

IMPROVING WAREHOUSE AND INVENTORY MANAGEMENT:

Operational Efficiency and Transport Safety

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Abstract <p>This Thesis work was done to analyze the current operations involving the finished-goods and fertilizer warehouse managements, as well as the fertilizer inventory management of Ghana Rubber Estates Limited (GREL). The aim was to explore improvement areas necessary in enhancing operational efficiency and transport safety, and come up with ways of improving the warehouse and inventory management.</p> <p>In this work, theoretical discussion was used alongside with the current operations of GREL to come up with the improvement suggestions. Some of these areas included warehouse management, inventory management, internal transportation, transport safety and operational efficiency.</p> <p>With regard to the company's current operations, the importance of each of the different kinds of fertilizers held in inventory was analyzed using the 80/20 rule, or the ABC analysis. The means of placing orders and the number of orders were also discussed, related to their appropriate timing. The outline of both the finished-goods and fertilizer warehouses, the equipment used and the means of operation were discussed as well.</p> <p>At the end of the work, suggestions were made for improvement in the management of both warehouses as well as the fertilizer inventory. Those suggestions included modifying the storage facilities in the fertilizer warehouse, as well as floor demarcation by the striping or marking of the finished-goods warehouse. The suggestion for improving the fertilizer inventory management was reduction in the inventory levels. This was to be done by, first, negotiating for shorter lead time and then, using seasonal ordering policy.</p>		
Keywords: Warehouse, Inventory, Transport safety, Obsolescence, working capital, Efficiency.		
Miscellaneous: Seasonal demand, Safety stock, Manual handling, Floor striping		

CONTENTS

1 INTRODUCTION	4
1.1 Company Description.....	4
1.1.1 Profile and History	4
1.1.2 Processes	5
1.2 Research Goals	8
1.3 Research Methods	9
2 WAREHOUSE MANAGEMENT	9
2.1 Classification of warehouses	10
2.2 Warehouse operations	10
2.2.1 Functions.....	11
2.2.2 Processes	12
3 INTERNAL TRANSPORTATION	13
3.1 Transport Equipment	14
3.1.1 Conveyors	14
3.1.2 Fork-lift Trucks	14
3.1.3 Automated Guided Vehicles (AGV)	16
3.2 Transport Safety	16
3.2.1 Safety Problems with Transport Equipment	17
3.2.2 Control Strategies for Transport Safety.....	17
3.2.3 Benefits of Transport safety	19
4 INVENTORY MANAGEMENT	19
4.1 Purpose of Inventory	20
4.2 Inventory Costs	21
4.3 Arrangement of Stocks	22
4.3.1 Storage Systems	22

4.3.2 Storage Space Allocation	22
5 OPERATIONAL EFFICIENCY.....	23
5.1 ABC Analysis	24
5.1.1 Steps in conducting ABC-analysis.....	25
5.1.2 Effects of the ABC Analysis	26
5.2 Economic Order Quantity	26
5.2.1 Seasonal Demand.....	27
5.2.2 Safety stock.....	28
5.3 Working Capital	28
5.4 Just-in-Time	29
5.5 First-In, First-Out versus Last-In, First-Out.....	30
6 COMPANY'S OPERATION	30
6.1 Warehouse Management	30
6.1.1 The Fertilizer Warehouse	30
6.1.2 The Finished-goods Warehouse.....	35
6.2 Fertilizer Inventory Management.....	37
6.2.1 ABC Analysis.....	39
6.2.2 Fertilizer Acquisition.....	40
6.2.3 Contractual agreement.....	40
6.2.4 Demand for Fertilizers	41
6.1.6 Operation Analysis	41
7 SUGGESTIONS FOR IMPROVEMENT	42
7.1 Suggestions for Improving Efficiency in Warehouse Management	43
7.1.1 Modifying Fertilizer Storage Facilities	43
7.1.2 Transport Safety of the Finished-goods Warehouse	47
7.2 Suggestion for Improving Inventory Management	49
7.2.1 Reduction in Inventory Levels.....	49

7.2.2 Improvement Benefits.....	50
8 CONCLUSION.....	50
REFERENCES.....	52

FIGURES

FIGURE 1. Rubber seed nursery	5
FIGURE 2. Young rubber trees	6
FIGURE 3. Latex being tapped from a rubber tree.....	6
FIGURE 4. A latex transporter	8
FIGURE 5. Warehouse processes	13
FIGURE 6. Pareto analysis.....	26
FIGURE 7. An example of manual handling	32
FIGURE 8. The finished-goods warehouse of GREL	35
FIGURE 9. The ABC curve of fertilizer inventories.....	39
FIGURE 10. Selective pallet racks.....	44
FIGURE 11. Handling fertilizers with forklift trucks.....	46
FIGURE 12. An example of warehouse line marking.....	48

TABLES

TABLE 1. Fertilizer types and usage rate at GREL.....	38
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1 INTRODUCTION

Activities of the warehouse are aimed at keeping materials in good conditions for future use entails chains of different individual activities. Among others they include space provision, material handling, transportation and shelter. All of those individual actions are to be managed and undertaken to make the existence of warehouse worthwhile.

1.1 Company Description

1.1.1 Profile and History

Ghana Rubber Estates Limited (GREL) is a rubber processing company. The company was established in 1957 with a plantation size of about 900 hectares. After three years, it was nationalized into Agricultural Development Corporation, and two years later, in 1962, it was further nationalized into State Farms Corporation. In essence, GREL was a state-owned company until 1996 when it was privatized. Currently, the private body, Société Industrielle des Plantations d'Hévéas (SIPH) owns about 60 percent of the capital, while the 25 percent remains the governments. The other 15 percent of capital is owned by a local company called Newgen.

It is the only company of its kind in Ghana; located in the western region of the country. Currently, GREL owns about 18,000 hectares of land for rubber plantation, of which approximately 50 percent; 9,000 hectares are covered with matured trees. In addition, GREL buys from about 5700 small scale farmers, who are also known as out-growers. The annual revenue of last year was an estimated £50 million. This amount was generated from an output of 20,000 tons of granulated rubber.

Over 70 percent of their product is exported; with the main buyer being tire manufacturer Michelin. Export countries therefore, include Italy, England and France among others where Michelin's factories are located. (Ghana Rubber Estates Limited: A Growing Partnership 2012.)

1.1.2 Processes

GREL as an industrial company has several operational branches that perform the individual activities that ensure the success of its goal: providing processed rubber crumbs for its buyers. The activities start from:

1. The nursing of rubber seeds into young plants



FIGURE 1. Rubber seed nursery (Ghana Rubber Estates Limited.

<http://www.grelgh.com/>).

2. Field planting: This is when the young plants are transferred from the nursery to plantation fields for cultivation.



FIGURE 2. Young rubber trees (AllAfrica: Photoessays.
[Http://allafrica.com/view/photoessay/post/post/id/200710180002.html](http://allafrica.com/view/photoessay/post/post/id/200710180002.html))

3. Harvesting of the matured trees. The matured trees are tapped, and collection cups are attached to them to collect the latex



FIGURE 3. Latex being tapped from a rubber tree (Ghana Rubber Estates Limited [Http://www.grelgh.com/](http://www.grelgh.com/))

4. The next step after harvesting is the processing of latex rubber into crumb rubber, which is the final product of GREL.

Some of the activities which are necessary for actualizing the processes above are:

- Fertilizer application
- Water irrigation
- Weeds and pest control
- Warehousing of fertilizer, spare parts and finished-goods
- Packaging
- Transportation
- Maintenance of machines and vehicles.



FIGURE 4. A latex transporter (Ghana Rubber Estates Limited <http://www.grelgh.com/>)

1.2 Research Goals

The goal of this work was to come up with improvement suggestions to the current warehouse and inventory management of GREL. Therefore, the current situation was discussed with the view of providing basis for answers to the following research questions:

- Which aspects of the fertilizer and finished-goods warehouses could be improved?
- Which aspects of the fertilizer inventory management could be improved?
- How can cost savings and efficiency be enhanced with the improvements?

1.3 Research Methods

A third of my practical training was undertaken at the said company. That exposed me to the practical occurrences in the organization.

Further means of acquiring information was through qualitative and quantitative researching methods. The qualitative part included interviews with a company representative who was assigned to offer information on this work. Also, interviews were conducted with senior workers when necessary. That helped in getting an improved overview of the company's operations

The quantitative research enhanced the acquisition of the figures and values needed for this work. The values included the amount of fertilizers and their corresponding percentage of usage per year. Other values were cost for handling fertilizers and an estimation of the annual wastage rate of fertilizers. The level of transport safety was also provided.

2 WAREHOUSE MANAGEMENT

In the past, warehouses were referred to as cost centers and rarely adding value. But the increasing need for transfer of products across cities, countries and continents resulting from movement of production to the Far East, the growth in e-commerce and increasing demands from end users have seen a change about the perception of warehouses. They are vital components within today's supply chain. (Richards 2011, 7.) They form the integral part of the supply chain in which they operate, and so trends such as increasing market volatility, product range proliferation and shortening lead times, all have effect on the roles the warehouse is required to perform. Warehouses are most likely involved in various stages of sourcing, production and distribution of goods, from the handling of raw materials, work-in-progress through to finish products.

It is therefore apparent that different activities take place at a warehouse and thus, require different nature of facilities, staff as well as equipment to suit each function. With the vast nature of difference, warehouse operations could easily be the most costly element of the supply chain. (Rushton, Croucher, and Baker 2010, 225.)

According to (Richards 2011, 7), the pressure is on warehouse managers to increase productivity and accuracy, reduce cost and inventory whilst improving on customer service. The successful management of the warehouse is critical in terms of the level of service provided, as well as the cost incurred (Rushton et al. 2010, 225).

2.1 Classification of warehouses

The nature of warehouses within the supply chain varies, and can be adopted in various forms of classification, among other things including the following:

- By the product type: examples include perishable products, frozen foods, explosive items, small spare parts and security items.
- By the stage in the supply chain: a warehouse could be meant to carry either materials, work-in-progress or finished goods depending on where it is situated in the supply chain.
- By geographic location: a warehouse is situated to serve only a certain geographical area like a region, a whole state or even the whole world.
- By function: that is whether to just hold inventory or for sorting.
- By company usage: it could be meant for use by just one company, or shared amongst various users in handling the supply chain. (Rushton et al.2010, 226.)

2.2 Warehouse operations

2.2.1 Functions

Warehouses are designed to meet specific requirements in the supply chain in which they form a part of. Meanwhile, there are some operations which are common amongst them. Emmett (2011, Chapter 4) categorizes such operations into the following functions;

- Goods in or receiving. This involves the physical activity of unloading incoming transports, checking deliveries against purchase orders and recording. Depending on the agreement of both parties, future checks may include quality control. Some or all of the delivered goods are either rejected or accepted at this stage. Rejected goods are sent back to the supplier.
Richards (2011, 45) discusses pre-receipt, suggesting that the warehouse manager should be involved in specifying and agreeing on the packaging, items per carton as well as any specific labeling required, in addition to the means of transport, so as to ensure that the delivered products are compatible with the storage facility.
- Put away into the storage area. Depending on the state of goods in the above stage, accepted goods are taken into storage. The storage area of the warehouse is often the largest space, with the spaces divided for the different kinds of goods that come in.
- Order selection and picking or packing. Goods are stored in the warehouse to be used later when needed. The needs for goods are made when orders are placed for them. When orders are placed, the goods are selected and picked according to their identifiable locations. The goods are then made ready for transportation to the point of need.
- Goods outward or dispatch. The goods are put together at the dispatch area and loaded onto the outbound vehicles, or picked up for use according to their size and place of need.

The key aspect to be considered in the activities is the conflicting priority of maximizing the use of the space allocated to each, while minimizing to undertake the activity (Emmett 2011, Chapter 4).

2.2.2 Processes

The warehouse processes according to Berg (2007, 60 - 61) are;

Receiving

This is the process of unloading incoming truck, identifying, registering and sometimes repacking.

Put away

This is when goods are moved from unloading dock to the storage area.

Storage - in bulk or pick

Activities at the warehouse affect goods in storage. For instance, the amount of stocks has to be counted to verify inventory quantities.

Replenish

If inventory levels of the pick storage drop to certain amounts, it is replenished with stocks from the bulk storage.

Pick

Upon order for need of an item in storage, either full pallets are picked from the bulk area of storage, or smaller quantities are picked from the pick area of storage.

Ship

The picked items are packed, consolidated and staged for shipping.

Cross-dock

Some goods do not make their way into storage. Such goods, upon receipt are transferred to the shipping dock for shipment to point of need.

Value Added Logistics

There also recognition for the value added by some logistics activities at distribution centers. Such value can be the labeling of goods to the specific customer or country of destination.

Below is an illustration of warehouse processes as discussed above;

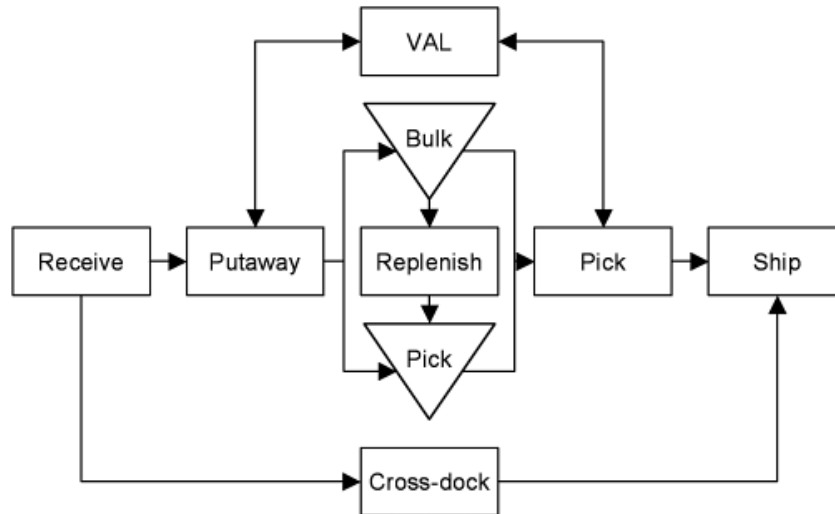


FIGURE 5. Warehouse processes (Berg 2007, 60).

3 INTERNAL TRANSPORTATION

A warehouse is a building with possibly many dock doors around the various sides, for the receiving, storing and dispatching of goods (Berg 2007, 57). Therefore, it is apparent that different types of equipment are needed to make the carriage, and movement and storage of items possible. Both human and machine are deployed to function at warehouses to perform value added services to the goods until they are transported to the next user on the supply chain.

For the purpose of this work, the focus is on the internal transportation of goods from point of receipt to storage, and to dispatch area and the vice versa. The safety of the

personnel will be highlighted, and also means to ensure transport safety by using floor strips or paintings and other measures are discussed.

Transport activities are very crucial in the successful operations of warehouses. The requirement is for easy and efficient carriage of goods from one point to another in the warehouse.

3.1 Transport Equipment

3.1.1 Conveyors

This means of transport is mostly used between fixed points. Goods are moved from one point to another fixed point. A conveyor can either be powered to function or be dependent on gravity. Gravity conveyors are used to transport goods within shorter distances. Some examples are chutes and skate-wheel conveyors. Such conveyors normally function with shorter distances. Power conveyors, on the other hand, are used for longer distances. The types of such conveyors include belt conveyor and chain conveyor.

Nevertheless, conveyors are more efficient where an operation has some features as;

- need for high throughput
- fixed routes for movement of goods
- continuous movements of goods
- uneven warehouse floors. (Rushton et al. 2010, 268.)

3.1.2 Fork-lift Trucks

Emmett (2011, Chapter 5) describes the fork-lift truck as the workhorse of most stores and warehouses. They come in different varieties depending on their lift capacity and lift heights. Consequently, different fork-lift trucks are used in different warehouses depending on the mode of operation.

Forklift trucks are designed mainly for lifting and transporting pallets. According to Rushton et al. (2010, 237), the effective storage of goods in warehouse normally involves the stacking of pallets, and their transportation or movement is made possible by fork-lift trucks.

Types of Fork-lift Trucks

Emmett (2011, Chapter 5) lists the following types:

- Counterbalanced fork-lift trucks.
- Reach Trucks
- Narrow aisle Truck
- Hand pallet truck
- Powered pallet truck
- Multi-riser picking truck
- Articulated fork truck.

Choosing a suitable forklift

From the most common to the more complex forklift trucks, Emmett (2011, Chapter 5) explains that picking a type for a warehouse operation depends among others on the following considerations:

- Type of product to be handled – if there is a need for special attachments like clamps
- The features of the collecting or delivery vehicles – example is the height
- The nature of racking – aisles and the heights
- The nature of the surroundings – if there are fumes or excessive noise
- Space availability for recharging a battery when necessary
- The community's policy on storing fuel
- Frequency of using the truck
- The kind of training required for the driver

- The cost of spare batteries and chargers.

3.1.3 Automated Guided Vehicles (AGV)

These transportation machines are powered by battery and are computer-controlled. In other words, they do not require a driver to function. They are normally used for moving pallets and a variety of unit loads.

The vehicles are guided to move along a certain designated area by several means. One common means according to Rushton et al. (2010, 237), is a wire guidance system. With this method, a wire is buried in the floor of the warehouse and sensors are fixed in the vehicles to detect and follow the magnetic field which is generated by the electric current flowing through the wire, which steers the vehicle. Other means are burying magnets in the warehouse floors and also lasers are used for laser guidance.

3.2 Transport Safety

There are various types of equipment deployed at the warehouse operations, together with the involvement of humans. It is therefore imperative that certain measures be put in place to ensure human and machine safety and also to ensure efficiency.

Transport equipment offer many benefits such as improving work efficiency, or reducing the need for manual handling, nevertheless, they can pose a major occupational hazard. Pedestrian workers often operate in close proximity to such mobile or transport equipment in many of the industrial workplaces. These workers could either be moving to or from workplace during the beginning or end of shifts, or during breaks. Also, they might be undertaking duties such as maintenance or quality control; activities that cannot be done by the mobile equipment. (Horberry 2011, 551.)

3.2.1 Safety Problems with Transport Equipment

Horberry (2011, 552) outlines a problem of partially obscured vision of a forklift operator as a result of carriage of large loads. Also, transport equipment is sometimes needs to be driven in reverse while carrying a load; as the operator has to check the stability and clearance of the load. The driver may be unable to see a pedestrian or other object, thus increasing the chances of collision.

Hughes and Ferrett (2010, 198) gives some possible incidents that occur in situations of pedestrian proximity to transport equipment as:

- collisions between pedestrian workers and trucks
- workers being struck by falling objects from forklift trucks
- pedestrians being stuck by an overturning truck
- collisions with stationary items.

3.2.2 Control Strategies for Transport Safety

Floor Demarcation

Separating the warehouse floor among its users is an effective way of reducing collisions of trucks and pedestrians. According to Horberry (2011, 553), exclusion zones and restrictions, as well as separating pedestrian walkways are means of separating hazards from that which is to be protected by time and space and physical barriers.

As suggested in Hughes and Ferrett (2010, 198), marking designated walkways serves a general means of preventing transport hazards. The separation can be done by striping or marking the floor. The marking is to will distinguish traffic routes, loading areas, storage areas as well as walkways for pedestrians. With the floor demarcation in place, managers must ensure that they are used accordingly so as to reap the benefits involved. In this instance, there comes a separation of a hazard, which is the moving

truck, from pedestrians and consequently, ensuring protection for the warehouse users and thus, enhancing transport safety.

Efficient handling of transport equipment

Transport hazards are reduced with efficiency transport equipment. Examples are - eliminating the need to reverse help reduce reverse incidents; avoiding overloading helps to prevent poor vehicle handling, restricted visibility; and minimizing the number of trips made help reduce chances of incidents. (Horberry 2011, 553.)

Effective resource control

Both transport or mobile equipment and human resource should be controlled according to acceptable laid-down regulations to help prevent the release of hazards. Some measures deployed in controlling the resources are:

- Management of fatigue by testing for operator fitness for duty
- Prevent the unauthorized use of vehicles
- Maintain level roadways and fit equipment stability and tilt controls
- Match equipment to site access ways and openings. (Horberry 2011, 553.)

Good working environment

Another means of avoiding collisions is by keeping clean working premises. Examples include the provision of suitable floor surface, keeping the walkways tidy and free from spills would avoid possible slips or falls. The lighting system must be of good standard to allow proper visibility. Also, ensure that pedestrian workers wear high visibility clothing and appropriate footwear to suit the type of floor surface. (Hughes and Ferrett 2010, 198-199.)

Traffic Guard

Just as there are traffic signs on external roads to ensure safety, so there should be in internal transportation. Speed limits and other warning signs are useful in enhancing transport safety by reducing the amount of hazard (Horberry 2011, 553).

3.2.3 Benefits of Transport safety

Some positive features that could result from putting in place control strategies to enhance safety include:

1. Reduction in collisions as a result of designated areas in the warehouse; with its related consequences like truck damage, repair cost and injuries among other things. In other words, cases of collisions between trucks and pedestrians, or trucks and stationary items would be reduced.
2. Reduction in claims and unwanted cases resulting from injury or death through accidents involving transport equipment.
3. Reduction of lost times, when there will be less stops due to injuries or damages.
4. A safer working environment is created with safe driving and operations. This also enhances efficiency in the performance of duties.

4 INVENTORY MANAGEMENT

The inventory of company includes its raw materials; work in process; supplies used in operations as well as finished goods (Muller 2011, 1). Managing an inventory is aimed at satisfying customer requirement while minimizing total operational cost. Emmett (2011, Chapter 2) defines inventory management as an approach to manage the product flow in a supply chain, to achieve the required service level at an acceptable cost.

Some techniques are adopted to minimize the level of stocks or inventories held in warehouses. According to Rushton et al. (2011, 226), some of these techniques are just-in-time, efficient consumer response (ECR) as well as collaborative planning, forecasting and replenishment.

4.1 Purpose of Inventory

Due to the unpredictable nature of our society and markets, it is sometimes imperative to hold stocks to a certain level at the various stages of the supply chain. The following are reasons why the warehouses need to hold inventory:

- Uncertain and irregular demand patterns: The demands of certain kind of products are vastly unpredictable, and holding stocks might be the main option to ensure on-time supply to the customer. Examples include the supply of umbrellas and ice-cream, whose demands revolve around the irregular changeability of the weather.
- Trade-offs to justify larger shipments: There are times when offers in transportation cannot be refused; for example, when transporting larger quantities causes lower cost per unit. As this instance, the trade-off is between cost of storage of additional goods and the relatively higher cost of transporting fewer goods.
- Discounts through bulk purchase: There could also be the possibility to reduce the unit cost of goods through bulk purchases. When such offers are patronized, the trade-off here is between the lower unit purchase cost and the increased storage cost per unit of the bulky products.
- Distance between supplier and buyer: There are instances when the two parties in the chain are far away from each other. Therefore, there comes the need to hold safety stocks due to the possible long lead time.
- Assurance in case of shutdowns: Some production companies might seasonally shut down the operations during vacations, maintenance activities or stock

counts. Keeping stocks as a retailer prior to any of those shutdowns will ensure stocks availability and continuous operation.

- Investment stocks: There are some products which increase in value in time. These products tend to increase in cost, and therefore are prudent to be held in stock to prevent high procurement cost in the future. Examples are precious metals, fine wines and fine arts among other things. (Richards 2011, 15.)

4.2 Inventory Costs

(Müller 2011, 2) puts inventory costs into two classes: ordering costs and holding costs. Ordering or acquisition costs are independent of the actual value of the goods. These costs include the salaries of the purchasing personnel, costs of expediting the inventory and others. The holding costs include the cost of the capital tied up in inventory, storage costs, and costs of handling stocks (equipment and staff). Others are stock losses through theft, obsolescence, and taxes.

According to Rushton et al. (2010, 179), four principal elements make up the inventory holding cost. They are as follows:

- Capital cost, which is the cost of the physical stock.
- Service cost, which is the cost of managing the stock and insurance
- Storage cost, which includes the cost of space, handling and other warehousing costs involved with the storage of the actual product
- Risk cost, which results as a consequence of theft, goods deterioration, stock obsolescence and damage.

Warehousing accounts for about 20 – 30 percent of logistics costs, while the carrying costs for the inventory accounts for another 18 – 20 percent. (Rushton et al. 2010, 233)

4.3 Arrangement of Stocks

4.3.1 Storage Systems

1. Block Stacking: this type of storage is by piling goods on top of each other without the support of a rack. An example is the stacking of crates of drinks.
2. Shelving rack: A rack is made up of a number of wooden or metal shelves on which individual pieces or bins can be placed.
3. Mezzanine: this is a level between the floor and the ceiling where goods are stored. It is spacious enough for the working personnel to walk and access the goods.
4. Pallet rack: this consists of a metal frame with horizontal beams on which pallets are placed (Bragg 2011, 65).
5. Gravity flow rack: this facilitates deep stacking and enhances the first-in-first-out policy. Here, pallets or cases are entered via the rear end on a roller conveyor. The rollers are tilted to certain degrees of angles thus facilitating the rolling forward of the goods (Berg 2007, 59).
6. Floor storage: Richards (2011, 90) believes that floor storage is an acceptable way of storage where capital is at a premium and the goods to be stored are of low value, with only few SKUs. However, the inability to utilize the cubic capacity of the building is a disadvantage. Also, First-in-first-out rule will be compromise in cases if replacing picked pallets.

4.3.2 Storage Space Allocation

Storage by product type

The storage sections of the warehouse are designated for specific type of products (Berg 2007, 64). This is inevitable because certain kinds of goods, like hazardous items, will require special treatment as compared to frozen foods.

ABC classification

There are different locations in a warehouse; some locations are more easily accessible than others. Putting away goods for storage and future picking can be made more effective and efficient by dividing the locations on the order of importance or moving rate. Berg (2007, 64) believes that the ABC classification helps to assign each of the products accordingly. For instance, fast moving products class A, medium moving products class B and slow moving product class C can be arranged so that A product is nearest, while C products will be farthest.

5 OPERATIONAL EFFICIENCY

Efficiency is defined as how well an operation is being run (Rushton et al. 2010, 480). According to Berg (2007, 26), by redesigning operations or processes so that less time, space and materials are need to complete an operation, the process is said to be more efficient. An example is the reduction of travelling distances in the warehouse by storing according to the order of importance or rate of need, as in the ABC classification. Thus, the need for warehouse staff, warehouse space and materials should be as small as possible.

Furthermore, Berg (2007, 145) distinguishes three actions that can enhance process efficiency. They are:

1. Eliminate activities: this is when certain activities that are redundant or improper are taken out.

2. Improve activities: here, the same activities are performed but with more efficiency.
3. Combine activities to reduce the number of repeating similar activities.

The problem of how much inventory should be held is that faced by many inventory managers. Maintaining a huge inventory means a quick response time to demand. Meanwhile, it is expensive to stock in larger quantities. While the goods themselves are costly, it also implies that money is tied up in inventory and cannot be invested elsewhere. (DuBrin 2008, 206.)

Efficiency in managing inventories could be a competitive advantage to certain companies in their quest to ensuring profitability and sustainability. In this regard, DuBrin (2008, 206) uses Wal-Mart and Dell Computers as examples. Dell only builds computers after receiving orders for them, while Wal-Mart's collaboration with its suppliers ensures that only the right amounts and quantities of merchandise are stocked on their shelves. Such policies help to minimize the need for keeping large inventories. Techniques are put in place to help in decision-makings regarding inventories. Some of such techniques will be discussed below:

5.1 ABC Analysis

Bigger industries are more likely to keep inventories of different goods in a same warehouse. Inevitably, some of the goods will be worth more than others. The use of the famous tool for structural analysis, the ABC-analysis or Pareto analysis, otherwise known as the 80-20 rule: where 20 percent of the goods carry 80 percent of the stock value and vice versa, ensures a proper way of planning. According to Cheverton and Velde (2010, 81), the Pareto analysis or ABC analysis is a statistical technique in decision making which is used for selecting a limited number of tasks that produce a significant overall effect.

According to Coyle, Langley, Gibson, Novack and Bardi (2008, 378), the ABC analysis is a classification technique which assigns to one of three groups according to the comparative influence or value of the items that make up the group. Therefore, assigning items to each of the groups is based on the criteria which will be used – value or impact.

The division between the classes A, B and C are made on the basis of:

- Class A - is the small group of items that represents the major part of the total spends; and thus it gets the greatest consideration.
- Class B – the intermediate group of items; gains relatively less consideration
- Class C – a large collection of items that represents a minor part of the total spend. This class gets the very least consideration. (Cheverton and Velde 2010, 83.)

5.1.1 Steps in conducting ABC-analysis

1. Prepare a list of the items and estimate their annual consumption,
2. Determine unit price,
3. Obtain annual usage value,
4. Arrange the annual usage value in descending order,
5. Calculate the cumulative cost percentage of total value,
6. Calculate cumulative item value,
7. Plot a graph of step 5 against step 6. The sharp rise in curve denotes the A items, while a distinct leveling off denotes the C items. (Khanna 2007, 313.)

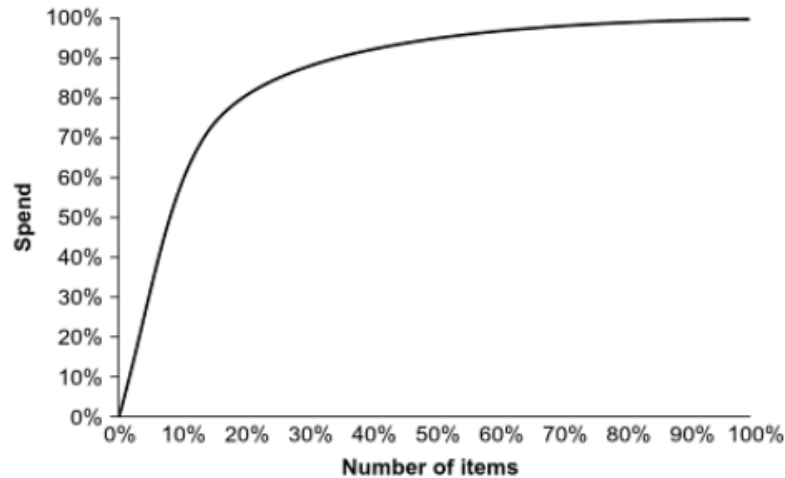


FIGURE 6. Pareto analysis (Cheverton and Velde 2010, 81)

5.1.2 Effects of the ABC Analysis

Although the ABC analysis has its shortcomings like restricting opportunities to a limited number of items; hindering improvements coming from simplification and standardization or harmonization (Cheverton and Velde 2010, 82), an organization knows which stocks are the valuable and the not-so-valuable ones. This goes a long way to help in effective decision making and planning, and thus provides answers to questions such as:

- Which stocks deserve the more investment?
- Which stocks will require a safety stock, so as to prevent stock-outs?
- Which stocks deserve regular monitoring?
- Which stocks deserve the most security?

5.2 Economic Order Quantity

DuBrin (2008, 206) defines economic order quantity, otherwise known as EOQ, as the inventory level that minimizes both administrative costs and carrying costs. He further

explains that EOQ is the reorder quantity that represents the least cost. According to Eroglu and Ozdemir (2007, 544), EOQ is a technique to find out optimum order quantity by generally taking into account the cost of procurement, inventory holding, and backorder. Brigham and Daves (2009, 817) discuss EOQ as the model that seeks to provide an order quantity, thus an inventory level that minimizes total costs.

Mathematically, EOQ is expressed as:

$$EOQ = \sqrt{\frac{2 \times D \times O}{C}}$$

Where;

D is the annual demand in units of the product

O is the fixed cost of placing and receiving an order and

C is the annual carrying cost per unit

In essence, C represents storage cost, taxes, insurance, interest and other expenses (DuBrin 2008, 206).

5.2.1 Seasonal Demand

It is sometimes unrealistic to assume that a constant demand for an inventory item is uniform or equal throughout the year. The reality is that demands are seasonal in some firms. In this case, the standard EOQ model is not applicable. The EOQ however, provides a point of departure for setting inventory parameters, which are modified to suit the seasonal patterns. (Brigham and Daves 2009, 827.) In this case, the EOQ model is applied to each period or season.

5.2.2 Safety stock

Safety stock is defined by Anderson, Sweeney, Williams, Camm and Martin (2010, 488) as inventory maintained so as to reduce the number of stock outs resulting from higher than expected demand. A further explanation (Brigham and Daves 2009, 823), regards safety stock as an extra amount added to the EOQ when ordering. It is also useful to guard against delays in receiving the orders.

5.3 Working Capital

The term working capital is used to refer to cash and other current assets like inventory, marketable securities and accounts receivables (Fields 2011, 308). He further expresses it mathematically as follows:

$$\textit{Working capital} = \textit{Current assets} - \textit{Current liabilities}$$

Oxford Dictionaries defines current assets as cash and other assets are expected to turn to cash within a year and current liabilities as amount due to be paid to creditors within a year.

According to Fields (2011, 308), the statement that a company has high working capital, means the company has high cash-related assets. Brigham and Daves (2009, 806 - 807) discuss the importance of managing the working capital in companies. It has become important to target at zero working capitals in today's intense global competition.

Advocates of zero working capital proclaim the advantages of generating physical cash and also operating more efficiently. Also, it costs to invest funds in working capital, therefore reducing those funds like inventories and other assets results in savings in

capital costs. Too much working capital is poor asset management; it is very expensive, can restrict cash flow and inhibits the company's ability to grow and prosper (Fields 2011, 117).

5.4 Just-in-Time

Another efficient way of inventory control technique is the Just-in-Time system. This system is explained by DuBrin (2008, 207) as the inventory control method designed to minimize inventory, and move it to the field for use exactly when needed. The key principle with this system is to eliminate excess inventory. By using this system, a manufacturing company for instance, stays lean by minimizing waste wherever possible.

Some techniques are used in executing just-in-time system. Some of such techniques are:

- Kanban: An inventory control method developed in Japan by automobile factories; aimed at keeping low inventory by scheduling needed goods and equipment to arrive a short time before production run commences. It relies on cards to communicate production requirements from the point of assembly to the manufacturing operations that precede it. (DuBrin 2008, 208.)
- High inventory turnover: According to DuBrin (2008, 208), the levels of finished raw materials or work in process are purposely reduced, with the target of zero inventory levels. In this instance, idle raw material in the warehouse is regarded as waste.
- Allocating specifics: being specific on where to store certain items enhances easy access. Such practice helps to eliminate numerous counting.

Along with the benefits of reduced inventories and its related privileges, DuBrin (2008 208) recognizes the difficulties that could result from the Just-in-Time system. One of

such is the need for a reliable supplier for the JIT system to succeed. Another is the vulnerability of a company to face work stoppages due to material shortage at the supplier's base; as a result of strikes or failures.

5.5 First-In, First-Out versus Last-In, First-Out

First-in-first-out (FIFO) and last-in-first-out (LIFO) are storage techniques which help in the management of inventory. While FIFO ensures that the oldest item at the warehouse is used first, LIFO promotes the use of new arrivals before the old ones (DuBrin 2011, 214).

Also, FIFO avoids the unwanted aging of inventories. On the other hand, the LIFO policy increases the average inventory age, and therefore, it is not recommended for perishable or deteriorating products (Berg 2007, 59).

6 COMPANY'S OPERATION

6.1 Warehouse Management

6.1.1 The Fertilizer Warehouse

Operations

Receipt and Put-away

Upon inspection and acceptance of delivered fertilizers, they are unloaded from trucks and put away to storage at the fertilizer warehouse. The fertilizer handling is mainly manual. Consequently, the bags are not stacked onto any kind of pallet upon arrival.

Thus, individual bags are carried one after the other from the trucks and loaded onto their appropriate allocations.

Packing and Storage

There are special kinds of pallets, huge enough to carry about thousand bags, which are placed on the floor of the warehouse. No single pallet is made to carry two types of fertilizers; so one pallet to one type of fertilizer.

The fertilizer bags are placed on one another during packing. The arrangement is made into a staircase form at the end of packing. According to the warehouse workers, that ensures easy access to the bags and enables easy picking and loading. Also, new arrivals could be added easily.

Picking

As mentioned earlier, the staircase arrangement ensures easy picking. At this stage, the personnel responsible for picking and loading use the staircase as a path to access and pick the bags from the top of the storage. The bags are then carried and placed into trucks, also manually.



FIGURE 7. An example of manual handling (Dugger 2007.

http://www.stopdown.net/AfricaMalawi_farmingsubsidies.htm).

Operations Analyses

Advantages

Low cost of storage

From the discussion of the warehouse operations above, it can be recognized that there is very little, if any, investment in the warehouse as to storage and material handling equipment. The storage equipment available is a few wide wooden pallets which keep the fertilizers from the floor; and internal movements of goods are done manually. Thus, resources which could have been used for warehousing purposes, like acquiring storage items and material handling equipment, serve as capital for some other operations within the organization.

Availability of manual labor

The operational orientation of GREL means that about 86,500 bags of fertilizers each weighing about 50 kilograms are to be handled manually during unloading and loading of trucks. Yet there are always available human resources to execute that task.

*Disadvantages**Higher need for labor and time*

There is a high dependency on human resources in the successful operations of the warehouse. Human labor is needed in high quantities to handle the bags of fertilizers. Whereas a single person could use a forklift truck to do the work done by so many people and within a shorter period.

Due to the methods used in packing and storing that large number of bags, it requires more personnel to count the number of bags in stock when necessary. Also, extra human resources are required to break into pieces the hardened-but-useful kind of fertilizers, as in the case of hardened urea.

High cost of handling

A price tag of GHS 1.20 is attached to the carriage of each bag during loading or unloading. Therefore, each bag costs GHS 2.40 when unloaded during the arrival of goods, and loaded during dispatching of fertilizers to the fields. Considering about 86,500 bags of fertilizers being unloaded and about 50,000 of those loaded for dispatching to the fields, it implies that handling costs for the year is:

$$GHS\ 1.20 \times (86,500 + 50,000) = GHS\ 163,800$$

High rate of wastage

The bags of the fertilizers are made of plastics, mostly Polypropylene, and each bag weighs about 50 kilograms. The use of human hands to handle this item inevitably

results in some breakages; especially from slipping and falling from their hands. Also, the staircase arranging method used means that the people will walk on the fertilizer bags to access orders. This can cause some bags to burst open and spill on the floor.

According to records, 105 bags of fertilizers were wasteful last year.

Health and safety concerns

The high use of humans in the warehouse of chemicals comes with its related health concerns. Even more, the possibility of breakage while handling makes it more worrying:

- Urea for instance, can cause dermatitis on the skin from prolonged contact.
- Inhaling the chemicals in the fertilizers could respiratory tract.
- There is also possible irritation of the eye
- There is also a likelihood of stress being generated from excessive manual labor.

Higher rate of obsolescence

The packing and storage method used is such that new arrivals are placed onto old goods already in storage. This prevents lack of the First-In-First-Out policy. As a result, some bags spend a lot of time in the warehouse and get hardened. Few are useful when hardened, although they will require extra cost in the form of labor, urea serves as an example. The lots of them may become useless.

Possible loss

It is very difficult if not impossible to count and know the exact amount of items in stock due to the arranging procedure. Consequently, loss of stocks through theft is especially difficult to determine. Even more so, since there are almost always some old stocks in storage when new stocks are brought in. In this instance, the records of orders placed and issues of bags made are used when taking stock values of the fertilizers.

6.1.2 The Finished-goods Warehouse

Warehousing or the storage center for the finished product, which is crumb rubber, is situated next-door to the processing centre. Each rectangular rubber crumb weighs about 35 kilograms, and 36 of them are stacked onto pallets. They are picked and delivered to the warehouse for storage by a forklift.

The warehouse has storage facilities in the form of racks built from metal. These racks are on both sides of the building, while an aisle is left in between to serve as a route for the personnel, load and forklift.



FIGURE 8. The finished-goods warehouse of GREL

Process outline

During picking and dispatching, the forklift is used to load the SKUs. Prior to the loading of a SKU by the forklift, the amount and type to be transported is picked and placed near the dispatching point.

A truck with a SKU goes along the edge of the loading area; a metal sheet is then put in place to connect the floor of the warehouse floor to that of the SKU being loaded. This serves as the route for the forklift when loading the SKU. On average, four SKUs are loaded for shipping per daily. But on a very busy day, up to seven SKUs could be loaded. While there are no trucks to be loaded, the forklift still works by picking and putting to storage the newly stacked pallets from the rubber crumb processing line.

Meanwhile, there is no form of warehouse floor demarcation in the form of line striping, to either serve as route path for forklift trucks, or the working personnel. Consequently, all the floor area unoccupied by the shelves or racks could be accessible by either the forklift trucks or humans at any point in time. The absence of floor demarcation in such a busy warehouse calls for a safety concern; therefore the advantages and challenges of such operation are outlined below.

Analysis

Advantages

Freedom

There is a lack of limitations to access the areas without shelves; people and truck could access all areas. Especially, when there is no indication of interruption.

More room when needed

As long as there are no limitations, more space can be created either for the personnel to loiter around, or pallet storage.

Disadvantages

The need for high level of focus

For a person to be present at the warehouse, he has to be aware of everything happening around him. This is due to the fact that the space being occupied by human might be needed by the forklift in any moment. The forklift driver has to look out to ensure there is no obstacle in his way.

Slower operations

The forklift driver will use more time in executing duties because he has to use some of the productive time to do other things such as looking out for obstacles, or moving slower than the speed limit allows, and other safety prevention strategies.

Collision with forklift

With human and forklift sharing the same route, there is the probability of collision. Also, there is a possible collision of the truck with the walls of the warehouse – which has happened a few times over the years according to records.

Damage to forklift

The likelihood for the forklift to collide with racks or the walls of the building due to the lack of demarcations could result in damage of the truck. The damage to the truck, which is the one and only means of moving the pallets within the warehouse and will imply a halt to all those movements, thus stagnating operations, cannot be taken lightly.

Incurring costs

There is the cost of repairs when there is damage to forklift or racks. Also, there will be claims as a result of injuries to personnel through collisions.

6.2 Fertilizer Inventory Management

Due to the different manure requirement throughout the various stages of rubber plant growth, different kinds of fertilizers are needed.

The kinds of fertilizers used are:

1. Urea
2. NPK 16.16.16
3. NPK 15.15.15
4. Muriate of potash
5. Sulphate of potash
6. Krista Sulphate of potash
7. Bendes fertilizer
8. Blanket fertilizer
9. Kisserite fertilizer
10. Rock phosphate fertilizer
11. Triple super phosphate

There are eleven different kinds of fertilizers needed for the successful cultivation of the rubber plants according to GREL's record.

Meanwhile, each of those fertilizers has a different rate of usage per annum. Below is a table which shows the different kinds of fertilizers used by GREL, and the percentage of use in 2011:

TABLE 1. Fertilizer types and usage rate at GREL

Fertilizers	Quantity ordered yearly/ Bags	Usage rate/ %
Urea	20,000	70
NPK 16.16.16	10,000	60
NPK 15.15.15	20,000	45
Muriate of potash	1000	30

Sulphate of potash	1000	50
Krista Sulphate of potash	500	100
Bendes fertilizer	16,000	60
Blanket fertlizer	16,000	60
Kisserite fertilizer	500	10
Rock phosphate fertilizer	1000	10
Triple super phosphate	500	10

6.2.1 ABC Analysis

The analysis for the classes or the importance of the different types of fertilizers is based on the amount of usage annually.

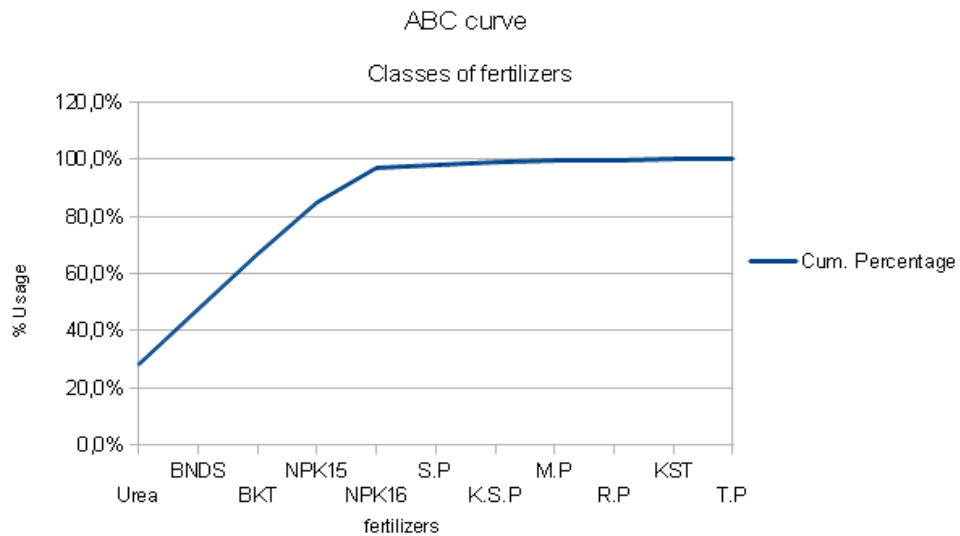


FIGURE 9. The ABC curve of fertilizer inventories

From the graph above it can be noted that;

1. Class A fertilizers are Urea, Bendes fertilizer, Blanket fertilizer and NPK 15.15.15.
2. Class B fertilizer is NPK 16.16.16 fertilizers
3. Class C fertilizers are Sulphate of potash, Krista sulphate of potash, muriate of potash, rock phosphate fertilizer, Kisserite fertilizer and Triple super phosphate.

6.2.2 Fertilizer Acquisition

According to GREL, there is one order placed for the various kinds of fertilizers in a year. In essence, there is one order for each kind of the fertilizer is one, therefore, there are eleven orders annually. The deliveries of the goods can be of more than just one type, thus two or more different types of fertilizers can be delivered at once, especially when the same supplier provides them. The order quantities are planned to cover the planting seasons and a nursing season during the year.

6.2 .3 Contractual agreement

According to their contractual agreement with their suppliers, there is a lead time of six months. This time duration goes for all the type of fertilizers regardless of the quantity or importance. Subsequently, the orders are placed months ahead, which happens to be around the nursing season. The goods are therefore, expected to be delivered before the start of the first planting season.

The suppliers are the parties that provide trucks for transporting the items from their depot to the warehouse of GREL. GREL as the buyer is responsible for paying for the transportation costs. The payment is made according to the number of unit bags. In

other words, the larger the quantity of shipment, the higher the transportation cost and vice versa.

There is a government subsidy for the purchasing price of two of the eleven fertilizers. Those two are N.P.K 15 15 15 and N.P.K 16 16 16, which are acquired in relatively huge quantities and they are also of high importance.

6.2.4 Demand for Fertilizers

GREL has two planting seasons, where the nursed rubber plants are planted on large plots of land. Therefore, the demand for fertilizer application takes place mostly around those periods.

Season 1

The first season starts from January to April every year. During this period urea, NPKs, sulphate of potash and a few other fertilizers are used.

Season 2

The second season starts around September to December. The need for fertilizers is almost similar to season one.

Nursery

The period for nursing rubber seeds is usually between the two planting seasons. Around that time, the need for fertilizer is very minimal: urea is the only fertilizer that is required.

6.1.6 Operation Analysis

Advantage

The main advantage with the nature of inventory management implies that there are more stocks than needed in inventory at any time of the year. Therefore, there is a very low possibility of fertilizer stock outs. Hence response to the need of fertilizers is rapid.

Disadvantages

High inventory cost

The nature of the order placement implies that there are always different kinds of fertilizers, in huge quantities, that are not being used especially during the nursing period of over four months. During that period of nursing, only urea is needed, and so all the others which are being kept for the next planting season bear some cost.

The travelling distance between GREL and fertilizer suppliers is about 300 kilometers - about a 3.5 hour drive, the cost of transportation and purchasing are also independent of the quantity of purchase. Therefore, to fund the inventory cost of an idle inventory could be regarded as a waste of working capital.

Higher obsolescence

Apart from the stock arrangement method, the amount of inventory held is also factor that promotes high possibility of obsolescence fertilizers.

7 SUGGESTIONS FOR IMPROVEMENT

Comparing the theoretical discussion to the status-quo of the operations of GREL, some suggestions are discussed below. The suggestions are aimed at both aspect of

management discussed throughout the paper: improving efficiency in warehouse and inventory management.

7.1 Suggestions for Improving Efficiency in Warehouse Management

7.1.1 Modifying Fertilizer Storage Facilities

A proposed improvement in the fertilizer inventory storage operations is the need to invest in warehousing tools and equipment. This implies the modification of the existing operations to enhance a more efficient warehousing operation.

Racks

An effective storage space is provided with the use of racks. With this facility in place, the storage is in separate entities and the use of space is more efficient. Also, fertilizers are made of different chemicals, and while some are compatible to each other, some of them are not. Therefore it is not advisable to store them in close proximity to each other to avoid unwanted reactions and their related effects on the environment and health.



FIGURE 10. Selective pallet racks (BORACA LOGISTICS EQUIPMENT CO. LTD - Products Category. http://www.boracs.com/Products/Product_Category/).

Storage on racks, like the selective pallet racks, allows easy accessibility and visibility of inventory and therefore their efficient control. For instance, the First-In-First-Out system, which is suitable for the kind of inventory, can be implemented. The result is a reduction in obsolescent goods and their accumulation.

Racks provide protection from slips, and thus, prevent or reduce breakages from falling of fertilizer bags. This helps to save costs in cleaning and reduces the need for secondary containment.

In addition, using racks will enhance the efficient use of warehouse space. A higher height and volume of the warehouse can be put into use, unlike in the current arrangement method used. This implies a bigger storage area, and a better chance of good ventilation, which is needed in a room of chemical compounds.

Pallets

The handling of huge quantities of fertilizer bags can be made more efficient by palletizing them. In other words, loading the fertilizers bags on pallets make it easier to handle when loading and unloading.

Considering that each bag weights about 50 kilograms, 20-25 bags can be stacked onto one pallet. Therefore a quantity of about 86,500 bags can be stacked and carried within a shorter time and also at a lesser cost.

Prove

Consider annual order quantity of 86,500 bags, and each pallet being stacked with 25 bags to weight 1250 kilograms plus the weight of the pallet:

It implies amount of trips made during unloading is:

$$86,500 \text{ bags} \div 25 \text{ bags per pallet} = 3460 \text{ pallets}$$

Reducing 86,500 individual trips to 3460 trips obviously saves time. The cost is also reduced since only the forklift driver is the needed human resource to do the job, as compared to several hands in carrying the bags one after the other. Another cost to be incurred is the operational cost of the forklift, which by estimation would be not be more that 20 percent of the current costs in handling the fertilizers (CAT Lift Trucks 2012: Electric versus Internal Combustion Forklift).

The chances of breakages through manual handling will be reduced; and thus there is a reduction in capital cost and other cost associated with cleaning. This also reduces the rate of negative influences it may have on the environment.

Counting and record keeping is easier and less stressful. This is because it will be easier to count pallets instead of counting the bags individually. Also, reducing the amount of human resources or manual labor in handling the fertilizers reduces or prevents some

health risks involved in getting in contact with the chemicals. In essence, health risks like respiratory problems and skin irritation are reduced.

Forklift truck

To use the above facilities implies the need for a forklift. This will serve the purpose of lifting the pallets, and transport them to and from storage when necessary. In this case, a machine will be used to do the work which currently done by more persons. The speed of work is higher and cost effective as well.



FIGURE 11. Handling fertilizers with forklift trucks (MEA fertilizers: Background.

<http://www.mea.co.ke/section.asp?id=9>).

The involvement of suppliers is necessary for the success of a modified storage facility. The supplier is responsible for the nature of delivered goods. Therefore there is the need for the buyer to renegotiate with the suppliers to deliver goods that will be suitable with storage facilities. Areas to be considered in this case are the need for palletizing and the number of bags on each pallet.

7.1.2 Transport Safety of the Finished-goods Warehouse

Action plan

Enhancing a safe working environment in an industrial warehouse like GREL, can be achieved by:

- Designing traffic routes, loading and storages areas; as well as designating a pathway for pedestrian workers. This can be achieved by floor markings of the warehouse. This can be done with tapes or paints, determined between the company and a specialist by considering the nature of the concrete floor. Appropriate floor marking or striping helps to separate the warehouse space among its users, so as to avoid interference and possible obstruction.
- According to Hughes and Ferrett (2010, 426), there is the need for the use of separate area access gates for trucks and pedestrians as means of reducing risk of collision. Considering the current structure of the warehouse - with a single entry that is shared by pedestrians and the forklift truck, this idea should help in their aim to reduce risk to the personnel and truck

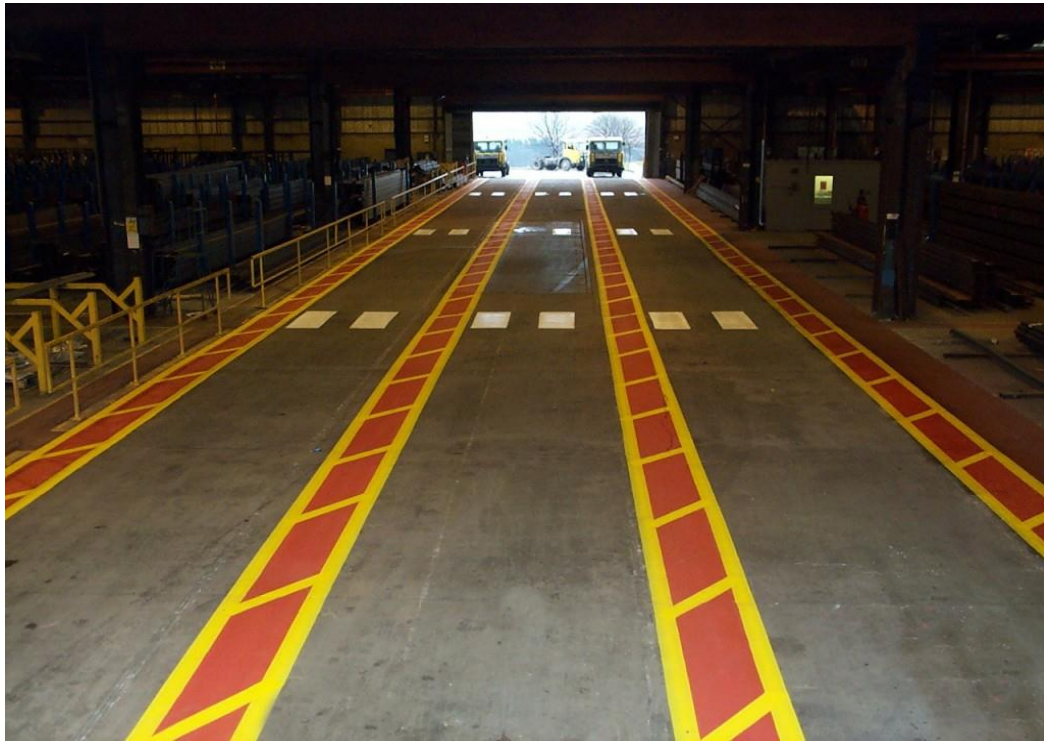


FIGURE 12. An example of warehouse line marking (Riggotts National Line Marking: Warehouse Line Marking. [Http://www.riggotts.co.uk/index.php/services/warehouses/](http://www.riggotts.co.uk/index.php/services/warehouses/)).

Benefits

Although there will be a need for capital cost to start with, and management will have the challenge of making sure the new outline is used accordingly, finally there will be positive result at last. Some of them are:

- The provision of a safe transport environment. Hughes and Ferrett (2010, 198) suggest marking designated walkways as a general means of preventing transport hazards, and thus creating a safer working environment
- Reduction in chances of collision between pedestrians and the truck, or the truck and stationary items.
- Reduction in lost time due to damage to truck or injuries from collisions

- Reduction in costs from claims through injuries or fatalities or repairs.
- Enhancing efficient working rate.

7.2 Suggestion for Improving Inventory Management

7.2.1 Reduction in Inventory Levels

A proposed means of operating efficiently and in a cost-effective way is the reduction of inventory levels. The analysis of the current operations shows that the demand for fertilizers is peaking during the first and second planting seasons. The first and second planting seasons are separated by four months: the first season ends at April and second season starts in September, in between these seasons there is the nursing season, which has the minimum demand for fertilizer, then only one type of fertilizer is needed.

Action plan

Reduction in lead-time

Although GREL uses some special blends of fertilizer which has to be mixed by the suppliers, and hence the long lead-time of six month, the privilege of being a buyer can be an advantage to GREL in its ability to reduce this lead time. The customer is always right, as they say, so it has to be the suppliers' responsibility to forecast or prepare to deliver orders within a shorter time than six months. Even more, taking into consideration the short traveling distance from the suppliers, which is about 300 kilometers, the lead-time could be made shorter than six month.

Seasonal ordering policy

With the reasonable reduction in lead-time to suit your plans as a buyer, and the transport cost being independent on the quantity transported, an avenue is created for the change of ordering policy. Therefore, there will be the possibility to place order on

seasonal terms. Order quantities can be obtained by calculating the seasonal demand with the help of past records plus safety stock. The orders can be placed, and deliveries made before the start of each season.

7.2.2 Improvement Benefits

Reduction of obsolescent goods

Buying the needed amount of fertilizers within a stipulated duration implies that there will be the least chance of accumulating hardened fertilizers.

Saving capital cost

Reduction in inventory levels implies saving some working capital. In other words, contrary to having an idle inventory, there will be cash on hand which can be used elsewhere in the industry.

Efficient operation

Efficiency is created in the operations. For instance records keeping will be easier and less stressful because smaller amounts of goods are dealt with at a time. Also, efficiency in inventory management is created when there is reduction in inventory levels of all items and especially of items that are not used or sold frequently (Hugos 2011, 32).

8 CONCLUSION

According to GREL, the current activities yield a reasonable amount of productivity and profitability. It therefore implies that implementing the suggested improvement areas in enhancing higher efficiency in the inventory control operations and putting in place transport safety measures to provide a safer working environment, can only result in even higher productivity and profitability while reducing cost.

A quote by Steve Jobs reads “I have a great respect for incremental improvement, and I have done that sort of thing in my life, but I have always been attracted to the more revolutionary changes. I do not know why; because they are harder” (The Rolling Stone Interview: Steve Jobs in 1994). The willingness and ability to implement improvement in areas that ought to be improved will ensure the adaptation to the increasing technological and modernization in this new era.

GREL has the vision of increasing the tones of granular rubber from 20,000 tons in 2011 to 60,000 tons in 2020 (Ghana Rubber Estates Limited: A Growing Partnership 2012). Therefore it is reasonable to consider the inevitability of improvement and expansions in operations and structures to ensure that achieving this goal a possibility.

Finally, implementing the suggested improvements will demand some capital cost to invest in the equipment and redesigning of operations and structures. The difficulty at first cannot be overlooked, but the benefits will suffice over a long term and would be worth the while.

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