BULLWHIP EFFECT ANALYSIS ON SUPPLY CHAIN MANAGEMENT (CASE STUDY: YOGYAKARTA CITY HEALTH DEPARTMENT AND YOGYAKARTA CITY PHARMACY INSTALLATION)

UNDERGRADUATE THESIS

Submitted to the International Undergraduate Program in Industrial Engineering in Partial Fulfilment of Requirement for the Degree of Sarjana Teknik at the Faculty of Industrial Technology
Universitas Islam Indonesia

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YOGYAKARTA
2024

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Yogyakarta, 28 August 2024

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Telah selesai melakukan penelitian di Wilayah Kerja Dinas Kesehatan Kota Yogyakarta tanggal 3 Juni 2024 untuk memperoleh data dalam rangka penyusunan proposal yang berjudul :
"*Bullwhip Effect Analysis on Supply Chain Management* (Studi Kasus : Dinas Kesehatan dan Instalasi Farmasi Kota Yogyakarta".

Demikian surat keterangan ini dibuat dan diberikan kepada yang bersangkutan untuk dipergunakan seperlunya.

a.n. Kepala,
Sekretaris

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SUPERVISOR APPROVAL SHEET

BULLWHIP EFFECT ANALYSIS ON SUPPLY CHAIN MANAGEMENT (CASE STUDY: YOGYAKARTA CITY HEALTH DEPARTMENT AND YOGYAKARTA CITY PHARMACY INSTALLATION)

UNDERGRADUATE THESIS

Written by:

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Yogyakarta, August 28th, 2024

Supervisor,

Ir. Muhammad Ridwan Andi Purnomo, S.T., M.Sc., Ph.D., IPM

EXAMINER'S APPROVAL PAGE

BULLWHIP EFFECT ANALYSIS ON SUPPLY CHAIN MANAGEMENT (CASE STUDY: YOGYAKARTA CITY HEALTH DEPARTMENT AND YOGYAKARTA CITY PHARMACY INSTALLATION)

UNDERGRADUATE THESIS

Written by :

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Has been defended before the board of examiners in partial fulfillment of the requirement for Bachelor Degree in Teknik Industri at the Faculty of Industrial Technology Universitas Islam Indonesia

Yogyakarta, ***August – 2024***

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DEDICATION PAGE

My deepest gratitude goes to my parents who have nurtured and educated me from birth until now and my 5 younger siblings who have provided both moral and material support. May we always be given health, happiness, and longevity.

Thank you to my Supervisor, Mr. Ridwan who always trains and guides me patiently and always pays attention to me at every guidance meeting.

Thank you to all parties who cannot be mentioned one by one for their support and assistance both directly and indirectly.

MOTTO

"Allah does not charge a soul except (with that within) its capacity". (Q.S. Al-Baqarah: 286)

PREFACE

Al-hamdu lillahi rabbil alamin experienced all the thanks given to Allah SWT as the strength and guidance that blessed the author to complete the report of the Undergraduate Thesis at Yogyakarta City Health Department and Pharmaceutical Installation and complete this thesis as part of the requirement to obtain a Bachelor of Engineering degree with the research topic "BULLWHIP EFFECT ANALYSIS ON SUPPLY CHAIN MANAGEMENT", Also, greetings dedicated to the beloved Prophet Muhammad SAW, who has brought mankind to the whole world of knowledge as at present.

This report is dedicated to my family and all readers, especially students from the Department of Industrial Engineering as a collective knowledge. Therefore, the author would like to thank those who have always sent support and motivation in completing the script report to the author namely:

1. Allah SWT, for all the uncountable blessing and Prophet Muhammad, SAW for His guidance in the right way.
2. My parents always prayed for me and supported me both financially and morally in every condition.
3. Prof. Dr. Ir. Hari Purnomo, M.T., IPU, ASEAN. Eng. as the Dean of Faculty of Industrial Technology.
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The author recognizes that there are still shortcomings and weaknesses in this report. Therefore, the author apologizes and expects criticism and advice so that further research can be improved.

Yogyakarta, 27 August 2024

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ABSTRACT

Health centers as health agencies that are very close to the community are required to be responsive in carrying out their functions to serve the community. One of the important functions of the health center is to provide drug supply to support the patient's recovery process. This study aims to analyze supply chain management aspect in the Pharmaceutical Installation and health centers using the Bullwhip Effect and Forecasting methods. Quantitative methods are used in this study, using questionnaires, observations, interviews, library studies, and documentation for data collection. The sample was taken by choosing 3 health centers in Yogyakarta city and 5 drugs that are mostly sold there. The results of the study at Pharmaceutical Installation showed that all of each health centers and drugs are having bullwhip effect. Forecasting data for the next 3 period also calculated in this research. This study produced several recommendations to improve the supply chain management. These recommendations include defining the factor that affects supply chain performance and also the method to forecast the demand for next period. By implementing these steps, the company hopefully can improve the supply chain performance regarding procurement and sales stock.

Keywords: Supply Chain Management, Bullwhip Effect, Forecasting

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CHAPTER I
INTRODUCTION

1.1 Background

Health centers as health agencies that are very close to the community are required to be responsive in carrying out their functions to serve the community. One of the important functions of the health center is to provide drug supply to support the patient's recovery process. It is a challenge for health centers to build a supply chain system to maintain adequate drug availability, on time and according to community needs. The phenomenon shows that delays in the supply of drugs at health centers are caused by supply constraints in the provider's pharmaceutical installation, causing the realization of e-purchasing of drugs not in accordance with the plan (Anggraiani & Rizki Fauzi, 2023)

The Yogyakarta city health department is one of the government devices of the city of Yogyakarta which has the task and function of assisting the Mayor of Yogyakarta in the health sector. They help facilitate the pharmaceutical installation and 18 health centers in Yogyakarta city to operate delivering medical needs to patients. Yogyakarta City Pharmaceutical Installation need to ensure the efficient goods delivery from pharmaceutical warehouse to several health centers. The fluctuation of demand and determining the correct ordering is required for the company.

There are several specific problems that arise from the problem of drug supply chain management in health centers, for example, such as inaccuracies in predicting demand due to inappropriate methods in predicting drug needs, so that shortages or excess stock often occur. In addition, the unsystematic re-order process relies only on estimates without a clear method, causing the accumulation of expired drugs. The absence of a unified meaning of process efficiency in the pharmaceutical industry's Supply Chain Management (MRP) path, has made it increasingly difficult to move in a better direction

If there are problems in the supply chain of drug delivery from pharmaceutical warehouses to health centers, some of the impacts that may occur are: Delayed Delivery which means medicines required by the health center do not arrive on time, which can cause disruptions in health services, especially for patients who require immediate medication; Increased Operational Costs which means problems in the supply chain may force health centers to look for alternative solutions, such as purchasing drugs from other sources that may be more expensive, thus increasing operational costs; and Impact on Public Health which means if problems persist and occur on a large scale, this could have a negative impact on the overall health of the community, especially in areas that depend on health center services for basic health needs.

To maintain the efficiency and effectiveness of health center it is necessary to pay attention to the supply chain aspect such as drug ordering and drug sales. By facing and overcoming these challanges it is expected that the health center can mantain their performance on giving medical care to support community

This study aims to identify and analyze the weaknesses and strengths in the existing supply chain system at health center. In addition, the results of the analysis can be used to develop policy recommendations to improve the quality of health services available at health centers. By ensuring the availability of timely and quality medicines, it is hoped that health services at health centers can improve.

Based on the explanation from the background above, the researchers raised the theme of this research under the title **"BULLWHIP EFFECT ANALYSIS ON SUPPLY CHAIN MANAGEMENT (CASE STUDY: YOGYAKARTA CITY HEALTH DEPARTMENT AND YOGYAKARTA CITY PHARMACY INSTALLATION)"**.

1.2 Problem Formulation

Based on the background, the formulation of the problem in this study is as

follows:

1. What is the score of Bullwhip Effect in Yogyakarta City Pharmacy and HealthEquipment Warehouse?
2. What kind of factors that affects Bullwhip Effect in Yogyakarta City Pharmacy andHealth Equipment Warehouse?
3. What is the solution that must be proposed to improve performance at YogyakartaCity Pharmacy and Health Equipment Warehouse?

1.3 Research Objectives

Based on the problem formulation, the objectives to be achieved through this research:

1. Identifying the Bullwhip Effect Score in Yogyakarta City Pharmacy and Health Equipment Warehouse.
2. Identifying the factors that causes Bullwhip Effect in Yogyakarta City Pharmacy and Health Equipment Warehouse.
3. Providing recommendations and suggestions for Yogyakarta City Pharmacy and Health Equipment Warehouse on how to improve their supply chain Performance

1.4. Benefits of Research

This research is expected to provide the following benefits:

1. For the company, this research is expected to be able to help in solving existing problems in the company in relation of supply chain management.
2. For next researchers, this research is expected to become future reference and will be developed more by future researchers that have interest with the related topics.

1.5. Research Limitations

There are several limitations of research that must be known as guidelines in carrying out this undergraduate research. The limitations of this undergraduate research are:

1. The research was conducted Yogyakarta City Pharmacy and Health Equipment Warehouse
2. The method used is the Bullwhip Effect analysis and Forecasting
3. The data that are used are latest 12-month data of drugs purchased and sold
4. The data were obtained through observation and interviews at Yogyakarta City Pharmacy and Health Equipment Warehouse
5. The inventory and sales data were taken from May 2023 – April 2024

1.6. Systematic Research

This undergraduate research will be organized into several chapters which will be explained below:

CHAPTER I INTRODUCTION

The introduction contains the background for the undergraduate thesis and the problem formulation; besides that, it also contains the objectives of the research, the scope of the research, and the benefits of the research.

CHAPTER II LITERATURE REVIEW

This section will summarize the findings from the prior studies and research which are relevant with this research. After reviewing the prior studies and research thoroughly, it will become reference for this undergraduate research to resolve the existing problem.

CHAPTER III RESEARCH METHODOLOGY

This section describes the framework, flow chart, and data collection method of this undergraduate research. This will help to make the research more structured and organized. Here, the flow of the research will be explained in detail so that the readers can understand the research methodology.

CHAPTER IV DATA PROCESSING AND RESEARCH RESULTS

This chapter describes the data collection in the form of an overview of the company organization, problem issues, and sales quantitative data to be further processed based on the Bullwhip Effect Calculation and Forecasting Method to become a proposed performance improvement project in the company.

CHAPTER V DISCUSSION

The outcomes of this research will be discussed in chapter 4. The result of the research will be analyzed subjectively using theoretical explanations and statistically based on the research findings and studies. The findings needed to satisfy the research objectives. Based on the analysis in this chapter, there will be recommendations on how to improve the supply chain of the metal casting company.

CHAPTER VI CONCLUSIONS AND RECOMMENDATIONS

Chapter 6 is a closing that contains conclusions and recommendations regarding the undergraduate thesis. The conclusion is made based on the result and discussion, also must answer the objective of the research.

BIBLIOGRAPHY

APPENDIX

CHAPTER II
LITERATURE REVIEW

2.1 Supply Chain Management

Supply chain management is the integration of material procurement activities, the process of converting semi-finished goods into final products, the delivery of goods to the end user, and additional procedures like raw material provision, order tracking, information sharing, performance evaluation, and new product development. Suppliers, manufacturers, warehouses or distribution centers, end users, and aliases for consumers are the first participants in the supply chain management process. SCM operations aim to make businesses more productive, reduce the amount of products that build up and raise the cost of warehouse storage, and manufacture high-quality goods at the lowest feasible cost of production in order to outperform competitors and maximize revenues (Latuconsina et al., 2023).

Joshi and Sharma (2022) define a supply chain as a network of companies that collaborate in creating and delivering an item to the end user. Alternatively, the term "supply chain" refers to the physical network of businesses that are involved in producing, supplying, and sending goods to end users. In order to achieve an effective supply chain, businesses must decide together on the five (five) main processes that drive the supply chain: production process, inventory management, transportation selection, location, and information flow.

SCM involves overseeing and coordinating all activities that occur at each stage in the supply chain, starting from customer demand, order processing, raw material procurement, production, packaging, delivery, to after-sales service.By managing the supply chain

effectively, companies can increase customer satisfaction, improve operational efficiency, reduce costs, and achieve sustainability in their business (Farooque et al., 2019).

The challenge in implementing Supply Chain Management (SCM) involves the need for good coordination among various activities in the supply chain, involving various stakeholders who have different systems. Effective coordination must extend from the beginning of the supply chain, which is customer demand, to the end of the supply chain, which are production and manufacturing (Retnowo & Waluyo, 2022). In practice, establishing coordination with various stakeholders is not easy. It requires good communication and cooperation from all parties involved in the supply chain. Failure in implementing SCM is often caused by a lack of good coordination in the supply chain.

2.2 Bullwhip Effect

The bullwhip effect is a supply chain phenomenon comprising two information distortion mechanisms, the demand distortion and the variance amplification (Fransoo, 2021, p. 130). In BWE, the demand distortion occurs for a given firm; the orders it places to its suppliers tend to be more variable than the demand it observes from its customers. This demand distortion increases the further a firm moves upstream and away from the final consumerm causing variance amplification. The combined effects of demand distortion and variance amplification generates a demand shock downstream that creates demands that oscillate withincreasing amplitude at each successive stage of the supply chain (Fransoo, 2021).

2.2.1 Bullwhip Effect Cause

There are four causes of the bullwhip effect, namely

a. Demand forecast errors, demand is rarely stable, resulting in demand

forecasting that has been made to be rarely accurate

b. Order batching, when the inventory or inventory in a company is reduced, the company usually does not immediately order goods
c. Price fluctuation, to increase sales, periodically manufacturers and distributors make promotions, so that consumers and customers can increase demand to be more than what is actually needed
d. Rationing and shortage gaming, the cause of this bullwhip effect occurs when one of the links in a supply chain commits fraud which results in the factory not being able to know the actual market demand. c. Rationing and shortage gaming

Meanwhile, approaches that can be taken to reduce the bullwhip effect are:

a. Information sharing
b. Shortening or changing the supply chain structure
c. Reduction of fixed costs
d. Creating price stability
e. Shortening lead time

2.2.2 Calculating Bullwhip Effect

Fransoo and Wouters (2000) proposed a measure of the bullwhip effect in a supply chain echelon as a ratio between the coefficient of variance of orders created and the coefficient of variance of demand received by the echelon concerned. It can be systematically formulated as follows

$$\omega = \frac{Cout}{Cin} \tag{2.1}$$

$$\text{Cin} = \frac{\sigma\ (\text{Din})}{\mu(Din)} \tag{2.2}$$

$$\text{Cout} = \frac{\sigma\ (\text{Dout})}{\mu(Dout)} \tag{2.3}$$

Where:

ω: Coefficient of variability (bullwhip effect value)

σ: standard deviation

Din: Total demand

Dout: Total sales

Cout: Var (Q): Sales variability

Cin: Var (D): Demand variability

2.3 Fishbone Diagram

Fishbone diagram is often also called Cause and Effect Diagram or Ishikawa Diagram introduced by Dr. Kaoru Ishikawa, a quality control expert from Japan, as one of the seven basic quality tools (7 basic quality tools). Fishbone diagram will identify various potential causes of one effect or problem, and analyze the problem through a brainstorming session. The problem will be broken down into a number of related categories, including humans, materials, machines, procedures, policies and so on. Each category has causes that need to be described through a brainstorming session (Mario Coccia, 2017).

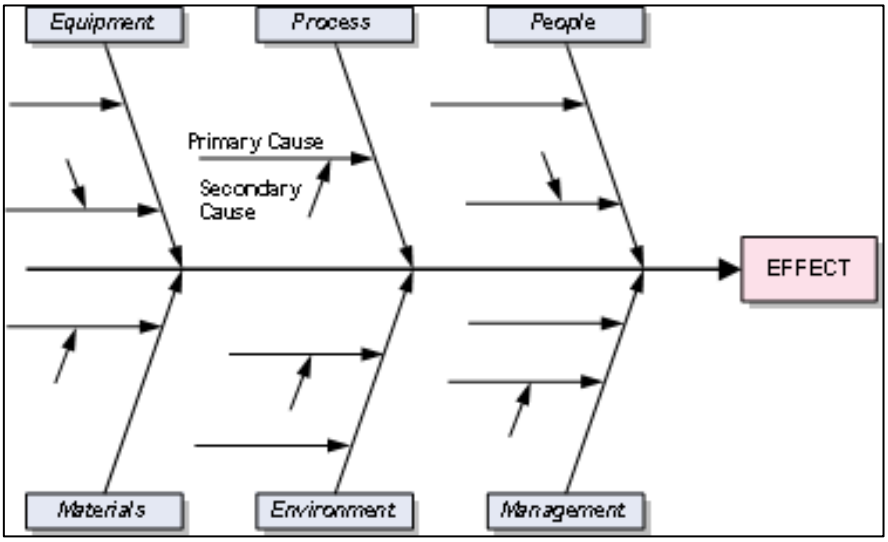

Figure 1. Fishbone Diagram Example

In making this diagram, a proper cause and effect analysis is needed. How to understand the cause of a problem and where to place it is important. That way, when a problem occurs, you can properly analyze the root cause that is right and accurate by relying on this di

2.4 Forecasting

According to Freeman and Waters (1993), forecasting is a basic input in decision making in operations management in terms of providing information about future demand with the aim of determining the amount of inventory to meet demand. Forecasting activities in supply chain management play an important role in making decisions related to forecasting analysis, because it must be used by all parties in the supply chain network.

a. Methods

1. Single Moving Average (SMA) Method

   The single moving average (SMA) method is a forecasting method that is carried out by taking a group of observation values, looking forthe average value as a forecast for the coming period

2. Weighted Moving Average Method (WMA)

The weighted moving average (WMA) method is the method used for the prediction process, in the WMA calculation formulation using the weighting of each data, greater weight is given to the last data compared to the previous data

3. Single Exponential Smoothing Method

   The single exponential smoothing (SES) method is a method that provides a moving average exponential weighting of all previous observation values.

b. Accuracy Value Calculation for Forecasting

In Calculation of Accuracy Value for Forecasting there are many methods that can be used, but not all methods can fit the existing case. In general, there are three types of calculations to see how much error there is in forecasting, namely:

1. MAD (Mean Absolute Deviation) Is a calculation used to calculate the average absolute error, with the formula:

$$\text{MAD} = \sum | \text{Actual} - \text{Forecast} | / \text{n} \qquad (2.4)$$

It can be interpreted that ∑ | Actual - Forecast | is the result of the subtraction between the actual and forecast values for each period which is then absolutized, and then the addition of the results of the subtraction is carried out. And n is the number of periods used for calculation

2. MSE (Mean Square Error)

   Is a calculation used to calculate the average error in rank, with the formula:

$$\text{MSE} = \sum (\text{Actual} - \text{Forecast}) \text{ ^ } 2 / \text{n} - 1 \qquad (2.5)$$

It can be interpreted that ∑ (Actual - Forecast) ^ 2 is the result of

thesubtraction between the actual and forecast values that have been squared, then the sum of these results is done. And n is the number of periods used for calculation

3. MAPE (Mean Absolute Percent Error

   Is a calculation used to calculate the average absolute percentage error, with the formula:

$$\text{MAPE} = \sum (|\text{ Actual} - \text{Forecast}| / \text{Actual}) * 100 / \text{n} \qquad (2.6)$$

   It can be interpreted that $\sum$ (| Actual - Forecast | / Actual) is the result of the reduction between the actual and forecast values that have been absolutized, then divided by the actual value per each period, then the sum of these resultsis done. And n is the number of periods used for calculation. The lower the MAPE value, the ability of the forecasting model used can be said to be good,and for MAPE there is a range of values that can be used as a measurement material regarding the ability of a forecasting model.

c. Validation

   Measurement of whether the forecasting model is valid or not uses a tracking signal. Tracking signal (TS) is a measure of how well a forecast estimates actual values (Gasperz, 2009). TS is calculated as the running sum of the forecast error (RSFE) divided by MAD.

$$\text{TS} = \text{RSFE} / \text{MAD} \qquad (2.7)$$

   It is recommended that the maximum TS value be ± 4, as the control limits for TS. Thus, if the TS value is outside the control limits, the forecasting model needs to be reviewed.

2.5 Previous Research

Previous research is an attempt by researchers to find comparisons and laterto find theories that have a correlation with the research theme. Previous research helps research to position research as well as refer to the originality of research. Inthis section, the researcher lists various previous research results related to the research to be carried out, as well as researchers gather sources from some references such as journals, books or other publications that can be said to be valid, then make a summary, whether published or unpublished research. Here are some previous studies that have been collected by the researchers:

1. Parwati, et al. (2020) with the research title "Pengurangan Bullwhip Effect dengan menggunakan Metode Periodic Review pada PT Sari Roti". This research includes research conducted using the periodic review method, which is an effort to reduce information distortion in the supply chain, by collecting sales and order data from the company. The objectives of this study are: (1) Measuring the bullwhip effect on the supply chain at Sari Roti Distributor. (2) Identifying the causes of the bullwhip effect. (3) Determine the right alternative solution to reduce the bullwhip effect on supply by using the periodic review method.The calculation of the bullwhip effect at pamella retailers in 4 (four) types of bread, namely, double soft bread, peeled bread, chocolate sandwich bread and cream cheese bread has a significant difference. The product studied at Pamella retailer 1 (one) has a false or bullwhip effect level above the predetermined limit occurs in the type: Double soft bread cider, where the bullwhip effect value reaches 8,161 in month 9 and month 10 of 2,573. The type of peeled bread sandwich cider in month 9 (nine) reached 2,629 and in month 10 amounted to 8,600. The type of chocolate sandwich cider has a bullwhip effect in month 9 (nine) of 2,989 and 1,185 in month 10. The type of cheese sandwich has a bullwhip effect in month 9 (nine) of 1,659 and 1,434 in

month 10.

2. Sari et al., (2020) with the research title “Analisis Peramalan Permintaan Kopi Susu Di Café Kopi Margonda”. The purpose of this study was to determine how strategies should be carried out to deal with increased consumer demand and manage the production process at Margonda cafe milk coffee in order to get maximum profit and not experience loss of profit. The data processing carried out resulted in the best selected method for forecasting the following year, namely the Weight Moving Average method with a MAPE of 0.204407 and aggregate planning using the Chase Strategy method because it resulted in a cost of Rp 1,528,055,687 which is less expensive than the level strategy and mixed strategy.
3. The next research was conducted by Kusumawati (2021) with the research title “Demand Forecasting Using Time Series Forecasting to Design Resources required for Printing SME”. This study aims to determine the best forecasting method and forecast consumer demand in 2021. Based on the results of data analysis, it is known that the best time series forecasting method for forecasting sales of plastic packaging products is the 3-period centered moving average method. This method was chosen because it has the lowest error rate when compared to the other methods analyzed, namely with an MAD value of 65,773.08333 and a tracking signal value that is within the control limits. So that the 3-period CMA method can be used in forecasting. From the 3-period CMA method, it is obtained that consumer demand forecasting from January to May 2021 is 883,780 pcs every month. So it is estimated that there is a need for not too much overtime to fulfill demand forecasting in January-May 2021 because the company's capacity per month is only 875,000 pcs.

CHAPTER III

RESEARCH METHOD

3.1 Research Object

The object of this research is to improve the performance of the supply chain process usingBullwhip Effect analysis and forecasting method. The data used in this research is obtainedfrom interviews and observations of the supply chain process in Yogyakarta City Pharmacyand Health Equipment Warehouse.

3.2 Research Instrument

This research uses the questionnaire as a medium to collect the data of supply chain assets and revenue of Yogyakarta City Pharmacy and Health Equipment Warehouse. The head ofpharmacy department will be asked a list of questions that have already been provided by the researcher.

3.3 Data Collection Techniques

This research used 2 types of data to process, primary and secondary data. The primary data are collected through interview, questionnaire, and observation. The secondary data is collected by studying supporting document such as scientific references, journals, and literature studies related to the research.

In this research, the researcher conduct interview with the Head of Pharmacy Department of Yogyakarta City Pharmacy and Health Equipment Warehouse. The Head of Pharmacy Department will be asked a list of questions to get the supply chain assets, business process and procurement data of Yogyakarta City Pharmacy and Health Equipment Warehouse:

3.4 Data Processing Method

1. Identification of the background of the problems in the company, expectations, efforts that have been made, an overview, and organizational structure based on

observations and interviews conducted at Yogyakarta City Pharmacy and HealthEquipment Warehouse.

2. Conducting Bullwhip effect calculation to determine whether there is bullwhipeffect in distribution supply chain
3. Develop Fishbone diagram to determine the problem in supply chain
4. Conduct Forecasting method using WinQSB Forecasting and Linear Regression

3.5 Data Analysis Method

The descriptive analysis method is a statistic used to analyze data by describing or describingthe data that have been collected as they are without intending to make conclusions that applyto the public or generalizations. To analyze the result the researcher uses descriptive analysisto determine the project improvements.

3.6 Research Flowchart

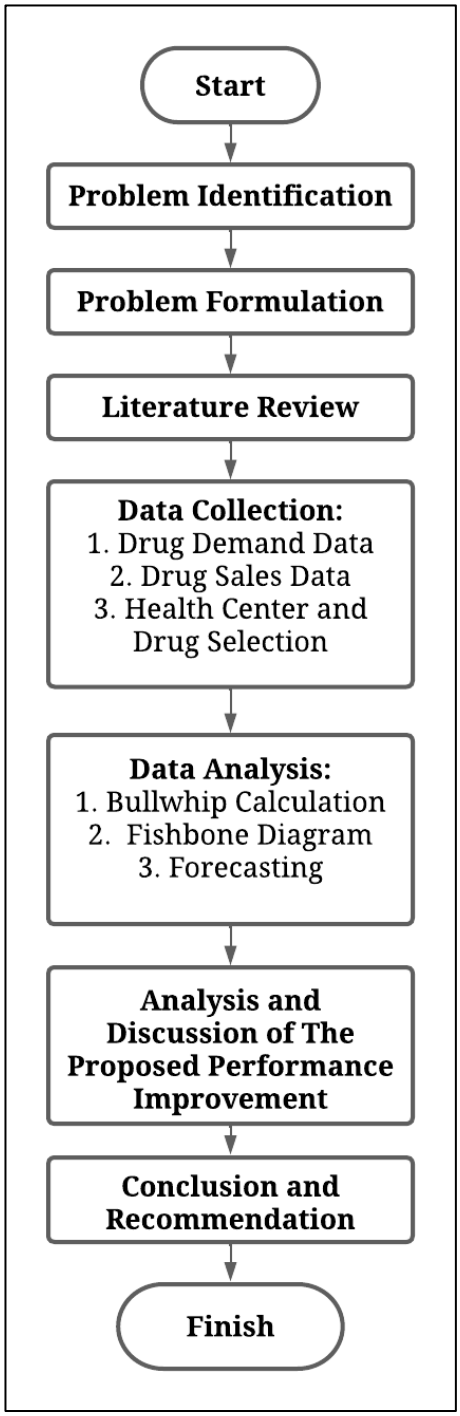

Figure 2. Research Flowchart

1. Problem Identification

   The first step in this work is to evaluate the field conditions. It is

assumed that the research determines what issues exist in it, with the recognition for this research focusing on the supply chain's output at the Yogyakarta City Pharmacy and Health Equipment Warehouse.

2. Problem Formulation

   The next stage is to define problems that are acceptable and in line with what occurred to Yogyakarta City Pharmacy and Health Equipment Warehouse in the supply chainphase after recognizing the problems that exist in Yogyakarta City Pharmacy and Health Equipment Warehouse. The formulation of this issue will be used to determinethe research's goals and benefits later on.

3. Literature Review

   Deductive and inductive studies are used to do literature reviews. Literature studies are conducted with related and similar sources from the previous study to collect hypotheses that support the research's direction. Furthermore, previous research can be used as a reference and consideration for current research.

4. Data Collection

   Primary and secondary data are collected at this time. At Yogyakarta City Pharmacy and Health Equipment Warehouse, primary data was collected through observation, interviews, and questionnaire design. Secondary data is gathered by conducting a review of previous research. The data collection process starts with the gathering of company profile information, followed by the identification of the company's supplychain activities in the procurement segment.

5. Data Processing

   a. Bullwhip Calculation

      The first step in data processing is to calculate the bullwhip effect value that occurs in the supply chain flow. The bullwhip effect value is used as an initial diagnosis of whether there is nervousness or information confusion in the supplychain system.

b. Fishbone Diagram

After calculating the Bullwhip effect value, then find the root cause of the problem using a fishbone diagram.

c. Forecasting

After identifying the causes of the bullwhip effect, the next step is to forecast thesales data for the next 3 months.

6. Analysis and Discussion

At this stage, analysis of the data that has been processed is carried out regarding various things that occur after data processing. Analysis of the results of dataprocessing will be used as a basis for drawing conclusions and suggestions. As for the data analyzed in this study, it starts from determining the sales data forecasting method based on the smallest MSE results using Microsoft Excel program.

7. Conclusion and Recommendation

Conclusions are drawn from the results of the analysis of the problems that occur which are then given suggestions as an effort to solve these problems.

CHAPTER IV
DATA COLLECTION AND PROCESSING

4.1 Data Collection

The health department is an implementing element of regional autonomy in the health sector which has a position under the responsibility of the regent through the regional secretary. In the city of Yogyakarta, the health department is one of the government devices of the city of Yogyakarta which has the task and function of assisting the Mayor of Yogyakarta in the health sector.

The initial formation of the Yogyakarta City Health Office was based on Yogyakarta City Regional Regulation No. 21 of 2000 concerning the establishment of the organizational structure and work procedures of the health office. Over time, the Yogyakarta City Health Office has undergone several regulatory changes. Yogyakarta Mayor Regulation No. 96 of 2021 concerning the position, organizational structure, functions and work procedures of the health department.

Vision

Affirming Yogyakarta City as a Livable City and Service Center with Strong Competitiveness for Community Empowerment based on Privilege Values

Mission

1. Improving community welfare and empowerment
2. Strengthening the people's economy and competitiveness of Yogyakarta City
3. Strengthening the morals, ethics and culture of the people of Yogyakarta City
4. Improving the quality of education, health, social and culture
5. Strengthening urban planning and environmental sustainability
6. Build public and residential infrastructure
7. Improve good and clean government governance.

4.2 Data Collection

4.2.1 Bill of Distribution

The bill of distribution of drugs in health centers can be seen below:

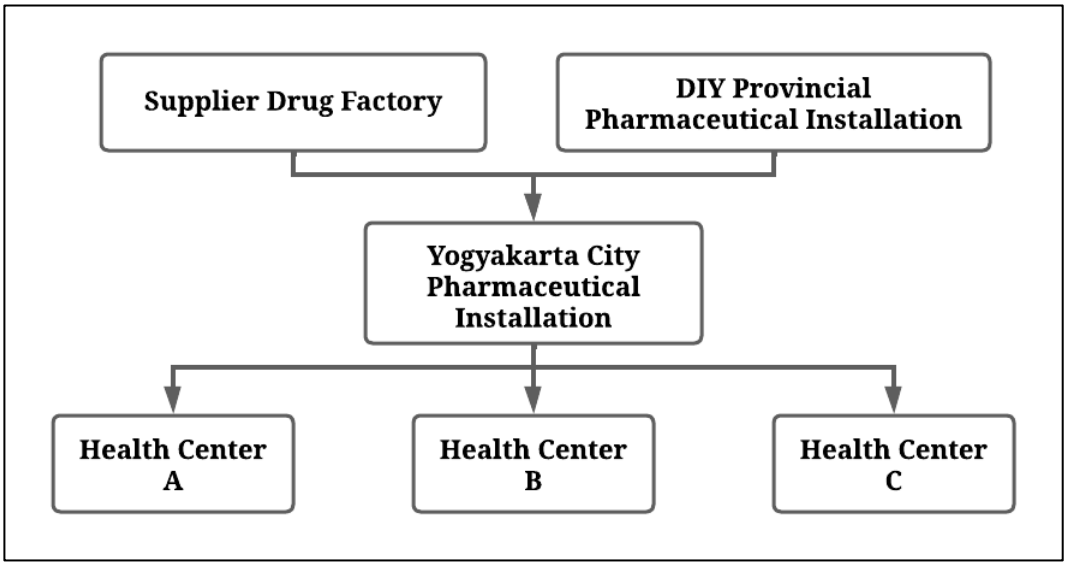

Figure 3. Bill of Distribution

The drugs are coming from the suppliers which is Supplier Drug Factory and DIY Provincial Pharmaceutical Installation. Yogyakarta City Pharmaceutical Installation is where the Pharmaceutical Warehouse is located, which then distributed the drugs to several health centers.

The Yogyakarta City Health Service has 18 health centers to serve the primary health needs of the Yogyakarta City citizen. The health centers are as follows:

1. Danurejan 1

   Jl. Danurejan, Bausasran, Kec. Danurejan, Kota Yogyakarta, Daerah IstimewaYogyakarta 55211
2. Danurejan 2

   Jl. Krasak Timur No.34, Bausasran, Kec. Danurejan, Kota Yogyakarta, DaerahIstimewa Yogyakarta 55211
3. Gedongtengen

Jl. Pringgokusuman No.30, Pringgokusuman, Gedong Tengen, Kota Yogyakarta, Daerah Istimewa Yogyakarta 55272

4. Gondokusuman 1

   Jl. Tunjung No.1, Baciro, Kec. Gondokusuman, Kota Yogyakarta, DaerahIstimewa Yogyakarta 55225

5. Gondokusuman 2

   Jl. Prof. DR. Sardjito No.22, Terban, Kec. Gondokusuman, Kota Yogyakarta,Daerah Istimewa Yogyakarta 55223

6. Gondomanan

   JL. Gondomanan No.9, Prawirodirjan, Gondomanan, Yogyakarta City, SpecialRegion of Yogyakarta 55166

7. Jetis

   Jl. Pangeran Diponegoro No.91, Bumijo, Kec. Jetis, Kota Yogyakarta, DaerahIstimewa Yogyakarta 55231

8. Kotagede 1

   Jl. Kemasan No.12, Prenggan, Kec. Kotagede, Kota Yogyakarta, DaerahIstimewa Yogyakarta 55173

9. Kotagede 2

   Jl. Ki Penjawi No.4, Rejowinangun, Kec. Kotagede, Kota Yogyakarta, DaerahIstimewa Yogyakarta 55171

10. Kraton

    Jl. Masikanan KT II No.457, Panembahan, Kec. Kraton, Kota Yogyakarta,Daerah Istimewa Yogyakarta 55131

11. Mantrijeron

    Jl. DI Panjaitan No.82, Suryodiningratan, Kec. Mantrijeron, Kota Yogyakarta,Daerah Istimewa Yogyakarta 55141

12. Mergangsan

    Gg. Brojopermono, Wirogunan, Kec. Mergangsan, Kota

Yogyakarta, DaerahIstimewa Yogyakarta 55151

13. Ngampilan
    JL. Munir Serangan Blok.NG.II No.215, Notoprajan, Ngampilan, Kota Yogyakarta, Daerah Istimewa Yogyakarta 55262
14. Pakualaman
    Jl. Jayeng Prawiran No.13, Purwokinanti, Pakualaman, Kota Yogyakarta,Daerah Istimewa Yogyakarta 55166
15. Tegalrejo
    Jl. Magelang KM.2 No.180, Karangwaru, Kec. Tegalrejo, Kota Yogyakarta,Daerah Istimewa Yogyakarta 55242
16. Umbulharjo 1
    Jl. Veteran No.43, Muja Muju, Kec. Umbulharjo, Kota Yogyakarta, DaerahIstimewa Yogyakarta 55165
17. Umbulharjo 2
    Jl. Hibrida No.194, Muja Muju, Kec. Umbulharjo, Kota Yogyakarta, DaerahIstimewa Yogyakarta 55165
18. Wirobrajan
    Jl. Dorodasih, Patangpuluhan, Wirobrajan, Kota Yogyakarta, Daerah IstimewaYogyakarta 55251

In order to be more focused, the researcher only took 3 pharmacies which would beused as research samples namely:

1. Gedong Tengen Health Center
2. Mergangsan Health Center
3. Ngampilan Health Center

4.2.2 Drug Sales Data for each Health Center

The chosen drugs for this research are Amlodipin 5mg, Amoxycillin 500mg, Meformin 500mg, Paracetamol 500mg, and Simvastatin 10mg. The drugs are chosen by the ranking

of highest or most drug sold in each health center. Below are the drug sales data of each drugs on each health centers namely: Gedong Tengen, Ngampilan, Mergangsan

a. Gedong Tengen Health Center

Table 1. Gedong Tengen Sales Data

Period	Drugs				
	Amlodipin 5mg	Amoksisilin 500mg	Metformin 500mg	Parasetamol 500mg	Simvastatin 10mg
May	7282	2663	11250	4957	2595
June	5413	1398	8695	2713	1936
July	7213	1906	11793	4337	2974
August	6765	2651	10719	5310	2399
September	7159	3267	11279	5480	2792
October	7383	3522	11302	4800	3027
November	6953	3386	11549	5710	3125
December	6783	2224	10845	4062	3860
January	6851	2534	11976	3935	3342
February	5889	2348	10602	4019	2925
March	6777	2066	11321	4932	3070
April	5561	2994	10005	4802	2617

b. Mergangsan Health Center

Table 2. Mergangsan Sales Data

Period	Drugs				
	Amlodipin 5mg	Amoksisilin 500mg	Metformin 500mg	Parasetamol 500mg	Simvastatin 10mg
May	10353	4077	13028	5139	1370
June	11034	4182	15398	5272	1465
July	11164	4423	14553	6440	2819
August	10367	4089	14966	5368	1220
September	11575	4314	16065	5163	4068
October	11279	4303	15300	5573	2052

November	10816	3651	15053	4094	3773
December	10608	4129	15043	5025	4690
January	10771	3278	13874	4517	6088
February	8936	3383	13108	4504	5400
March	10781	2632	13602	4390	5185
April	9328	3305	12635	4345	3305

c. Ngampilan Health Center

Table 3. Ngampilan Sales Data

Period	Drugs				
	Amlodipin 5mg	Amoksisilin 500mg	Metformin 500mg	Parasetamol 500mg	Simvastatin 10mg
May	9101	2373	9266	4368	4178
June	8267	2172	8215	3857	3210
July	7719	3339	8790	4623	6312
August	[u7	2833	9298	4796	4219
September	9638	2344	9910	4773	4660
October	9538	2574	9764	4718	3969
November	9660	2142	9570	4250	4492
December	8942	1760	9325	3830	3453
January	9626	2689	9822	4660	2820
February	8348	1710	9395	3439	2645
March	8556	1934	8545	3985	2292
April	8145	1638	8190	3270	2293

4.2.3 Drug Order Data for each Health Center

Drug order data for each health center is the amount of drug that are ordered from the supplier to each health center, the data can be seen in the table below:

a. Gedong Tengen Health Center

The drug order data for Gedong Tengen Health Center are:

Table 4. Gedong Tengen Drug Order Data

Period	Drugs				
	Amlodipin 5mg	Amoksisilin 500mg	Metformin 500mg	Parasetamol 500mg	Simvastatin 10mg
May	2700	1000	7000	6000	1000
June	12000	5000	13000	5000	3600
July	1500	800	8000	800	2100
August	10500	600	14000	5000	3000
September	6000	4000	9000	7000	1020
October	7500	6000	12000	6000	4200
November	15000	3400	22000	6000	6300
December	0	0	0	0	0
January	6000	3000	10600	5800	4500
February	6800	3000	14600	6500	2400
March	13000	5600	23000	9600	7000
April	0	0	0	0	0

b. Mergangsan Health Center

The drug order data for Mergangsan Health Center are:

Table 5. Mergangsan Drug Order Data

Period	Drugs				
	Amlodipin 5mg	Amoksisilin 500mg	Metformin 500mg	Parasetamol 500mg	Simvastatin 10mg
May	9000	7600	15000	3000	1200
June	9000	4000	12000	5000	0
July	6000	1000	12000	3000	9000
August	12000	6000	18000	7000	0

September	12600	5000	13000	8500	600
October	9000	3000	18000	4000	0
November	24000	9000	34000	7000	18000
December	0	0	0	0	0
January	12000	3000	12000	4500	0
February	10000	4000	15000	10000	3000
March	20000	8000	30000	8000	15000
April	0	0	0	0	0

c. Ngampilan Health Center

The drug order data for Ngampilan Health Center are:

Table 6. Ngampilan Drug Order Data

	Drugs				
Period	Amlodipin 5mg	Amoksisilin 500mg	Metformin 500mg	Parasetamol 500mg	Simvastatin 10mg
May	7500	1000	5800	2900	6000
June	6000	4000	10800	4400	6000
July	8200	1900	8200	3800	4600
August	9000	3600	4000	5200	3600
September	12000	4000	10000	4500	6900
October	31200	600	16000	9000	3600
November	0	7600	19000	6000	10900
December	0	0	0	0	0
January	8400	200	9000	3300	3300
February	5000	1000	5000	2000	0
March	20000	4400	20000	8000	4000
April	0	0	0	0	0

4.2.4 Lead Time (Supplier)

Lead Time is data on the time interval when ordering goods until the order is received and ready for use. This data is needed to determine when is the right time to order goods so that they can arrive on time. The lead data for each health center is as follows

Table 7. Lead Time

No	Health Center	Lead Time (days)
1	Gedong Tengen	1
2	Mergangsan	1
3	Ngampilan	1

4.2.5 Inventory Data

Inventory data is inventory data that still exists at the time of forecasting forthe coming period. Inventory data is a record of the state of inventory at thetime of the last recording, namely at the end of May 2024. The data is used to plan the distribution of inventory for sales in the coming period

Table 8. Inventory Data

No	Drug Type	Health Center		
		Gedong Tengen	Mergangsan	Ngampilan
1	Amlodipin 5mg	8679	12486	14535
2	Amoksisilin 500mg	3967	6618	4509
3	Metformin 500mg	15140	21200	13564
4	Parasetamol 500mg	6554	7766	6714
5	Simvastatin 10mg	5105	9285	5660

4.2.6 Safety Stock

The safety stock provided by each health center is the highest sales value in a1-year period multiplied by 2. The safety stock value can be seen from the table below:

Table 9. Safety Stock

No	Drug Type	Health Center		
		Gedong Tengen	Mergangsan	Ngampilan
1	Amlodipin 5mg	14766	23150	19320
2	Amoksisilin 500mg	7044	8846	6678
3	Metformin 500mg	23952	32130	19820
4	Parasetamol 500mg	11420	12880	9592
5	Simvastatin 10mg	7720	12176	12624

4.3 Data Processing

4.3.1 Bullwhip Effect Calculation

In this study there will be 3 calculations of Bullwhip effect from the results of aggregation of demand and order data aggregation, which are: bullwhip effect 1 (ω 1) which is demand and order for each drug in each Health Center, bullwhip effect 2 (ω 2) is demand and the last order on each drug for the whole Health Center, bullwhip effect 3 (ω 3) is demand and order on the whole drug in each Health Center.

According to Fransoo and Wouter (2000) in this case we can measure the level of Bullwhip effect by calculating the results of the comparison of sales variance coefficients. The coefficient of order variance can be calculated with the following mathematical formula:

$$\text{CV (Order)} = \text{STD (Order)} / \text{AVR (Order)} \qquad (4.1)$$

The sales variance coefficient can be calculated with the following mathematical formula:

$$\text{CV (Sales)} = \text{STD (Sales)} / \text{AVR (Sales)} \quad (4.2)$$

The value of the Bullwhip effect in a supply chain can be mathematically formulated as follows:

$$\text{BE} = \text{CV (Order)} / \text{CV (Sales)} \quad (4.3)$$

Where:
STD: Standard Deviation (σ) AVR: Average (μ)
CV: Coefficient of Variance (CV)
BE: Coefficient of Variability / Bullwhip Effect Score (ω)

1. Bullwhip Effect Calculation (ω 1)
   In this first bullwhip effect (ω1) calculation, the calculation is carried out for each drug for each Health Centerer by aggregating consumer demand data at Health Center and Health Center orders at distributors for different drugs from 5 Health Centerers, while still using the same formula, the calculation of the bullwhip effect for each drug for each Health Centerer (ω 1) above is then recapitulated into a table as follows:

   Recapitulation of Bullwhip Calculation of Gedong Tengen Health Center

Table 10. Gedong Tengen Bullwhip Calculation

Drug	Type	μ	σ	CV	BE
Amlodipin	Sales	6669,08	673,043	0,10092	7,47909
	Order	6750	5094,83	0,75479	
Amoksisilin	Sales	2579,92	638,931	0,24766	3,2653
	Order	2700	2183,41	0,80867	
Metformin	Sales	10944,7	891,633	0,08147	7,91136
	Order	11100	7154,15	0,64452	
Parasetamol	Sales	4588,08	827,183	0,18029	3,44749
	Order	4808,33	2988,6	0,62155	

Simvastatin	Sales	2888,5	484,506	0,16774	4,67616
	Order	2926,67	2295,57	0,78436	

Recapitulation of Bullwhip Calculation of Mergangsan Health Center

Table 11. Mergangsan Bullwhip Calculation

Drug	Type	μ	σ	CV	BE
Amlodipin	Sales	10584,3	770,246	0,07277	9,24904
	Order	10300	6932,66	0,67307	
Amoksisilin	Sales	3813,83	555,573	0,14567	4,94273
	Order	4216,67	3036,1	0,72002	
Metformin	Sales	14385,4	1101,22	0,07655	8,69714
	Order	14916,7	9931,2	0,66578	
Parasetamol	Sales	4985,83	657,593	0,13189	4,87094
	Order	5000	3212,19	0,64244	
Simvastatin	Sales	3452,92	1689,77	0,48938	3,38191
	Order	3900	6454,6	1,65502	

Recapitulation of Bullwhip Calculation of Ngampilan Health Center

Table 12. Ngampilan Bullwhip Calculation

Drug	Type	μ	σ	CV	BE
Amlodipin	Sales	8914,58	685,613	0,07691	13,1096
	Order	8941,67	9015,39	1,00824	
Amoksisilin	Sales	2292,33	508,993	0,22204	4,50992
	Order	2358,33	2361,61	1,00139	
Metformin	Sales	9174,17	602,497	0,06567	11,2912
	Order	8983,33	6661,4	0,74153	
Parasetamol	Sales	4214,08	532,194	0,12629	5,36336
	Order	4091,67	2771,43	0,67734	
Simvastatin	Sales	3711,92	1171,27	0,31554	2,49398
	Order	4075	3206,85	0,78696	

The above calculations are then recapitulated into one to make it easier to read. The followingis a recapitulation of the calculation of the bullwhip effect for each drug for each Health Centerer (ω 1):

Table 13. Bullwhip Effect 1 Calculation

Health Center	Drug	BE Score	Category
Gedong Tengen	Amlodipin	7,47909476	BE
	Amoksisilin	3,265296849	BE
	Metformin	7,911359194	BE
	Parasetamol	3,447493488	BE
	Simvastatin	4,676164175	BE
Mergangsan	Amlodipin	9,249042435	BE
	Amoksisilin	4,942728527	BE
	Metformin	8,697142505	BE
	Parasetamol	4,870935301	BE
	Simvastatin	3,381912848	BE
Ngampilan	Amlodipin	13,1095533	BE
	Amoksisilin	4,509917584	BE
	Metformin	11,29118575	BE
	Parasetamol	5,363359842	BE
	Simvastatin	2,493977137	BE

From the table above, it can be seen that all of the drugs and health center are having bullwhip effect

2. Bullwhip Effect Calculation (ω 2)

   In the calculation of the second bullwhip effect (ω 2), the calculation is carried out for each drug in all Health Centerers by aggregating consumer demand data at Health Center and Health Center orders at distributors for the same drug from all 5 Health Centerers, while still using the same formula, the calculation of the bullwhip effect for each drug for all Health Centerers (ω 2) above is then recapitulated into a table as follows:

Table 14. Bullwhip Effect 2 Calculation

Drug	Type	μ	σ	CV	BE	Category
Amlodipin	Sales	26168	1649	0,06303	7,47909	BE
	Order	25992	16358	0,62936		
	Sales	8686	1276	0,14688		

Amoksisilin	Order	9275	6283	0,67737	3,2653	BE
Metformin	Sales	34504	2277	0,066	7,91136	BE
	Order	35000	22834	0,65241		
Parasetamol	Sales	13788	1710	0,12404	3,44749	BE
	Order	13900	7912	0,56922		
Simvastatin	Sales	10053	1166	0,11594	4,67616	BE
	Order	10902	10277	0,94269		

From the table above, it can be seen that all of the drugs in each health center are having bullwhip effect

3. Bullwhip Effect Calculation (ω 3)

   In this third bullwhip effect (ω3) calculation, the calculation is carried out for the entire drug for each Health Centerer by aggregating the overall drug demand for each Health Centerer with what is sent by the distributor. By using the same formula, the following is a recapitulation of the bullwhip effect (ω3) calculation:

Table 15. Bullwhip Effect 3 Calculation

Drug	Type	μ	σ	CV	BE	Category
Gedong Tengen	Sales	27670,3	2793,12	0,10094	6,375	BE
	Order	28285	18202,4	0,64354		
Mergangsan	Sales	37222,3	2404,08	0,06459	10,805	BE
	Order	38333,3	26750,8	0,69785		
Ngampilan	Sales	28307,1	2671,84	0,09439	7,129	BE
	Order	28450	19144,6	0,67292		

From the table above, it can be seen that each health center and all drugh are having bullwhip effect

4.3.2 Bullwhip Effect Calculation Review

From the results of the calculation of the bullwhip effect value (ω 1) calculation for each drug for each Health Center, (ω 2) for each drug for the whole Health Center, and (ω 3)

the whole drug for each Health Center. Then recap in one table to make it easier to read. the recapitulation table of the bullwhip effect calculation is shown in the table as follows:

Table 16. Bullwhip Effect Calculation Review

Bullwhip Calculation	Health Center	Drug	Category
Bullwhip Effect 1	Gedong Tengen	Amlodipin	BE
		Amoksisilin	BE
		Metformin	BE
		Parasetamol	BE
		Simvastatin	BE
	Mergangsan	Amlodipin	BE
		Amoksisilin	BE
		Metformin	BE
		Parasetamol	BE
		Simvastatin	BE
	Ngampilan	Amlodipin	BE
		Amoksisilin	BE
		Metformin	BE
		Parasetamol	BE
		Simvastatin	BE
Bullwhip Effect 2	All Health Center	Amlodipin	BE
		Amoksisilin	BE
		Metformin	BE
		Parasetamol	BE
		Simvastatin	BE
Bullwhip Effect 3	Gedong Tengen	All Drug	BE
	Mergangsan		BE
	Ngampilan		BE

Of all the bullwhip effect calculations, the researcher chose the calculation of the bullwhip effect for each drug for each Health Center (ω1) as a reference in making the order plan. The reason for choosing this calculation is because the calculation of the bullwhip effect (ω1) explains the bullwhip effect value for each health center for each drug variant, from which we can find out which health centerers with what drug variants are experiencing bullwhip effects. Based on the table above, it can be seen that all drugs and all Health

Centers have a bullwhip effect.

4.3.3 Fishbone Identification

For the initial stage of creating fishbone diagram, the identification of the causes of the bullwhip effect is carried out using the 5 W + 1 H analysis. This is done by knowing information about

What: what are the problems that occur?

Who: Who is involved?

Where: Where can the problem arise?

When: When can the problem arise?

Why: Why did the problem occur?

How: How did the problem occur?

Table 17. 5W + 1H Analysis

5W + 1H	Description
What?	Bullwhip effect occurred in GT, MG, and NG Health Center
Who?	Pharmaceutical Division in each Health Center the party doing demand forecasting Pharmaceutical Division that makes order to Pharmaceutical Installation Supplier that provides drug to Pharmaceutical Installation
Where?	Supplier Pharmaceutical Warehouse Health Center
When?	When there are fluctuations in demand When there is a forecasting error When there is a shortage of inventory
Why?	Weather cycle Uncertain demand from customer Delay in product delivery
How?	Due to uncertain demand from customer Due to shipments that are not routine (combining 2 shipment in 1)

Due to miss in forecasting that sometime there are to many or too low product in hand

4.3.4 Fishbone Diagram

Identification of the causes of the bullwhip effect, depicted in the fishbone diagram. The use of this fishbone diagram aims to make it easier to identify the many possible causes of an effect or problem by sorting the problems in one category.

The basic concept of the fishbone diagram is that the underlying problem is placed on the right side of the diagram or at the head of the fishbone framework. The causes of the problem are depicted on the fins and bones. In this study, the fishbone diagram was used to identify the causes of the types of drugs at each health center that experienced the bullwhip effect. The following fishbone diagram whose input data is obtained from interview data and 5W + 1H analysis

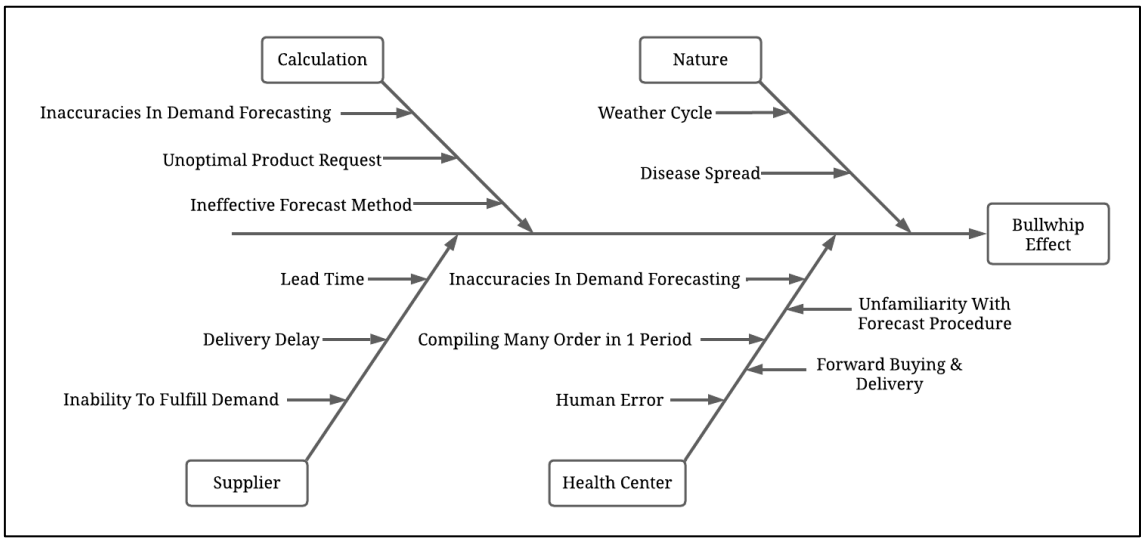

Figure 4. Fishbone Diagram Result

From the fishbone diagram, it is known that the bullwhip effect is influenced by four factors, namely Calculation, Nature, Supplier, and Health Center. On the measurement factor it is caused by Inaccuraries in demand forecasting, Unoptimal product request, and

Ineffective forecast method. On the nature factor it is caused by weather cycle and disease spread. On the supplier factor it is caused by lead time, delivery delay, and inablity to fulfill demand. On health center factor it is caused by Inaccuracies in demand forecasting, unfamiliarity with forecast procedure, forward buying & delivery, and human error

4.3.5 Forecasting

Based on the results of previous calculations which show that there is a bullwhip effect phenomenon on five drug variants, namely Amlodipine,Amoxicillin, Metformin, Paracetamol, and Simvastatin. at this stage, the historical sales data of the five drug products that have been obtained will beprocessed to forecast sales for the next 3-month period. To forecast and get the right forecasting method, first plotting past sales data is carried out. fromthe results of plotting the data, the right forecasting method can be determinedto calculate forecasting so as to obtain sales estimates for the coming period. below are the results of plotting previous period sales data for Health Center puskesmas Gedong Tengen, Mergangsan, and Ngampilan

a. Gedong Tengen Health Center
   Amlodipin

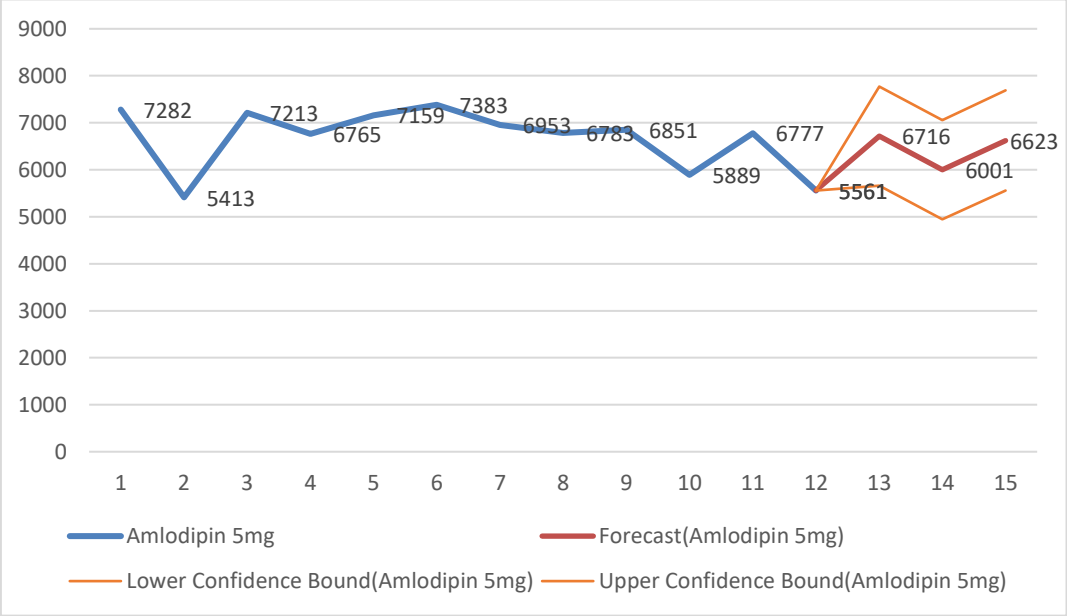

Figure 5. Gedong Tengen Amlodipin Forecast

Amoxicillin

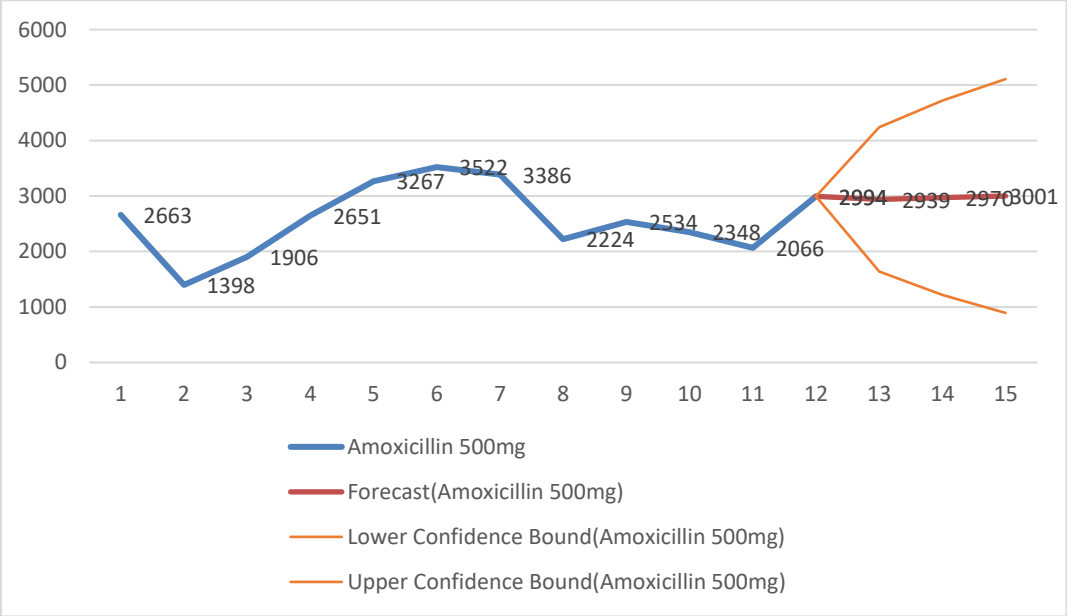

Figure 6. Gedong Tengen Amoxicillin Forecast

Metformin

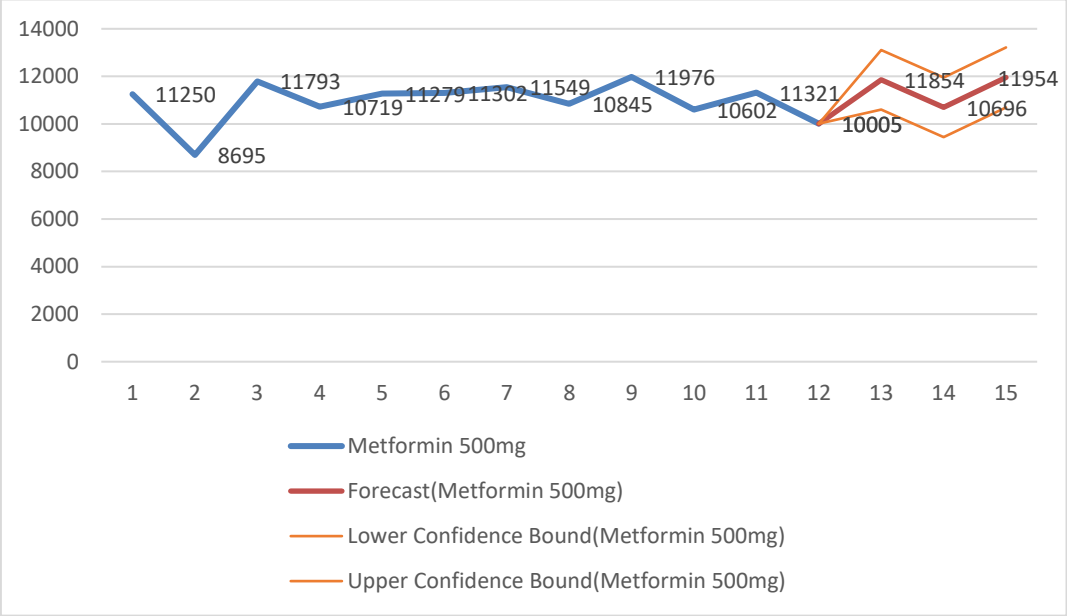

Figure 7. Gedong Tengen Metformin Forecast

Paracetamol

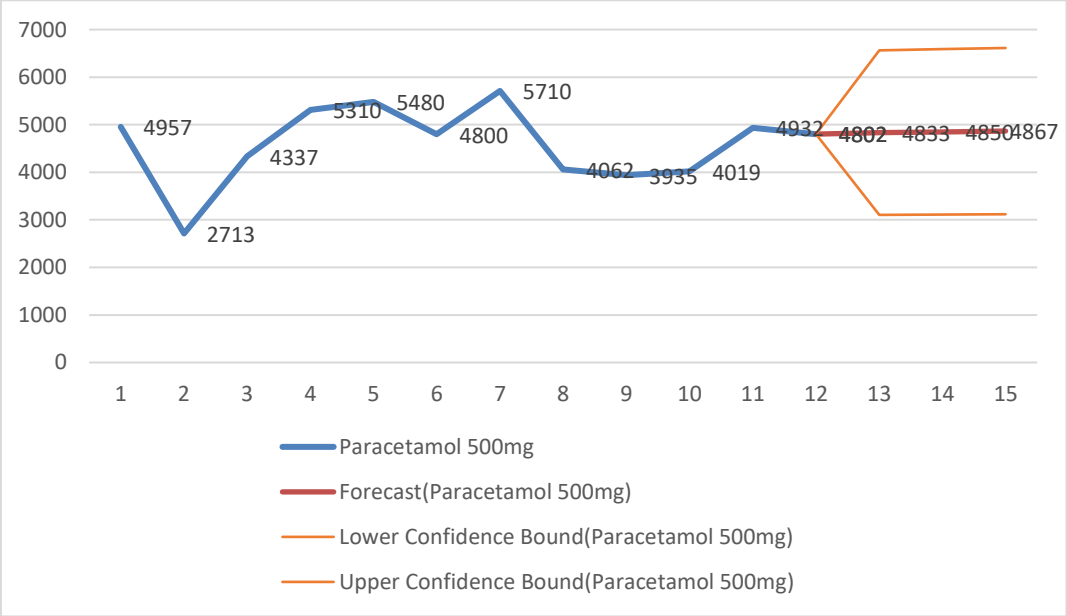

Figure 8. Gedong Tengen Paracetamol Forecast

Simvastatin

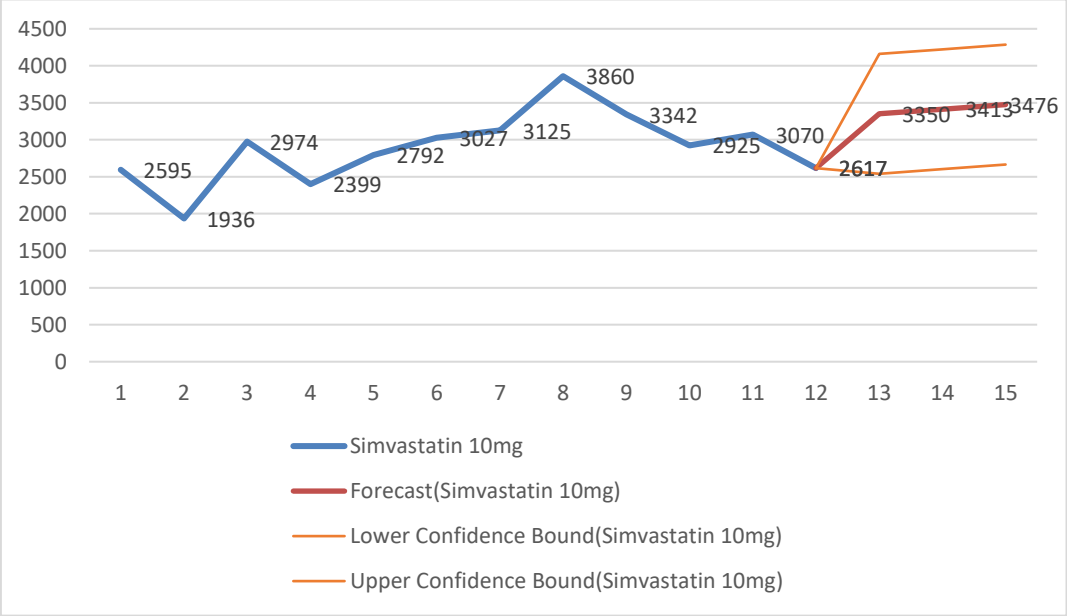

Figure 9. Gedong Tengen Simvastatin Forecast

b. Mergangsan Health Center
Amlodipin

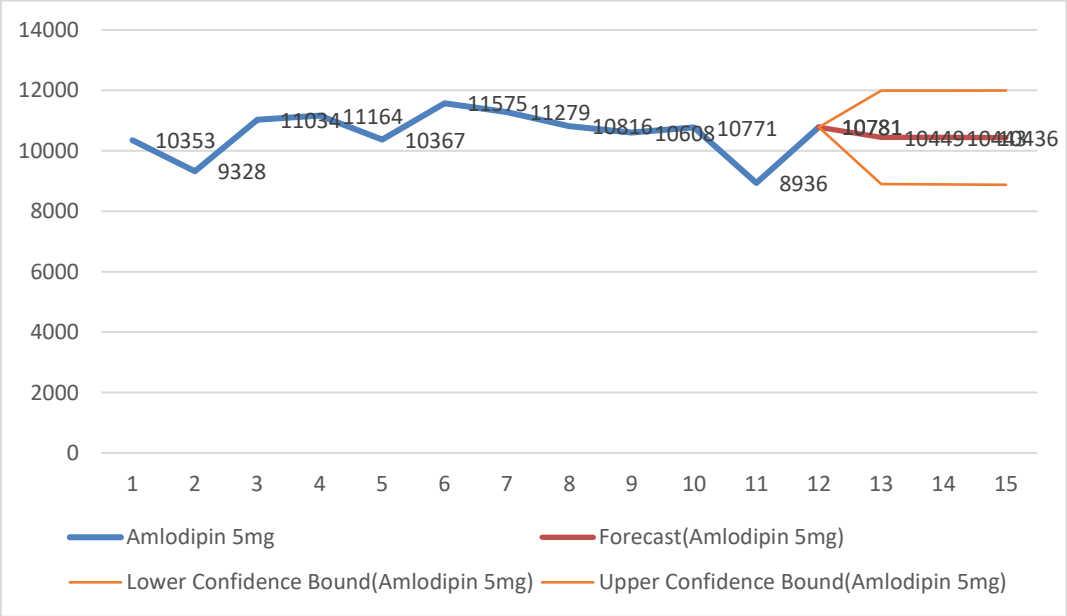

Figure 10. Mergangasan Amlodipin Forecast

Amoxicillin

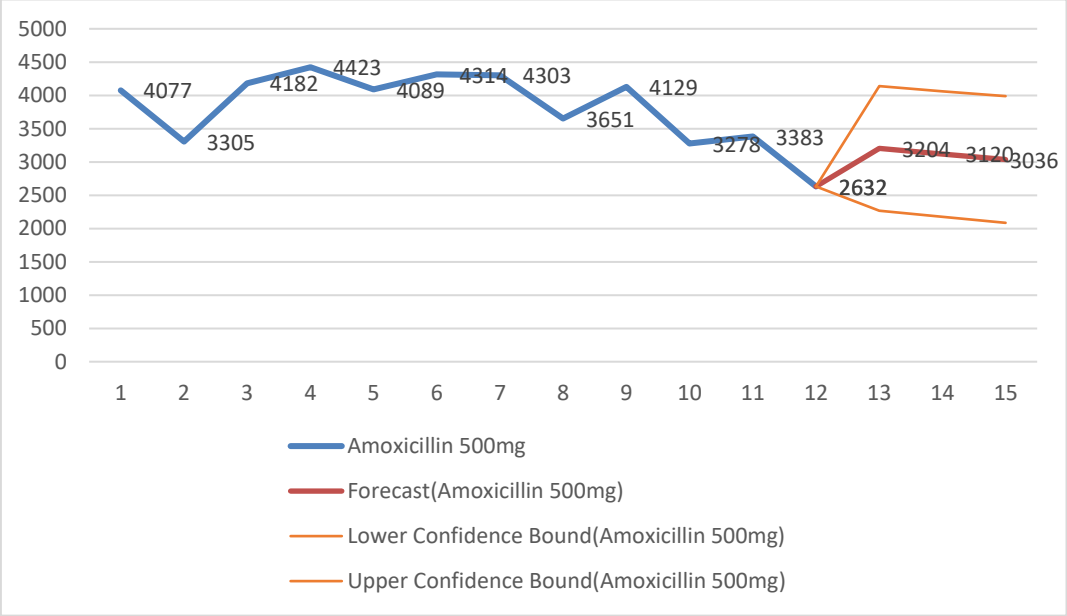

Figure 11. Mergangasan Amoxicillin Forecast

Metformin

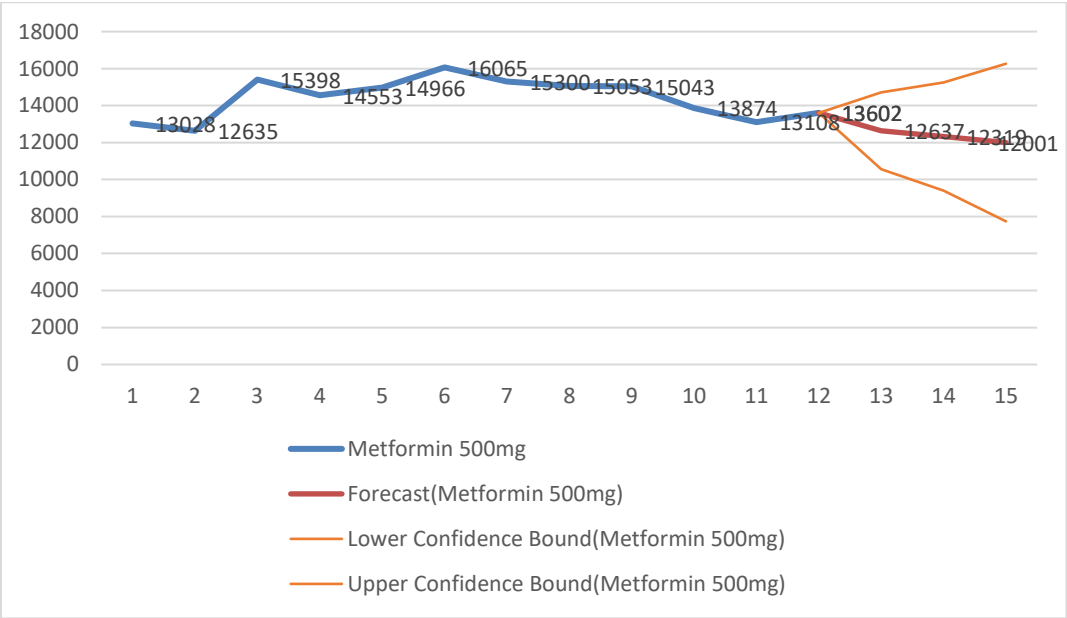

Figure 12. Mergangasan Metformin Forecast

Paracetamol

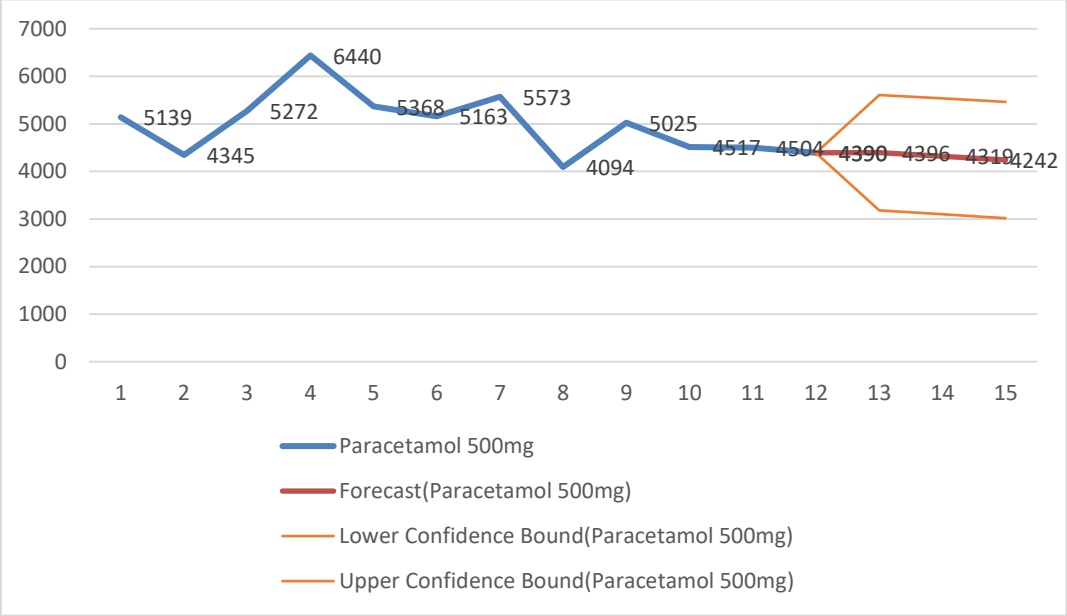

Figure 13. Mergangasan Paracetamol Forecast

Simvastatin

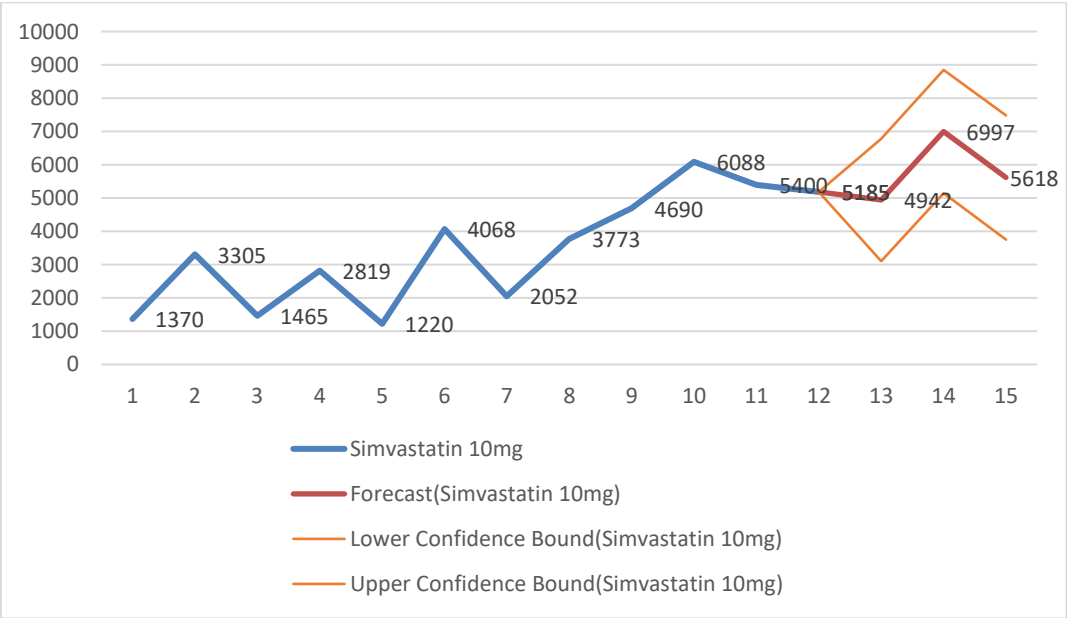

Figure 14. Mergangasan Simvastatin Forecast

c. Ngampilan Health Center
Amlodipin

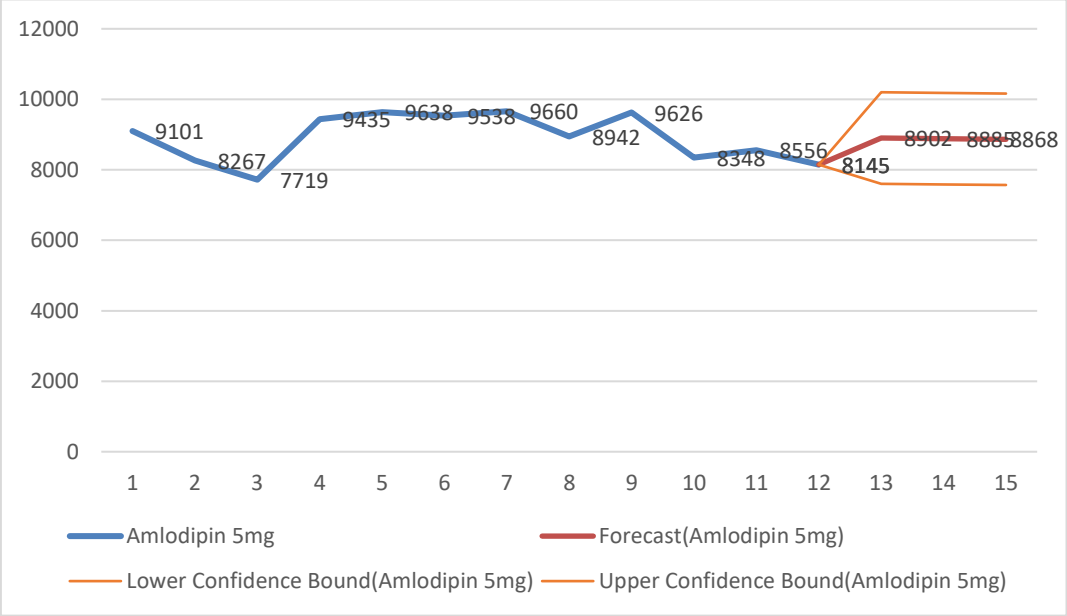

Figure 15. Ngampilan Amlodipin Forecast

Amoxicillin

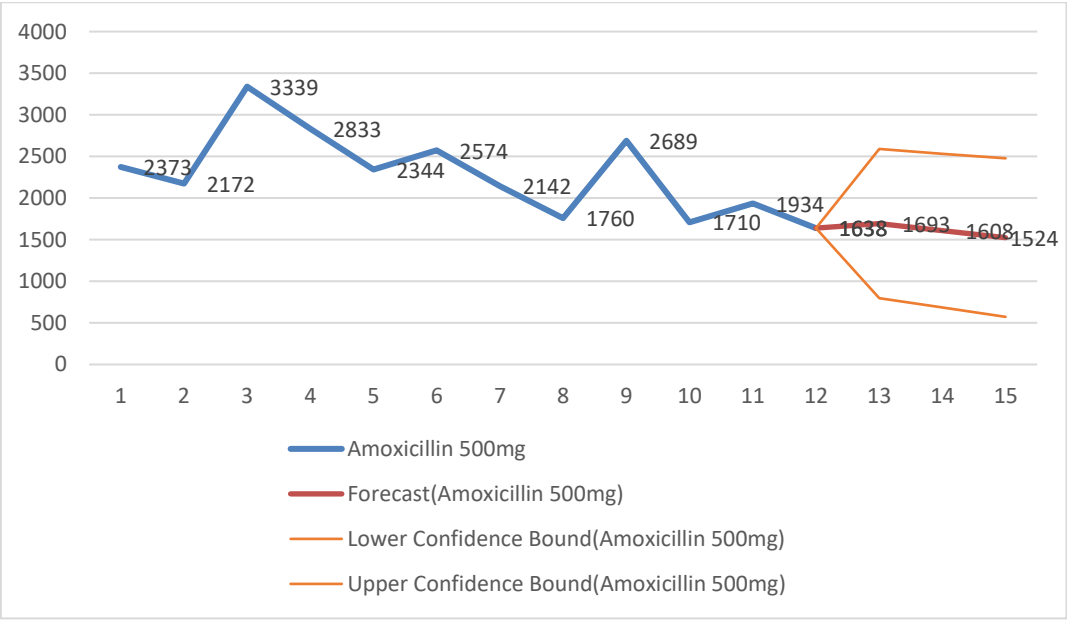

Figure 16. Ngampilan Amoxicillin Forecast

Metformin

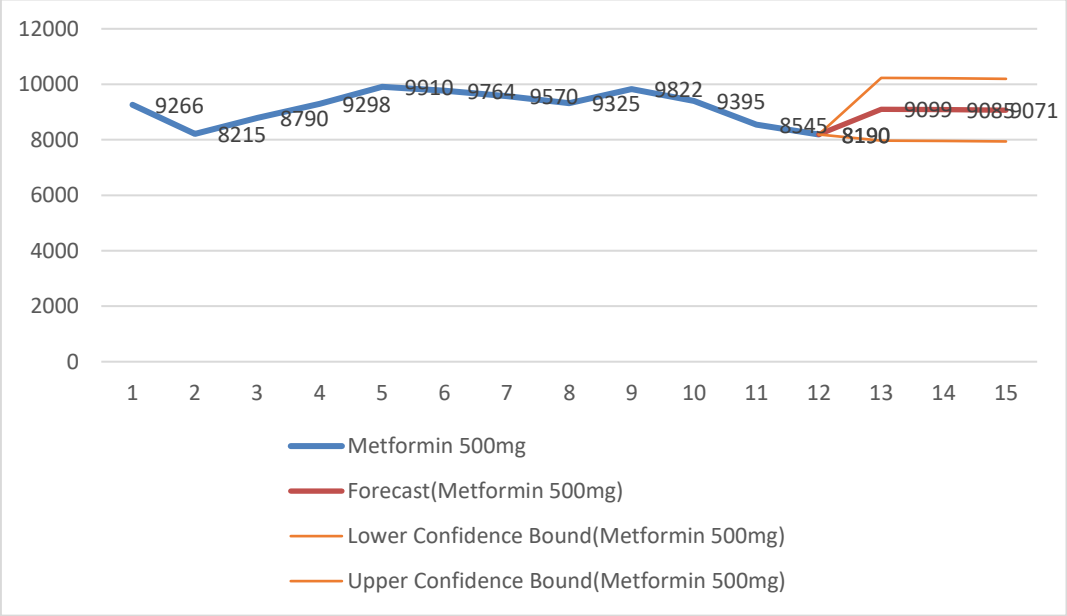

Figure 17. Ngampilan Metformin Forecast

Paracetamol

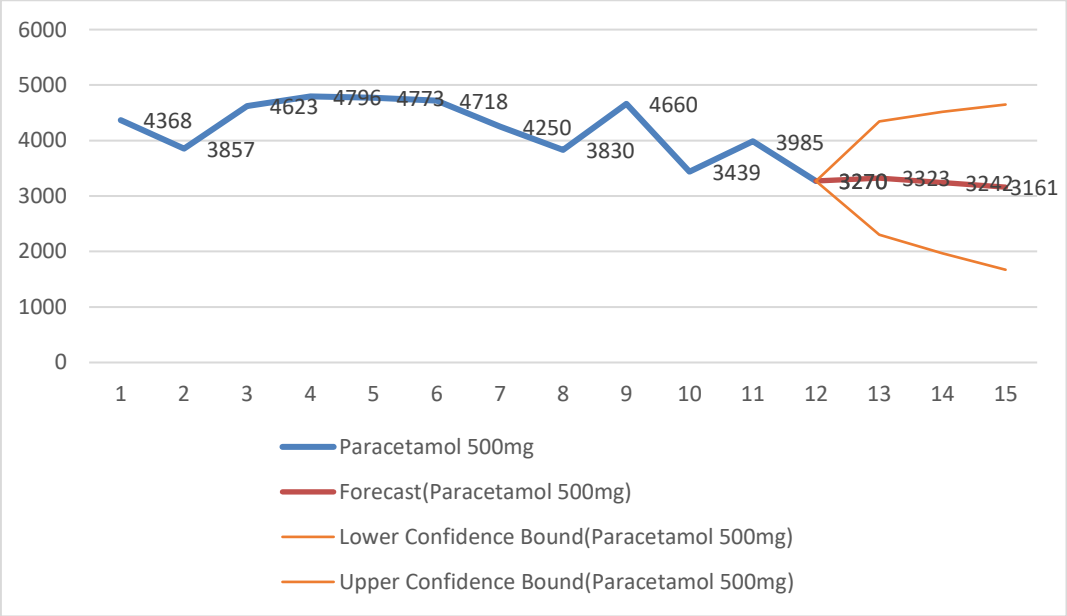

Figure 18. Ngampilan Paracetamol Forecast

Simvastatin

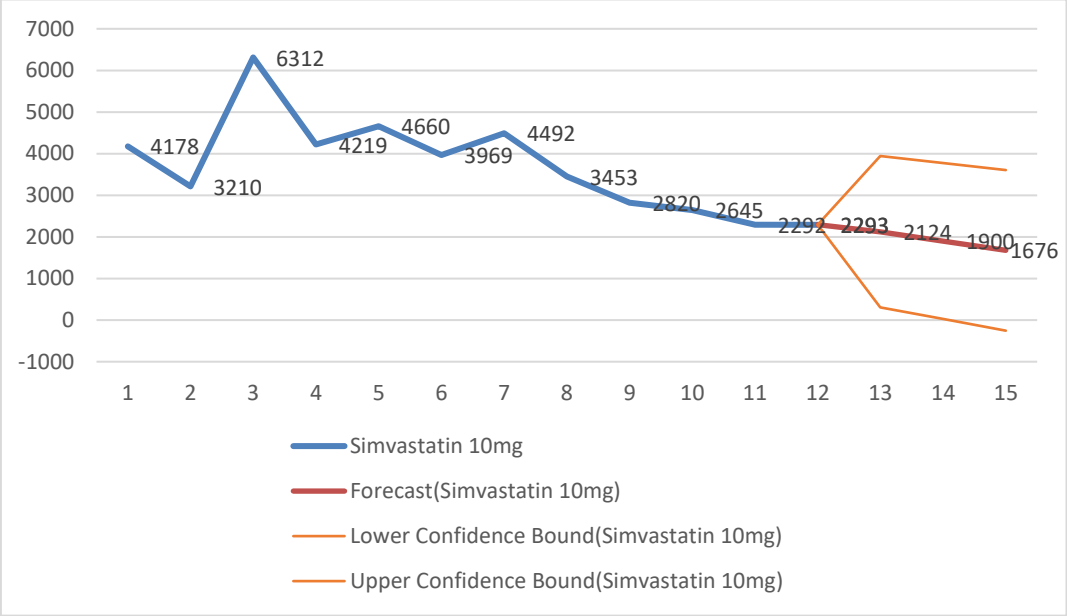

Figure 19. Ngampilan Simvastatin Forecast

Above are all the forecasting calculation graph of drug order for the next 3 months using Microsoft excel forecast sheet software.

4.3.6 Forecasting Calculation

The result of Forecasting calculation using Microsoft Excel program can be seen from the table below:

Table 18. Forecasting Calculation

Health Center	Drug	Forecasting			Confidence Bound
		May	June	July	
Gedong Tengen	Amlodipin	6716	6001	6623	±1055
	Amoxicillin	2939	2970	3001	±1301
	Metformin	11854	10696	11954	±1252
	Paracetamol	4833	4850	4867	±1729
	Simvastatin	3350	3413	3476	±810
Mergangsan	Amlodipin	10449	10443	10436	±1545
	Amoxicillin	3204	3120	3036	±935
	Metformin	12637	12319	12001	±2069
	Paracetamol	4396	4319	4242	±1212
	Simvastatin	4942	6997	5618	±1837

Ngampilan	Amlodipin	8902	8885	8868	±1299
	Amoxicillin	1693	1608	1524	±897
	Metformin	9099	9085	9071	±1131
	Paracetamol	3323	3242	3161	±1020
	Simvastatin	2124	1900	1676	±1819

Since Health Center can only order in box which include 10 pack in which include 10 tablets, the forecasted order should be rounded in hundreds and rounded up. The final number of boxes ordered could be seen in the table below:

Table 19. Forecasting Calculation in Box

Health Center	Drug	Forecasting		
		May	June	July
Gedong Tengen	Amlodipin	68	61	67
	Amoxicillin	30	30	31
	Metformin	119	107	120
	Paracetamol	49	49	49
	Simvastatin	34	35	35
Mergangsan	Amlodipin	105	105	105
	Amoxicillin	33	32	31
	Metformin	127	124	121
	Paracetamol	44	44	43
	Simvastatin	50	70	57
Ngampilan	Amlodipin	90	89	89
	Amoxicillin	17	17	16
	Metformin	91	91	91
	Paracetamol	34	33	32
	Simvastatin	22	19	17

CHAPTER V
ANALYSIS & DISCUSSION

5.1 Bullwhip Effect Calculation Analysis

Based on data processing and bullwhip effect calculations that have been carried out, it can be seen the value of the bullwhip effect that occurs in every health center.The value of the bullwhip effect is obtained from the calculation between the sales variance coefficient and the demand variance coefficient. If the BE value> 1 meansthere is a bullwhip effect and vice versa if the BE value < 1 means there is no bullwhip effect (Pujawan, 2005). In this study there are 3 calculations of 5 types ofdrugs from 5 health centers. The following is the recap of the bullwhip effect calculation:

Table 20. Bullwhip Effect Analysis

Bullwhip Calculation	Health Center	Drug	BE Score
Bullwhip Effect 1	Gedong Tengen	Amlodipin	7,479
		Amoxicillin	3,265
		Metformin	7,911
		Paracetamol	3,447
		Simvastatin	4,676
	Mergangsan	Amlodipin	9,249
		Amoxicillin	4,943
		Metformin	8,697
		Paracetamol	4,871
		Simvastatin	3,382
	Ngampilan	Amlodipin	13,110
		Amoxicillin	4,510
		Metformin	11,291
		Paracetamol	5,363
		Simvastatin	2,494
Bullwhip Effect 2	All Health Center	Amlodipin	7,479
		Amoxicillin	3,265
		Metformin	7,911
		Paracetamol	3,447
		Simvastatin	4,676

Bullwhip Effect 3	Gedong Tengen	All Drug	6,375
	Mergangsan		10,805
	Ngampilan		7,129

A. Bullwhip Effect 1

The results of data processing on the first bullwhip effect are the results of calculating the bullwhip effect on each drug for each health center, aftercalculating it is found that from the 3 health centers there is a bullwhip effect of 5 types of drugs sold.

At the Gedong Tengen health center the bullwhip effect value on Amlodipine 5mg is 7.47, Amoxicillin 500mg is 3.27, Metformin 500mg is 7.91, Paracetamolis 500mg 3.45, and Simvastatin 10Mg is 4.68.

At the Mergangsan health center the bullwhip effect value on the drug Amlodipine 5mg is 9.25, Amoxicillin 500mg is 4.93, Metformin 500mg is 8.70, Paracetamol 500mg is 4.87, and Simvastatin 10Mg is 3.38.

At the Ngampilan health center, the bullwhip effect value on Amlodipine 5mg is 13.1, Amoxicillin 500mg is 4.51, Metformin 500mg is 11.29, Paracetamol 500mgis 5.36, and Simvastatin 10Mg is 2.49.

Based on the data above, it can be said that all drugs in all health centers experience bullwhip effect where the bullwhip effect value

is > 1

B. Bullwhip Effect 2

For the results of data processing for this second Bullwhip effect, namely on eachtype of drug in each of the 3 health centers. The bullwhip value of each drug is as follows: Amlodipine is 7.48, Amoxicillin is 3.27, Metformin is 7.91, Paracetamol is 3.45, and Simvastatin is 4.68. Based on the data above, it can be said that all drugs experience bullwhip effect where the bullwhip effect value is > 1

C. Bullwhip Effect 3

For the results of data processing, the third bullwhip effect calculation is for theentire health center or 3 health centers by aggregating all drugs sold at each health center. The bullwhip value at each health center is as follows: Gedong Tengen is 6.375, Mergangsan is 10.805, and Ngampilan is 7.129. The results obtained show that all 3 puskesmas experience bullwhip effect because the bullwhip effect value > 1

5.2 Causes of Bullwhip Effect Identification

From the fishbone diagram there are 4 main factor that causes Bullwhip effect, namely: Calculation, Nature, Supplier, Health Center. Calculation is factor that related with how the health center conduct forecasting or drug order request to the supplier, it consists of inaccuracies in demand forecasting, suboptimal product request, and ineffective forecast method. This mean that the demand from health center is far off from the actual demand which can cause overstock or stockout in inventory. Nature is factor that related to the outside factor that relates with nature. It consists of weather cycle and disease spread which directly causing on how people got affected with disease or virus, this means the demand for drug can also affected. Supplier is factor that related with how the supplier

affects the Bullwhip effect, it consists of lead time, delivery delay, inability to fulfill demand. This means the supplier can causes the bullwhip effect because they cannot fulfill the order completely and on time. Health center is factor that caused from the health center. It consists of Inaccuracies in demand forecasting, unfamiliarity with forecast procedure, compiling order, and human error. This factor mostly caused by human or worker from health center that are not given full training on how to conduct forecasting, since the only forecasting method is only from counting from latest highest sale times 2 for the safety stock.

5.3 Forecast

Based on the data pattern of drug sales with the types of Amlodipine 5mg Amoxicillin 500mg, Metformin 500mg, Paracetamol 500mg, and Simvastatin 10mg in the period April 2023 - May 2024, it is known that the historical sales data pattern is stationary. The forecasting methods used is using forecast sheet from Microsoft excel program.

CHAPTER VI
CLOSING

6.1 Conclusion

Based on the results of the data collection, processing, and analysis that has been carried out, the conclusions that can be drawn are as follows:

1. Based on the data processing, there is a bullwhip effect on the distribution of medicines. In the three puskesmas, namely Puskesmas Gedong Tengen, Puskesmas Mergangsan, and Puskesmas Ngampilan, bullwhip effect occurs in each type of drug, namely Amlodipine 5mg Amoxicillin 500mg, Metformin 500mg, Paracetamol 500mg, and Simvastatin 10mg.
2. Factors that cause the bullwhip effect in Yogyakarta City Pharmacy and Health Equipment Warehouse are:
   a. Demand Forecast

      Inaccurate demand forecasting can be overcome by improving forecasting techniques in order to get more accurate demand forecasting results
   b. Forward Buying

      Forward buying is caused by fluctuating demand by the downstream level due to the health center stacking demand for 2 periods into one
   c. Supplier's Inability to Fulfill Demand

      Supplier's inability to fulfill demand is a situation where a supplier is unable to provide the required quantity of goods to meet the demand from customers. It can lead to shortages, delays in the supply chain, and can negatively impact the operations of businesses
3. To improve performance at Yogyakarta City Pharmacy and Health Equipment Warehouse the Health Center need to make a good forecasting when making a request for drug delivery. The proposed drug order plan is:
   a. Gedong Tengen Health Center

- Amlodipin 5mg
  68 boxes for May, 61 boxes for June, and 67 boxes for July
- Amoxicillin 500mg
  30 boxes for May, 30 boxes for June, and 31boxes for July
- Metformin 500mg
  119 boxes for May, 107 boxes for June, and 120 boxes for July
- Paracetamol 500mg
  49 boxes for May, June, and July
- Simvastatin 10mg
  34 boxes for May, 35 boxes for June, and 35 boxes for July

b. Mergangsan Health Center
   - Amlodipin 5mg
     105 boxes for May, June, and July
   - Amoxicillin 500mg
     33 boxes for May, 32 boxes for June, and 31 boxes for July
   - Metformin 500mg
     127 boxes for May, 124 boxes for June, and 121 boxes for July
   - Paracetamol 500mg
     44 boxes for May, 44 boxes for June, and 43 boxes for July
   - Simvastatin 10mg
     50 boxes for May, 70 boxes for June, and 57boxes for July

c. Ngampilan Health Center
   - Amlodipin 5mg
     90 boxes for May, 89 boxes for June and July
   - Amoxicillin 500mg
     17 boxes for May, 17 boxes for June, and boxes 16 for July
   - Metformin 500mg

91 boxes for May, June, and July

- Paracetamol 500mg
  34 boxes for May, 33 boxes for June, and 32boxes for July
- Simvastatin 10mg
  22 boxes for May, 19 boxes for June, and 17boxes for July.

6.2 Suggestion

The following are suggestions that can be given by researchers based on the conclusions:

A. For the Company

1. It is very important that a system of supervision and control of information carefully and continuously, so that the flow of information and coordination among trading partners can run well and the company's performance can be maintained.
2. It is recommended that the company use the forecasting method with upper and lower confidence bound in forecasting the distribution of goods because Health center can find out the date and number of drugs that should be sent to each health centerer sothat they are not out of stock or overstocked

B. For the Next Research

This research only limited to find out the forecasted data for the next 3-month sales,the next research could do an analysis on conducting the distribution process and calculating the minimum cost to do that. It could be using Distribution Requirement Planning

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APPENDIX

Appendix 1. Research Completion Letter from Health Center

PEMERINTAH KOTA YOGYAKARTA
DINAS KESEHATAN
PUSKESMAS MERGANGSAN

Jl. Taman Siswa Gang Brajapermana MG II/1168 Yogyakarta
Kode Pos 55151 telp (0274)382031
E-Mail : puskmg@jogjakota.go.id HOT LINE SMS : 0812278001 HOT LINE E-MAIL : upik@jogjakota.go.id
WEBSITE : www.jogjakota.go.id

SURAT KETERANGAN
Nomor : 000.9/1922

Yang bertanda tangan di bawah ini :

Nama	: drg. Risa Dhiana Permanasari
NIP	: 19740310 200604 2 003
Pangkat/Gol	: Pembina Tingkat I, IV/b
Jabatan	: Kepala Puskesmas
Instansi	: Puskesmas Mergangsan

Dengan ini menerangkan bahwa :

Nama	: Farid Yuzma Wiarco
NIM	: 17522046
Tempat Pendidikan	: Program S1, Program Internasional, Teknik Industri, Universitas Islam Indonesia Yogyakarta

Menyatakan telah melaksanakan Penelitian di Puskesmas Mergangsan, dengan judul :

"*Bullwhip Effect Analysis on Supply Chain Management* (Studi Kasus : Dinas Kesehatan dan Instalasi Farmasi Kota Yogyakarta)"

Demikian surat keterangan ini dibuat untuk dipergunakan sebagaimana mestinya.

Yogyakarta, 03 Juni 2024
Kepala Puskesmas

PEMERINTAH KOTA YOGYAKARTA PUSKESMAS MERGANGSAN DINAS KESEHATAN

drg. Risa Dhiana Permanasari
NIP. 19740310 200604 2 003

SEGORO AMARTO
SEMANGAT GOTONG ROYONG AGAWE MAJUNE NGAYOGYAKARTO
KEMANDIRIAN-KEDISIPLINAN-KEPEDULIAN-KEBERSAMAAN

Appendix 2. Gedong Tengen Drug Sales Data

1 LPLP GT MEI 2023 .XLSX

LAPORAN PEMAKAIAN DAN LEMBAR PERMINTAAN OBAT (LPLPO)

KODE FASYANKES P3471120201
NAMA FASYANKES PUSKESMAS GEDONGTENGEN
KECAMATAN : GEDONGTENGEN
KOTA : YOGYAKARTA
PROPINSI : DAERAH ISTIMEWA YOGYAKARTA

NOMOR LPLP : LPLP56/PUSKESMAS GEDONGTENGEN/2023
PERIODE PEMAKAIAN : May 2023
PERIODE PERMINTAAN : Jun 2023

CEK :
Data bernilai NEGATIF ; Data Bernilai DESIMAL
Data PERMINTAAN --> Koreksi Permintaan pad
Lengkapi data dengan KETERANGAN (bila per

NO.	KODE	NAMA BARANG	SATUAN	STOK AWAL	PENERIMAAN	PEMAKAIAN	RUSAK/ED	STOK AKHIR	STOK OPTIMUM	PERMINTAAN	KETERANGAN	Stok Fisik	Selisih dengan Stok	kolom bantu cetak
1	100102	Allopurinol 100mg tablet	tablet	1,177	100	675	-	602	1,800	1,200		602	-	
2	100145	Allopurinol 300mg tablet	tablet	525	-	180	-	345	200	-		345	-	
3	100104	Ambroxol 30mg tablet	tablet	727	700	675	-	752	1,400	700		752	-	
4	100156	Amlodipin 10mg tablet	tablet	3,579	2,000	3,473	-	2,106	6,000	4,800		2,106	-	
5	100158	Amlodipin 5mg tablet	tablet	7,708	2,700	7,282	-	3,126	11,667	11,000		3,126	-	
6	100108	Amoksisilin 125mg/5ml suspensi	botol	-	-	-	-	-	40	40		-	-	
7	100136	Amoksisilin 250mg/5ml suspensi	botol	-	-	-	-	-	30	30		-	-	
8	100109	Amoksisilin 500mg tablet	tablet	2,526	1,000	2,663	-	863	5,167	4,400		863	-	
9	100113	Antasida DOEN suspensi	botol	-	-	-	-	-	100	100		-	-	
10	100112	Antasida DOEN tablet	tablet	845	1,200	1,127	-	918	1,300	1,400		918	-	
11	100114	Antibakteri DOEN 5g salep	tube	11	-	3	-	8	12	4		8	-	
12	100119	Antifungi Whitfield As.Benz3%+As.Sal6% salep	pot	8	-	3	-	5	6	1		5	-	
13	100115	Antihemoroid DOEN Suppositoria	suppo	79	40	48	-	71	67	30		71	-	
14	100504	Antimigrain Ergot1mg+kofein50mg tablet	tablet	-	100	10	-	90	167	200		90	-	
15	100117	Aqua pro injeksi steril 25ml	plabot	12	2	10	-	4	14	16		4	-	
16	100131	Aquadest 1000ml	plabot	-	15	2	-	13	-	-		13	-	
18	111306	Asam Asetil Salisilat 80mg tablet	tablet	2,136	-	1,035	-	1,101	2,000	1,000		1,101	-	
19	102234	Asam askorbat / Vit C 50mg tablet	tablet	601	1,600	1,018	-	1,183	1,100	900		1,183	-	

LPLPO LPLPV LPLPLAB

288 of 861 rows displayed

Appendix 3. Mergangsan Drug Sales Data

1 MG_LPLP_MEI 2023 REVISI FIX .XLSX

LAPORAN PEMAKAIAN DAN LEMBAR PERMINTAAN OBAT, BMHP, REAGEN, BAHAN LABORATORIUM, DAN VAKSIN

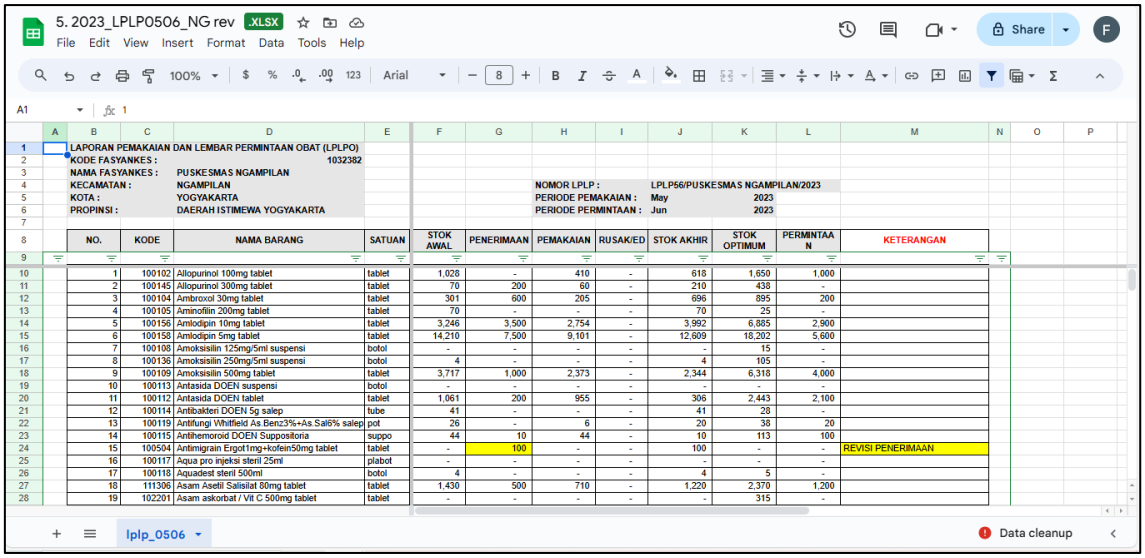
KODE FASYANKES :
NAMA FASYANKES : PUSKESMAS MERGANGSAN
KECAMATAN : MERGANGSAN
KOTA : YOGYAKARTA
PROPINSI : DAERAH ISTIMEWA YOGYAKARTA

NOMOR LPLP :
PERIODE PEMAKAIAN : Mei 2023 5
PERIODE PERMINTAAN : Juni 2023

No	Jenis	KODE	NAMA BARANG	SATUAN	Stok Awal	Penerimaan	Pemakaian	Retur ke penyedia /	Stok Akhir	Stok Optimum	PERMINTAAN	KETI
1	141018	bmhp	Jarum suntik no.23G	biji	94	0	4	0	90	8		
2	141908	bmhp	Sarung tangan latex nonsteril L	pcs	286	0	286	0	0	572		
3	141401	bmhp	Nurse cap	pcs	200	0	5	0	195	10		
4	141302	bmhp	Masker Disposible Karet	pcs	2215	0	0	0	2215	0		
5	140106	bmhp	Alat suntik sekali pakai 5ml	syringe	124	0	1	0	123	2		
6	141909	bmhp	Sarung tangan latex nonsteril M	pcs	300	0	0	0	300	0		
7	171916	bmhp	Surgical gown	pcs	62	0	39	0	23	78		
8	141902	bmhp	Sarung tangan panjang steril / gynecological	pcs	0	0	0	0	0	0		
9	141306	bmhp	Masker N95	pcs	126	0	4	0	122	8		
10	141306	bmhp	Masker KN95	pcs	84	0	7	0	77	14		
11	141910	bmhp	Sarung tangan latex nonsteril S	pcs	1154	5000	82	0	6072	164		
12	141905	bmhp	Sarung tangan steril no.7	pcs	11	0	0	0	11	0		
13	141906	bmhp	Sarung tangan steril no.7,5	pcs	58	0	0	0	58	0		
14	140108	bmhp	Hand sanitizer 500ml	botol	14	0	1	0	13	2		
15	140110	bmhp	Hand sanitizer 5L	galon	0	0	0	0	0	0		

LPLPC LPLPV LPLPO lplplab

Appendix 4. Ngampilan Drug Sales Data



5. 2023_LPLP0506_NG rev .XLSX

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1	LAPORAN PEMAKAIAN DAN LEMBAR PERMINTAAN OBAT (LPLPO)														
2	KODE FASYANKES :		1032382												
3	NAMA FASYANKES :		PUSKESMAS NGAMPILAN												
4	KECAMATAN :		NGAMPILAN					NOMOR LPLP :		LPLP56/PUSKESMAS NGAMPILAN/2023					
5	KOTA :		YOGYAKARTA					PERIODE PEMAKAIAN :		May 2023					
6	PROPINSI :		DAERAH ISTIMEWA YOGYAKARTA					PERIODE PERMINTAAN :		Jun 2023					
7															
8	NO.	KODE	NAMA BARANG	SATUAN	STOK AWAL	PENERIMAAN	PEMAKAIAN	RUSAK/ED	STOK AKHIR	STOK OPTIMUM	PERMINTAAN	KETERANGAN			
10	1	100102	Allopurinol 100mg tablet	tablet	1,028	-	410	-	618	1,650	1,000				
11	2	100145	Allopurinol 300mg tablet	tablet	70	200	60	-	210	438	-				
12	3	100104	Ambroxol 30mg tablet	tablet	301	600	205	-	696	895	200				
13	4	100105	Aminofilin 200mg tablet	tablet	70	-	-	-	70	25	-				
14	5	100156	Amlodipin 10mg tablet	tablet	3,246	3,500	2,754	-	3,992	6,885	2,900				
15	6	100158	Amlodipin 5mg tablet	tablet	14,210	7,500	9,101	-	12,609	18,202	5,600				
16	7	100108	Amoksisilin 125mg/5ml suspensi	botol	-	-	-	-	-	15	-				
17	8	100136	Amoksisilin 250mg/5ml suspensi	botol	4	-	-	-	4	105	-				
18	9	100109	Amoksisilin 500mg tablet	tablet	3,717	1,000	2,373	-	2,344	6,318	4,000				
19	10	100113	Antasida DOEN suspensi	botol	-	-	-	-	-	-	-				
20	11	100112	Antasida DOEN tablet	tablet	1,061	200	955	-	306	2,443	2,100				
21	12	100114	Antibakteri DOEN 5g salep	tube	41	-	-	-	41	28	-				
22	13	100119	Antifungi Whitfield As.Benz3%+As.Sal6% salep	pot	26	-	6	-	20	38	20				
23	14	100115	Antihemorod DOEN Suppositoria	suppo	44	10	44	-	10	113	100				
24	15	100504	Antimigrain Ergot1mg+kofein50mg tablet	tablet	-	100	-	-	100	-	-	REVISI PENERIMAAN			
25	16	100117	Aqua pro injeksi steril 25ml	plabot	-	-	-	-	-	-	-				
26	17	100118	Aquadest steril 500ml	botol	4	-	-	-	4	5	-				
27	18	111306	Asam Asetil Salisilat 80mg tablet	tablet	1,430	500	710	-	1,220	2,370	1,200				
28	19	102201	Asam askorbat / Vit C 500mg tablet	tablet	-	-	-	-	-	315	-				

lplp_0506

Data cleanup