result. On the other hand, if there is no seasonality in the data,

methods such as (1) Holt-Winters method and (2) seasonality method could not be used. More extremely, if both trend and seasonality are not found in the data, the available method that can be applied is only moving average and exponential smoothing which annul this study altogether.

Therefore, this step is crucial to be done before jumping into the main objective which is simulating time-series forecasting as it makes the data ready to be analysed and to be simulated for the time-series forecasting to complete this study.

3.3 Data Analysis

The last step to be done in this study is to perform data analysis which is the core part of this study. This stage is mainly done to determine time-series forecasting methods based on the time-series characteristics verification.

After the data pre-processing has been successfully completed, the data analysis can now be executed. Referring to Bon and Jun [11] and Bon and Ng [4], the data analysis is carried out using Risk Simulator Software add-on for Excel developed by Real Option Valuation, Inc. This program is capable to do time-series forecasting that are covered in this paper [28]. All 10 time-series forecasting methods suggested in this paper are as follows:

1. Single Moving Average
2. Single Exponential Smoothing
3. Double Moving Average
4. Double Exponential Smoothing
5. Regression Analysis
6. Holt-Winters' Additive
7. Seasonal Additive
8. Holt-Winters' Multiplicative
9. Seasonal Multiplicative
10. ARIMA (Autoregressive Integrated Moving Average)

4. Findings and Conclusions

In conclusion, this paper is a preliminary to the overall research in improving one of the financial service company in Indonesia's inventory management using appropriate time-series forecasting methods. Based on the interview with General Affair staffs, they are just replenishing stocks that have been ordered in the previous period with no precaution initiatives such as safety stock and forecasting. Therefore, the end result of this study should suggest the appropriate forecasting method to be applied for the selected inventory items which can be determined through the methodology above.

This study is designed to overcome inventory management problem at one of the Indonesian financial service company in mitigating the out of stock inventories at a certain period of time. Thus, this can help the firm to give an idea on the importance of applying appropriate time-series forecasting by the General Affairs and Procurement department in the company. Moreover, the proposed improvement for inventory management at the end of this study can be used as a base or reference for further in-depth research or experiment for the chosen financial service company since there are still lots of other fast-moving inventories that are not being studied in this study. Ultimately, it is hoped that this study can become one of the benchmarks that can be applied for any kind of companies that are facing challenges in the inventory management.

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