INTERNSHIP REPORT

ON

Analysis on Inventory Management & Economic Order Quantity of Linde Bangladesh Limited

United International University

Internship Report

On

Analysis on Inventory Management & Economic Order Quantity of Linde Bangladesh Limited

Submitted to:

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Date of Submission:

Letter of Transmittal

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Subject: **Submission of internship report**

Respected Sir,

With due respect I would like to take this opportunity to thank you for the guidance and support you have provided me during the course of this report.

This report is a summary and analysis of my internship experience in Linde Bangladesh Limited, Tejgaon Branch (HEAD OFFICE)**.** The topic of this report is **"Analysis on Inventory Management & Economic Order Quantity of Linde Bangladesh Limited".**

I have practically worked and observed their working patterns, management and other company activities, in order to gain experience about the corporate environment. To carry out the report, I have acquired various papers/documents, periodicals etc. from my line manager as well as from internet. On the basis of these secondary data and practical observation, I have prepared the report later.

I request you to excuse me for any mistake that may occur in the report despite of my best efforts. I would really appreciate it you enlighten me with your thoughts and views regarding the report. Also, if you wish to enquire about an aspect of my report, I would gladly answer your queries.

Sincerely Yours,

Md. Saib Ahmed

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Acknowledgements

My first acknowledgement goes to the almighty Allah for bestowing us the patience and courage to finish this huge task within its deadline.

I want to express my utmost gratitude to my academic supervisor, **Dr. Md. Shariful Alam** Sir for supervising and guiding me to present this report. He has counseled me in every step of the report.

Moreover, I am exceedingly thankful to my manager of procurement department at Linde Bangladesh Ltd., **Mr. Md. Habib Ullah**, who has assisted me in every day to day activity that brought out my inner potentiality. He has provided me with all the necessary information and documents that was required to prepare a rigorous report.

Furthermore, I am also overwhelmed by my fellow colleagues at Linde Bangladesh Limited who have supported me in thick and thin, made me feel at home and communicated practical advice which helped me carry on my duty as an intern.

Finally, I would also like to take the opportunity to thank my family and friends, especially my father has always encouraged me to draw out the best in me and to those people who have helped us a lot directly and indirectly while making the report.

Executive Summary

Linde, a multinational company, Linde Bangladesh Limited is a member of the Linde Group that has been present in Bangladesh for over 50 years with continuous expansion in operations and business. As a pioneer multinational company in the gases business, Linde Bangladesh has 3 major locations / installations at Tejgaon, Rupganj and Shitalpur. Besides, it has 18 sales centers spread throughout the country serving a customer base of over 35,000. The company is currently capable of producing 80 tons of liquid ASU gases per day and 23,100 MT of Welding Electrodes per year. Its product folio and services include liquid and gaseous Oxygen and Nitrogen, Argon, Acetylene, Carbon Dioxide, Dry Ice, Refrigerant Gases, Lamp gas and other gas mixtures, Medical Oxygen, Nitrous Oxide, Entonox, medical equipment and accessories, Welding Electrodes, gas and arc welding equipment and accessories, welding training and services

I have apportioned this report into five major chapters. Firstly, in the first chapter, I discussed about the background, scope and origin of the report. The second chapter describes about the history, product offerings, vision and other key factors related to the company in general. The next chapter gives an Economic Order Quantity and Inventory Management. Later on, in the fourth chapter there is a brief description of the inventory management practices and application of EOQ Model. And in the final chapter I have written about the findings and conclusion of the company. Lastly, I have also added some recommendations based on my observations during my internship period at Linde Bangladesh Limited in the last chapter.

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1.0 Framework Of The Report

The report, "Inventory Management Practices at Linde Bangladesh Ltd: An Application of EOQ Model", has been prepared to fulfill the internship requirement of BBA program under the supervision of Dr. Md. Shariful Alam, Assistant Professor of United International University. While preparing this report, I had a great opportunity to have an in depth knowledge of the Gases and Welding business activities and the financial position through different analyzing tools and methods.

1.1 Background of The Study

To do the study of Inventory Management, Linde Bangladesh Ltd. has been preferred because it's one of the pioneer multinational companies in the gases and welding business of Bangladesh. I have performed an analysis of the company and tried to evaluate its justification with the acquired knowledge.

Gases and Welding business is gaining increased importance in the economy of Bangladesh with its gradual transformation to industrial one. Bangladesh is the seventh-largest producer of natural gas in Asia. Gas supplies meet 56% of domestic energy demand. Meanwhile, the welding business is also growing fast and in the early 80'sstate of the art RAM extruder addition to the production line results into dramatically improvement in output and quality of electrodes. From practical knowledge, we will be able to know real life situations of Linde Bangladesh Limited. Linde Bangladesh Ltd. is a listed company, limited by shares and was incorporated in Bangladesh in 1973 under the Companies Act 1913.

1.2 Problem Statement

Whether LINDE minimizes their inventory cost by following their own inventory management policy or the application of EOQ Model refers the lowest possible inventory cost.

1.3 Significance of The Report

Education will be the most effective when theory and practice blends. Theoretical knowledge gets its perfection with practical application. And the report is designed to bridge the gap between the theoretical knowledge and real application. We all know that there is no alternative of practical knowledge which is more beneficial than theoretical aspects. The prime reason of this study is to become familiar with the practical business world and to attain practical knowledge about the overall manufactured company and Corporate world, which is so much essential for each and every student to meet the extreme growing challenges in job market.

1.4 Scope of The Report

In order to maintain the speed of development now engineering companies must compete in the market place both with local institution as well as foreign ones. The presentation of the organizational structure and policy of Linde Bangladesh Limited and investigating the strategies applies by it provide the scope of this report.

The scope of this report is limited to the overall description of the company, its Inventory management, its exposure towards various processes and the practical progress of its operation. The scope of the study is limited to organizational setup, functions and performances:

- Learning of existing Inventory Management Model that is practiced in Linde Bangladesh Ltd.
- The risks at which Linde Bangladesh Limited is exposed to.
- Recent performance of Linde Bangladesh Limited in terms of ratio analysis.

1.5 Broad Objective

The main objective is to analyze how the inventory is managed with the application of EOQ model at Linde Bangladesh Ltd.

1.5.1 SPECIFIC OBJECTIVE

The following aspects can be listed as the specific objectives for practical orientation-

- To present a historical overview of Linde Bangladesh Limited.
- To evaluate the Inventory Management of Linde Bangladesh Limited.
- To identify the risks associated with inventory management of Linde Bangladesh Limited.
- To identify Inventory turnover and to analyze performance of the Linde Bangladesh Limited.

1.6 Methodology

There are many ways or techniques to evaluate a firm's Inventory Management. Such as, Opening and ending inventory, stock and sales monitoring, Balance Sheet Analysis, Cash Flow Analysis, Ratio Analysis, Trend Analysis so on. However, for doing the study of Linde Bangladesh Ltd.'s Inventory Management, we have chosen the EOQ Model as this is the widely used technique for evaluating Inventory Management. The information has been calculated with company's internal inventory management policies.

1.7 SOURCES

Sources included direct observation, face-to-face discussion with employees of finance and Sales & Marketing departments of the Linde Bangladesh Limited, study of files, circulars & overall practical experience of last four months.

1.7.1 PRIMARY SOURCES

For the completion of this report, the primary sources of data are-

- Discussion with the organization's Supervisor
- Talking to the organization employees

1.7.2 SECONDARY SOURCES

For this internship report, the secondary data are collected from the below sources-

- Company Websites
- Annual report
- Revision of relevant files
- Official records

1.8 LIMITATIONS

It is not possible to prepare a report on a topic without any limitations. So regarding this report, the limitations are:

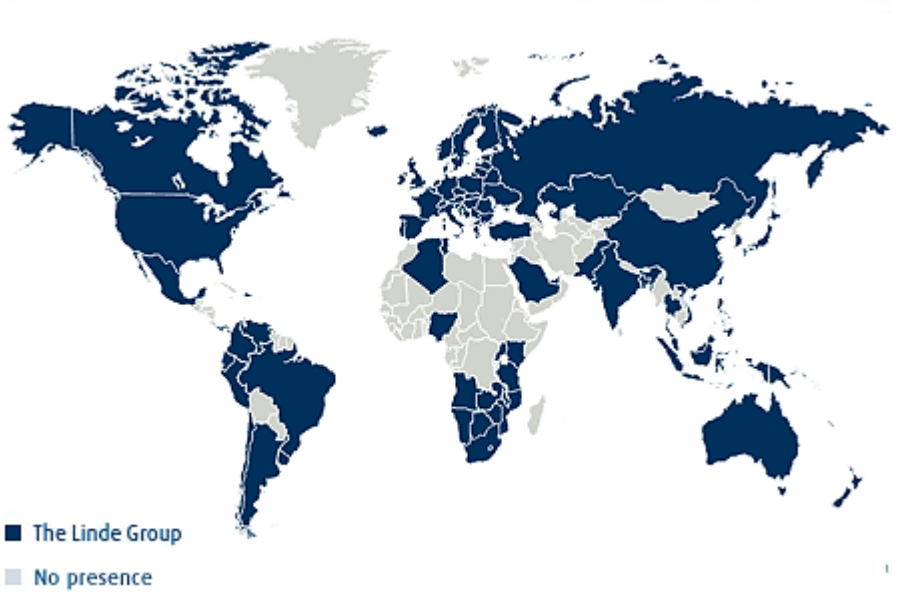
- Duration of the program was four months only which seemed to be not enough for the details study.
- Because of policy restrictions many useful data was not available.
- Because of the limitation of information, some assumptions were made. So there may be some personal mistake in the report.

2.0 An Overview Of Linde Group

The LINDE Group is a global company, pursuing technological leadership and innovation at many levels and in many locations. Their resources include a worldwide network of scientists; engineers and technicians, all linked together so that information and expertise can flow freely around the Group. The success of their global technology effort can be measured in many ways; by the number of patents they seek for their new inventions - an average of three per week - and by the continuous flow of new products and processes delivered to their customers.

"The LINDE Group has an international portfolio of companies grouped for management control and reporting into three business segments. These are Gases & Related Products, Health Care and Vacuum Technology & Supply chain Solutions. LINDE Adds value to a diverse range of industries and organizations worldwide: from electronics to food; from water treatment plants to chemical processes; from coating most of the world's high-performance glass to distributing food, clothes and other consumables." (Linde website)

"The LINDE group has historically focused on its geographic strengths, building relationships in the countries that it serves. Recent changes have turned the organization outward, to focus more upon our customers and their needs. The LINDE Group's orientation is now toward markets, encouraging product and process innovation worldwide. Whilst needing to retain local strengths, there are global markets emerging which can best be served by an organization with worldwide capability. Global customers expect to do business with LINDE gases on a global basis, and they are focused on a number of global market sectors to pursue the objectives of customer focus and global effectiveness."



"Whatever the industry or interest, our goal is to respond to their needs as quickly and effectively as possible. Their ever-changing requirements are the driving force behind the development of company's products, technologies and support services. LINDE recognizes that LINDE people are the most important asset and through them company can ensure that

we play a full and active role in communities around the world and they are committed to the highest standards of safety and environmental practice. At the same time, they believe that the best way they can assist any of the communities in which they operate is to build a successful business." (Linde website)

The LINDE group is built around its customers, more than two million of them found all over the world. LINDE is one of only a handful of truly global companies based in the UK. They manufacture in some sixty countries and sell their products in more. They employ 40,000 people and thrive and expand by meeting the need of our customers.

2.1 Historical Background

2.1.1 THE FIRST BUSINESS YEARS: 1879-1890

Thanks to the Linde engineers and the reliability and performance of the Linde plants, the young engineering firm "Gesellschaft für Linde's Eismaschinen", whose refrigeration machines were manufactured primarily by Maschinen fabrik Augsburg and the Swiss company Gebrüder Sulzer, soon became the market leader in Germany and Europe and was even represented in the United States through a licensee.

In order to create a broader selling base, Carl von Linde also built his own cold storage facilities for food and ice factories for industrial and private consumption. His ice machines were also used as freezer plants for ships, for ice skating rinks, for refrigeration in dairies, and for the liquefaction of carbonic acid and chlorine.

2.1.2 ESTABLISHMENT OF BOC

While in Germany "Gesellschaft für Linde's Eismaschinen" soon gained a reputation in refrigeration technology, the history of BOC began almost simultaneously in London. In 1880, six years before the company was founded, the brothers Arthur and Leon Brin took out a patent on a chemical process for separating oxygen. Five years later, the brothers showed a demonstration machine at the Inventions Exhibition in South Kensington, London. Henry Sharp, a stoneware manufacturer, was sufficiently interested to persuade friends and members of his 12 family to help form a company to develop the Brins' process - "Brin's Oxygen Company Ltd" was founded in January 1886 and the following year, the company produced 4,024m³ of oxygen.

2.1.3 BOC AND LINDE

BOC had had to give up its own oxygen production in favor of the Linde liquefaction process in 1906, after losing a patent dispute with "Gesellschaft für Linde's Eismaschinen".
The company was renamed "The British Oxygen Company", and after winning the patent dispute, Carl von Linde became a member of the Board of Directors of BOC. The company achieved a first breakthrough for industrial applications with the introduction of autogenously (gas) welding in the early 20th century.
Together with the name change, the production process was further refined by combining the best features of the Linde process with a new process developed by Georges Claude. Today The Linde Group is a world leading gases and engineering company with almost

48,000 employees working in more than 100 countries worldwide. In the 2009 financial year it achieved sales of EUR 11.2 bn. The strategy of The Linde Group is geared towards sustainable earnings-based growth and focuses on the expansion of its international business with forward-looking products and services. Linde acts responsibly towards its shareholders, business partners, employees, society and the environment – in every one of its business areas, regions and locations across the globe

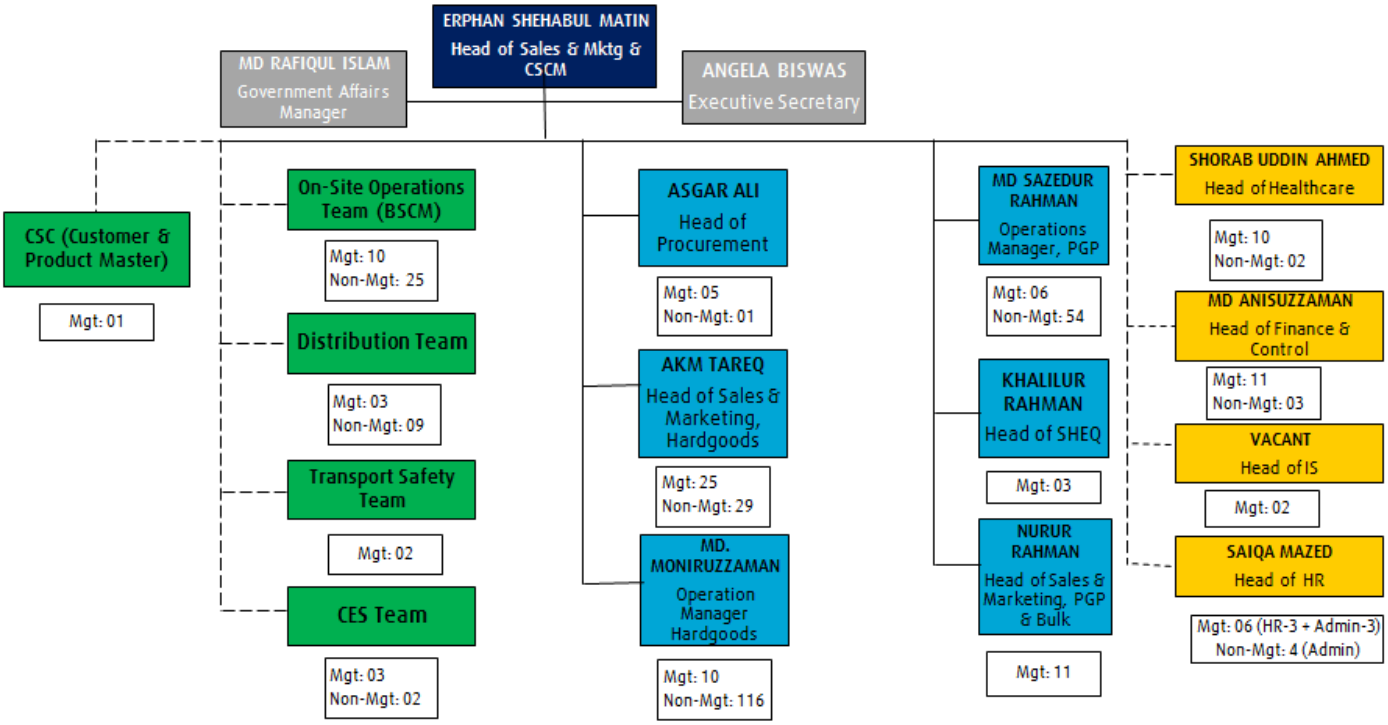
Linde Bangladesh Limited, a member of the Linde Group, has been contributing towards the development of the nation as a silent partner. A strong in–built culture with work values reinforced and developed Linde Bangladesh over the years which are reflected in the performance of its employees for more than 50 years with continuous expansion in ranging on wide spectrum of industries from chemicals and petrochemicals to steel. It has a team of around 400 trained, motivated and professional members who look over operations for 24 hour at three major locations across the country to support the customers.

Linde Bangladesh Limited is committed to the quality of its products & services. The company's motto is to ensure optimum conditions in health, safety and the environment for employees, customers and stakeholders.

2.1.4 MILESTONES AT A GLANCE

1958	Pakistan Oxygen Limited.
1964	Tejgaon plant commissioned and two plants, oxygen and acetylene were set up. Chittagong welding electrode plant was established.
1968	Khulna plant was inaugurated.
1971	After the liberation war company changed name from "Pakistan Oxygen Limited" to "Bangladesh Oxygen Limited" which was known as "Oxygen Limited" during the transition period of incorporation.
1973	Incorporated in the joint stock companies and received government approval as the first full-fledged "Company" of the newly formed country.
1976	First CO2 plant was introduced.
1979	Welding Training Centre started its journey.
1990	BOC transferred its corporate office from Motijheel to Mohakhali.
1995	The company changed its name from "Bangladesh Oxygen Limited" to "BOC Bangladesh Limited".
1996	BOC set up its first line welding electrode plant.
1997	Rupgonj Plant was commissioned.
1999	Shitalpur plant was bought over with 20TPD production facility. BOC set up its second line welding electrode plant.
2000	ASPEN and LPG Bottling plant was commissioned.
2004	Inaugurated present corporate office in Tejgaon.
2006	BOC Bangladesh Limited was acquired by the Linde Group.
2010	Achieved BDT 100 Crore Profit.
2011	BOC set up its Wittemann carbon dioxide plant.

2.2 ORGANOGRAM



2.3 VISION & STRATEGIES OF THE COMPANY

Linde corporate culture builds on the vision, values and principles that guide the way do their business.

2.3.1 VISION

The Linde Bangladesh's vision is "We shall be recognized as the leader in all the business sectors in which we compete in Bangladesh. Our success will be built on our absolute dedication to the satisfaction of our customers, through constant innovation, operational efficiency, cost effectiveness and the talents of our people. We shall always apply high standards of integrity and responsibility in our activities."
The Linde Group's vision is "To be the world's leading global gases and engineering group - admired for our people, who create innovative solutions that make a difference to the world."

2.3.2 THE LINDE SPIRIT

Quoted from the Linde website: "The core values are anchored in the Linde Spirit, our corporate philosophy. All of the actions are guided by a strong commitment to corporate integrity. It is the fabric of their moral and ethical code, ensuring that they always act with honesty and fairness."

2.3.3 CODE OF ETHICS

"Linde's ethical framework is captured in the Code of Ethics with guidelines that align with legal and internal company policies." (Quoted from the Linde website)

2.3.4 CORPORATE RESPONSIBILITY POLICY

"Just like the Code of Ethics, the Linde Group's Corporate Responsibility policy also builds on the values and principles set down in the Linde Spirit. It outlines the sense of responsibility to Linde's stakeholders, such as business partners, employees and society. It also addresses the commitment to protecting natural resources." (Quoted from the Linde website)

2.3.5 SHEQ

"SHEQ (Safety, Health, Environment, and Quality) policy frames and inspires the continuous improvement of our activities in the areas of environmental protection, occupational health, safety and product quality."
"Together, these guidelines create an umbrella framework that guides the actions of all Linde employees and divisions across the globe. They are the cornerstones of Linde's common identity."

2.4 PRODUCTS &SERVICES

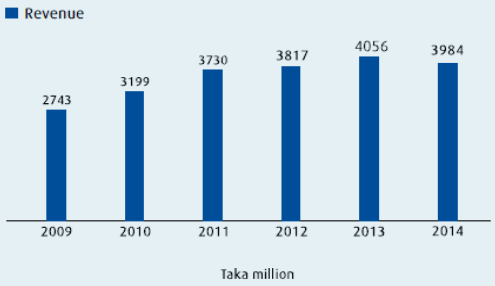
Industrial gases	Welding gases & equipment	Medical gases & equipment
→ Compressed oxygen	→ Mild steel electrodes	→ Medical oxygen liquid
→ Liquid oxygen	→ Low hydrogen/low alloy electrodes	→ Medical oxygen compressed
→ Compressed nitrogen	→ Cast iron electrodes	→ Nitrous oxide
→ Liquid nitrogen	→ Hard surfacing electrodes	→ Entonox
→ Dissolved acetylene	→ Stainless steel electrodes	→ Sterilizing gases
→ Carbon dioxide	→ Arc welding equipment & accessories	→ Medical gases cylinders
→ Dry ice	→ Gas welding rod & flux	→ Anaesthesia machines
→ Argon	→ Gas welding and cutting equipment & accessories	→ Anaesthesia ventilators
→ Lamp gases	→ MIG welding equipment & accessories	→ ICU/CCU monitoring system
→ LPG	→ TIG welding equipment & accessories	→ ICU/CCU ventilators
→ Refrigerant gases (Freon & Suva)	→ Plasma cutting equipment & accessories	→ Pulse oximeter
→ Hydrogen	→ Welding training & services	→ Infant warmer
→ Fire suppression system	→ Welding equipment repairs	→ Photo therapy units
→ Compressed helium	→ Welding testing & services	→ Infant incubators
→ Helium		→ OT table
→ Sulphurhexafluoride		→ OT light
→ Sulphurdioxide		→ Autoclave/Sterilizer
→ Special gases & gas mixtures		→ Gynaecological tables
→ Any other gas on request		→ Humidifier
		→ Oxygen concentrator
		→ Resuscitators
		→ Central sterilizing and supply department (CSSD)
		→ Other medical equipment on request

2.5 Financial Performance

Financial History.

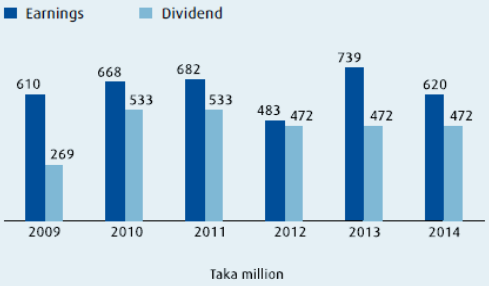
		2009	2010	2011	2012	2013	2014
Revenue	Taka'000	2,742,817	3,199,375	3,729,754	3,817,127	4,056,278	3,984,482
Profit before tax	"	772,611	903,256	940,136	660,493	1,001,587	851,035
Taxation	"	181,972	241,320	230,584	180,575	225,544	242,659
Deferred tax	"	–19,231	–6,132	28,037	–2,593	37,148	-11,756
Earnings	"	609,870	668,068	681,515	482,511	738,895	620,132
Final dividend proposed	"	117,181	152,183	152,183	167,401	167,401	167,401
Interim dividend paid	"	152,183	380,457	380,457	304,366	304,366	304,366
General reserve*	"	1,666,177	1,823,141	1,993,048	2,019,010	2,286,138	2,434,503
Share capital	"	152,183	152,183	152,183	152,183	152,183	152,183
Revaluation reserve	"	20,174	20,174	20,174	20,174	20,174	20,174
Shareholder's equity*	"	1,838,534	1,995,498	2,165,405	2,191,367	2,458,495	2,606,860
Net fixed assets	"	922,735	1,043,552	1,238,834	1,474,836	1,508,991	1,535,145
Depreciation	"	136,321	132,769	131,915	146,144	157,425	164,531
Earnings per share	Taka	40.08	43.90	44.78	31.71	48.55	40.75
Price earnings ratio	"	12.00	16.00	14.00	17.00	13.00	22.00
Dividend per share	"	17.70	35.00	35.00	31.00	31.00	31.00
Dividend percentage	%	177	350	350	310	310	310
Net assets per share*	Taka	120.81	131.13	142.29	144.00	161.55	171.30
Operating cashflow per share	"	68.41	45.45	34.57	31.78	54.91	50.89

Revenue



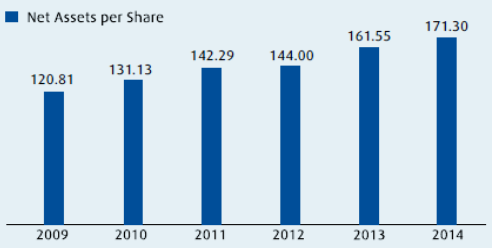
Taka million

Earnings & dividend



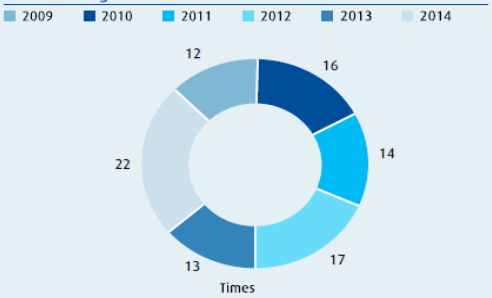
Taka million

Net assets per share



Taka

Price earning ratio*



Times

3.0 Theoretical Framework Of Inventory Management

An inventory system provides the organizational structure and the operating policies for maintaining and controlling goods to be stocked. The system is responsible for ordering and receipt of goods: timing the order placement and keeping track of what has been ordered, how much, and from whom.

Inventory management system has two main concerns. One relates to the level of customer service, and at the right goods, in sufficient quantities, in the right place, and at the right time. The other relates to the cost of ordering and carrying inventories. As a hundred percent export oriented manufacturing company, Linde Bangladesh limited places a great importance in valuation and management of inventories.

As such, there is a broad and deep volume of literature in the management of this asset in various situations the interaction of this asset with other asset and similar issue. A complete and comprehensive discussion of the issues in inventory management is beyond the scope of this report. I limit my coverage to only the most basic inventory.

3.1 Objective of Inventory Management:

3.1.1 OPERATING OBJECTIVES:

- Ensuring Availability of Materials
- Avoidance of Abnormal Wastage
- Promotion of Manufacturing Efficiency
- Avoidance of Out of Stock Danger
- Better Service to Customers
- Designing poorer organization for inventory management

3.1.2 FINANCIAL OBJECTIVES:

- Economy in purchasing
- Reasonable Price
- Optimum Investing and Efficient Use of capital

3.2 Why Inventory Management Is Important

Like all other assets, inventory represents a costly investment for LINDE. In order for this investment to be worthwhile there must be some advantage in making it. Those reasons vary with the type of inventory carried. For purpose of discussion inventory is divided into three types

3.2.1 MOVEMENT INVENTORIES

3.2.2 BUFFER INVENTORIES

3.2.3 ANTICIPATION INVENTORIES

3.3 CONTROL OF MATERIALS:

Rigid control over materials are necessary not only to guard against theft, but also to minimize waste and misuse from causes such as excessive inventories, over issue, deterioration, spoilage, and obsolescence.
There are certain prerequisites to an effective control system of LINDE for materials:

1. Materials of the desired quantity will be available when needed.
2. Materials will be purchased only when a need exists and in economical qualities.
3. Purchases of materials will be made at most favorable prices.
4. Vouchers for the payments of materials purchased will be approved only if the materials have been received in good condition.
5. Materials will be protected against loss by proper physical control.
6. Issue of materials will be properly authorized and accounted for and
7. All materials, at all times, will be charged, as the responsibility of some individual. The control of materials, as an element of cost of production, is illustrated with reference to the purchase and issues procedures, inventory systems, and inventory control techniques.

3.4 PURPOSES OF INVENTORY

LINDE keeps a supply of inventory for the following reasons are:

- To maintain independence of operations.
- To meet variation in product demand.
- To allow flexibility in production scheduling.
- To provide a safeguard for variation in raw material delivery time.
- To take advantage of economic purchase-order size.
- Reduction in investment in inventory.
- Proper and efficient use of raw materials.
- No bottleneck in production.
- Improvement in production and sales.
- Efficient and optimum use of physical as well as financial resources.
- Ordering cost can be reduced if a firm places a few large orders in place of numerous small orders.
- Maintenance of adequate inventories reduces the set-up cost associated with each production run.

3.5 Key Functions

The key functions of the Linde Bangladesh Limited inventory management systems are like-

- To ensure material is available.
- Receipts, custody, and issue of materials.
- To recording the record of all stock movements.
- Co-ordinate with management, maintenance, production, marketing & finance departments and other departments in the company for meeting their requirements for materials and spares.
- Assist in devising management reports.

3.6 Associated Risks And Risk Management

Sufficient inventory will ensure a smooth flow of business processes and avoid manufacturing delays, but this inventory also has certain risks associated with it.

In order to alleviate such risks from business, we need to understand them completely. By doing this, we can draft appropriate risk management strategies using best practices for inventory control. Linde faces some types of following inventory risks those are described below:

3.6.1 THEFT

Theft is one of the biggest risks with regard to inventory control, specifically when the inventory is higher in value. If internal employees are involved in the theft, it is much more difficult to identify as they know the entire system and would probably be wise enough to erase all their tracks after the theft.

Every year, LINDE spends millions of dollars to prevent theft risk. They invest money in security measures like cameras and by hiring watch guards who work in shifts to cover 24 hours to prevent any incidents of inventory theft.

3.6.2 INVENTORY WASTE & DAMAGE

Inventory usually tends to get damaged while being used in the normal business processes. Damaged inventory cannot be used and goes to waste, increasing the costs of the business.

To avoid inventory from being damaged and to reduce waste costs, LINDE creates inventory control policies such as they focus more on packaging to minimize the damage as much as possible as well as issue rules and regulations regarding the effective use of inventory to prevent waste. And the packaging is that much strong that the goods rarely get damaged.

3.6.3 INVENTORY LOSS

Inventory is a current asset to a firm. A loss of inventory means a reduction in the company equity. Goods in the inventory get lost when the inventory is not managed properly or the employees are not careful in handling inventory.

LINDE has now created an inventory control system to identify the exact amount of inventory loss as well as the cause of the loss. This enables them to reduce company expense and prevent such inventory losses.

3.6.4 LIFECYCLE

All products go through the product life cycle. Those products that are in the decline stage are at a higher inventory risk. Such products tend to tighten their inventory control and manufacturing policies and we should only produce enough to sufficiently meet their current demand. A surplus production of goods is that is not sold in the market become obsolete and a heavy burden on the firm.

To avoid this stock provision risk, LINDE makes some action plans to sell the goods and try to reach our potential and old customer who once purchased those particular goods.

3.7 ECONOMIC ORDER QUANTITY

Economic Order Quantity (EOQ) has been a well-known formula that calculates the optimal economic order quantity. The Economic Order Quantity (EOQ) formula has been used in both engineering and business disciplines. Engineers study the EOQ formula in engineering economics and industrial engineering courses. On the other hand, business disciplines study the EOQ in both operational and financial courses. In both disciplines, EOQ formulas have practical and specific applications in illustrating concepts of cost tradeoffs; as well as specific application in inventory.

“Optimizing Economic Order Quantity” focused on the economic order quantity. Today’s leading technology, many companies are not taking advantage of the fundamental inventory models. There are various software packages in aiding companies with inventory control, but if the data inputted are inaccurate, it may lead to poor results. In order to have suitable results for any inventory model, accurate product costs, activity costs, forecasts, history, and lead times need to be in place. As a result of bad debts, companies have had bad experience with some inventory models, and that is one of the reasons they do not take advantage of the EOQ model.

3.7.1 THE EOQ INVENTORY MODEL

At times, people in the retail business or in the manufacturing industry do not know or do not understand what EOQ stands for and how it is used. In an article, “The EOQ Inventory

Formula," written by James A. Cargal clearly explains the fundamental theory of the Economic Order Quantity. Cargal published this article from Troy State University Montgomery. The article is straight forward and easy to understand. Cargal does a great job explaining each variable and how it's used accordingly. The formula is written and described as the following,

- EOQ = $\sqrt{\frac{2*D*S}{H}}$

Q= the EOQ order quantity. This is the variable we want to optimize. All the other variables are fixed quantities.
D= the annual demand of product in quantity per unit time. This can also be known as a rate.
S= the product order cost. This is the flat fee charged for making any order and is independent of Q.
C=Unit cost.
H= Holding cost per unit as a fraction of product cost.

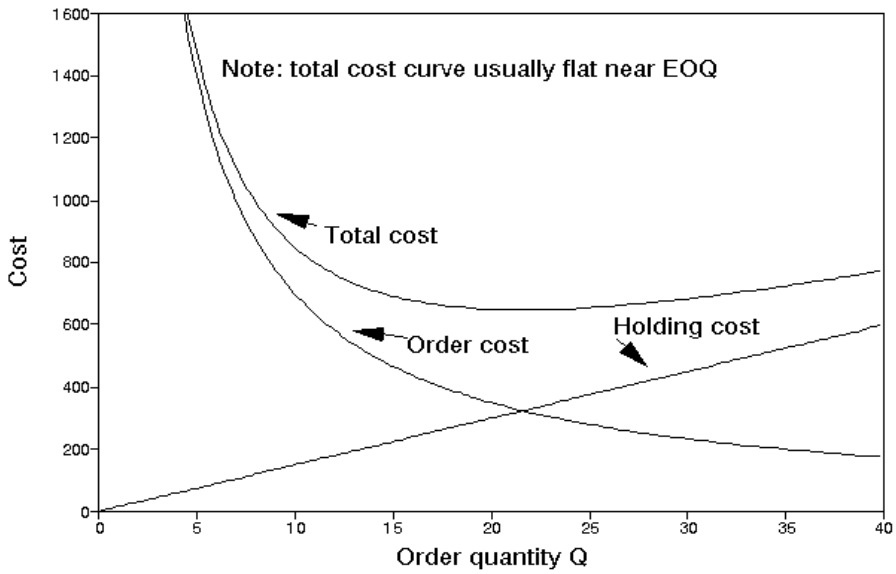


Figure: 1

3.7.2 FORECASTING

Forecasting is the first activity of estimating the quantity of a product or service that consumers will purchase. There are different forecasting methods that can assist in predicting the quantity of a product a consumer will purchase. Choosing what forecasting method to use from a Company's historical sales data can be quite challenging.

In the analysis portion of the project, there are several methods used in conjunction with the EOQ and ROP model. One method is demand forecasting which included seasonal and annual trends. These techniques are used to calculate the annual trends involved moving averages and exponential smoothing. Furthermore, the annual trend is used in the EOQ

model as the annual demand in order to manipulate the fix order cost or the holding cost of each product.

3.7.3 REORDER POINT AND SAFETY STOCK

Another important technique is used along with the Economic Order Quantity is the Reorder Point (ROP) and Safety Stock.

The ROP quantity reflects the level of inventory that triggers the placement of an order for additional units. The problem, how much to order, is solved by determining the economic order quantity, yet answer should be sought to be second problem, when to order. This is a problem of determining the reorder point. The reorder point is that inventory level at which an order should be placed to replenish the inventory. To determine the reorder point under certainty, we should know: (a) lead time (b) average usage, and (c) economic order quantity. Lead time is the normally taken is replenishing inventory after the order has been placed. By certainty we mean that usage and lead time do not fluctuate. Under such a situation, reorder point is simply that inventory level which will be maintained for consumption during the lead time.

In determining the reorder point the following three factors need to be at hand:

1. **Demand**=Quantity of inventory used or sold each day.
2. **Lead Time** =Time (in days) it takes for an order to arrive when an order is placed.
3. **Safety Stock=**The quantity of inventory kept on hand in case there is a unpredictable event like delays in lead time or unexpected demand. If the demand is constant and the lead time is known, then the reorder point is w ng:

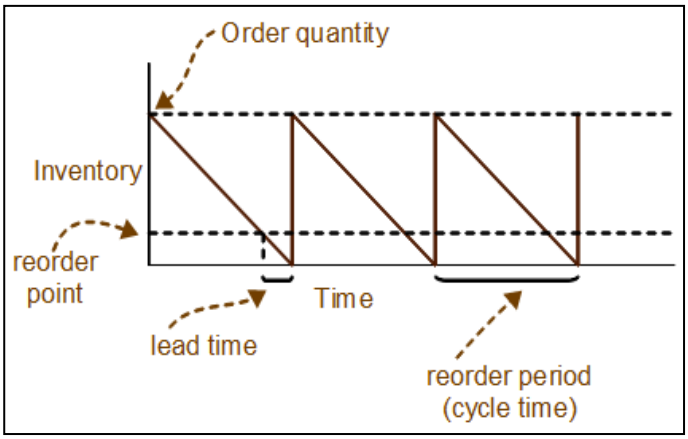


Figure: 2

- <u>When the demand is constant and the lead time is known, the reorder point is-</u>
  - **Reorder Point**= Daily usage rate*Lead time (in days)
- <u>When a safety stock is maintained, then the reorder point is-</u>
  - **Reorder Point**= [Daily usage rate *Lead time (in days)] +safety stock

The demand for inventory is likely to fluctuate from time to time. In particular, at certain points of time the demand may exceed the anticipated level. In other words, a discrepancy between the assumed (anticipated/expected) and the actual usage rate of inventory is likely to occur in practice. The effect of increased usage and/or slower delivery

would be shortage of inventory. That is, the firm would disrupt production schedule and alienate the customers. The firm would, therefore, be advised to keep a sufficient safety margin by having additional inventory to guard against stock-out situation. Such stocks are called safety stocks. This would act as a buffer/cushion against a possible shortage of inventory. Safety stock may, thus, be defined as minimum additional Inventory to serve as safety margin/buffer/cushion to meet unanticipated increase in usage resulting from unusually high demand and/or uncontrollable late receipt of incoming inventory.

- Safety Stock due to uncertainty in lead time-

  - **Safety Stock**= (Maximum lead time-Normal lead time) x Consumption rate

  - **Safety Stock**= (Maximum rate of consumption- Average rate of consumption) x Lead time

3.7.4 LEAD TIME

The materials lead time consists of many component lead times which represent the activities or tasks which must be performed. Any attempt to develop a strategy to reduce the lead time length and improve reliability must focus on the component lead times and their interrelationships with other components. These actions can be organized into four steps approach typically used in PERT/CPM method as described below.

- The First Step is the identification of the relevant lead time components associated with the product involved. Each product requires different combination of parts and materials involving different industries and suppliers. Therefore, it is important to identify all major component lead times relevant for the product.
- The Second Step is to estimate the length and variances of all involved lead time components. The lead time length can be expressed by either an average time or a range of time along with the associated variance. This information is critical in estimating the minimum total lead time for the product and in estimating the reliability of the lead time.
- The Third Step is to determine the interrelationships between the lead time components. The interrelations can be expressed as a diagram linking all component lead times. Using this diagram, interrelationships between different component lead times can be identified and the minimum time it takes to receive the necessary parts and materials can be determined. The total materials lead time is the cumulative lead time of all the relevant component lead times directly linked together. The minimum materials lead time is the cumulative length of the longest path in the diagram. It is also known as critical path.
- The Final Step is to analyze the possibility of reducing lead time for those components which are on the critical path. Any effort to reduce the length and to improve the reliability of the lead time must be focused on the component lead times found on the critical path. Otherwise, the effort will not produce the desired results, but merely create additional slack in non- critical activities. It should be

noted that the critical path is dynamic and it can shift as a result of efforts to reduce the lead time. Thus, it is important to be sure that the component lead time being analyzed is on the critical path.

After completing these steps, each lead time component activity can be analyzed. Appropriate actions can be designed to reduce the length and variance of the components.

3.7.5 ECONOMIC ORDER QUANTITY TECHNIQUE

One of the major inventory management problems to be resolved is how much inventory should be added when inventory is replenished. When LINDE is buying raw materials, it has to decide first in which it has to be purchased on replenishment. When Linde is planning a production run, the issue is how much production to schedule (or how much to make). These problems are called order quantity problems, and the task is to determine the optimum or economic order quantity. Determining an optimum inventory level involves two types of costs: (a) ordering costs and (b) carrying/holding costs.

4.0 INVENTORY BUSINESS PROCESSES

The steps of inventory business processes are illustrated in Figure 3 below-

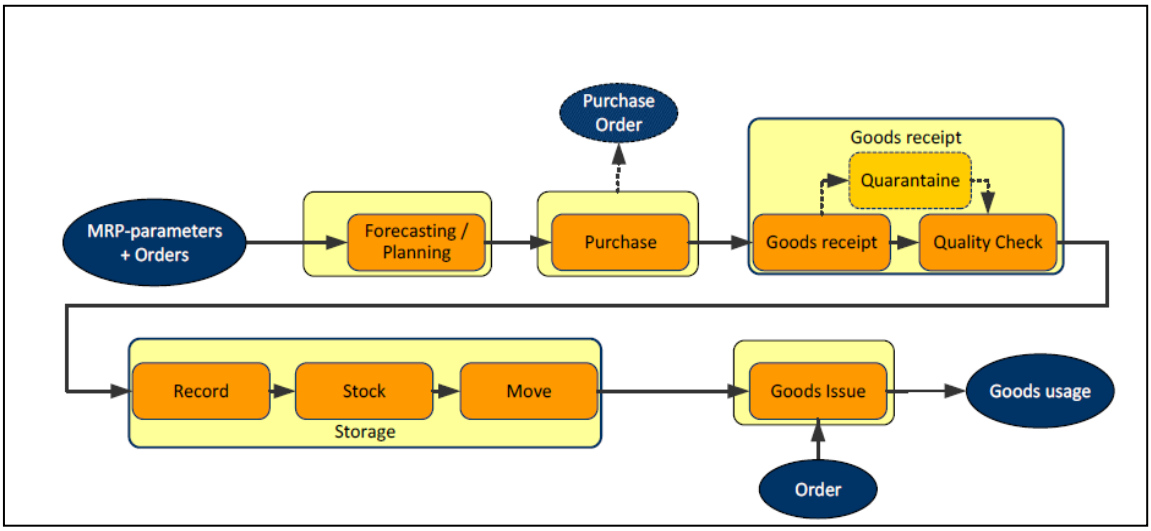


Figure: 3

The yellow blocks r each main process one or more processes take place which are displayed in orange. The quarantine process has a different color, because this process step is optional. The dark blue oval blocks represent in- and outputs. By MRP-parameters only the MRP I system is referred to: MRP II, which incorporates the planning of human and machinery capacities as well, is not part of the input. An order triggers the goods issue process and finally the goods are used which forms the output in this process.

The forecasting, goods receipt, storage and goods issue processes are described in more detail in the proceeding sections. These are the four major processes taking place in inventory management and these can all very well be managed using an ERP application. The purchase step is only considered very basic. In this case purchase will only be considered as goods being ordered; how and when and according to what strategy is not taken into account because that falls outside the scope of inventory management and this research. Purchase strategies are not directly part of the operational process and are therefore the purchase order is displayed in another color, with a dotted arrow towards it, in Figure 3.

Each process step is described in detail: within some of these steps, several activities took place again. Next the potential benefits provided by ERP where investigated and allocated to the above process steps. The figure below shows the entire Linde inventory management process; with each identified potential ERP benefit, allocated to a specific process step:

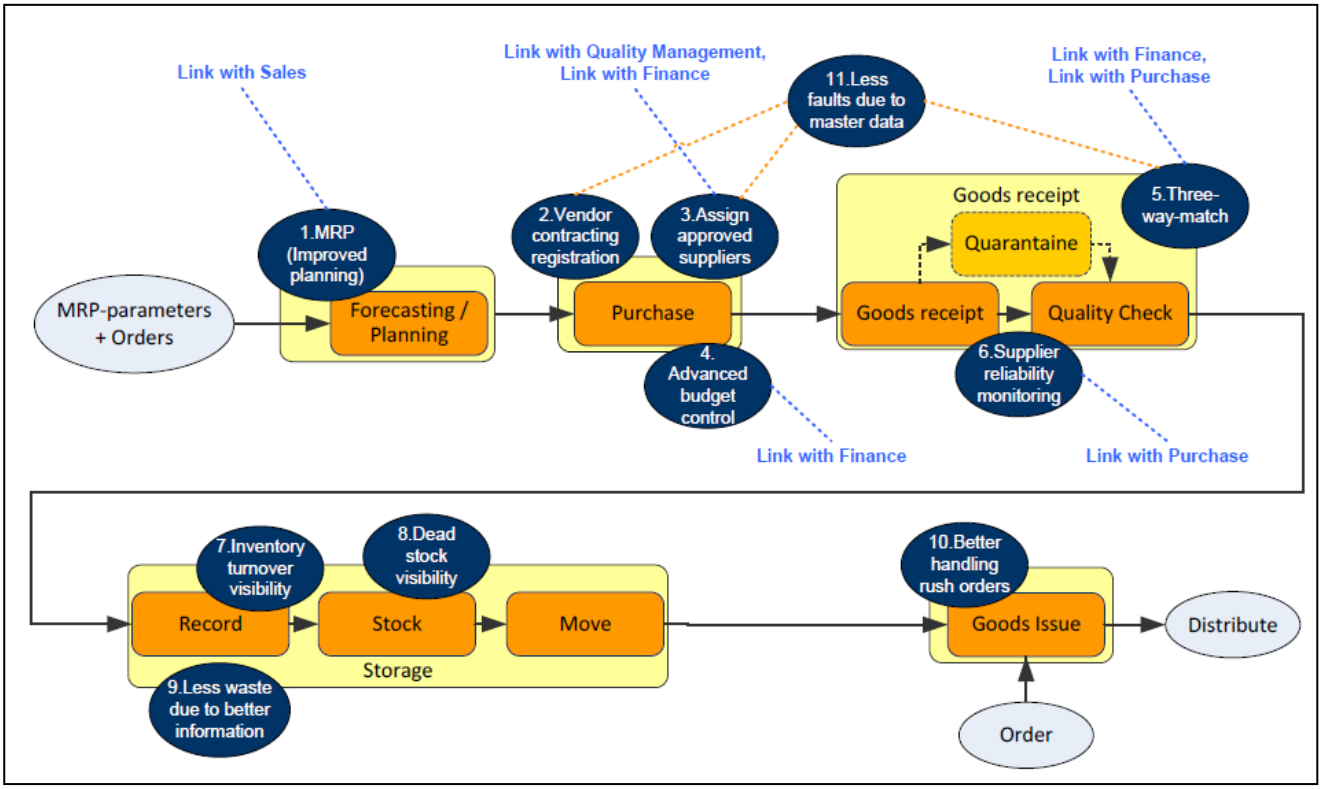
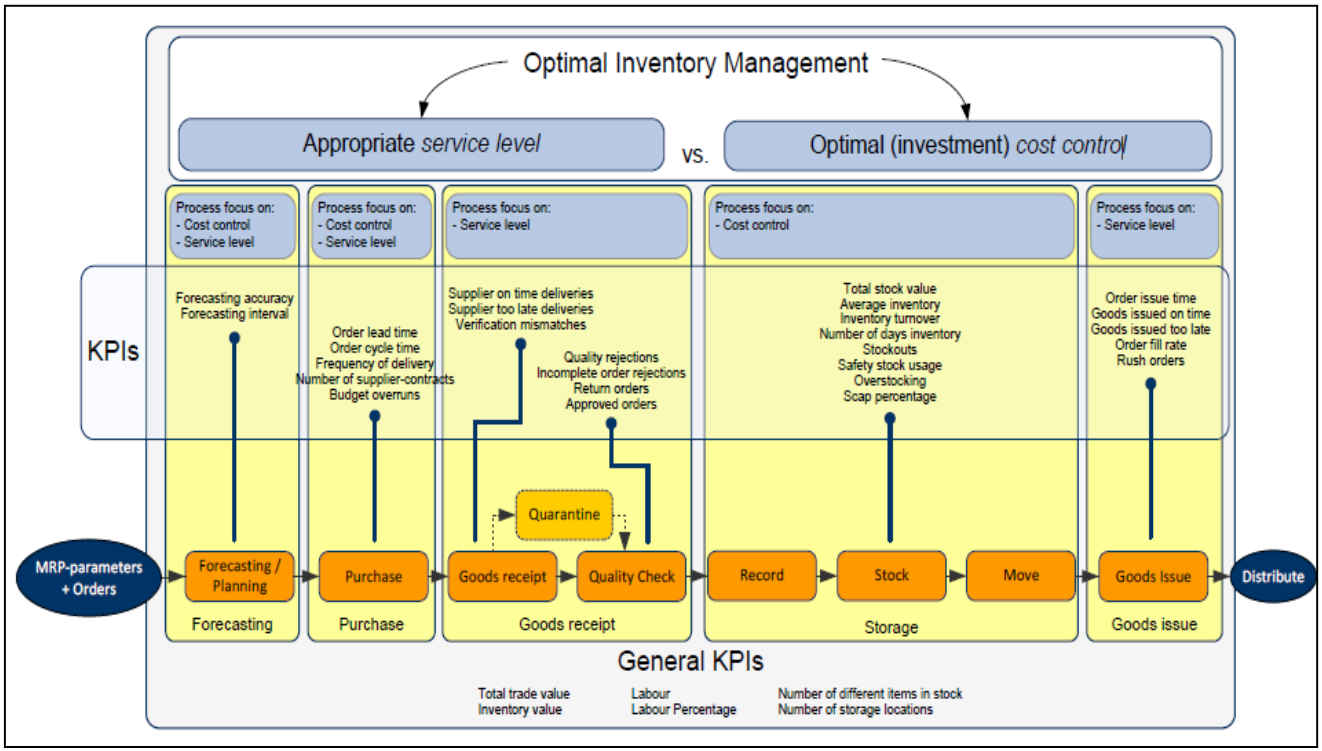


Figure: 4

4.1 THE FRAMEWORK

To construct a measurement tool (a framework), first a large number of different sources of literature were consulted to acquire a large set of KPIs, relevant for inventory management. This created a long-list of relevant KPIs. Next a selection was made, based on duplication and most popular KPIs, but also based on interviews with experts and the theoretical



background described at the beginning. Finally the selected KPIs were mapped on one of the five process steps identified during the analysis. At the top of the framework the two goals of optimal inventory management are displayed. This is basically how the final inventory performance measurement framework is constructed. The final result looks as follows:

Figure: 5

4.2 LINDE INVENTORY MANAGEMENT METHOD – FIFO

4.2.1 WHAT IS FIFO?

A Method of inventory valuation based on the assumption that goods are sold or used in the same chronological order in which they are bought. Hence, the cost of goods purchased first (first-in) is the cost of goods sold first (first-out). During periods of high inflation-rates, the FIFO method yields higher value of the ending inventory, lower cost of goods sold, and a higher gross profit (hence the higher taxable income) than that yielded by the last-in first-out (LIFO) method.

4.3 PRODUCT DESCRIPTION

As LINDE has a variety of products, to make the calculations flawless I've chosen one of their product category that is - MS Electrodes.

An **electrode** is an electrical conduct or used to make contact with a nonmetallic part of a circuit (e.g. a semiconductor, an electrolyte, a vacuum or air). Electrode in an electrochemical cell is referred to as either an *anode* or a *cathode.* The anode is now defined as the electrode at which electrons leave the cell and oxidation occurs, and the cathode as the electrode at which electrons enter the cell and reduction occurs. Each electrode may become either the anode or the cathode depending on the direction of current through the cell. A bipolar electrode is an electrode that functions as the anode of one cell and the cathode of another cell.

4.3.1 PRIMARY CELL

A primary cell is a special type of electrochemical cell in which the reaction cannot be reversed, and the identities of the anode and cathode are therefore fixed. The anode is always the negative electrode. The cell can be discharged but not recharged.

4.3.2 SECONDARY CELL

A secondary cell, for example a rechargeable battery, is a cell in which the chemical reactions are reversible. When the cell is being charged, the anode becomes the positive (+) and the cathode the negative (−) electrode. This is also the case in an electrolytic cell. When the cell is being discharged, it behaves like a primary cell, with the anode as the negative and the cathode as the positive electrode.

4.3.3 ALTERNATING CURRENT ELECTRODES

For electrical systems which use alternating current the electrodes are the connections from the circuitry to the object to be acted upon by the electric current but are not designated anode or cathode because the direction of flow of the electrons changes periodically, usually many times per second.

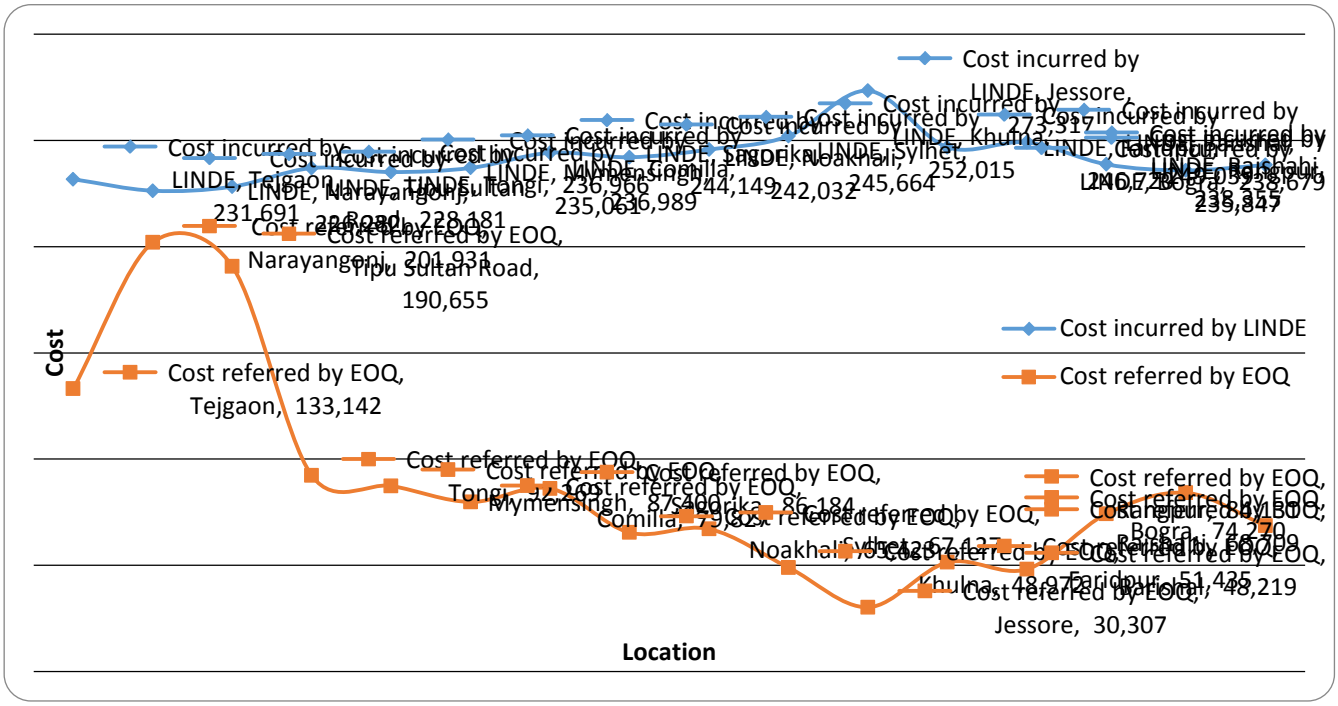
4.4 EOQ ANALYSIS

Analyzing the optimum inventory management system requires knowing forecasted demand, Lead time, Safety stock, Re-order point, Economic Order Quantity (EOQ), those are widely used approach to find out how many goods should be ordered for a certain forecasted demand, which is already discussed in previous chapter.

The analysis of EOQ of MS Electrode is made based on their each sales location for the year 2015. Here a tabular and a graphical presentation of comparison has been shown between the cost that LINDE incur for the order they place and the cost which is found out by applying economic order quantity.

Location	Order quantity	Annual Demand	Holding Cost/Unit	Ordering Cost/Order	EOQ	Total Cost incurred by LINDE	Cost referred by EOQ
Tejgaon	15000	2,369,782	1.013	14.433	8619.81	231,691	133,142
Narayangonj	15000	3,680,065	0.489	14.433	15456.60	226,282	201,931
Tipu Sultan Road	15000	3,852,358	0.467	14.433	16180.25	228,181	190,655
Tongi	15000	1,465,822	1.228	14.433	6156.58	236,966	92,269
Mymensingh	15000	1,212,190	1.485	14.433	5091.30	235,061	87,400
Comilla	15000	1,098,157	1.639	14.433	4612.36	236,989	79,827
Sagorika	15000	1,627,525	1.106	14.433	6835.75	244,149	86,184
Noakhali	15000	881,248	2.043	14.433	3701.32	242,032	65,423
Sylhet	15000	1,028,650	1.750	14.433	4320.42	245,664	67,127
Khulna	15000	633,529	2.841	14.433	2660.88	252,015	48,972
Jessore	15000	330,007	5.454	14.433	1386.06	273,317	30,307
Faridpur	15000	620,445	2.901	14.433	2605.92	246,720	51,435

Barishal	15000	576,237	3.124	14.433	2420.25	249,039	48,219
Bogra	15000	1,014,480	1.774	14.433	4260.91	238,679	74,270
Rangpur	15000	1,162,963	1.548	14.433	4884.55	235,847	84,131
Rajshahi	15000	857,910	2.098	14.433	3603.30	238,355	68,709



Graph: 1

- Detail calculations have been shown in Appendix 1

4.4.1 EVALUATION OF THE EOQ RESULT

The graph shows that there is a significant difference, in each location, between the cost of Actual Order Quantity that LINDE place and the cost of Economic Order Quantity that has been found out from the analysis of this report. There is another finding that LINDE places same amount of order for each location in every month, which is described in the next chapter. Thus mismanagement of inventory makes their cost higher where following EOQ can make a good opportunity to put away the higher cost.

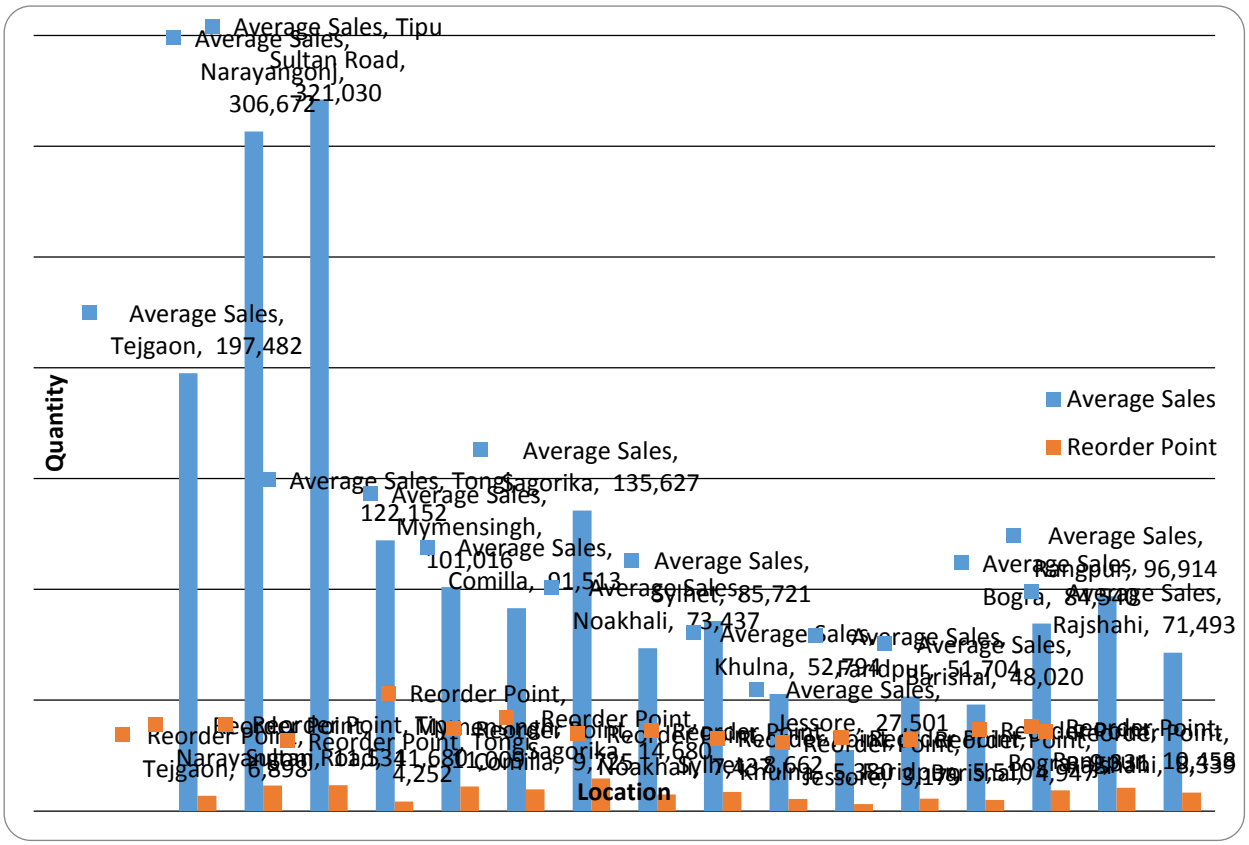
4.5 Reorder Point & Safety Stock Analysis

Along with the economic order quantity, a reorder point was provided. The reorder point took in consideration the annual demand and the lead time. The lead time is the number of days it takes to receive the product when an order is placed. The reorder point states that an order needs to be placed once the product falls below a certain amount of units as indicated in the tables in Appendix 2. Furthermore, the reorder point maintains enough stock to satisfy the demand between orders.

The Reorder Point has been calculated from the daily usage rate of the forecasted sales of 2016. And as LINDE maintain Safety Stock so that has been also adjusted to find out in which

point the orders should be placed. The Chart demonstrates that for an average sale what should be the Reorder Point. The formula is given below:

- **Reorder Point**= [Daily usage rate *Lead time (in days)] +Safety Stock



Graph: 2

Detail Calculations have been shown in Appendix 2.

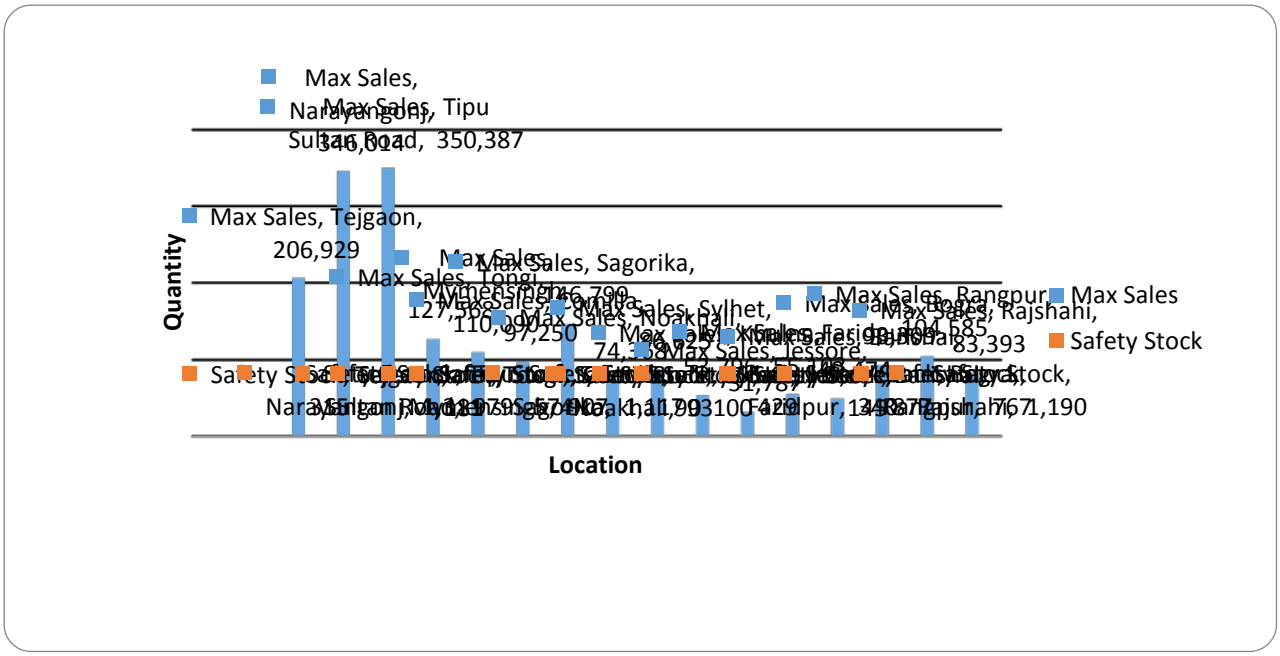
4.5.1 EVALUATION OF THE REORDER POINT RESULT

The Graph shows that Reorder Point is very slightest for an average sale. The reasons are:

- Less Lead Time.
- Flexible Movement of Vehicles that carry goods.

Safety Stock is important as there can always be lacking of goods, e.g. seasonal effects. Safety Stock has been calculated from the forecasted data of 2016. It can be found from the deduction of average rate of consumption from the maximum rate of consumption. The result is multiplied with the lead time. The formula is given below.

- **Safety Stock**= (Maximum rate of consumption- Average rate of consumption) x Lead time



Graph: 3

Detail calculations have been shown in Appendix 2.

4.5.2 EVALUATION OF THE SAFETY STOCK RESULT

From the graph it's clear that there is very low room for the safety stock in comparison to the possible maximum consumption of 2016. The Reasons can be established in this way:

- As LINDE places order that the vehicle can carry at its maximum rate, so there is a less scope for maintaining safety stock because there are always moderate amount of goods in the storage.
- Less Lead Time
- So whenever there is a new customer order the product is in the storage.

- Following of FIFO doesn't take safety stock into consideration.

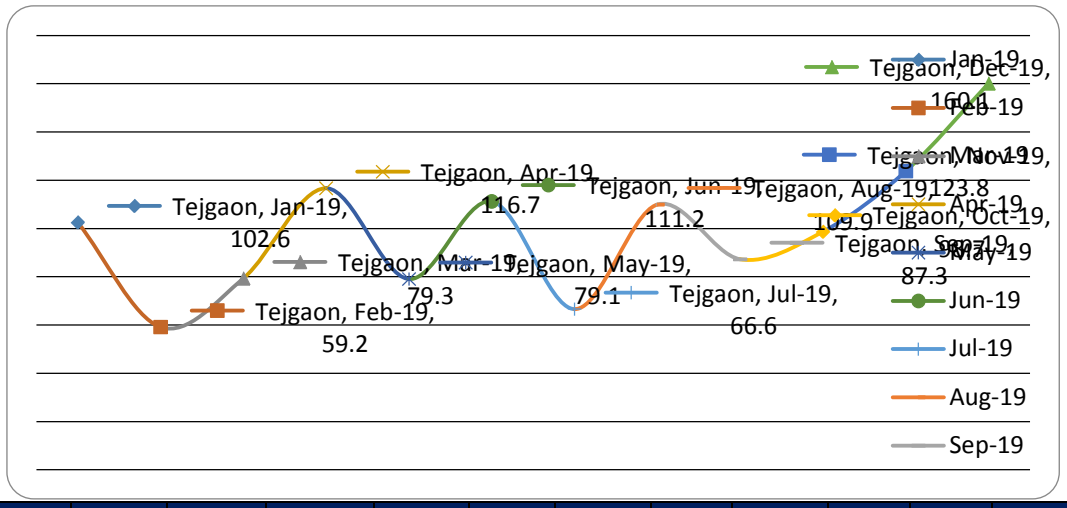
4.6 Inventory Turnover Ratio

The inventory turnover ratio, one of the activity ratio, measures the rate at which inventory is used over a measurement period. One can use the formula to see if a business has an excessive inventory investment in comparison to its sales level, which can indicate either unexpectedly low sales or poor inventory planning. The formula is given below:

$$\text{Inventory Turnover Ratio} = \frac{\text{COGS}}{\text{Average Inventory}}$$

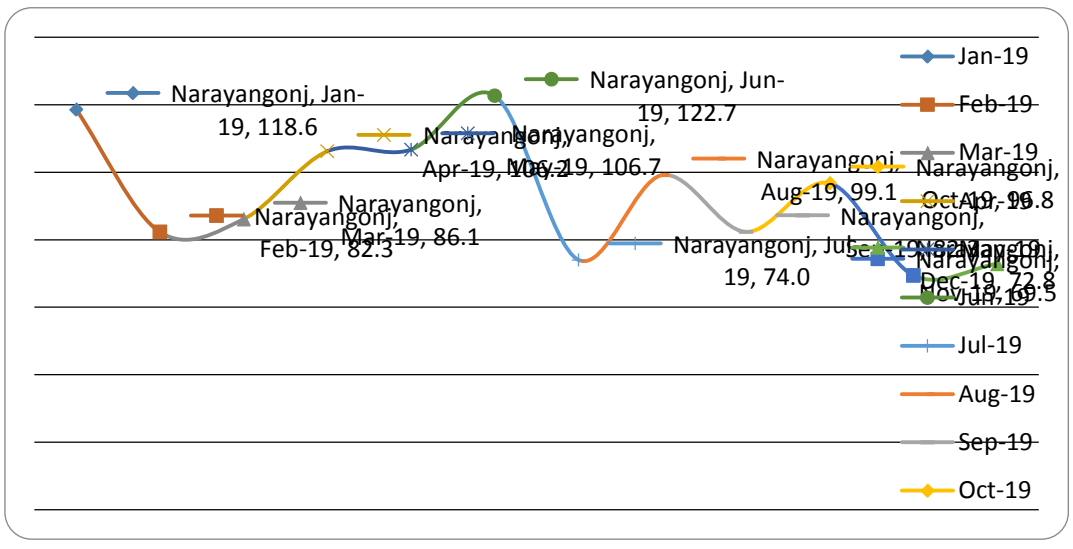
The turnover ratio for LINDE has been calculated for each location separately for the year 2015.

4.6.1 LOCATION: TEJGAON



Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Tejgaon	102.6	59.2	79.3	116.7	79.1	111.2	66.6	109.9	87.3	98.7	123.8	160.1

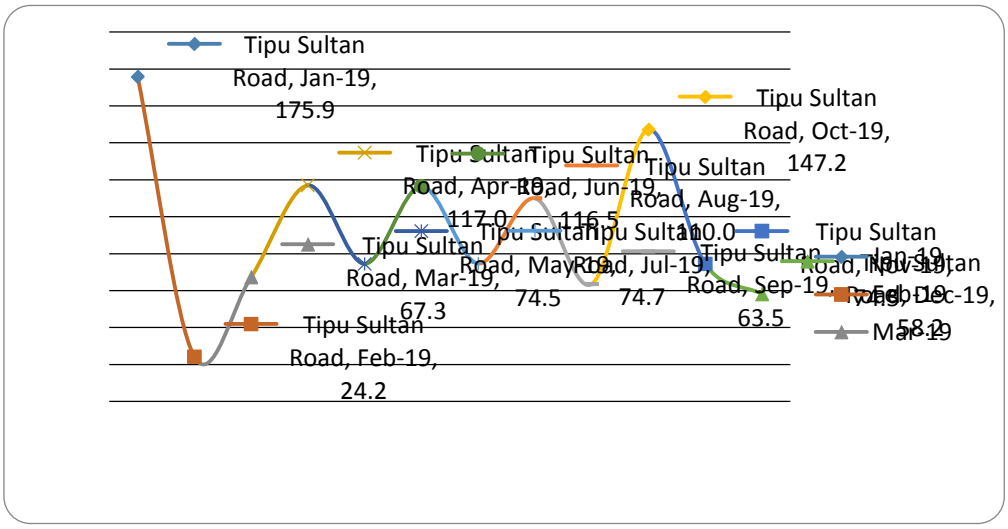
4.6.2 LOCATION: NARAYANGONJ



Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15

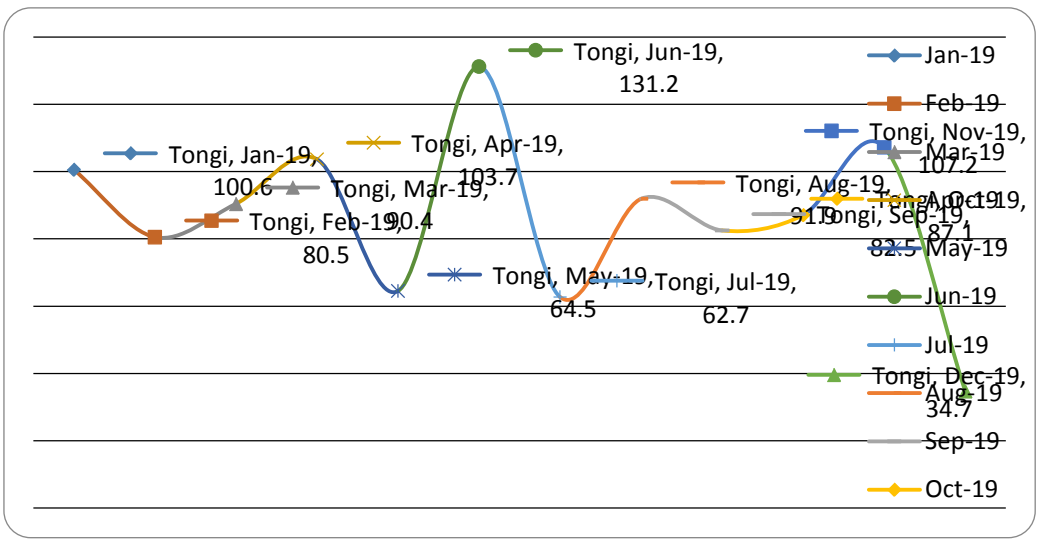
Narayangonj	118.6	82.3	86.1	106.2	106.7	122.7	74.0	99.1	82.3	96.8	69.5	72.8

4.6.3 LOCATION: TIPU SULTAN ROAD



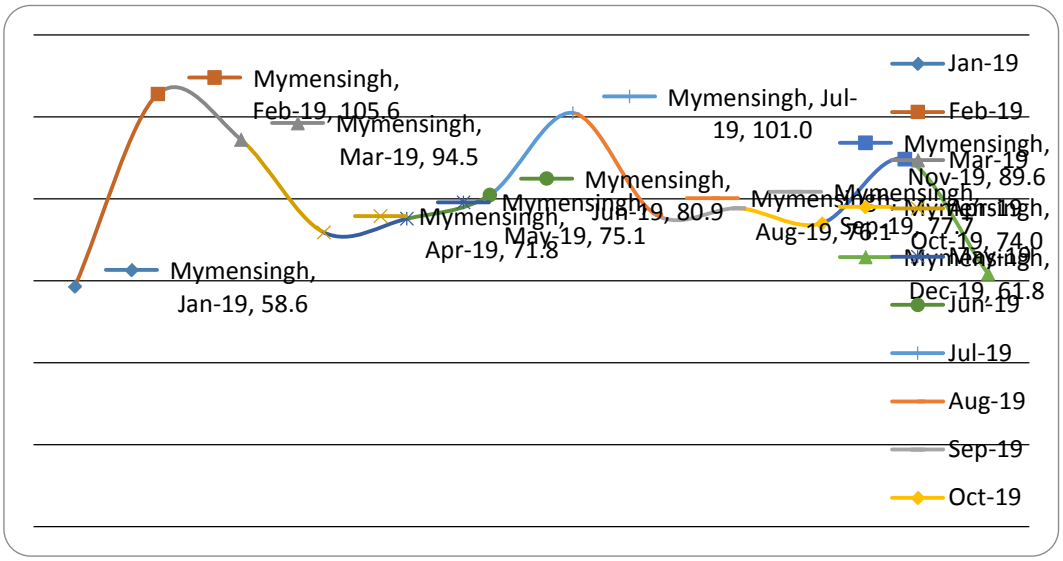
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Tipu Sultan Road	175.9	24.2	67.3	117.0	74.5	116.5	74.7	110.0	63.5	147.2	74.5	58.2

4.6.4 LOCATION: TONGI



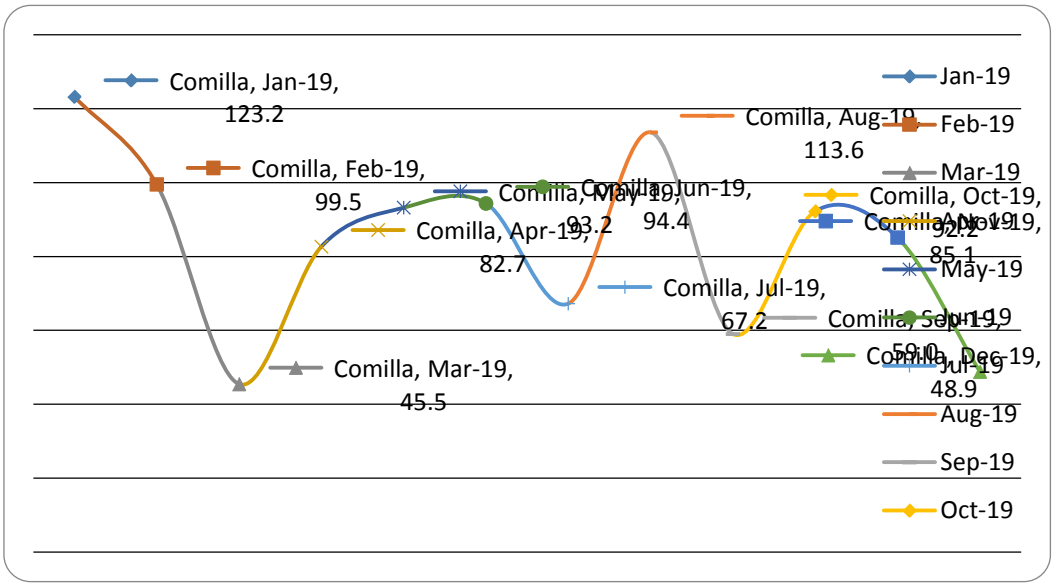
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Tongi	100.6	80.5	90.4	103.7	64.5	131.2	62.7	91.9	82.5	87.1	107.2	34.7

4.6.5 LOCATION: MYMENSINGH



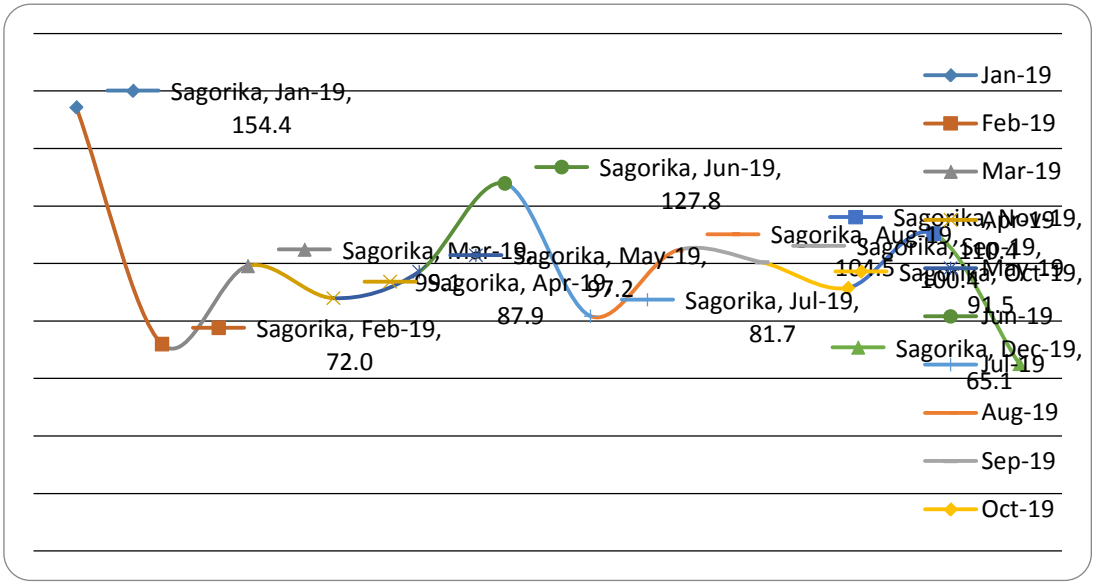
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Mymensingh	58.6	105.6	94.5	71.8	75.1	80.9	101.0	76.1	77.7	74.0	89.6	61.8

4.6.6 LOCATION: COMILLA



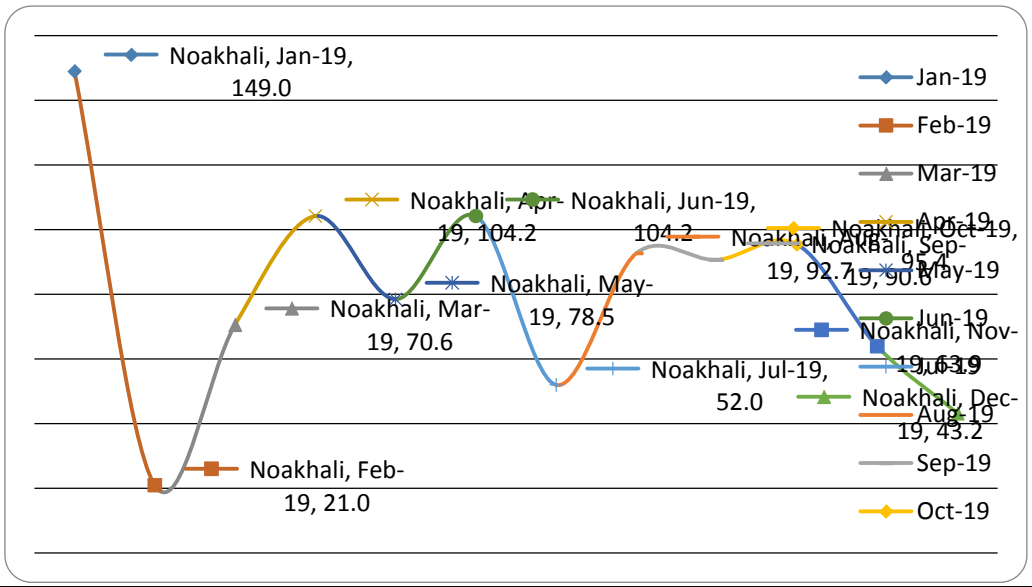
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Comilla	123.2	99.5	45.5	82.7	93.2	94.4	67.2	113.6	59.0	92.2	85.1	48.9

4.6.7 LOCATION: SAGORIKA



Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Sagorika	154.4	72.0	99.1	87.9	97.2	127.8	81.7	104.5	100.4	91.5	110.4	65.1

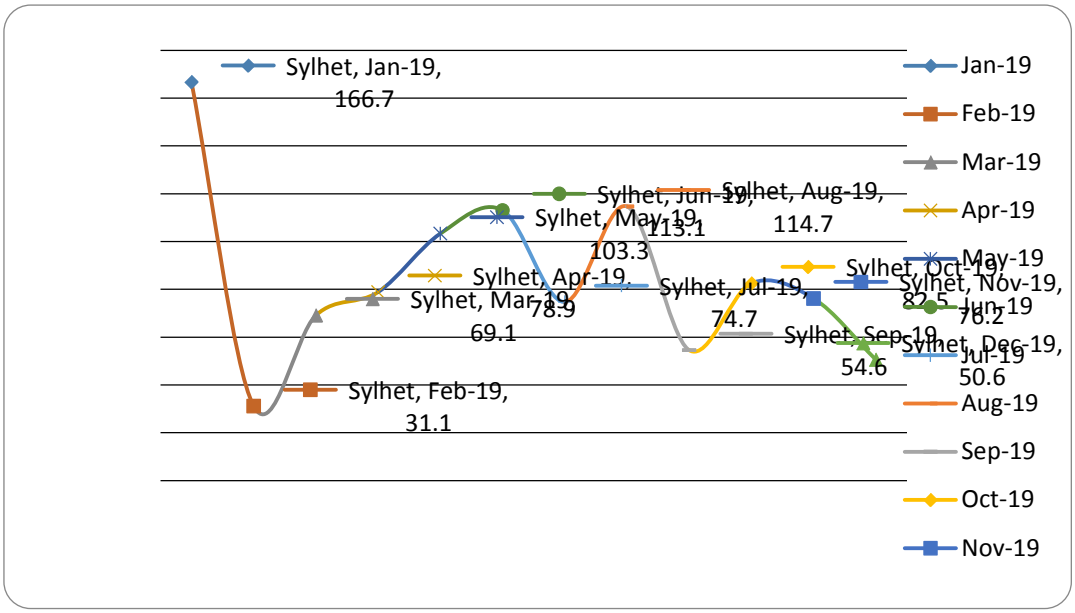
4.6.8 LOCATION: NOAKHALI



Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15

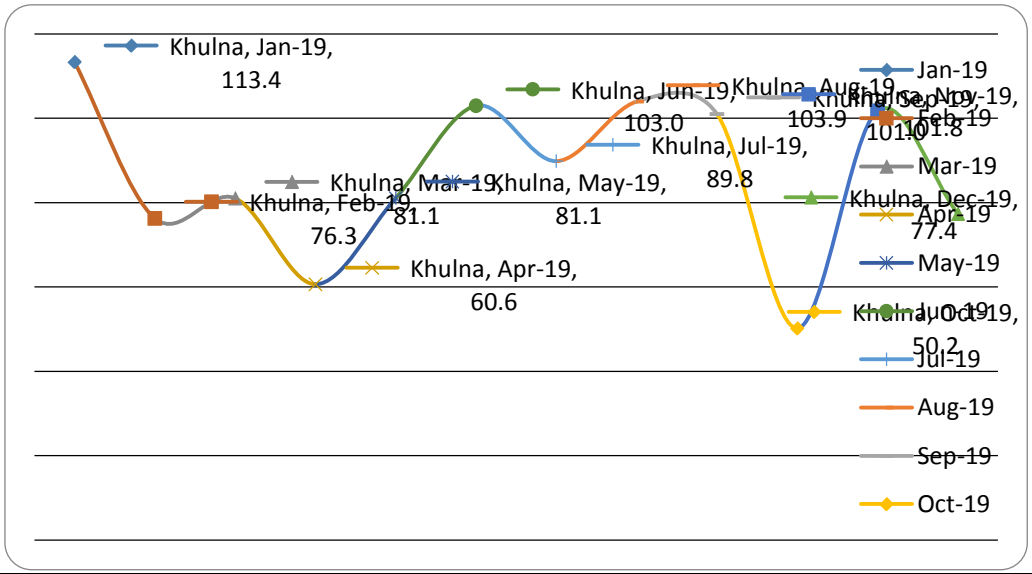
Noakhali	149.0	21.0	70.6	104.2	78.5	104.2	52.0	92.7	90.6	95.4	63.9	43.2

4.6.9 LOCATION: SYLHET



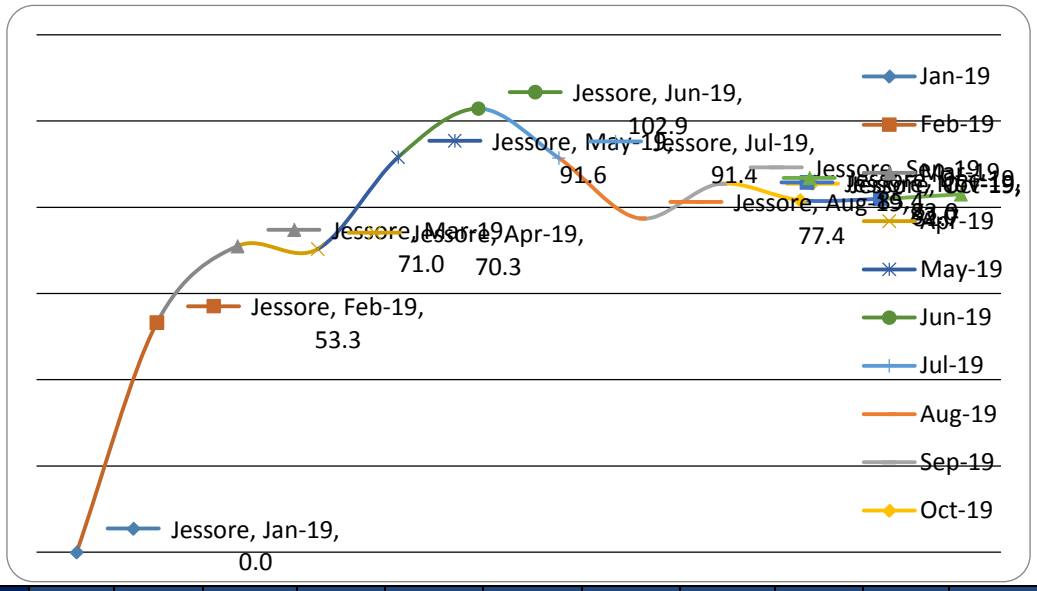
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Sylhet	166.7	31.1	69.1	78.9	103.3	113.1	74.7	114.7	54.6	82.5	76.2	50.6

4.6.10 LOCATION: KHULNA



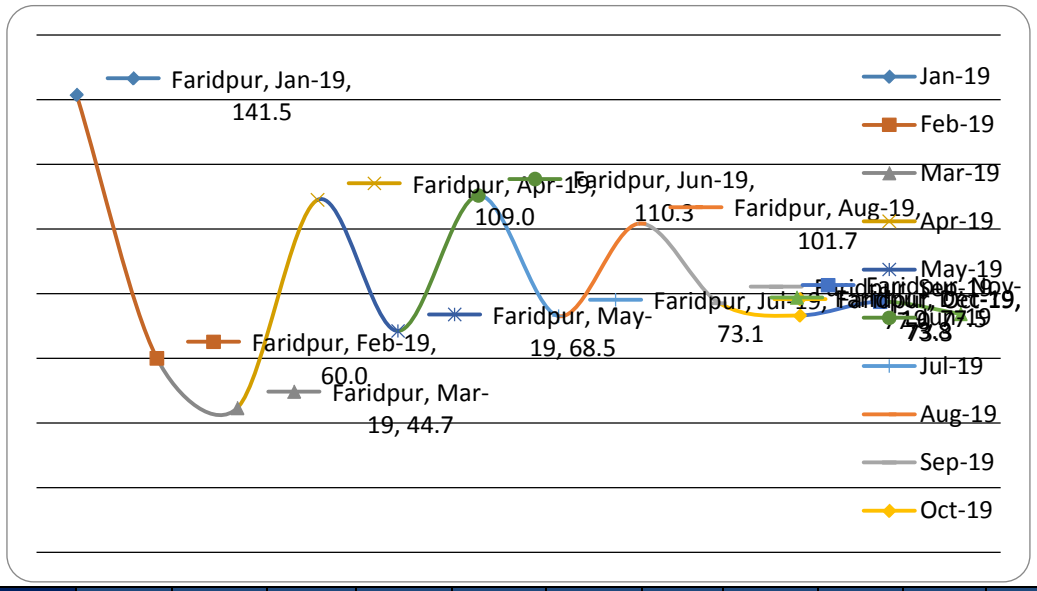
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Khulna	113.4	76.3	81.1	60.6	81.1	103.0	89.8	103.9	101.0	50.2	101.8	77.4

4.6.11 LOCATION: JESSORE



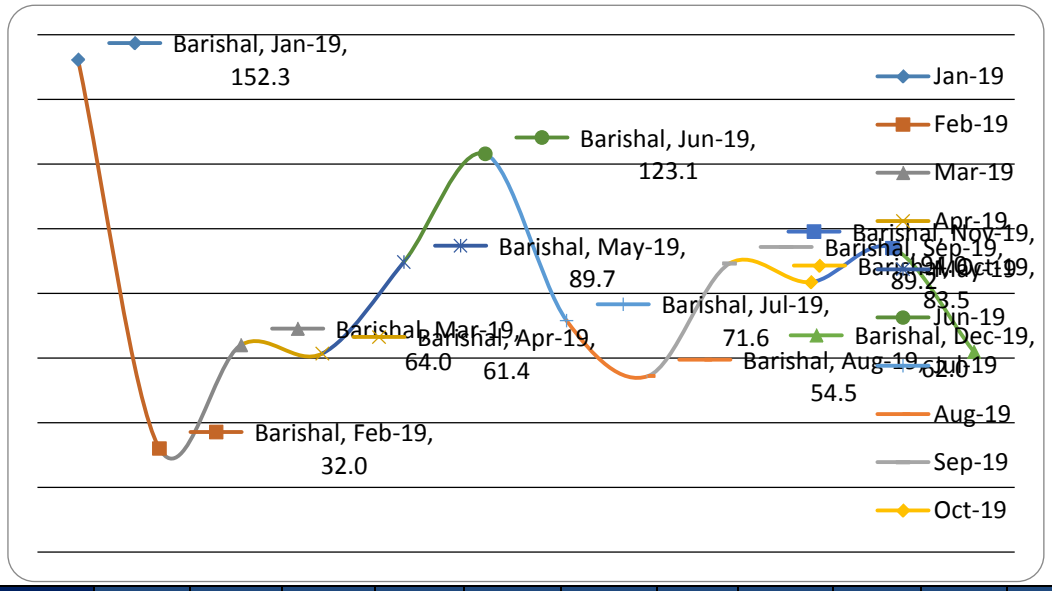
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Jessore	0.0	53.3	71.0	70.3	91.6	102.9	91.4	77.4	85.4	81.7	82.0	83.0

4.6.12 LOCATION: FARIDPUR



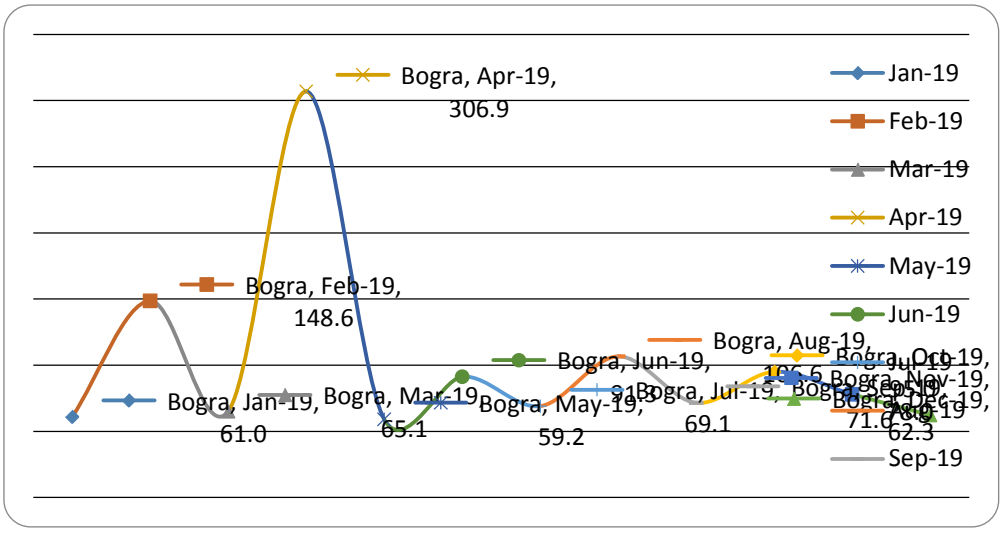
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Faridpur	141.5	60.0	44.7	109.0	68.5	110.3	73.1	101.7	77.0	73.3	77.5	73.8

4.6.13 LOCATION: BARISAL



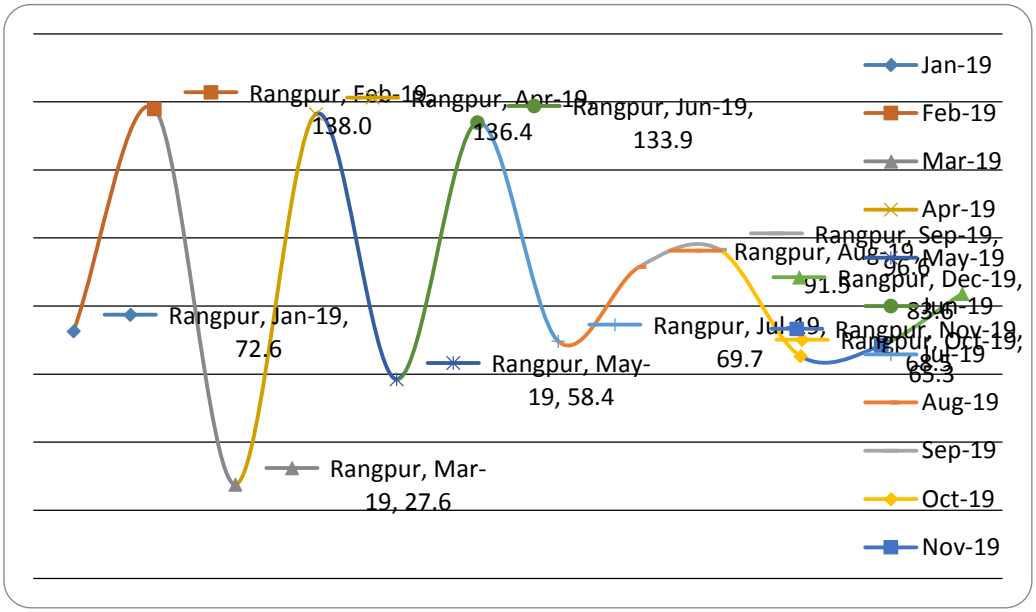
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Barishal	152.3	32.0	64.0	61.4	89.7	123.1	71.6	54.5	89.2	83.5	94.0	62.0

4.6.14 LOCATION: BOGRA



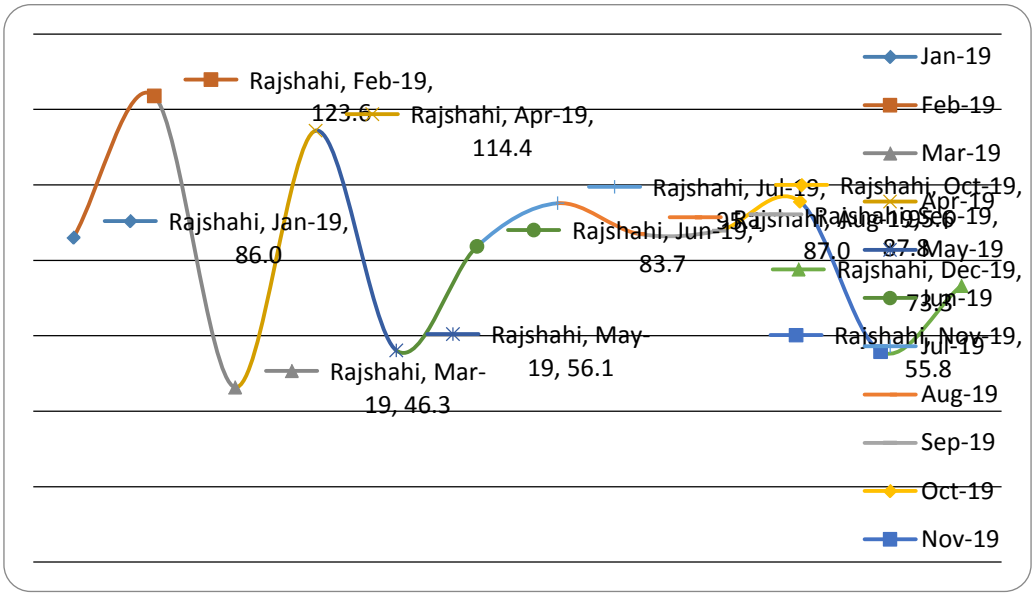
Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Bogra	61.0	148.6	65.1	306.9	59.2	91.3	69.1	106.6	71.6	95.0	78.0	62.3

4.6.15 LOCATION: RANGPUR



Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Rangpur	72.6	138.0	27.6	136.4	58.4	133.9	69.7	91.5	96.6	65.3	68.5	83.6

4.6.15 LOCATION: RAJSHAHI



Inventory Turnover	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Rajshahi	86.0	123.6	46.3	114.4	56.1	83.7	95.1	87.0	87.8	95.6	55.8	73.3

4.6.16 EVALUATION OF THE INVENTORY TURNOVER RATIO

High inventory turnover ratio implies either strong sales or ineffective. A high inventory turnover ratio can indicate better liquidity, but it can also indicate a shortage or inadequate inventory levels, which may lead to a loss in business.

Well in the case of Linde the higher ratio somehow implies the ineffective inventory management system as you can see from my study. The reason of the very frequent fluctuation is because ineffective forecasting of sales results into stocks remains at home for longer time. Thus whenever there is a demand the products get sold immediately. High inventory levels are usual unhealthy because they represent an investment with a rate of return of zero. It also opens the company up to trouble if the prices begin to fall.

Some of the location has a very significant peak which is the effect of seasonal demand. There is an exception of Inventory turnover at Jessore is zero in the first month of the year because there were no sales at that month because of some modification in that sales location.

5.0 FINDINGS

Study Findings shows that the inventory cost that is calculated by LINDE is much higher than the cost that is obtained by EOQ. The recommended model aids the company in forecasting more accurately according to each product and their demand behaviors. Along with the forecasting model, the economic order quantity allows the company to optimize each order and reduce the total cost. As a result, the company would ensure the right amount of products is in stock to satisfy customers demand and save money.
The major findings are:

- LINDE has a contractual agreement for the vehicles, which carry goods, that they will pay a fixed rent to the vehicles no matter from which location they are moving towards another location.
- LINDE places equal amount of order to get the advantage of the flexible movement of the vehicles across the Bangladesh. Even if they don't order all at once for a particular location, this is also absorbed by allocating order of another location. So ordering cost for each order results into same.
- LINDE follows this policy so that they gain a shorter lead time as they faces almost overfull demand.
- As LINDE follow FIFO so they try to take the advantages of FIFO by having this equal amount of order policy.
- LINDE has their own storage facility so they have lower holding cost as they can always minimize their warehousing & administrative cost.
- FIFO maintenance appears fewer stock provision, minor product damage and less Lead time so they don’t take into the consideration of EOQ method.
- LINDE doesn't strictly follow keeping safety stock. They maintain maximum and minimum inventory record in their system.
- LINDE focuses on strong packaging system to make sure that the product damage becomes almost zero. As they order much more inventory at a time Thus if a product stays longer time in the storage it may be needs minor adjustment to sell it.
- The Company has established a provision policy for doubtful debts. This represents the Company's estimate of incurred losses of trade debtors. Thus they can survive by not upholding properly Re-order point & Safety Stock

5.1 CONCLUSION

The current inventory management system in Linde Bangladesh Ltd. has brought problems due to ineffective management of inventory that resulted in overfull stock of products and higher inventory cost. In order to help them their stuffed stocks and high cost, an inventory

management model, EOQ, is provided along with forecasting, reorder point and safety stock. The EOQ model and the reorder point provides the order quantity for each product when an order is placed, reducing the company's high inventory cost issue.

By providing and recommending the inventory control model, the results have shown improvements in forecasting as well as in cost reduction. So, if the company follows through and implements the recommended inventory model, they would be able to reduce the total cost by approximately 57% for their top selling products.

In the end, the issues the company faces would be reduced by implementing the recommended inventory model. The model will ensure the right amount of product is in stock, which would drive product sales properly and would allow the company to increase profit by reducing cost accordingly. The recommended analysis showed that simple, yet complex techniques are the key for success which can give them the competitive edge.

APPENDICES

Appendix A: EOQ

Formula of EOQ = $\sqrt{\frac{2*D*S}{H}}$

Where,

D= Annual Demand

S= Ordering Cost per order

H= Holding Cost per Unit

- **Calculation of Annual Demand**
  - Step # 1: Collection of 2015 total sales month-wise
  - Step # 2: Sales Forecasting for the year 2016 based on the trend analysis of past sales, customer information and with the adjustment of seasonal variation. Here sales of 2015 is also a reference for the forecasting.
  - Step # 3: Finding of annual demand based on the sales forecast of 2016.

Step # 1: Historical Data of 2015 total sales in month

Location	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15
Tejgaon	133,165	182,568	200,981	199,969	159,486	190,788	129,906	187,639	146,413	210,306	207,683	173,541
Narayangonj	171,819	200,250	212,322	230,653	225,670	230,004	140,660	240,063	174,722	245,271	265,574	313,007
Tipu Sultan Road	200,496	228,143	276,079	278,821	255,068	275,189	189,779	275,352	201,408	300,035	303,873	299,490
Tongi	101,727	110,294	125,134	110,603	108,196	105,236	79,328	120,356	90,319	120,725	129,028	123,068
Mymensingh	16,781	99,101	111,574	101,606	60,353	93,168	66,050	75,080	76,610	89,993	109,998	74,304
Comilla	50,780	80,030	105,035	80,017	74,465	85,400	57,186	87,214	58,177	88,608	100,102	80,946
Sagorika	156,065	173,109	191,947	182,777	174,362	175,744	103,281	148,135	109,568	160,004	180,460	164,581
Noakhali	33,187	77,037	93,054	87,191	81,052	85,114	44,387	83,467	50,558	80,500	71,653	69,677
Sylhet	75,377	86,554	106,105	101,322	81,482	100,738	80,022	79,914	55,076	95,118	100,982	89,623
Khulna	38,522	53,031	63,681	64,873	35,177	55,017	40,209	46,544	44,642	55,004	60,395	50,197
Jessore	12,026	19,107	20,581	18,275	14,448	15,011	10,150	19,319	15,810	20,080	24,778	28,201
Faridpur	19,716	49,188	65,151	54,000	23,997	55,023	30,186	46,591	38,917	50,059	55,174	43,444
Barishal	35,199	52,922	56,486	47,931	19,397	55,040	39,997	40,719	41,551	50,141	60,017	38,760
Bogra	3,357	76,272	100,000	95,630	58,798	60,005	40,368	67,444	50,155	75,164	80,200	77,499
Rangpur	21,536	100,075	112,450	102,957	56,137	81,048	61,053	88,440	66,658	90,154	100,299	81,313
Rajshahi	1,887	48,116	36,886	3,111,323	48,116	2,199	35,430	3,052,901	66,340	3,033	13,982	1,260,219

Step # 2: Sales forecasting for the year 2016

Step # 3: Finding out the Annual Demand

Location	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Annual Demand
Tejgaon	188,035	189,753	191,470	193,188	194,905	196,623	198,341	200,058	201,776	203,494	205,211	206,929	**2,369,782**

Narayangonj	267,330	274,483	281,636	288,789	295,942	303,095	310,249	317,402	324,555	331,708	338,861	346,014	**3,680,065**
Tipu Sultan Road	291,673	297,010	302,348	307,686	313,023	318,361	323,699	329,036	334,374	339,712	345,049	350,387	**3,852,358**
Tongi	116,735	117,720	118,705	119,690	120,675	121,659	122,644	123,629	124,614	125,599	126,583	127,568	**1,465,822**
Mymensingh	91,942	93,592	95,242	96,891	98,541	100,191	101,841	103,491	105,140	106,790	108,440	110,090	**1,212,190**
Comilla	85,776	86,819	87,862	88,906	89,949	90,992	92,035	93,078	94,121	95,164	96,207	97,250	**1,098,157**
Sagorika	146,799	144,768	142,737	140,705	138,674	136,643	134,611	132,580	130,549	128,518	126,486	124,455	**1,627,525**
Noakhali	72,506	72,676	72,845	73,014	73,183	73,353	73,522	73,691	73,860	74,030	74,199	74,368	**881,248**
Sylhet	86,625	86,460	86,296	86,132	85,967	85,803	85,639	85,474	85,310	85,146	84,981	84,817	**1,028,650**
Khulna	51,792	51,974	52,156	52,339	52,521	52,703	52,885	53,067	53,250	53,432	53,614	53,796	**633,529**
Jessore	23,214	23,994	24,773	25,552	26,332	27,111	27,890	28,670	29,449	30,228	31,007	31,787	**330,007**
Faridpur	48,304	48,922	49,541	50,159	50,777	51,395	52,013	52,631	53,249	53,867	54,485	55,103	**620,445**
Barishal	46,565	46,830	47,094	47,359	47,623	47,888	48,152	48,416	48,681	48,945	49,210	49,474	**576,237**
Bogra	75,771	77,365	78,960	80,554	82,148	83,743	85,337	86,932	88,526	90,120	91,715	93,309	**1,014,480**
Rangpur	89,242	90,637	92,032	93,427	94,821	96,216	97,611	99,006	100,400	101,795	103,190	104,585	**1,162,963**
Rajshahi	59,592	61,756	63,920	66,083	68,247	70,411	72,574	74,738	76,902	79,065	81,229	83,393	**857,910**

- **Calculation of Ordering Cost per Order**
  - Collection of the order quantity that LINDE place for each Location
  - Compilation of the fixed cost for each order
  - Get the result of Ordering cost per order = Ordering Cost/Ordering Quantity

Location	Order Quantity	Cost for Order		
		Fuel cost	Rent	Wages
Tejgaon	15,000	86,500	115,000	15,000
Narayangonj	15,000	86,500	115,000	15,000
Tipu Sultan Road	15,000	86,500	115,000	15,000
Tongi	15,000	86,500	115,000	15,000
Mymensingh	15,000	86,500	115,000	15,000
Comilla	15,000	86,500	115,000	15,000
Sagorika	15,000	86,500	115,000	15,000
Noakhali	15,000	86,500	115,000	15,000
Sylhet	15,000	86,500	115,000	15,000
Khulna	15,000	86,500	115,000	15,000

Jessore	15,000	86,500	115,000	15,000	
Faridpur	15,000	86,500	115,000	15,000	
Barishal	15,000	86,500	115,000	15,000	
Bogra	15,000	86,500	115,000	15,000	
Rangpur	15,000	86,500	115,000	15,000	
Rajshahi	15,000	86,500	115,000	15,000	
Total		**216,500**			

- **Calculation of Holding Cost per unit**
    - Find out the Annual Cost of Goods by multiplying Annual Demand with Ordering cost per order
    - Next, Assortment of Holding Cost/year for each location
    - Then divide the Holding cost/year with the annual Cost of Goods to find out the Holding cost in percentage form
    - Finally the computation of Holding Cost/Unit = Holding Cost per year/{Annual demand x (1+Holding cost percentage)}

Location	Annual Demand	Ordering cost per Order	Annual COG	Holding Cost/year	Holding Cost (%)	Holding cost/unit
Tejgaon	2,369,782	14.43	34203854.24	2,400,000	7.02%	1.013
Narayangonj	3,680,065	14.43	53115597.89	2,400,000	3.39%	0.489
Tipu Sultan Road	3,852,358	14.43	55602376.43	3,000,000	3.24%	0.467
Tongi	1,465,822	14.43	21156677.58	2,000,000	8.51%	1.228
Mymensingh	1,212,190	14.43	17495941.71	1,500,000	10.29%	1.485
Comilla	1,098,157	14.43	15850069.31	1,500,000	11.36%	1.639
Sagorika	1,627,525	14.43	23490609.52	3,000,000	7.66%	1.106
Noakhali	881,248	14.43	12719352.28	1,500,000	14.15%	2.043
Sylhet	1,028,650	14.43	14846843.7	2,000,000	12.12%	1.750
Khulna	633,529	14.43	9143947.6	1,500,000	19.69%	2.841
Jessore	330,007	14.43	4763097.005	1,250,000	37.79%	5.454
Faridpur	620,445	14.43	8955086.844	1,250,000	20.10%	2.901
Barishal	576,237	14.43	8317019.203	1,250,000	21.64%	3.124
Bogra	1,014,480	14.43	14642332.39	1,500,000	12.29%	1.774
Rangpur	1,162,963	14.43	16785442.73	1,500,000	10.72%	1.548
Rajshahi	857,910	14.43	12382499.3	1,250,000	14.54%	2.098

- **Calculation of Cost Saving Opportunity**
  - First Calculate the cost that is incurred by LINDE
  - Next, calculate the Cost referred by EOQ = (Ordering cost per Order+ Holding cost per unit)*EOQ
  - Finally compare both the cost and see how many opportunity you can get by deducting Cost referred by EOQ from Cost incurred by LINDE.

Location	Ordering cost per Order	Holding cost per unit	Order Quantity of LINDE	EOQ	Cost incurred by LINDE	Cost re
Tejgaon	14.43	1.013	15,000	15456.60	231,691	
Narayangonj	14.43	0.489	15,000	16180.25	226,282	
Tipu Sultan Road	14.43	0.467	15,000	6156.58	228,181	
Tongi	14.43	1.228	15,000	5091.30	236,966	
Mymensingh	14.43	1.485	15,000	4612.36	235,061	
Comilla	14.43	1.639	15,000	6835.75	236,989	
Sagorika	14.43	1.106	15,000	3701.32	244,149	
Noakhali	14.43	2.043	15,000	4320.42	242,032	
Sylhet	14.43	1.750	15,000	2660.88	245,664	
Khulna	14.43	2.841	15,000	1386.06	252,015	
Jessore	14.43	5.454	15,000	2605.92	273,317	
Faridpur	14.43	2.901	15,000	2420.25	246,720	
Barishal	14.43	3.124	15,000	4260.91	249,039	
Bogra	14.43	1.774	15,000	4884.55	238,679	
Rangpur	14.43	1.548	15,000	3603.30	235,847	
Rajshahi	14.43	2.098	15,000	8619.81	238,355	

Appendix B: Reorder Point & Safety Stock

- Calculation of Safety Stock
  - **Safety Stock**= (Maximum rate of consumption- Average rate of consumption) x Lead time
  - Max Consumption has been computed from the Sales Forecast of 2016
  - Average Consumption has been also computed from the Sales Forecast of 2016

- Calculation of Reorder Point
  - **Reorder Point**= [Daily usage rate *Lead time (in days)] + Safety stock

Location	Max Sales	Average Sales	Lead Time (in days)	Safety Stock	Re
Tejgaon	206,929	197,482	0.03	315	

Narayangonj	346,014	306,672	0.03	1,311	
Tipu Sultan Road	350,387	321,030	0.03	979	
Tongi	127,568	122,152	0.03	181	
Mymensingh	110,090	101,016	0.10	907	
Comilla	97,250	91,513	0.10	574	
Sagorika	146,799	135,627	0.10	1,117	
Noakhali	74,368	73,437	0.10	93	
Sylhet	86,625	85,721	0.10	90	
Khulna	53,796	52,794	0.10	100	
Jessore	31,787	27,501	0.10	429	
Faridpur	55,103	51,704	0.10	340	
Barishal	49,474	48,020	0.10	145	
Bogra	93,309	84,540	0.10	877	
Rangpur	104,585	96,914	0.10	767	
Rajshahi	83,393	71,493	0.10	1,190	

Appendix C: Inventory turnover Ratio Calculation

- Step # 1: Relocation of COGS

Location	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-1
Tejgaon	5,706,193.5	2,767,178.9	5,095,241.9	8,311,873.9	3,764,690.9	6,918,356.6	3,462,133.2	7,249,552.9	3,883,4
Narayangonj	5,518,329.7	4,164,762.7	6,204,079.8	7,613,171.7	6,352,670.0	5,308,033.2	2,804,855.0	4,438,209.3	3,910,4
Tipu Sultan Road	819,151.5	476,447.5	3,488,320.9	6,048,148.8	3,871,783.8	6,219,170.5	3,739,826.6	5,799,410.3	3,992,7
Tongi	1,272,166.4	1,169,653.9	1,646,225.6	1,726,007.9	1,476,845.0	2,760,193.7	1,023,235.1	1,910,760.5	1,675,7
Mymensingh	1,266,610.9	2,461,910.3	1,571,523.8	1,295,447.2	2,248,180.1	3,240,533.1	3,428,079.1	2,220,576.5	2,527,4
Comilla	2,793,328.0	1,197,188.3	1,006,417.7	2,782,143.1	3,550,788.8	3,461,286.7	2,713,530.2	4,043,695.7	1,790,4
Sagorika	5,078,662.4	2,219,343.9	4,656,269.7	5,227,157.9	7,789,990.3	9,868,432.7	6,162,819.5	8,381,729.2	7,039,6
Noakhali	1,844,948.1	203,844.8	1,418,991.1	1,904,098.5	1,415,117.9	1,833,310.4	1,060,840.5	2,226,070.2	1,544,8
Sylhet	2,595,890.1	392,248.2	1,962,005.5	3,179,066.0	5,107,150.7	4,561,644.4	2,425,186.9	3,154,443.1	1,501,5
Khulna	2,918,215.9	1,597,264.8	2,269,934.6	2,899,155.8	6,109,239.4	7,683,432.5	5,596,963.6	5,590,507.0	3,684,8
Jessore	0.0	557,819.0	1,259,093.1	1,874,512.0	2,943,271.2	2,891,549.6	2,207,924.6	2,207,270.5	2,720,9
Faridpur	2,524,693.7	648,354.4	1,323,019.6	3,811,167.5	2,442,230.1	3,960,111.6	2,300,993.9	3,305,270.4	2,284,3
Barishal	1,567,638.3	187,446.3	820,470.8	1,354,040.4	2,996,664.8	3,227,071.2	1,159,467.1	1,542,606.5	3,062,8
Bogra	2,456,214.7	4,608,265.5	1,152,537.1	5,969,897.0	1,422,821.2	3,172,503.0	3,017,490.1	4,477,662.1	2,494,0
Rangpur	931,680.3	1,440,824.5	527,755.7	2,947,824.9	1,354,807.8	3,477,489.1	1,509,950.2	2,578,256.3	2,396,2
Rajshahi	3,111,322.7	3,052,900.5	1,260,218.6	3,461,086.7	2,094,236.1	4,743,781.0	5,107,976.7	4,207,646.7	3,780,5

Step # 2: Inventory

Location	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	
Tejgaon	64,488.50	29328.5	57,238.75	94,838.50	33,025.25	72,428.25	38,055.75	87,366.75	43,828.75	57,409.25	5
Narayangonj	54,068.55	38989	62,211.75	81,916.50	61,463	57,637.75	28,905.75	46,872.75	42,653.40	52,330.65	3
Tipu Sultan Road	6,623.40	2690.45	36,698.10	66,906.80	36,476	67,487.85	39,285.50	60,891.75	44,550.10	81,160.45	1
Tongi	13,784.75	11512.7	17,535.70	18,881	14,415	31,374.25	10,703.75	21,926.75	19,650.90	20,970.90	1
Mymensingh	14,942.50	28275.8	18,368.75	14,904	21,188	38,653.95	41,422.20	26,493.20	31,853.70	33,220.65	3
Comilla	32,515	12826.2	11,239.70	33,013.35	34,294.15	41,914.10	31,447.45	49,255.50	21,948.75	38,755.05	2
Sagorika	48,281.65	17514.8	44,174.35	49,749.40	69,140.70	91,218.85	63,174.40	87,731.10	72,709.85	67,527.10	6
Noakhali	22,453.35	2311.4	17,143.60	23,069.80	13,478.05	22,590.75	12,599.75	28,213.25	19,817.40	14,271.30	8
Sylhet	27,753.70	3384.7	21,811.20	34,968.20	45,661	53,218.35	27,481.35	37,459.35	17,562.10	37,474.30	3
Khulna	33,418.55	18069.9	23,805.45	32,207.05	63,409.45	87,295.25	61,919.60	62,700.45	44,866.95	28,084.35	6
Jessore	0.01	6679.66	14,269.16	21,208.56	32,117.91	32,158.06	24,056.96	24,245.81	32,778.31	30,931.51	2
Faridpur	29,002.10	6680.2	14,918.70	44,331.45	25,587.95	45,754.70	26,027.15	36,969.50	28,042.30	31,256.90	3
Barishal	18,520.75	2065.15	9,636.75	15,985.30	28,107.50	38,719.65	13,701.15	18,704.65	37,950.55	30,687.90	2
Bogra	27,725.05	52844.05	9,179.85	26,210	12,688.25	35,420.50	34,052.95	53,343.80	30,627.90	39,085.70	2
Rangpur	9,683.20	15970.45	4,914.20	33,341.80	9,877	36,492.70	15,433.30	27,907.85	28,466.45	21,168.20	3
Rajshahi	36,885.55	35429.5	13,981.50	40,397.55	20,123.50	54,534.80	58,841.30	48,541.90	48,155.95	37,923.60	2

Step # 3: Calculation of Average Inventory

Location	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15
Tejgaon	55,634.8	46,781.1	64,233.7	71,228.7	47,618.9	62,212.6	51,996.9	65,938.0	44,509.2
Narayangonj	46,528.8	50,600.4	72,064.1	71,689.8	59,550.4	43,271.8	37,889.3	44,763.1	47,492.0
Tipu Sultan Road	4,656.9	19,694.3	51,802.5	51,691.4	51,981.9	53,386.7	50,088.6	52,720.9	62,855.3
Tongi	12,648.7	14,524.2	18,208.4	16,648.0	22,894.6	21,039.0	16,315.3	20,788.8	20,310.9
Mymensingh	21,609.2	23,322.3	16,636.4	18,046.0	29,921.0	40,038.1	33,957.7	29,173.5	32,537.2
Comilla	22,670.6	12,033.0	22,126.5	33,653.8	38,104.1	36,680.8	40,351.5	35,602.1	30,351.9
Sagorika	32,898.2	30,844.6	46,961.9	59,445.1	80,179.8	77,196.6	75,452.8	80,220.5	70,118.5

Noakhali	12,382.4	9,727.5	20,106.7	18,273.9	18,034.4	17,595.3	20,406.5	24,015.3	17,044.4
Sylhet	15,569.2	12,598.0	28,389.7	40,314.6	49,439.7	40,349.9	32,470.4	27,510.7	27,518.2
Khulna	25,744.2	20,937.7	28,006.3	47,808.3	75,352.4	74,607.4	62,310.0	53,783.7	36,475.7
Jessore	3,339.8	10,474.4	17,738.9	26,663.2	32,138.0	28,107.5	24,151.4	28,512.1	31,854.9
Faridpur	17,841.2	10,799.5	29,625.1	34,959.7	35,671.3	35,890.9	31,498.3	32,505.9	29,649.6
Barishal	10,293.0	5,851.0	12,811.0	22,046.4	33,413.6	26,210.4	16,202.9	28,327.6	34,319.2
Bogra	40,284.6	31,012.0	17,694.9	19,449.1	24,054.4	34,736.7	43,698.4	41,985.9	34,856.8
Rangpur	12,826.8	10,442.3	19,128.0	21,609.4	23,184.9	25,963.0	21,670.6	28,187.2	24,817.3
Rajshahi	36,157.5	24,705.5	27,189.5	30,260.5	37,329.2	56,688.1	53,691.6	48,348.9	43,039.8

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