Investigation of Sustainable Inventory Management system and its challenges in Adama Agricultural Machinery Manufacturing Industry

Yared Negash Beyene

A Thesis Submitted to the Department of Mechanical Engineering School of Mechanical, Chemical, and Materials Engineering

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Manufacturing Engineering

Office of Graduate Studies

Adama Science and Technology University

June 2023

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DECLARATION

I declare that this thesis entitled “Investigation of Sustainable Inventory and its Challenges in Adama Agricultural Machinery Manufacturing Industry’ is my own work and has not been submitted to any university purpose. The references used in this thesis is duly recognized by proper citations

Yared Negash	----------	----------
Name of students	signature	Date

RECOMMENDATION OF ADVISORS

I, the major advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled “Investigation on Implementation of Sustainable Inventory and its challenges in Adama Agricultural Machinery Industry” prepared under my guidance by **Yared Negash**. Submitted in partial fulfillment of the requirements for the degree of masters of Science in Manufacturing Engineering.

Therefore, I recommend the submission of a revised version of the thesis to the department for following the applicable procedure

Dr. Guteta Kabete	_____	_____
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APPROVAL SHEET

We hereby certify that the recommendation and suggestion given by the thesis review committee are appropriately incorporated into the final version thesis entitled Investigation on Implementation of Sustainable Inventory and its challenges in Adama Agricultural Machinery Industry**'.** By Yared Negash Beyene**.**

Dr. Guteta Kabete	_____	_____
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APPROVAL OF BOARD OF REVIEWERS

We, the undersigned, members of the Board of Reviewers of the thesis open defense by Yared Negash have read and evaluated the thesis entitled Investigation on Implementation of Sustainable Inventory and its challenges in Adama Agricultural Machinery Industry' and assessed the understanding of the candidate during the open Defense This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of master of science in manufacturing Engineering .

Dr. Habtamu	_____	_____
Chairperson	Signature	Date
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Reviewer 1	Signature	Date
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Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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ACKNOLEDGMENT

First of all, I have had a lot of ups and downs in the process of finishing this thesis; I've met a variety of generous people, battled a lot, and triumphed in the face of adversity. And it was only because of God that I was able to have this experience and learn thesis life lessons. So, first and foremost. I would like to express my gratitude to the almighty GOD for his unending blessings and lessons in my life. Dr. Guteta Kabeta my thesis advisor, deserve special thanks for his advice, support, and understanding throughout the thesis.

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Finally, I would like to acknowledge my wife, my sister and families, for their love. Encouragement, appreciation, and ends support which made me stronger each day.

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Acronyms

AAMI	Adama agricultural machinery industry
CVA	Critical value analysis
EC	Ethiopian Calendar
E.F.D.R	Ethiopia Federal Democracy Republic
FIFO	First in first out
HP	Horsepower
IT	Information technology
JIT	Just in time
MRP	Material requirement's planning
NATAF	Nazareth Tractor Assembly Factory
SSA	Sub-Saharan Africa Countries
USSR	Union of Soviet Socialist Republic
RMI	Raw Material inventor
FG	Finished goods
EOQ	Economic Order Quantity
CVI	critical value analysis
WIP	Work in process
MTO	Marketing to Operation
MTS	Marketing to supply
ERP	Enterprise resource planning
HML	High price items, Medium Price item and low price items
VED	Vital essential and desirable
SOS	Seasonal off -Seasonal
SDE	Scarce, Difficult and Easy
FSN	Fast moving, slow moving and non-moving

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Abstract

The Adama Agricultural Machinery Industry (AAMI) was founded in September 1978 E.C. with the goal of improving and mechanizing the agricultural sector while supporting the Ethiopian Metal Industry. To perform this case the company was under threatening because of different types of problems (the increase in the inventory level and obsolete inventory). The purpose of this thesis is to investigate the factors affecting the sustainable inventory management and propose strategies to overcome the challenges of AAMI. The primary and secondary data sources were used for analysis of the existing inventory management system. The primary data collected by using questionnaire and interviews whereas the secondary data collected from the document analysis. The ABC analysis used to classify inventories. The result have shown that the A-items shares 70.82% in values and 16.48% in quantity, B-items in turn shares 19.94% in value and 26.37% in quantity whereas the C-item shares 9.24% in value and 57.14% in quantity. The higher and medium HP tractors shares more than 80% in price, so they need special attention to balance and optimize the stock level. The annual production and demand computed to forecast the future demand and production for tractors. The forecasted value shows the average demand of tractors expected to be increased 85.8% in 2018E.C compared to 2012E.C production year. Conclusion and recommendation were drown.

Key-words; ABC analysis; Inventory management, Tractors, Obsolete inventory and Stock level

CHAPTER-1

INTRODUCTION

1.1 Background of the study

Inventory management is essential in the operation of any business that desires to achieve efficiency in production. The relationship between inventory management practices and productivity of the company is strong to manufacture and assemble modern and efficient manufacturing industry implementing inventory is important to reduce waste and increase productivity. Many studies revealed that inventory management practices improve employee work morale, enhances continuous production, and reduces resource wastage (Kemal, 2018). Stated the importance of inventory management practices which minimizes wastages (rejects), production costs, and delivery time.

Sustainable inventory management relates to decisions on inventory, warehousing, and material handling by focusing on reducing environmental and social impacts without affecting profitability. It is crucial to develop a Sustainable inventory management model that takes into account income increase and waste prevention and reduces energy cost. Decisions on lead times, replenishment quantities, and storage facilities influence emissions and costs (World Bank', 2012).

Every manufacturing industry needs to have the stock, but in such amount to avoid out-of- stock and overstock situations, so balancing the need for stocks are very important to increase efficient resource utilization. Thus, inventory management is the backbone to improve company's inventory control existing situation and decrease costs.

Inventory management and warehousing belong to the most extensive Fields of logistics in terms of the amount and complexity of developed logistics processes. These Fields offer a wide range of options and solutions for their optimization and management approaches. Corpo-rate ability to effectively manage its performance in given areas leads to increase as well as sustain the competitiveness, reduce costs, and hence competitive corpo-rate prices. The entry of the Czech Republic to the European Union significantly affected the development of logistics as awhile, due to the fact that after the Schengen Agreement, there were significant interconnections and relations of the domestic market with international markets, and the Czech enterprises had to

initiate struggling for their customers. An effective logistics has become the key to successes already mentioned (Vrat, 2014).

Adama Agricultural Machinery Industry in old name Nazareth Tractor Assembly Factory (NTAF) was established in September 1984 G.C. with technical and economic cooperation agreement signed between the Ethiopian government and former Soviet Socialist Republic (USSR). It was supposed to assemble 3000 Belarus tractors per year in three shift, of which 61% tractor components and 75% spare parts were to be manufactured locally , the remaining 39% tractor components and 25% tractor spare parts imported from abroad . NTAF was administered under privatization agency.

AAMI has three production factories located on 114,388 square meters of land. It assembles and manufactures tractors, water pumps, and various agricultural combines and products. Its products are primarily used by governmental and state-owned enterprises, farm unions, for agricultural, water irrigation, construction, and transportation-related project purposes. It also provides farming machinery maintenance services and trains tractor and tractor pulled implements operators. NTAP was administered under privatization agency up until it is transferred to E. F. D. R. Metal and Engineering Corporation in 2010 G.C. it restructured itself and got a new name AAMI under Ethio-Engineering Group following the council of Minsters Regulation No.475/2020 on 16/09/2020.

Table 1.1 Company products

No	Product type	Model
1	walking tractors	from 8hp to 15hp
2	small tractors	from 18 HP to 35 HP
3	Medium tractors	from 40 HP to 65 HP
4	higher tractors	from 65 HP to 180 HP
5	disc plough	from 3 disc to 6 disc
6	disc harrow	from 16 disc to 48 disc
7	pump	from 16 liter/second to 100 liter /second

1.2 Statement of the problem

The AAMI lacks a digital documentation system that may be utilized as a source of information for inventory categorization, as well as comprehensive or useful documentation that

can be used to implement inventory management methods as instructions for managing material flow. As a result, inventory management is problematic, and overstock has become common as a result. The profitability and performance of the company are significantly influenced by inventory expenses. Despite the fact that there is a constant need for agricultural gear, there is still a lot of material waste in the AAMI due to poor inventory management. Poor completed inventory handling systems and a lack of spare parts inventory made maintaining machinery more difficult, and the cost of damaged items from prolonged storage rose. The yearly output capacity of the AAMI is 1000 tractors every shift; however the three-year number is just 450 tractors. They live for a very long time. As a result, the price is increased. Materials used in manufacturing have direct and indirect expenses, and the sum of labor costs, equipment costs, and raw material prices is what is referred to as the reconditioning cost. Sales price is determined by the direct and indirect materials utilized in manufacture. As we can see above, the industry's methodology does not account for the fact that the price for reconditioning is set; hence this domo shows a sizable loss. Sales prices are equivalent to the whole cost of manufacturing, including both direct and indirect costs.

1.3 Objectives of the thesis

The following are the objectives of the research:

1.3.1 General objective

The general objective of this thesis is to analyze the effectiveness of the current inventory management system and its difficulties in the Adama Agricultural manufacturing sector.

1.3.2 Specific objectives

The specific objectives of the study:

1. To evaluate the performance of inventory management system at AAMI.
2. To study the root causes of poor inventory management system and its effects on profit
3. To propose appropriate strategies to improve the performance of inventory management of the organization.
4. To compare the findings with the existing inventory management system
5. To sort out the specific spare parts that are challenging the supply shortage in the stocks

1.4 Scope of the study

The scope of this thesis mainly emphasizes on the Adama Agricultural Machinery Industries' (AAMI), from the inventory management perspective of view for adequate and sustainable inventory management in the company. The study mainly intended for reducing wastage in the stock as it shows the way to avoiding out-of-stock and overstock situations. Whereas the lack of a well-structured inventory management system and poor documentations of files tum out to be the challenging fact for inventory classification, so to fulfill those gaps both primary and secondary data sources were used. Besides the inventory management at the case company, the relationship between the productivity and inventory management system at Adama Agricultural Machinery Industries' (AAMI) also analyzed.

1.5 Significant the study

More than 80% (source the world fact book) of the Ethiopian population lives in a rural area and this increases the need to focus on the agricultural sector in the country. AAMI is a huge industry in Ethiopia and manufactures agricultural machinery for agricultural transformation but due to other external factors like the purchasing ability of the customers and other constraints the industry not efficient in its inventory management system. The above problems and hopes for future increase the need for development in the sector and give a clear indication for emphasizing on the stock level at the case company. The need for agricultural machinery increases in the country because farmers look beyond their need for immediate consumption, so the production of agricultural machinery is important in Ethiopia. Most of the assembled parts of the agricultural machinery come from abroad and the level of inventory increase in the warehouses from time to time also the finished products or machinery are seen at the company for a prolonged time. The fluctuation in the demand and supply of products increases the need for effective inventory management at the AAMI by using inventory management techniques. Finally, this research gives additional ingredients for the policymakers and future studies that focus on inventory in the sector.

1.6 Motivation of the study

I was inspired to submit my idea since there are several expenses associated with the AAMI high number of assets and location issues. For instance, delaying the delivery of a finished product to the client would result in rework and expenditures. The standard will be defined when I import

items to generate products, thus it costs a lot to make a tractor. The objective is to research sustainable inventory management in order to solve issues based on the below Figure

Figure 1.1 Industry uses of raw materials

1.7 Thesis Organization

A general system for the Investigation sustainable inventory management system is the system that this thesis proposes.

1. Introduction
2. Problem Definition, Proposed Methods, Research Objectives, and Thesis Outline.
3. Literature Review
4. System Analysis
5. Results
6. Conclusions
7. References

CHAPTER -2

LITERATURE REVIEW

2.1 Introduction

Nowadays numbers of manufacturing industries are alarmingly increasing as one of the implications of world globalization. The powerful competitions within the industries make productivity a topic of high interest. Productivity which is a measure of the efficiency of the transformation process and defined in various ways by different fields of industrial management study (Kemal, 2018). Inventory management plays a vital role during the competences of different industries. The studied the way to increase the company performance, for which inventory management is crucial to maintain it.According to (Ilyas Masudin, 2018), this author examined inventory management and procurement practices and their impact on organizational performances; financial performance and customer satisfaction of the company.

The result of the analysis done by (Kemal, 2018). Showed that flexibility in inventory control management is an important approach to achieve organizational performance. The study found that inventory management enhances organizational performance. In addition he found that organizations benefits from inventory control management by way of easy storage and retrieval of material, improved sales effectiveness, and reduced operational cost.

Materials Requirements Planning (MRP) and Just-in-Time (JIT) are currently two inventory control methods mostly used in many companies as manufacturing technologies (Lim, 2018 & Shang, 2008), has reviewed that factors such as management support, market strategy, organization climate, vendor support, experience with IT systems, and company size and age successfully affect the implementation of MRP.

Inventory exists in different ways such as raw materials, partially finished goods (work-in-progress), and finished goods, an organization maintains to meet its needs. Inventory is commonly a sizeable investment and a potential source of waste that needs to be carefully controlled in the industry's resource management system. Inventory is defined as a stock of goods that is maintained by a business in anticipation of some future demand (Mehmet and Mustafa, 2019).

The quantity to which inventory must fall to signal that an order must be placed to replenish

an item. Using an extension of a standard inventory-dependent demand model provides a convenient characterization of products that require early replenishment. The optimal cycle time is largely governed by the conventional trade-off between ordering and holding costs, whereas the reorder point relates to a promotions-oriented cost-benefit perspective. The optimal policy yields significantly higher profits than cost-based inventory policies, underscoring the importance of profit-driven inventory management. To work towards perfect order metrics, there has to be aggressive inventory management, restructuring supply chain operations, and updating standards to the perfect standard. When updating the metrics, this would include the cases shipped and the orders on-time delivery, data synchronization, damages, and unusable products, days in supply, the ordering time cycle, and shelf level of service (Sarkar and Tayyab, 2018).

2.2 Inventory Management

Inventory management involves different activities which are performed by management and inventory controllers to minimize handling cost, maintain production, constant stock, and reduce a loss (Ilyas,2018). Accordingly, there are different types of inventories exists such as

- **Buffer Inventory** is also called the safety stock. This kind of inventory is for when unexpected or uncertainties of demand and supply arise.
- **Cycle inventory** is for when the stage in the process is unable to supply according to the demand, the build-ups of inventory products are available while processing the other products.
- **Decoupling inventory** happens when the working stages can function reasonably and independently.
- **Anticipation inventory** is accumulated for future demand and unanticipated supply interruption.
- **Pipeline inventory** exists due to material cannot be transported all at once.

Holding best possible levels of inventory is very essential in any organization, this is due to having too much of inventory will create holding costs on inventory such as (space rent costs, costs of decision making, old unused stock costs, damages, theft) and insufficient inventory is very costly as consumers may stop supporting the organization but go to competitors Gardner and Diaz 2002). The primary aim of good inventory management is to excel in customer

satisfaction and offer vital customer service in control of the lowest everyday inventory costs. Good customer service is resulted from ordering the right materials and quantities of the stock at the right time.

Inventory optimization tools assist organizations to generate consistent decisions on the ordering of products. Making these correct decisions increases efficiency by improving the forecasting of future demand Creating, applying, and managing of processes, procedures, and systems are all purposes included in the inventory management. They are the two most known systems to inventory management, which are; the periodic and continuous (perpetual) inventory systems (Plaza and Shirazi ,2018). In a continuous inventory system, the purchase order is placed for the continual quantity each time the inventory on hand reaches the reorder point level, whereas, in the periodic inventory system, purchase order is placed for a variable quantity after the definite fixed time interval. According to continuous system is normally used for Class A items, which are about the great percentage of the total value of the inventory on hand. The Class A inventory on hand should be as low as possible and safety stocks put at minimal. It is all about the accurate demand estimations. Demand is uncertain mostly due to changes from purchase orders and unpredictable events.

Inventory problems of too much or overage of inventories as well as shortage or too small inventories on hand can cause business failures in the manufacturing sector as well as service sector. If an organization experiences stock-out of a critical inventory item, production could stops. Inventory management indicates the broad frame work of managing inventory. The Inventory management practice is highly important to determine the optimum level of inventory and finding answers to problem of safety stock and lead time. Inventory management has highly developed to encounter the growing challenges in most Business and this is in response to the fact that inventory is an asset for proper utilization of resources. The inventory management is also a continuous flow that starts from the raw material preparation up to packaging, warehousing and other finishing work but also work in progress in very important tool to add features at each stage in the production lines (Tijesh and Neeraja,2018). The Figure 2.1 shows the flow of inventory from the raw material up to finished goods as shown below.

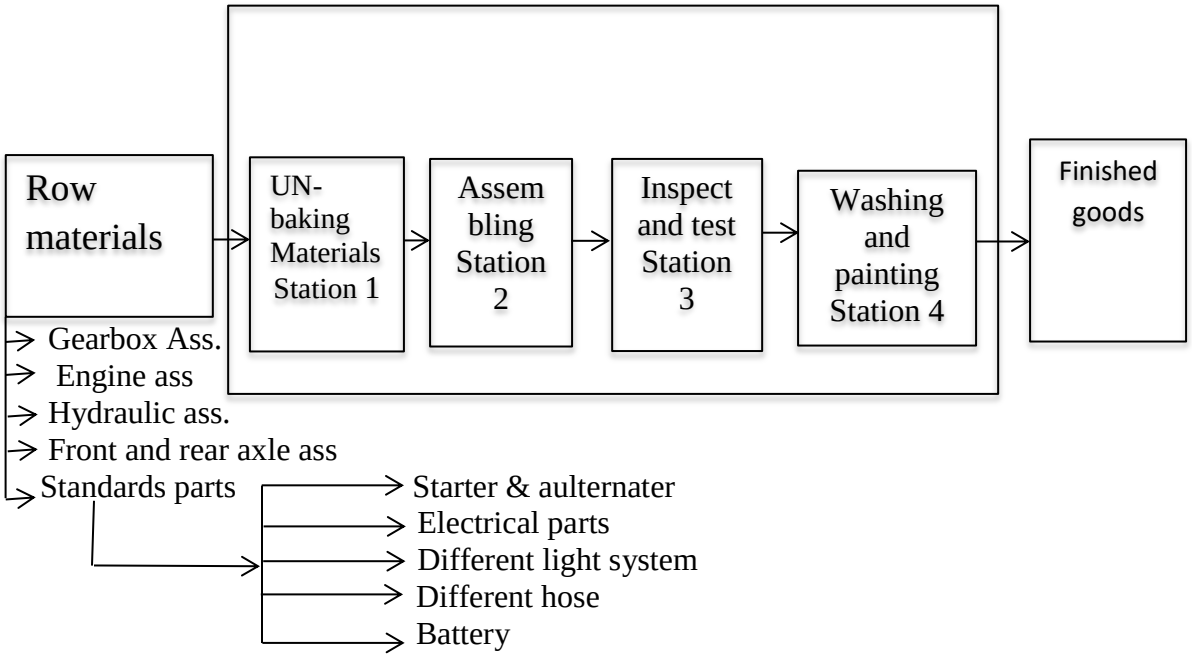


Figure 2.1 Different types of inventories in the production lines

The key determination on all inventory models is about answering the primary questions; how much to order and when to order. Inventory fulfills many important functions in an organization and to keep total costs at minimal. Inventory model like; economic order quantity (EOQ), is for the purchase order that are placed at fixed order quantity and that helps with minimizing the total inventory cost. Explains three types of inventory costs, inventory costs are different according to the type of the business and extremely high (Kemal, 2018) and the acknowledgement generally is that carrying/holding costs represent a quarter (25%) of on hand inventory value. The three types of inventory costs that are alarms the inventory model are; carrying costs, ordering costs, and shortage costs.

2.3 Inventory costs

Lower inventory cost is certain benefit for the organization that successfully controls the inventory. When making inventory management decisions of any nature, there are costs that need to be considered. Effective inventory control cut down these costs since it cuts the total volume of inventory required to operate the organization. Inventory control checks and tracks the levels of inventory and proactively manages obsolescence and deterioration by ordering in

proper volumes (Anh chi phn,2019). When the costs are up so is the inventory levels and the direct and indirect costs will be measured. The following costs have to be considered:-

Holding (or carrying) costs:- This kind of cost broadly covers most kind of costs that are caused by storing stocks, the stock will need to be taxed, security and insured against theft and natural disasters, and there will also be the obsolescence and depreciation of stocked items.

Setup costs (also known as production change costs):- For production to change from one batch of product to another different batch of product is about acquiring the material needed and organizing the production machine for setups and also cleaning out material used from the previous batch.

Ordering costs: - This type of cost is about the administrative costs in dealing with creating a manufacturing or procurement order. Ordering costs take into account all the information, for instance checking the products when delivered, and computing manufacturing or procurement order quantities. A system that deals with tracking of orders is included in this type of cost.

Shortage costs: - When there is stock out, there will be placing of procurement order or cancellation of an order and this will cause waiting for the stock. When demand is not achieved is referred to as stock out and it causes orders to be cancelled. According to (Soni and Bhavshr,2016), effective inventory control impacts on storage costs by reducing the costs, which is ordering enough inventories to fulfill the demand of consumers.

2.4 The inventory classification models

Different types of inventory classification found in industries for resource management and to take measures which was helpful to overcome the challenges in inventory management and control. These help the company to allocate time and money, to deal with multiple product lines, and multiple stock-keeping units. The Commonly used inventory classifications models are the ABC analysis and the Critical Value analysis but also other types of inventory classification and management techniques exists some of the techniques briefly described in the following section.

2.4.1 The ABC analysis

In ABC analysis inventories classified in to three sections the A-items, B-items and C-items, the products in the company are to be categorized based on their importance. The ABC system is a widely used classification technique to identify various items of inventory for purposes of

inventory control and effective resource management. On the basis of unit cost and the amount or quantity, the various items are classified into 3 categories:

A-items consisting of items with the large investment,

B-items, which stands mid-way between category A & C and

C-items are relatively takes less investments but large number in quantity.

Category A needs the most rigorous control, C requires minimum attention and B deserves less attention than A but more than C. The ABC stock control technique relies on that the decision a little bundle of the things may usually address the weight of money estimation of the total stock. It is used as a part of the era method, while a tremendous number of things may happen from a little part of the money estimation of stores (World Bank, 2012). Accordingly, to manage stock control high regard things are more solidly controlled than low regard things. ABC examination is an essential action method that follows the Pareto Principle concerning an organization's arrangement of stock. Most organization attempts and oversights are depleted on managing A things. C things get the base thought, and B things are in the centers. The ABC approach ranks using the following criteria: according to (Dhoka and choudary,2013), the A-items represent 70–80% of the firm's annual consumption approximation in value and just 10–20% of aggregate stocked items. B-items represent 15- 25% of annual use esteem and 30% of aggregate the stock, and C-items characterize 5% of the annual application of esteem and half of total stocked items.

2.4.2 The critical value analysis (CVA)

The critical value analysis pays more attention to C items. Similar with ABC analysis, it ranks products based on importance but, critical value analysis (CVA) analysis products classified based on stock out rates. Priorities for the items are given in five ranges and stock out rates in percent are assigned for each category.

Top priority: critical item and no stock outs are permitted. Therefore, have 0% stock out rates.

High priority: essential item, but limited stock outs are permitted. Therefore, have 3% stock out rates.

Medium priority: necessary item, but occasional stock out permitted. Therefore, have 5% stock out rates.

Low priority: desirable item, but stock outs are allowed. Therefore, have 10% stock out rates.

Lowest priority: needed item, but stock outs are permitted on a wide basis. Therefore, have 15%

stock out rates.

2.4.3 Economic ordering quantity (EOQ)

This is the most common method to find out how much to order and not feasible and advisable for complex systems. The choice of inventory control technique was based on factor such as usage, simplicity etc. Economic ordering quantity, EOQ (push type) model is based on the assumption that demand is constant, no shortage and the lead-time is zero or constant (Maddah and Jaber,2008). These assumptions are not faced in real life applications. It does not consider demand pattern of the end product before determining the inventory levels of parts and materials. This mathematical approach balances between holding and ordering costs and gives the order level where total costs are minimized.

According to (Maddah and Jaber,2008), one of the major inventory management's problems to be resolved is how much inventory should be needed and when inventory shortage and overage seen in industries, if the firm is buying raw material. If the firm is planning a production path or manufacturing activity the issue is how much production or how much to make, those problems are called order quantity problems. And the task of the firm is to determine the optimum or economic order quantity determining on optimum inventory low involve two types of costs. I.e. ordering cost and caring cost. Economic order quantity (EOQ) is inventory level that is intended to reduce the total ordering cost and caring (holding) cost. Ordering cost increase with the number of orders thus the more frequently inventory, on other hand it the firm maintain large inventory levels there will be few orders placed and ordering cost will be relatively small thus ordering costs decrease with increasing size of inventory (Huang,2017). Caring cost vary with inventory size. This behavior is control to that of ordering costs which decline with increase in inventory size; the economic size of inventory would thus depend on tradeoff between caring costs and ordering costs.

Economic Order Quantity is the Inventory management technique for determining optimum order quantity which is the one that minimizes the total of its order and carrying costs. In the given Table the EOQ & the number of orders purchased per year for various components are calculated. The calculated EOQ is compared with the number of units of each component purchased in the organization. It is found that, there is a variation in the EOQ & number of unit purchased. It is understood that the company is not following EOQ for purchasing the materials

& therefore the inventory management is not satisfactory.

There are two major cost associated with inventory. Procurement cost and carrying cost. Annual procurement cost varies with the numbers of orders. This implies that the procurement cost will be high, if the item is procured frequently in small lots. As stated in (Huang,2017). The annual procurement cost is directly proportional to the quantity in stock. The inventory carrying cost decreases, if the quantity ordered per order is small. The two costs are diametrically opposite to each other. The right quantity to be ordered is one that strikes a balance between the two opposition costs.

According to (Rodrigus,2015), the inventory management needs to be organized in a logical way so that the organization can be able to know when to order and how much to order. This must be attained through calculating the Economic Order Quantity (EOQ). Monetary request amount engages correlation to arrange their stock re-establishment on an ideal premise. For instance, the arrangement can be scheduled to happen from month to month, quarterly, half yearly, or yearly. By so doing, it enables firms to have insignificant limit costs or zero inside their circulation focuses. Along these lines, as associations attempt to enhance the stock administration, the EOQ and Re-Order Point (ROP) are necessary instruments that associations can utilize.

2.4.4 Material Requirement Planning (MRP)

The Material Requirement Planning (MRP) model determines the demand of a product using orders obtained from the sales department (Mabert,2007). Inventory levels are then calculated using these figures and the cost inputs from the purchasing department. It forecast demand of manufactured product into a schedule for obtaining components, subassemblies and raw materials to avoid the items in inventory. It emphasizes on a realistic master production schedule to coordinate the production stages in terms of volume of production that prevents slack in order. It calculates dependent demand and prevents creation of superfluous inter stage slack due to unbalanced lot sizing of matched set of parts. Thus in this approach only safety stocks are allowed to be in inventory. It decides when to order and quantity how much to order and orders are made as late as possible to avoid stock out.

2.4.5 Just in time, (JIT)

The JIT technique is a Japanese philosophy, rationality associated with assembling which comprises having the right things in the right quality and amount in the correct place and at the

opportune time. Utilization of JIT technique brings about the increment in quality, profitability, and effectiveness, enhanced correspondence, and abatements in expenses and squanders. [18], Characterizes JIT as a process that is prepared for moment response to the request without the necessity for any overstocking, either in the desire of the application being approaching or as a concern of improvident characteristics all the while.

According to (Mackelprang,2010), additionally concentrated on that the prime objective of JIT technique is the accomplishment of zero stock, not simply inside the bounds of a single association at the end of the day all through the whole production network. It can be connected to the assembling procedure inside any organization as it is additionally being adjusted inside administration associations.

The components of JIT technique incorporate consistent change, taking out the seven sorts of squanders among others. The fundamental reason of JIT is to have as of late the proper measure of stock, whether rough materials or finished stock, open to meet the solicitations of your creation strategy and the solicitations of the enterprise's end customers. The less a firm spends to store and pass on the stock, the less obsolete quality it has to markdown (Mackelprang,2010).

Just in time, JIT (pull type) model takes into consideration of various uncertainties in the industry such as machine failure, demand fluctuations, stochastic set-up times and random yields. It has meant for producing with minimum waste. Waste is taken in its most general sense and includes time and resources as well as materials.

2.5 Uncertain demand

Uncertainty causes great challenges in production planning and control. Inventory system models take into account that there is certain or uncertain demand and supply. However, reality is demand changes at all times caused by the changes on orders, random capacity of suppliers and unpredictable events such as weather, machine breakdowns and human errors (Lim,2018). When we discuss uncertainty, safety stock is required to cover the possibility of stock outs created by uncertain demand. When there is demand uncertainty, the use of constructed EOQ on regular demand will most highly influence on stock-out. Thus, to overcome the threat of stock-out is by increasing the reorder point by putting extra stock which is safety stock. The spare stock preserved to cover the possibilities of stock-outs which may be caused by supply or demand variation is defined as logistician's expression in safety stock terms (Shang,2018). Safety stock is

extra planned on- hand inventory that guards against the possibility of stock outs.

2.5.1 Stock level

According to Ilyas Masudin,2018), optimizing of the stock level is one of material management techniques. In order to save over stocking or under stocking most of the larger companies adapt scientific approach of fixing stock level. Under stock is when the material in stock is below the required amount over stocking is when excess materials are held in store by the business organization. Therefore each item of materials should be kept within the appropriate level of materials by fixing stock level. The stock level is re order level, minimum level, maximum level and economic order quantity or reorder quantity (Ndivhwo and Charles,2017). Maximum level is the material at the lowest rate of consumption which could be expected, if delivery was received in shortest possible time. The additional of the reorder quality shows the highest point of material which would be allowed the formula that determines maximum level is as follows.

Reorder point is the problem how much to order is solves by describing the economic order quantity. Yet the answer should be thought to the record problem when to order. This is the problem of determining the reorder point. The reorder point is that inventory level at which on order should be placed to replenish the inventory. To determine the order point under certainty to be should know lead time, average usage and economic order quantity.

Lead time is the normal takes in replenishing inventory after the order has been placed by certainty that means usage and lead time do not fluctuate under such a situation reorder point is simply that inventory level which will be:-

Reorder point: - Lead x average usage safety stock. It is difficult to predicate usage and lead time accurately. The demand for materials may fluctuate from day to day or from week to week. Similarly the actual delivery time may be different the delivery problem of stock out. Some minimum or buffer inventory as cushion against unexpected increased and delayed on delivery time. Record level is the level of materials at which purchase requisition is initiated for fresh supplies this level is fixed by reordering when materials fail to the minimum.

2.5.2 Safety stocks

Safety stocks are the minimum additional inventories which serve as a safety margin to meet an unanticipated increase in usage resulting from an unusually high demand and an uncontrollable late receipt of incoming inventory. Actual demand is commonly given for each component for a

period of 1 year and the lead-time is calculated at a maximum of 100 days & normal of 60 days and these were converted into per annum (Tejesh and Neeraja, 2018). So, from calculation of safety stock, we can able to determine how much the company can hold the inventory in reserve stock per annum.

2.6 Vendor managed inventory

Vendor Managed Inventory is a streamlined way to deal with inventory management and request satisfaction whereby the merchant is completely in charge of the recharging of stock in light of opportune point of all data to the purchasers (retailer). This idea builds the client responsiveness by lessening the free market activity hole consequently giving the fulfillment to end client by benefiting the coveted item when required. Store network accomplices must share their vision of interest, necessity, and requirement to set the regular destinations. According to (Vrat,2014), the author identifies that upstream information exchanged to suppliers such as the current stock level and precise deals conjecture is the most vital element for the effective usage of Vendor Management Inventory.

2.7 Inventory management practices and organizational competitiveness

Inventory management is very crucial to any organization that is improving on its performance and attaining high levels of customer satisfaction. According to (Nzuza,2015), the material held by an organization makes up for most of the organization assets. Most organization invests so much money in materials and it is important for the organization to put in place a good material management system in order to manage the stock properly. Poor inventory management system can negatively affect the profitability of an organization. The management has very devastating effect on the performance of the organization about the material management system put in place to determine the performance of the said material and the general performance of the organization.

In most cases where inventory management decisions have been effective, inventory planning models have been developed and implemented focusing especially on the twin problems of inventory size and timing. Usually, inventory management models are designed to achieve a balance between the costs of acquiring and holding inventory and in so doing it makes it possible to know whether companies are earning profits or not. Variability of inventory majorly results due to firms not applying the inventory control systems in accordance with the baseline

principles. According to (Ogbo,2014), the information flow between leaf collection centers and factories is inadequate contributing significantly to high operational costs. Inventory of tea leaves is a requirement for the efficient operational performance; hence, inventory needs proper control as it is one of the largest assets of the factory. To excel in competitive environment, companies have to design and operate materials management and product distribution functions effectively.

Inventory control systems enable a business to determine and maintain an optimum level of investment in inventory in order to achieve required operational performance. (Ogbo,2014), Expressed that the inventory management of inventory control is to meet customer demand. Further, the author argues that to meet customer demand, firms have to ensure that stock-outs are avoided without incurring high inventory costs. Stocking level variability is caused by factors such as deficient information sharing and deficient forecasts. He found out that variability of inventory majorly results due to firms not applying the inventory control systems. His stated enumerated the effects of inventory variability as inaccurate forecasting leading to periods of not having enough capacity leading to inadequate customer service and high inventory costs.

2.8 Lean theory

Lean theory is an augmentation of thoughts of JIT. The theory disposes of buffer stock and minimizes waste in production procedure. Inventory leanness decidedly influences the productivity of a business firm and is the best inventory control tool. The theory expounds on how manufacturers' adaptability in their requesting choices diminish the supplies of stock aimed at eliminating costs associated with the transportation of inventory. Feedback presented against the theory insinuates that materials must be available when dealing in long haul cooperation constituting data and information sharing and the exchange of accomplices between firms.

2.9 Research gaps

Table 2.1 Summary of reviewed literatures

No.	Author's	Criteria	Methods to be Used
1	(Mitra, Pattanayak, Bhowmik, 2015)	Impact, IM Annual Consumption and Unit Price	ABC and HML Analysis
2	(P.S. Vaisakh, J. Dileeplal andm V. Unni, 2021	Average Stay, Consumption Rate and	FSN and VED Analysis

		Criticality	
3	(Thomas, and Jayakrishnan, 2015)	Annual Consumption Value, Criticality and Seasonal/Off seasonal Availability	ABC,VED and SOS Analysis
4	(H. Soni, Jayeshkumar Piroda, and J.J. Bhavshar, 2016)	Annual Consumption, Availability , Order and Inventory Carrying Cost	ABC, SDE and EOQ Analysis
5	(J. Bulinksi, C. Waszkiewicz, and P. Buraczewski,and ke'emers.J 2013)	Cumulated Sales Value and Rate of Selling	ABC and XYZ Analysis
6	(Dhoka, and Choudary, 2013)	Sales Data	ABC Analysis
7	(S.A. Sagar, and K.N. Agrawal, 2015)	Annual Consumption , Criticality, Lead Time	ABC,VED, XYZ Analysis
8	(Ndivhuwo Nemtajela and Charles Mbohwa, 2017)	Relationship between inventory management and uncertain demand for fast moving consumer goods organizations	Used descriptive research method
9	(M.keshavarz Gharabee,EK Zavadskes 2015)	Multi-criteria ABC analysis using artificial-intelligence-based classification techniques	ABC Analysis

Most of the researcher's focused on inventory management in the manufacturing and service sectors, but achieving efficient inventory management is far from achieving the required performance level. In the research gap, the selected research papers were compared to select appropriate methods of inventory management. Still, traditional inventory management techniques are used by different authors to solve a related problem which is poor inventory control systems in industries. Some of the authors used one critirion for inventory management systems, but at the same time, other authors suggested using multiple criteria for inventory management to fully understand the constraints from different perspectives. From the Table, 2.1 researches, fully understood the constraints from different perspectives. In this research, the analysis of improving the inventory management system at AAMI will be performed.

CHAPTER-3

MATERIALS AND METHODOLOGY

3.1 Description of the study area

The study was carried out at the AAMI in the Oromia regional state; the AAMI was established to support the country's agricultural industry by producing agricultural machinery like tractors and other parts that were mounted on the tractors and other components that were installed on the tractors. Stock levels changed often in the event that the company and the industry have a troublesome inventory handling system as a result of the firm's insufficient inventory management methods.

3.2 Sources of Data

The present study uses both primary and secondary data. Primary data is collected from the AAMI employer's mainly intended to answer the specific objectives as mentioned in chapter one. The sample size was determined to distribute the questionnaire and interview result and detail analysis made by using different kinds of statistical tools. The other means of data collection tool is the secondary data's from the factory documented files or reports from 2012-2014 E.C.

3.3 Research Design

This study emphasis on the sustainable inventory control and management the brief explanation about how the desired information was collected, analysed and interpreted was explained in this section. The research methodology included the data collection methods such as primary and secondary data sources. The data's were included the questionnaire, the interview, review of related reference materials and organization documents. The collected qualitative data were analysed by using simple descriptive statistics like frequencies, percentages and graphs. For the case of determine which factors are highly contribute to the effect of inventory management the factors are categorized. The qualitative data which were gathered from focus group discussion and interview was interpreted qualitatively. The interpretation and discussion were made to-gather by using the collected data's and the documented data's are very important tools for using

different types of inventory management techniques like ABC analysis. The raw material, Work in progress (WIP) and finished goods are the main component of manufacturing industries inventories so by using ABC analysis inventories categorized depending on their value and quantity. By comparing the existing inventory management techniques in the case company the appropriate strategies was forwarded to overcome the challenges in the inventory control and management system in AAMI. The Figure 3.1 shows the research design frame work.

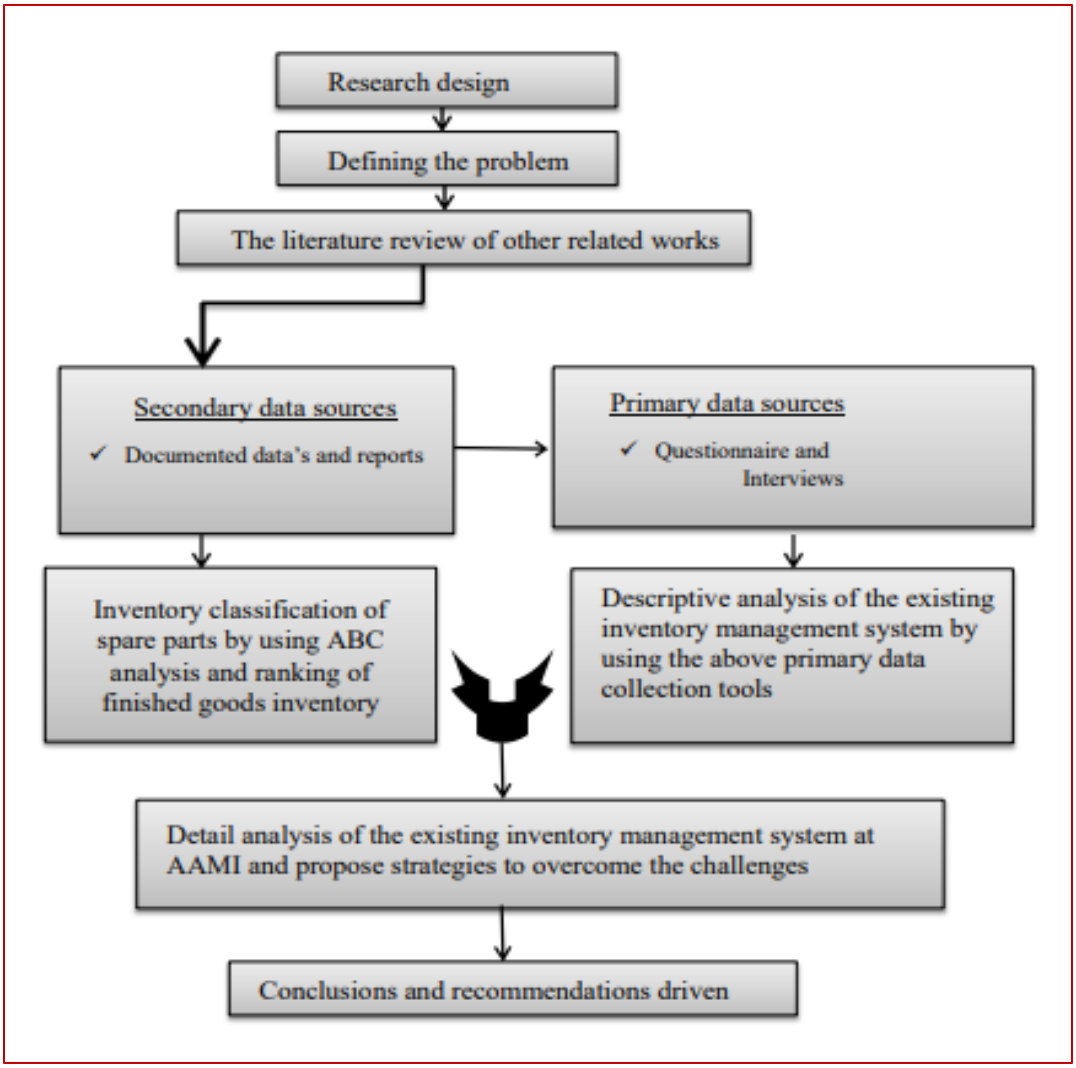


Figure 3.1 Research design

Finally, based on the outcome of the analysis, there was a simulation model is developed to check which alternative scenarios is selected to use optimal ordering point, target stock,

customers dissatisfactions and inventory on hand. Finally summary conclusion and recommendation is to be provided.

3.4 Data collection

The primary and secondary data used in this thesis was explained as follows.

- **Questionnaire**: - the researcher used questioner for data collection to detect challenges in the inventory management system in the case company. The questioner was organized and distributed for workers based on the sample size
- **Interview**: - the researcher also used the interview as a data collection method to answer questions related to the existing inventory management system and other related factors which affects the system. Experienced workers and well aware skilled man powers selected for the interview
- **Observation**: - data collection for research through observation of the factory and material's stores.
- **Referring documented data: -** the researcher has referred to the documented data of inventory at the case company to get the essential data. The aim of referring these documents were, to collect the data which is related to the case company background, the above listed factors are key tools for classification of inventories based on the ABC analysis. The brief description about ABC analysis and the techniques which were used for data analysis mentioned in the next part.

3.5 Sample size

The total population size of AAMI workers was 487 mainly regular workers considered to undertake the total population size. As shown in table 3.1 population sizes of 487 was lies between **281-500** based on the population size the researcher used **39** as a sample size by considering time and cost constraint's. The selected sample size exists nearby the medium possible sample size by considering the above conditions the sample size determined. To determine the sample sixe the researcher preferred to use a sample size developed by [4] as sited in (Endashaw,2016). As shown in Table 3.1 sample size of 39 lies above the low sample size and around the large sample size. Also the range of different population size is stated as follows;

Table 3.1 Sample size determination

POPULATION SIZE	Sample size		
	low	Medium	Large
51-90	5	13	20
91-150	8	20	32
151-280	13	32	50
281-500	**20**	**50**	**80**
501-1,200	32	80	125
1,201-3,200	50	125	200
3,201-10,000	80	200	315
10,001-35,000	125	315	500
35,001-150,000	200	500	800

3.6 Data Analysis Methods

This research used descriptive method of data analysis. Here the data values will be transformed in to understandable form and it will be ready for interpretation. To do so, the data will be summarized; categorized and rearranged data will be tabulated to indicate the event. Percentages, cumulative percentages and frequency distribution data interpretation will be in a logical sequence to processing and analysing, for such work SPSS analytical software can be used. After generalizing the planned data it will be edited, summarized and rearranged according to the obtained response having done such analysis it will be presented by charts, Table and percentage. Among from different types of inventory management techniques the researcher used the ABC analysis technique to classify the inventories.

3.6.1 The effect of poor inventory management system on the production

Production process mainly depends on the availability of raw materials inventory at the required quantity and time. Providing the adequate raw materials to the production line is very important task to process without delay and interruption of material shortage inventories classified as raw materials, work in progress and finished goods so shortage of raw material inventory affects the

performance of the production line and which decreases the final output. So if the inventory not properly managed it greatly affects the performance of AAMI and disorder the material storage system. Currently manufacturing capacity of AAMI was very high but quality of manufactured tractor machineries is vital. So structural building of manufacturing industries to produce quality and durable product were the basic requirements of industries to be competitive in the market. The last type of inventory is finished goods inventory as shown in the Figure 3.2 products like walking tractors and highest horse power tractors are shown

Figure 3.2 Poor management of finished products inventory in AAMI

CHAPRER-4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter basically consists of the results and discussions interpreted depending on the data gathered from the survey, interview and document analysis of inventory management at AAMI. In this chapter, results of different types of different types of data sources discussed and then factors affecting the sustainable inventory management were identified. Therefore depending upon the collected data, different statistical tools and graphs are developed to clearly understand the data.

4.2 Demographic Profile of respondents

The study analyze the background information of the respondents by using parameters of experience in the company this can be helps to know how much the respondents aware about the inventory practice of the company. The experience of employee's at the case company is the important determinant factors for examining the adequate data and to increase the confidence of the responded answers for further analysis. The experience of the respondents was shown in the Table 4.1 as shown below

Table 4.1 work experience of the questionnaire respondents

Work experience		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 1 year	5	12.8%	12.8%	12.8%
	Between 1-5 year	11	28.2%	28.2%	41.0%
	Between 5-10 year	17	43.6%	43.6%	84.6%
	More than 10 years	6	15.4%	15.4%	100.0%
	Total	39	100.0%	100.0%	

Table 4.1 shows the questionnaire respondents of AAMI employee work experience frequency and percentage table with regard to the work experience within a group, the highest value or 17(43.6%) of the respondents are 5 to 10 years of work experience, followed by 11(28.2 %) of

the respondent experience have between 1 to 10 years of work experience, and 6(15.4 %) of the respondents have more than 10 years of work experience and the remaining 5(12.8%) of the respondents have experience of less than 1 year, the above table shows around 72% of respondents have experience of year between 1 to 10 and this fact increase the understanding of the existing inventory management system at the case company and strengthens the reliability of the collected data.

Educational level of questionnaire respondents also gives a strong reliability to the collected data especially if the employees have more experience on the work expected as highest confidence on the response provided by that individual. The other demographic profile was the educational background of the questionnaire respondents was revealed in Table 4.2 as shown below

Table 4.2 Educational levels of questionnaire respondents

	Education level	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under diploma	8	20.5%	20.5%	20.5%
	Diploma	16	41.0%	41.0%	61.5%
	Degree	13	33.3%	33.3%	94.9%
	Master's and above	2	5.1%	5.1%	100.0%
	Total	39	100.0%	100.0%	

As shown in table 4.2 8(20.5%) of the respondents have educational level of under diploma whereas 16(41%) of the respondents have educational level of diploma and the remaining 15(38.4%) have education level of above degree. Most of the respondents' educational level exist between diploma and degree which also strength the technical knowledge of the respondents towards the inventory management at the company.

Besides the experience of the questionnaire respondents the age group of the respondents was also important parameter to make sure about the respondents understanding capability towards the questions. The heterogeneity of the survey respondent's age group was an important for the quality of the collected data. According to (Andrews and Herzog, 1986) stated that when respondents age group increase the construct validity of measurement tends to decrease and two kinds of measurements errors random errors and correlated errors tend to increase. The

description of the respondent's age group, frequency, percentage and other relevant result which shows the respondents ager group was discussed in the Table 4.3 below

Table 4.3 Frequency of the age group of questionnaire respondent's

	Age group	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 30	5	12.8%	12.8%	12.8%
	30-40 years old	11	28.2%	28.2%	41.0%
	40-50 years old	17	43.6%	43.6%	84.6%
	More than 50 years old	6	15.4%	15.4%	100.0%
	Total	39	100.0%	100.0%	

The above Table shows the age group of the questionnaire respondents, the age group was subdivided in to 4 categories as shown in the table 4.3 the frequency and percentage of each group share was described. As shown in Table 4.3 around 28(71.8%) of the respondents have and age group which exists between the age group between 30-50 whereas the remaining 6(15.4%) and 5(12.8%) share belongs to the group more than 50 years old and less than 30 years old respectively .

4.3 Descriptive statistics

The questionnaire is the other tool for primary data collection from the distributed questions the respondent's reaction for the questions was described in the Table 4.4. In the questionnaire the researcher used the liker scale for the selected questions in addition to the open ended questionnaire. In the liker scale rated value from 1-5 given for the answers of the questions in which 1 describes very less effect, 2 for less, 3 for moderate, 4 for high and 5 for very high. The table includes the descriptions of the respondent's such as number of the respondents, minimum and maximum rated value for each question, mean or average value and standard deviation. The highest average value out of listed factors seen at the presence of manufacturing reliable and quality products to the customers and the respondents given mean value of 3.82 which means near to the highest performance and having a standard deviation of 0.914 which was out of the 39 questionnaire respondents. The respondents reply shows there is highest achievement in building customer trusts by manufacturing reliable and quality products to the market. The rate

of conversion of raw material inventory in to finished goods has mean value of 3.72 out of valid 36 questionnaire respondents and also the standard deviation of 1.059. In the Table 4.4 according to the descriptive statics of the existing performance of raw material conversion rate in to the finished goods exists in a good stand. Based on the questionnaire respondents the conversion rate was high but lack of proper market assessment most of the manufactured goods remain at the company without delivering to the customer. This shows the important of consideration raw material inventory as well as finished goods inventory for assessment of the inventory management system at the case company.

The AAMI manufacture different types of tractors for the agricultural sector and other departments like in the construction sector, according to the survey result the company manufacture durable and competitive products. The result shows out of 38 respondents the mean or average value of the ability of AAMI to manufacture durable and competitive products rated as 2.84 and which was close to 3 or means moderately manufacture durable and competitive products in the market and the standard deviation of 1.053. The mean value was moderate so it was important to build market oriented products and competitive agricultural machinery to reduce the overage of finished machinery inventory staying time in the compound of the AAMI. The market demand of machineries was very crucial precondition to determine the stock level and to allocate resource to all parts of the inventory classifications. So the response strongly indicates the need of effective utilization of inventories by manufacturing market oriented products. As shown in the table 4.4 the degree of substituting the import spare part inventory when shortage of the raw material inventory occurs rated mean value of 2.78 and a standard deviation of 1.004 put of 37(94.87%) respondent's. this statistics indicate the need of purchasing extra spare parts inventory because the ability of the AAMI to manufacture or to substitute the space was very less. The increase in the level of inventory in the warehouse is the other difficult fact for effective inventory management so careful management of inventory shortage and overage was very important to accommodate the difficulties in the lack of spare parts for substitution.

The survey questions include both positive and negative arguments. The application of effective inventory management techniques in the case company was less. According to the questioner respondent's as shown in Table 4.4 the mean rated value was around 2.69 which is less

compared to the amount of inventory handled by AAMI. Implementation of strategic and scientific inventory management techniques was very important tool to overcome such challenges. The need of effective inventory classification increase from time to time in the global market especially in massive inventory existing area, besides this for implementing those techniques the adequate and skilled manpower is very important ingredient to accomplish the need of success in the inventory classification and management in industries. Also in the Table 4.4 the descriptive statistics of the supply of raw material inventory was briefly mentioned. The table shows average of 3.23 rated values given for the supply of raw material inventory, which was more than the moderate and the supply of raw materials exists in a good way but still lack of foreign currency to accommodate for purchasing of raw materials seems a big challenge to import spare parts inventory from abroad.

The mean (average) of a data set is found by adding all the questionnaire response value in the data set and then dividing by the sum of total number of the questionnaire respondent's rated values. The standard deviation is used in the descriptive analysis to measures the dispersion of a data set relative to its mean value. If the data points are further from the mean, there is a higher deviation within the data set; thus, the more spread out the data, the higher the standard deviation. The other parameter used in the Table 4.4 were the minimum and the maximum sample values in the statistics and also called the largest and smallest least elements of the sample.

In general the descriptive statistics of the questionnaire was described in the Table 4.4 in which the total number of respondents (N), percentage of response rate (%), maximum and minimum rated values, mean value and standard deviation was described in the Table 4.4.

Table 4.4 The descriptive analysis of the selected questions

No	Statements or distributed questions	N	Percentage (%)	Minimum	Maximum	Mean	Std. Deviation
1	Manufacture reliable and quality products	39	100%	2	5	3.82	*0*.914
2	Manufacture durable and competitive products	38	97.44%	1	5	2.84	1.053
3	Supply of raw material inventory	39	100%	1	5	3.23	1.404
4	Rate of conversion of raw material inventory in to finished goods	36	92.30%	2	5	3.72	1.059
5	Level of customer complains in the quality of finished machineries	39	100%	1	5	2.79	1.056
6	Existence or shortage and overage of work in progress inventories	39	100%	1	5	2.36	1.063
7	Variability of the customer orders and production amount in the purchasing of raw material inventory	37	94.87%	1	4	2.24	0.895
8	Substituting the import spare part inventory when shortage of the raw material inventory occurs	37	94.87%	1	5	2.78	1.004
9	Application of effective inventory control technique	39	100%	1	4	2.69	1.004
	Valid N (list wise)	32					

As shown in Table 4.4 The level of customer complains in the quality of finished machineries rated mean value of 2.79 out of 39(100%) of the respondents and the standard deviation was 1.056. finished inventory was the connecting agent of the customers and the firm, so giving attention to the finished goods inventory was very vital. Quality of every manufactured goods commonly defined by the customer besides the aesthetics, most of the assembled and manufactured tractors specially before giving enough service to the customer the machinery failed to give the intended service to the customer this increase the complaint between the firm and the service users. The other challenge was the existence of shortage and overage of work in progress inventories. Commonly a lot of inventories bot seen at the production line or wore in progress based to the survey result out of 39(100%) of the questionaries' respondents the mean value of existence of shortage and overage of WIP inventory was rated as 2.36 and the standard deviation of 1.063. the Table shows there was less number of inventories seen at the production

line ore WIP inventory so the main problem mostly depends on the finished product quality because a lot of finished product seen at the company waiting of customer orders.

Mass production most commonly relies on the goods ordered before manufacturing or assembly of the given product. In the context of AAMI most of the finished goods stays for ling time at the compound of the company waiting for their respective new customers. The need of market not known so the production amount mainly determined by the market analysis. As shown in the Table 4.4 the variability of the customer orders and production amount in the purchasing of raw material inventory has less effect. The average or mean value calculated as 2.24 and a standard deviation of 0.895 and this shows the supply of raw material inventory affected by the need of finished good. The total number of respondent's for variability of the customer orders and production amount in the purchasing of raw material inventory 37(94.87%). So efficiency of resource management highly depends on the flow of inventories' starting from the raw material inventory to the finished goods inventory. Most of the loss on the resource seen at the raw material inventory because of lack of proper forecasting the need of the raw material not properly known to purchase spare part inventories.

Balancing the over and under stock condition is very important fact in order to determine the inventory level in industries. Most commonly the inventory management techniques in not considered in Ethiopia it is common problem for most of the industries. Based on the survey result 30 out of 39 of the respondents (76.9%) believes the existence of overstock in company, whereas 5 out of 39 (12.8%) opine that the overstock condition is not seen in the company and the reaming 4 out of 39 respondents (10%) have not reacted on this question. The following figure gives the clear descriptions about the existence of overstock in the company.

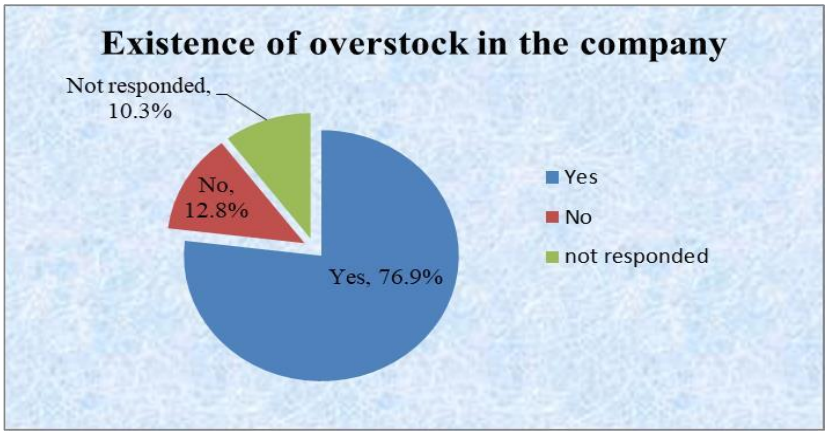


Figure 4.1 Existence of overstock in the company

As shown in figure 4.1 76.9% of the respondents reply was yes for existence of over stock condition in AAMI. The respondents also give causes for the existence of over stock condition in AAMI such as manufactured product not considered the market demand, stock purchased without appropriate study, stocks purchased without proper planning and problem of giving less emphasis to the customers demand are listed by the respondents as challenges for overstock conditions in the AAMI. According to the respondents reply continuing with this problem it was difficult to turn out to be effective, so this problem needs strong attention to overcome the problem. The respondents also give their possible solution taken to solve the problem among those increasing the delivery rate of finished product inventory to the users is the leading. Existence of stock more than the needed quantity is sometimes important in some extent to capacity of the ware houses and impact on management of capital investment.

Figure 4.2 shows the ability of AAMI to stay in the manufacturing for extra time without external supply of raw material inventory. The figure shows 31(79.5%) of the respondents replay yes for the staying of the AAMI independently for extra more time in the manufacturing process without the supply of raw materials from outside. The survey result also shows 6(15.40%) of the respondents replay as no and the remaining 2 (5.10%) not responded for the given question. The description of the survey result was given as follows in the figure below.

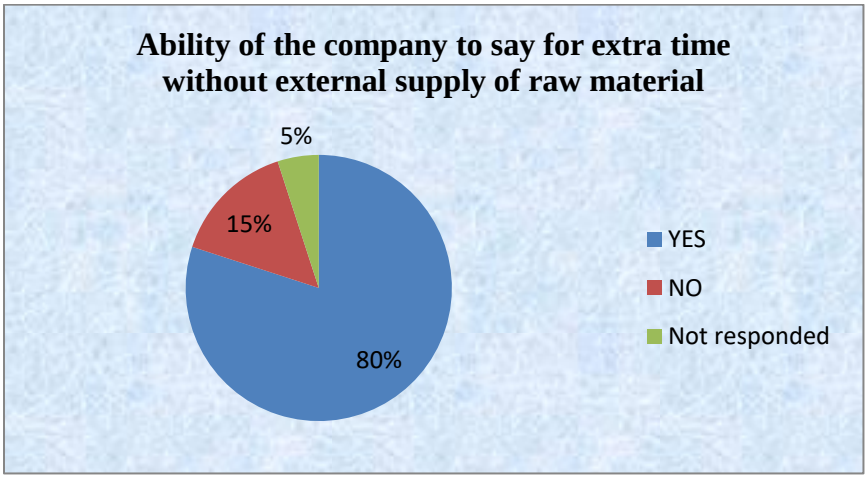


Figure 4.2 ability of the company to stay for extra time without external supply of raw material inventories

As shown in the Figure 4.2 around 95% responded for the given question. Besides the given description it was difficult to purchase all raw material inventories, so it is essential if selected parts manufactured in the company to substitute the import spare parts and also to reduce the foreign currency spend on the material. The respondent's give different types of reply for the reason of the company being in operation even the supply of raw material inventory cut suddenly. The reason forwarded for this statement was over stock level in the company.

4.2.1 Current Inventory Management System at AAMI

Inventory management is very essential tool to control material flows from the raw material up to delivery of finished goods. In the current AAMI condition a lot of inventories or over stock situation seen at the company because of the company purchase large amount of spare parts at once without proper market need and assessment. The problem of providing adequate material at the right time and quantity is the other problem which inhibits the performance of the case company. Most commonly the required spare parts purchased at once to reduce the cost of transportation from the international market. Sometimes spare parts shortage seen at the company but it seems impossible to purchase small amounts of products at the company, so it needs substitution of the given spare parts inventory by its own. Balancing the stock level is very essential thing in order to control and manage the over stock and under stock condition but this task is far from achieving in AAMI company because of existence of overstock condition. Warehousing of inventories was the other problem in the AAMI because tractor spare parts are large in size and it needs wide warehouses to store but still large amount of raw material inventories and other finished inventories randomly placed at everywhere. The need of tractor products increase from time to time throughout the country and the Ethiopian economy highly depends on the need of agricultural machineries to transform in to agricultural mechanization. Based on the market need it is important to focus on effective inventory control management system to increase the profitability of the company. In recent years companies not compromise in the customer satisfaction so it was important to manufacture market oriented products.

4.3 Interview result

According to the interview directed at the AAMI different kinds of challenges forwarded by the interview respondents. The interview questions asked for the case company senior workers because they are assumed to be aware about each kind of products related with inventory management system and its effect on the performance of the industry. Total 12 interview respondents are mentioned as follows in Table 4.5:

Table 4.5 The interview respondent's categories

No	**Work area of interview**	**Respondents**
1	Warehouse (storage)	4
2	Production department	3
3	Planning department	2
4	Purchasing department	3
	Total	**12**

As shown in the Table 4.5 the interview respondents selected from 4(four) department such as warehouse, production department, planning and purchasing departments. The interview results were discussed as follows:

- **What do you think of the company to remain competitive and profitable in the market for a future?**

The segment of Ethiopian agricultural machinery assembly that the AAMI industry founded. According to interviewees, the majority of them place a great focus on market analysis. In contrast to high cost industrial items, small priced industries are not as likely to fail if they employ mass manufacturing. If the manufactured tractors do not find a market, the industry will lose a significant amount of resources necessary for long-term survival. The interviewees said that production should be based on market demand, logistics supply trends should be more flexible, and manufacturing should follow current operation trends in order to be competitive in the market. The respondents' additional suggestions for remaining competitive in the market include manufacturing high-quality goods and operating inventory management tasks in accordance with fundamental principles and procedures. The responders have drawn attention to

the aforementioned points in an effort to address the issues impeding AAMI's inventory management system's effectiveness.

- **What type of agricultural machinery fabricated and is there any machineries that becomes impossible to fabricate at the current state of your company?**

The interview's findings indicate that the firm manufactures a variety of agricultural machinery, including small HP tractors, medium HP tractors, high HP tractors, and other parts installed on the tractor to plough. Some of the interviewees felt that the AAMI industry was capable of producing various types of tractors and other connected agricultural products, from the smallest to the largest tractors made at the case firm.

- **How long it takes for single and specific type of machinery to hand over customer following the date of order?**

According to the respondents' responses, delivery takes an average of three to four days, but can occasionally take up to 30 days, depending on the model and kind of goods. The only work involved in the items is personalized service and administrative tasks pertaining to finances. The client places an order and receives its products from the inventory of fabricated or completed goods, but this early manufacturing of machines before the customer order ran into significant issues managing the final goods. It is advantageous to let the spare part inventory remain in its place and fabricate when the order comes because early assembly of the parts, in the opinion of some respondents, is not advantageous because handling raw material inventory is easier than handling finished goods inventory

- **Does the “under stock ’’ can ever happen in the company?**

The stock level is a key tool for balancing demand and actual output. The productivity of industries is impacted negatively by both overstock and understock situations. The interviewees claimed that the AAMI faced neither a common difficulty related to stock conditions nor a substantial stock build-up in the instance firm. Additionally, a few respondents mentioned the existence of an inadequate supply of stock, particularly for raw materials, citing the scheduling and procurement process as a contributing factor. This condition might occasionally result in an inadequate supply of stock at an operational level. The company's efficacy falls as a result of the

factory's decreased capacity to produce goods and deliver them to the market. In the AAMI, the under sock condition was uncommon.

- **What documentation or reference do you have in the company to control the materials flow?**

The documentation of the raw material situation inside the organization aids in calculating the flow of materials within the organization and in taking action when there is a shortage of raw materials. There is no accepted practice of material documentation, according to interviewees. The majority of materials, especially finished items, are arbitrarily placed in storage units, which results in resource waste and the discovery of inventory in critical condition.

4.4 Application of inventory management techniques in the AAMI

Based on both the questionnaire and the interview result in this section the current inventory management techniques in the case company were identified. According to the questionnaire result the company tried to use effective inventory management techniques but not successfully implement those measures due to different kinds of problems. The application of effective inventory control technique in the AAMI have score 2.69 mean value and a standard deviation of 1.004 which means performs at the medium range in performance this shows effective inventory control and management techniques not applied fully in the company. Figure 4.3 shows the brief description of the existing inventory control techniques in the AAMI and described as follows

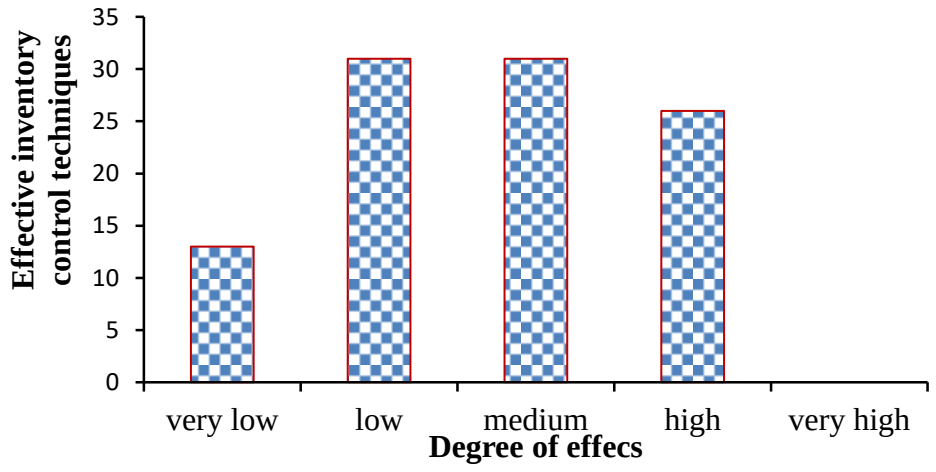


Figure 4.3 application of effective inventory control techniques (source: - survey result)

Figure 4.3 from the respondents 31% believes the currently existing inventory management performed at low. The remaining response for the statement of the application of effective inventory control techniques considers the AAMI performs at medium 31% share in percentage, respondents having high and low shares 26% and 13% respectively. This shows the application of effective inventory management system at AAMI exists in a medium performance. Whereas the interview result shows the over stock condition in the case company hinders resource management and increase difficulties in handling of materials. Based on the above problems the appropriate strategies forwarded to overcome the challenges in the AAMI Company.

4.5 Documented data from the AAMI

The effect of shortage and excess of the existing inventory strongly affects the production performance of industries. AAMI experienced this kind of problems in every quarter of the year both shortage and overage of inventories in manufacturing sector plays a tremendous role and in general, the inventory management in practical situations was complex. It is difficult or almost impossible to design a system that can handle every kind of inventory situation the Figure 4.4 shows the collection of finished goods inventory of tractors. As mentioned earlier the main products AAMI manufacturing is agricultural machineries based on this fact the planned production in the 2015 E.C was described as follows in the Figure 4.4 below

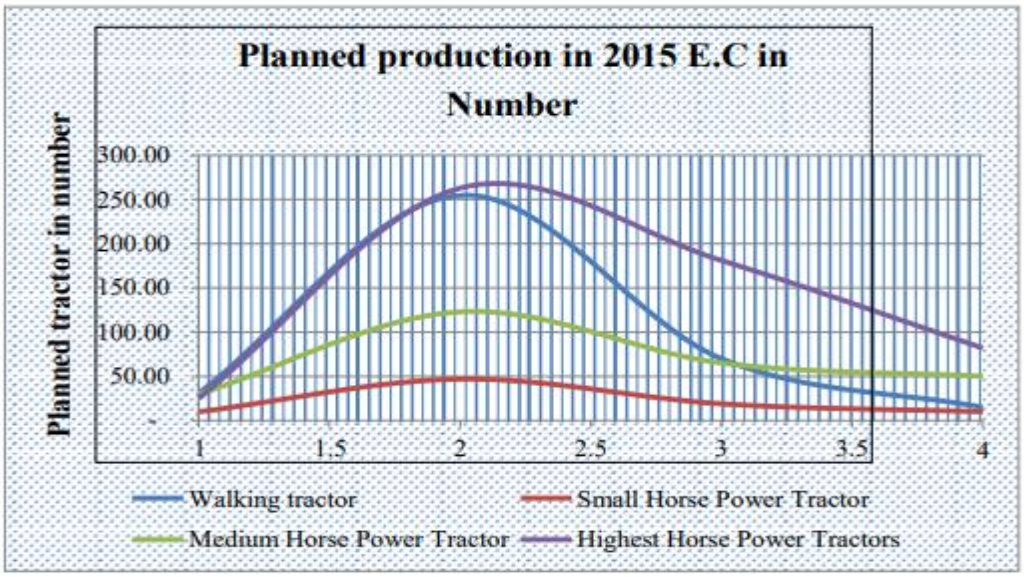


Figure 4.4 the planned production amount in the 2015 EC (source: - computed by using AAMI documented data)

As shown in the Figure 4.4 at the second quarter of the year the production of agricultural machineries increases ash shown in the yearly plan. Most of the time specially based on the previous year's projection the demand of agricultural machineries increase at the second quarter of the year. Highest horse power tractor and medium horse power tractors are the main products which were frequently needed by the customers and walking tractors was high but compared to the production of highest and medium horse power tractors it is less.

Figure 4.4 also shows the planed sales of highest horse power tractors commonly needed by the customers and the demand reaches its peak at the second and third quarter of the year. In the first and fourth quarter demand is the lowest in the yearly period of time. The planned production amount of all kinds of finished goods inventory of tractors in 2015 E.C was described in Figure 4.5 as follow:

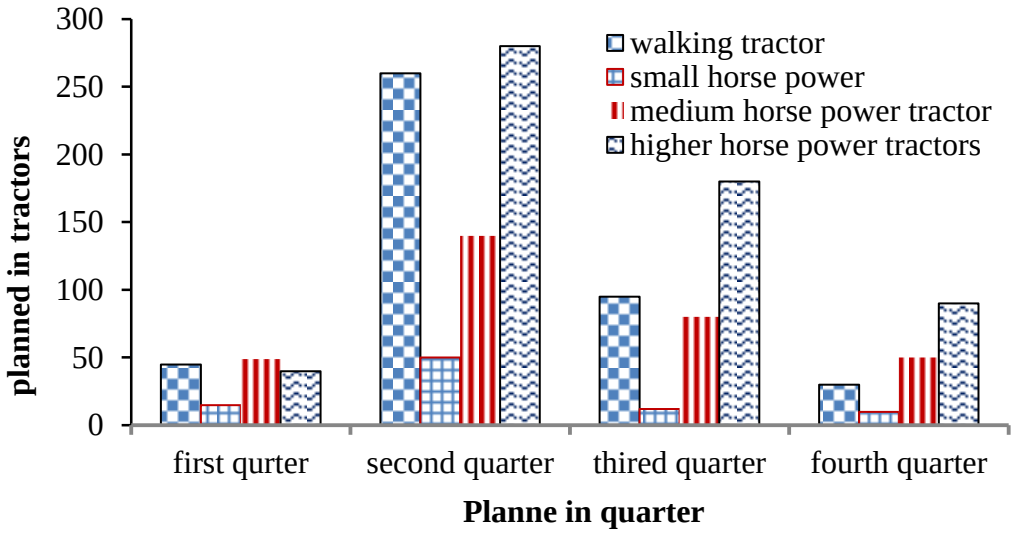


Figure 4.5 the planned sales of 2015 E.C (Source: - computed by using documented data from AAMI)

The second quarter of the year commonly experienced highest sales because in the fourth quarter of the year the finished goods or machinery strongly needed by the agricultural sector or by the customers. Sustainable inventory management plays and important role by reducing the effect of supply fluctuation and the unexpected market demand fluctuation. To maintain the gap the strong monitoring process on the sides plays an essential role to sustain the factory as a competitive in

the market. Under the operation given by the AAMI three industries exists but their manufacturing capacity and structural complexity different from one to another. The above problems increase the difficulties of giving services at the three industries to overcome problems of unequal manufacturing capacity and structural complexity of the three existing operational industries at AAMI.

The other problem in AAMI was the interfering of technical and repairing services of machineries given under the conventional lines at the case company. These increase the amount of inventory in the manufacturing line and decrease the performance of the company, so it is important to differentiate the repairing of machineries from the conventional assembly lines of tractors. The three manufacturing or assembly lines of tractors have faced difficulties of producing the required tractors in quality and quantity and the industries faced to produce products with lowest cost advantage to the farmers and the other sectors that needs the products of the AAMI machineries. AAMI manufactures tremendous amount of tractors for the market but lack of adequate spare parts and trained technicians for maintenances faced a big problem which decreases the relies of customers to purchase the products. After purchasing agricultural machineries a lot of complains comes from the customer side so it is important to upgrade the technical knowledge of the employee to solve problems raised after purchasing. From 2003-2011 E.C the industry product delivered to the market was 7066 tractors' and 7014 accessory tractor parts sold to the customer.

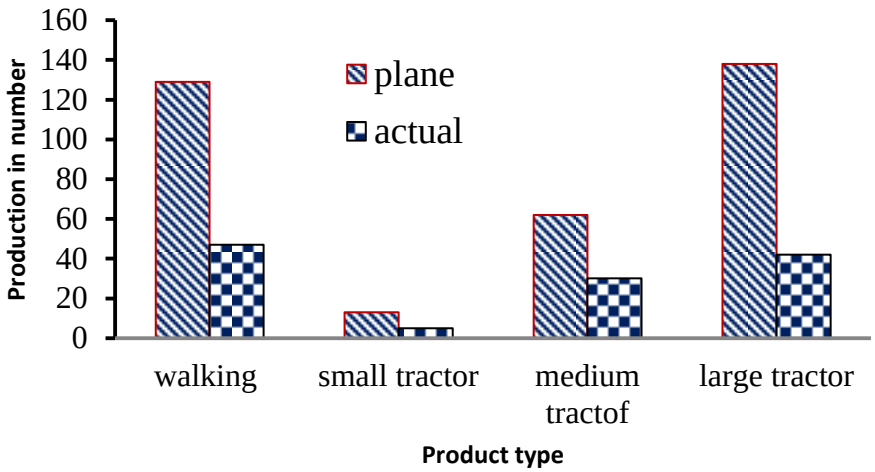


Figure 4.6 planned and executed production in the first quarter of 2015 E.C (source: - computed by using documented data from AAMI)

Figure 4.6 shows the difference between the actual and planned production amount most of the time the AAMI planned to manufacture ambitiously before knowing the market need. As shown in the above figure the actual assembled walking was 47 but the planed amount was around 129 tractors thesis indicates the highest difference around 3 times less walking tractors assembled in the AAMI in the first quarter of 2015 E.C based on this year projection. The same is true for all kinds of machineries manufactured in the case company. Affecting the raw material supply, work in progress and finished goods handling and management system.

4.6 Major limitation related to sustainable inventory management system

The researcher used different kind's data collection tools as mentioned in the methodology parts the main data collection tools are by using questionnaire, interview and documented data analysis. Based on the liker scale questionnaire result the possible or significantly highest affecting factors ranked in order as shown in Table 4.6 below 1 represents performance very less,2 represent less, 3 medium, 4 high and 5 very high. The other main constraints in the case company was the finished goods stays and not sale for the customers for long time due to this problem tremendous amount of government and peoples wealth waste before reaching the customers. The other problems related to inventory was the spare part inventory the excess spare parts exists in the AAMI and leads to highest influence on the handling capacity of the company as discussed in the questionnaire and interview result the major limitations which handers the effective and sustainable inventory management and control system was tabulated in the Table 4.6 as shown below

Table 4.6 Major limitations in the sustainable inventory management system

No.	Major limitations related to sustainable inventory control and managements at AAMI	Mean value
1	Variability of the customer orders and production amount in the purchasing of raw material inventory	**Less**
2	Existence or shortage and overage of work in progress inventories	**Less**
3	Application of effective inventory control technique	**Medium**

	Substituting the import spare part inventory when shortage of the raw material inventory occurs	
4		**Medium**
5	Level of customer complains in the quality of finished machineries	**Medium**
6	Manufacture durable and competitive products	**Medium**
7	Supply of raw material inventory	**Medium**
8	Rate of conversion of raw material inventory in to finished goods	**Highest**
9	Manufacture reliable and quality finished machineries	**Highest**

To sustain the production amount the fluctuation of raw material must be solved if not it is important to develop effective forecasting method to estimate the market demand and to decrease the inventory in the production line. As shown in the table 4.6 the highest or major

4.7 Inventory classification

Different type of inventories exists such as raw material, work in progress and finished goods in this section the brief classification of inventories conducted by using ABC analysis by classifying inventories into A-items, B-items and C-items and their importance. Also finished goods assembled in AAMI ranked to identify which machinery has highly marketable in the case company by including or considering different types of tractors. Flow of materials or WIP in the assembly line demonstrated by using flow table and the detail descriptions.

4.7.1 Raw material inventory

In this section inventories classified based on the ABC analysis by using the secondary data from the case company the inventories classified in to three categories such as A-items, B-items and C-items. Based on the quantity as well as total price inventories classified as shown in Table 4.7 in which the highest value takers are considered are the A-items small in quantity and shares largest price (70%-80% of the total cost). The B-items are moderately important materials and they are medium in quantity as well as in price between the A-items and the C-items (15%-20% to the total cost). Finally the C-items share a largest part in quantity but less in value (10% to 15% of the total cost) the detail description shown in Appendix IV:-

As shown in the Appendix XI inventories categorized based on the ABC analysis procedure thus based on the quantity classification of inventories out of 91 inventories 15 (16.48%) of inventories classified as A-items or items having less in quantity but highly important materials. the other group of inventory classification was B- item which has 24(26.37%) share of inventories in quantity and most commonly identified as moderately important materials. The remaining C-items have shares 52(57.14%) of inventories and characterized as very high in quantity and less important material compared to the A-items and B-items.

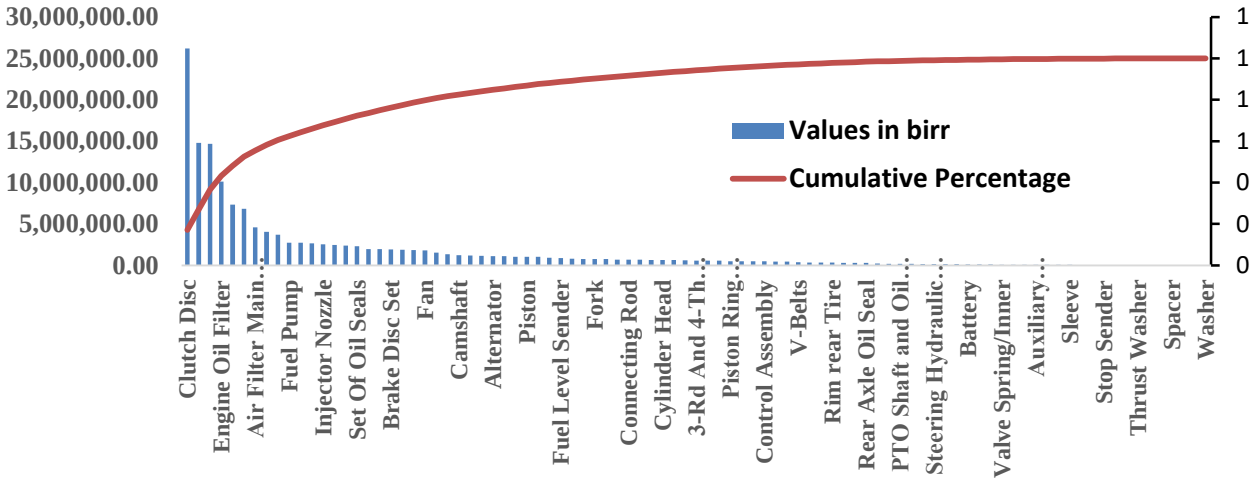


Figure 4.7 ABC items used

Table 4.7 ABC analysis result based the inventory quantity

Category	Item used	% of item used	Cumulative percentage	Degree of important
A-items	15	16.48%	16.48%	Highly important material
B-items	24	26.37%	42.85%	Moderately important material
C-items	52	57.14%	99.99%	Less important material

Besides inventory classification by using the quantity also classification based on the items value was described in Table 4.8 in which A-items have 70.82% share and that is the largest share in value. The next largest share taken by B-items which was medium or 19.94% share the last item

was C and which shares 9.24% and this class of items most commonly considered as the less important materials in the ABC classification technique. The brief description of the three class of items described in Table 4.8 as shown in below

Table 4.8 ABC analysis result based on the items values

Category	Annual demand value (birr)	% of annual demand	Cumulative percentage	Degree of important
A-items	107,885,066.40	70.82%	70.82%	Highly important material
B-items	30,366,935.09	19.94%	90.76%	Moderately important material
C-items	14,079,864.07	9.24%	100%	Less important material

Table 4.8 shows the relationship between the percentage of annual demand and the cumulative percentage availability of the items inside the AAMI. The series 2 shows the cumulative percentage of the availability of the items inside of the store and it has a rapid increase in the probability in the probability of the availability of from 25% up 100%. Series 1 shows that the percentage of annual demand and it decreased down to zero or the demand for the product is null. Figure 4.8 shows the ABC classification curve of the three items as shown in below

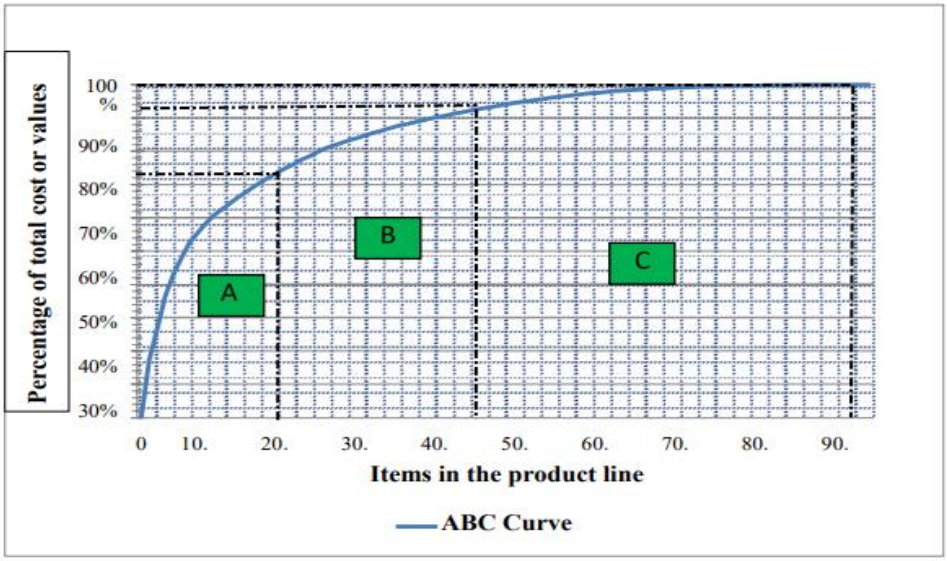


Figure 4.8 ABC analysis curve of the spare parts inventory (source: - computed by using documented data from AAMI)

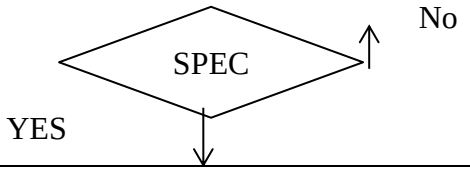
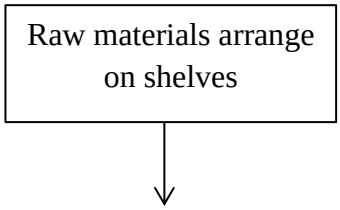
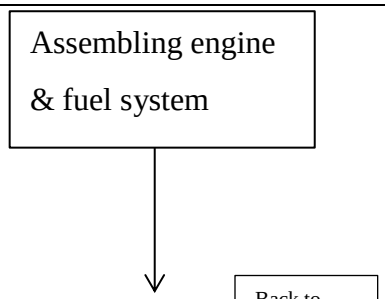
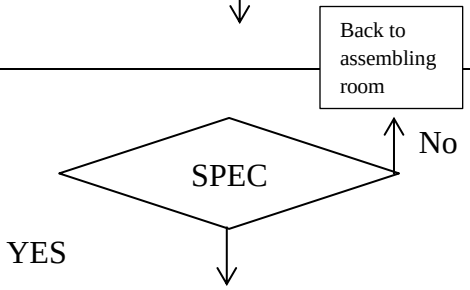
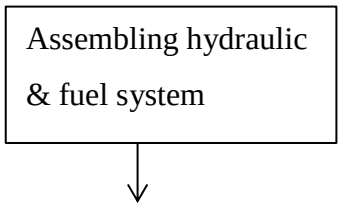
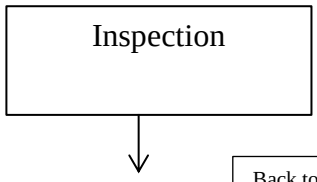
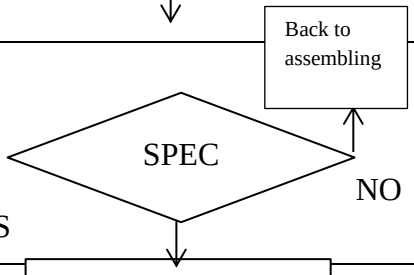
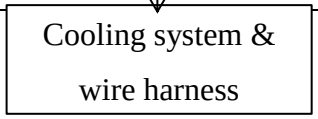
From the above two lines we can conclude that if the demand for the product is decreased dawn to zero in line one, the percentage or probability of the availability of such items is to be higher and which leads to holding excess or unwanted inventory items inside of warehouse and incurs high inventory holding cost, difficulty of controlling items, lack of space to receive additional inventory etc.

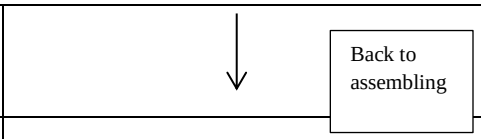
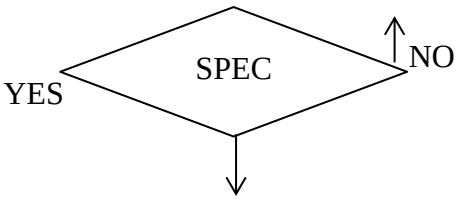
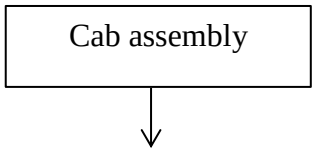
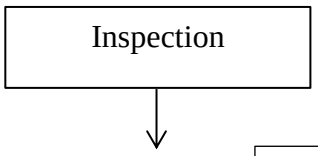
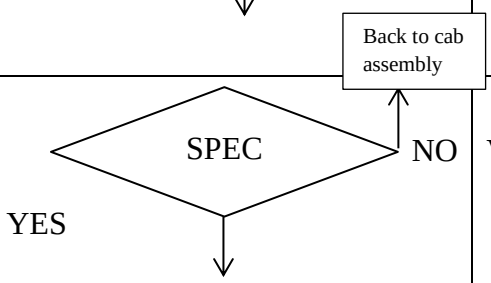
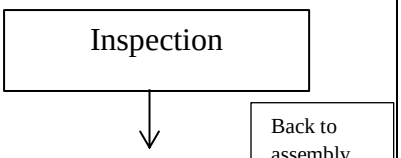
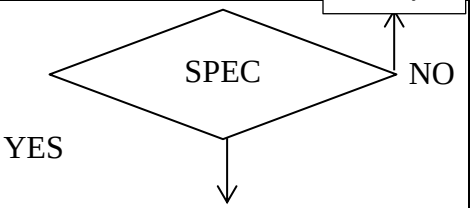
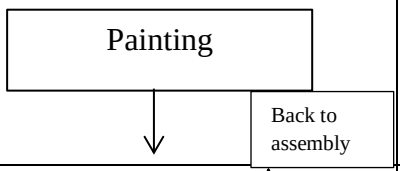
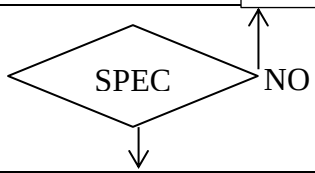
4.7.2 Work in progress and the assembly line arrangement

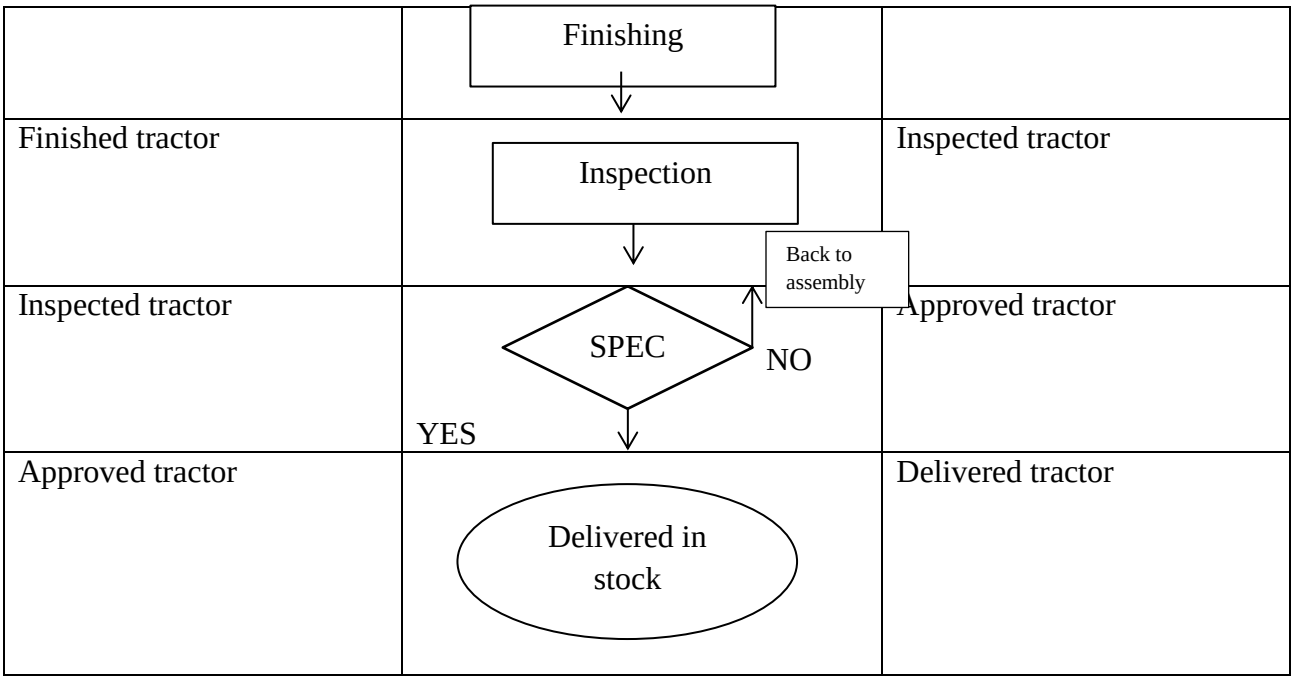
The sustainability of raw material supply was the main challenges in the AAMI because the factory handle tremendous amount of spare parts in the factory like raw material, work in progress and finished goods inventory. So the need of effective operational flow of activities plays very essential role by reducing the effect of maximum inventory in the production line. According to the interview result maximum inventory seen at the production line besides this the production not executed based on the market demand due to this the performance of inventory management becomes very poor in the sector. The following flow chart developed based on the tractor assembly line to increase the effective inventory control and management system.

Table 4.9 Material flow and operations chart in the production of tractor

Input	process	Out put
Production plan(work order)	Receiving work order	Received work order /production plane
Received work order or production plane	Acquire Raw materials	Received Raw material's
Received Raw material's	Unpacking and de-preserving	Unpacked & de-preserved raw material's
Inspect raw material's	Back to unpacking	

		Verified raw material's
Inspected raw material's		Arranged raw materials on shelves
Arranged raw materials on Shelves		Assembling engine and transmission
Inspected engine and transmission assembly		Verified assembled engine and transmission
Assembling hydraulics and fuel system to assembled engine and transmission		Assembling hydraulics and fuel system
Assembling hydraulics and fuel system		Inspected assembling hydraulics and fuel system
Inspected assembling hydraulics and fuel system		Verified assembled hydraulics and fuel system
Assembling of cooling system wire harness to		Assembled cooling system and wire harness

former assembled		
Inspect assembled cooling system and wire harness		Verified assembled cooling system and wire harness
Assembly cab to tractor		Assembled cab to tractor
Assembled cab to tractor		Inspected cab assembly
Inspected cab assembly		Verified assembled cab
Assembly of wheel and finder tractor		Assembly of wheel and finder to tractor
Inspected of wheel and finder assembly		Verified wheel and finder assembly tractor
Verified tractor		Painted tractor
Inspect painted tractor		Verified painted tractor
Pained tractor		Finished tractor



As shown in the Table 4.9 flow chart materials describe from the raw material selection to the delivery of finished goods or stocks. Previously as shown in the descriptive statistics of the questionnaire that the AAMI not use the internationally accepted inventory control management tools rather randomly placed materials the above flow chart aimed to solve the problems at the assembly lines by integrating the smooth flow of inventory.

4.7.3 Finished goods inventory

Large quantity of inventory found in the AAMI especially finished goods inventory largely accumulated in the company because of lack of proper market assessment and other related problems. To classify the inventory the researcher used ABC analysis for both raw material and finished goods. The AAMI mainly fabricate agricultural machineries such as tractors and other parts which were mounted on the tractors. The company manufacture product without the customer order and when the customer needs those machineries then select from the manufactured products based on his need. Most of finished products seen at the company in poor handing system as shown in Figure 4.9 Varity of finished product shown main tractor, finished products arranged in the random manner in categories of their type. When finished goods inventory stay at the company different parts of the machineries exposed to damages.

Figure 4.9 finished goods inventory in AAMI: a) higher HP tractors b) walking HP tractors (source: - computed by using documented data from AAMI)

As shown in the Figure 4.9 tremendous amount of finished machineries seen based on quantity as well as by the values of the inventories the finished goods classified in to three groups like raw material classification by using ABC analysis. For classification the researcher used tractor products which were the main types of finished goods inventory in AAMI. Quantity and items value are the main classification tools for the inventories.

4.7.4 Ranking of finished goods based on items value

Based on the finished goods or items value the total price calculated and tanked in the descending order as shown in Appendix VI. The table also show the highest price taker is the high horse power tractors compared to the mall and medium tractors. The first step in the ABC analysis was ranking inventories in their share in quantity as well as in the items price based on this in the Appendix VI inventories ranked based on the items value as shown in below

As shown in Appendix VI highest priced finished goods were tractors compared to other instrument's which are helpful in mounting on tractors for using agricultural machineries. The highest total priced machinery was the 130 HP tractors (RS1304) which takes total price of 84,357,407 birr and 65 on quantity the second highest priced machinery was 80Hp tractor (RM8014) and having 70,608,880 birr in total price. The unit price of highest HP tractors has

highest also the market demand of those products mainly depends on the need of investors and highest capital holders in the agricultural sector. The highest unit priced agricultural machineries which rated unit prices more than 1 million are 180 HP tractors (180A), 1804 HP tractor (1804), 140 HP tractor (14014), 130 HP tractor (RS1304), 120Hp (Model RS1204) tractor and 110Hp tractor are the highest price tractors and their unit prices are 2,766,527birr, 2,083,895birr, 1,376,169birr, 1,297,806birr, 1,142,312birr and 1,076,875birr respectively. In the other hand the lowest unit price products in the AAMI are commonly the walking tractors. Small agricultural holders and economically poor clients purchase the walking tractors. The price of less than 100,000 birr takers of walking tractors are 8Hp walking tractor, 15Hp walking tractor, and 12Hp walking tractor and their unit price were 23,984birr, 30,930birr, and 33,000birr respectively. The need of agricultural machineries increase from time to time but the purchasing ability of customers still low but the government tried to take different kinds of measures to reduce the effects of highest priced machineries on the farmers and investors. The need of highest HP tractors increase from time to time as shown in the figure below the largest share in total sale price from the finished goods inventory goes to highest HP tractors whereas the lowest part goes to the walking tractors the detail description shown in the chart as shown in figure below

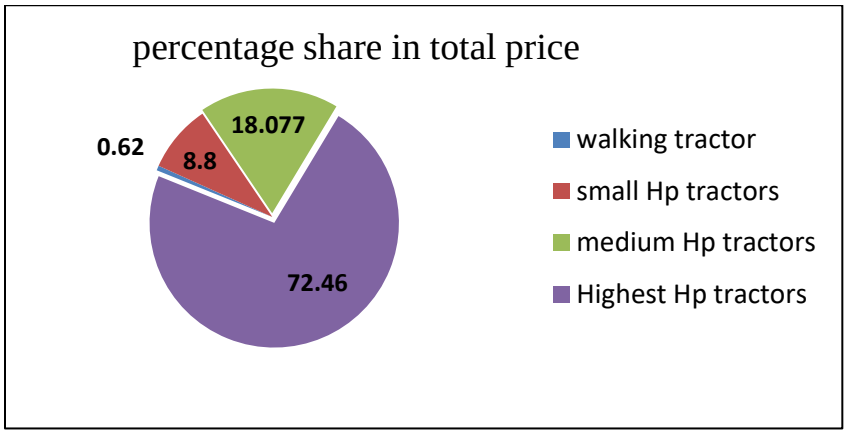


Figure 4.10 percentage shares in items price

As shown in Figure 4.10 the largest share or 72.46 % of the total sale price get from the highest HP tractors the second largest share contributor for the total sale machineries get from medium HP tractors and having 18.077% share and the third largest contributor is from the small HP tractors. The last or the smallest annual Seles recorded from the walking tractors having 0.62% share from the total sales

4.7.5 Ranking of finished goods based on quantity

Classification of inventories in manufacturing industries was an essential tool to balance the stock level because both over stock as well as under stock both play a negative role on the performance of industries. If the manufactured products have less important in the market then the demand of products decrease and over stock becomes familiar in such kind of poor planning in the manufacturing sector. In this section finished goods inventories classified based on the quantities which were sale to the market in 2014 E.C. In AAMI centrifugal pumps are commonly sale in large quantity compared to tractors Appendix VI shows the detail description of finished goods in quantity based ranking method as show below

As shown in Appendix VI walking tractors were less in price but the purchased amount by the customer was still vey less this indicate the cost is not the only parameter to purchase products so the AAMI must tried to focus on manufacturing of market oriented products based on the need of customers.

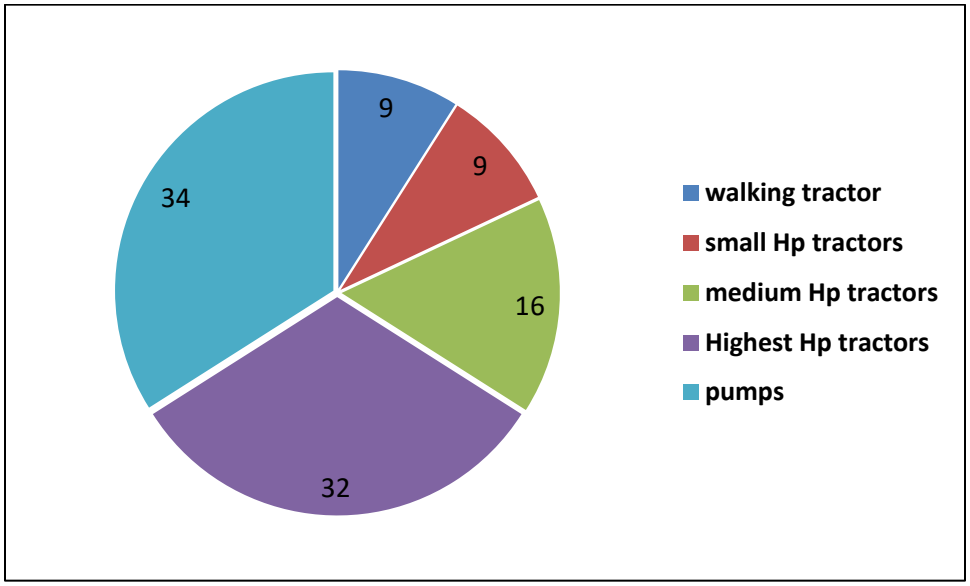


Figure 4.11 percentage shares in items quantity

As shown in the Figure 4.10 both highest HP tractors as well as pumps shares the largest part taking 32% and 34% respectively but different in product verities for example pumps 5 verities of centrifugal pumps in its category but highest HP tractors having 16 verifies of products within its category. The need of those products increase from time to time but the AAMI fabricates

more than the demand of the market which playsets part in increasing the level of finished goods inventory in the company. The third highest needed machineries by the customer were medium HP tractors and having 16% share and remaining walking tractors and small HP tractors shares 9% watch from the total inventories sell in the AAMI.

4.8 Proposed strategies to solve existing problems

The demand of agricultural machineries increases from time to time in Ethiopia especially for commercial farms like wheat farms so to increases the competitiveness of the sector it was important to increase effective and sustainable inventory management in AAMI. To overcome those problems the researcher proposed strategies to reduce the effect of over stock accumulation and poor inventory management to sustain the performance of the industry. There are plenty of options to choose the inventory control and management system, so how do you choose the best inventory system for businesses is the basic question. Inventories classified in to three categories such as A-items, B-items and C-items in the ABC analysis as shown in Figure 4.7 and their significance and urgency was not similar in cost as well as in quantity. This section consists of a series of proposed techniques to solve the poor inventory management and control system in the AAMI.

4.8.1 Proposed inventory management tools and stock level optimization

Tractors were the main agricultural products of AAMI and it accommodates highest investments by the company. Commonly manufactured agricultural machineries or tractors in AAMI were walking tractors, small HP tractors, medium HP tractors and highest HP tractors. Based on the classification of inventory by using ABC analysis the optimum stock level proposed in this section. The A-items are highly important materials, B-items are moderately important materials and the c-items are considered as less important materials. The ABC analysis gives strong emphasis to the A-items compared to the C-items. The imbalance between the demand and supply affects the performances of industries, tractors are specially requires highest capital to manufacture so the optimization of the demand of stock is vital to reduce the obsolescence. Figure 4.12 shows the demand curve of the total annual production and the demand, the trend in the past three years stated as follows;

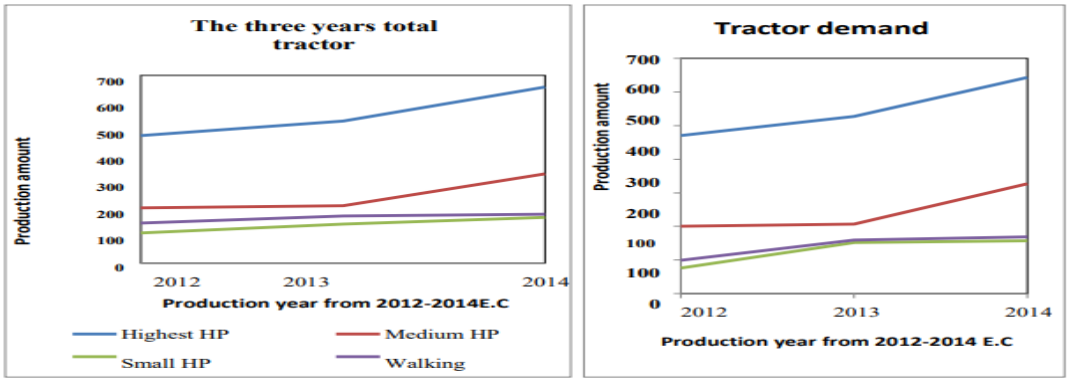
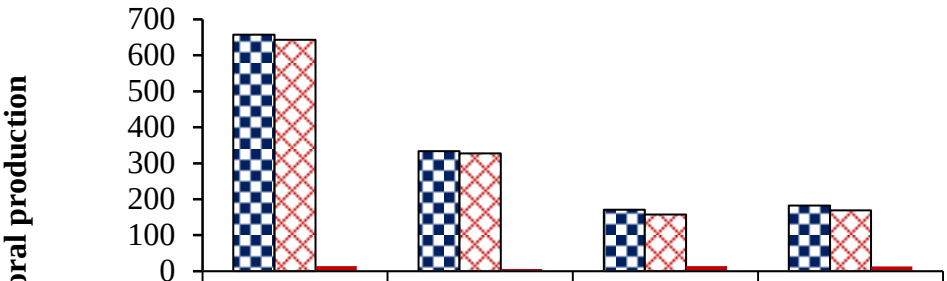


Figure 4.12 shows the actual production and the tractor demand trend of 2012-2014 E.C

Comparatively the highest HP tractors and medium HP tractors annual production and demand growth was highest compare to walking tractor and small HP tractors. Besides the trend the stock level or shortage or excess stock level plays its role by increasing storage cost and handling difficulty in order to track inventories.

The following points are very important to sustain industries in the market according to (Gardner Jr, E,.,& Diaz-Saiz J,2002). The proposed strategy in this section gives a strong emphasis to balance the stock level in AAMI. Figure 4.12 shows the annual production, optimized stock level and shortage and excess of inventory level and comparison described in the figure as follows:



	Highest HP tractors	Medium HP tractors	Small HP tractors	Walking tractors
current production amount	657	333	171	182
Optimized production	643	327	157	169
shortage and excess of stock level	14	6	14	13

Figure 4.13 shows the actual production, optimized and the stock level of tractors (source: - computed by using documented data from AAMI)

The AAMI established mainly to support the agricultural sector so due to this fact the demand of tractors was the main supporting instrument to enhance the efficiency of the company. As shown in the figure the difference between the optimum demand level and 2014 E.C annual production described. The actual demand prediction model developed for optimum production amount in the APPENDIX IV to optimize the actual inventory. The model expected to manage the demand and actual production, the percentage of improvement was described in the table as follows

Table 4.10 shows the optimum improvement in percentage of the inventory level

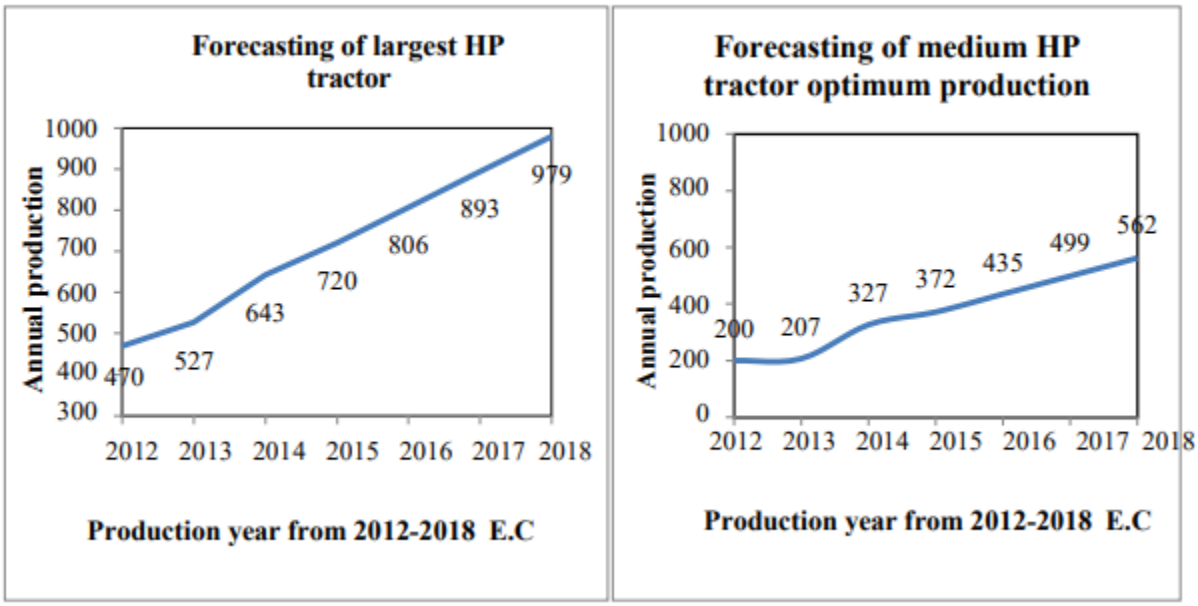
Different types of tractors	2012	2013	2014
Highest horse power (HP) tractors	1.20%	0.50%	2.13%
Medium horse power (HP) tractors	3.40%	3.27%	1.80%
Lowest horse power (HP) tractors	32.14%	4.10%	8.19%
Walking tractors	34.00%	9.66%	7.14%

The main demanded product in AAMI was highest HP tractors and developed model expected to enhance the stock level by 1.2% in 2012 E.C, 0.5% in 2013E.C and 2.13% in 2014 E.C also the model was used to predict the optimum stock level for the next year. The medium HP tractors stock level optimized by 3.40% in 2012 E.C from the actual production of tractors and 3.27% in 2013 E.C and 1.80 in 2014E.C compared to the actual production amount. The demand of lowest HP tractors and walking tractors enhanced by 32.14% and 34.00% respectively in 2012 E.C also the 2013 E.C the expected optimized stock level developed at the APPENDIX IV were 4.10% and 9.66% respectively. The above stock level optimization plays a vital role by balancing the actual production amount and the demand of finished goods in the market. Finally based on the models the next year demand and optimum stock level projection shown in the appendix to manage and control the stock levels in the case company.

4.8.2 Forecasting

In modern industrial activates forecasting plays a vital role in budgeting, planning, and estimating a future growth, specially forecasting is the predication of future outcomes based on the past events. The three years annual production amount and the demand of agricultural machineries in AAMI were an input for forecasting the optimum annual production for tractors

the overstock conditions in AAMI resulted from unpredicted production of machineries so this forwarded optimum forecasted trend helps by reducing the inventory level. The most commonly manufactured in AAMI was tractors and they share largest part in price of goods as shown in the ABC analysis and finished goods ranking in Table 4.10. the researcher used largest HP tractors, medium HP tractor, small HP tractor and walking tractor to forecast the future demand of annual production from 2012-2018 and the optimal annual production forecast were forwarded. Tractors were the basic agricultural machineries to transform the Ethiopia agricultural sector so it was vital to manufacture tractors, besides the production the inventory control and management was also needed to reduce the obsolescence of materials. The above parameters show the important of forecasting the demand to manage and control the inventory level in the AAMI for the next year. The brief description for the optimized future demand to tractors shown in



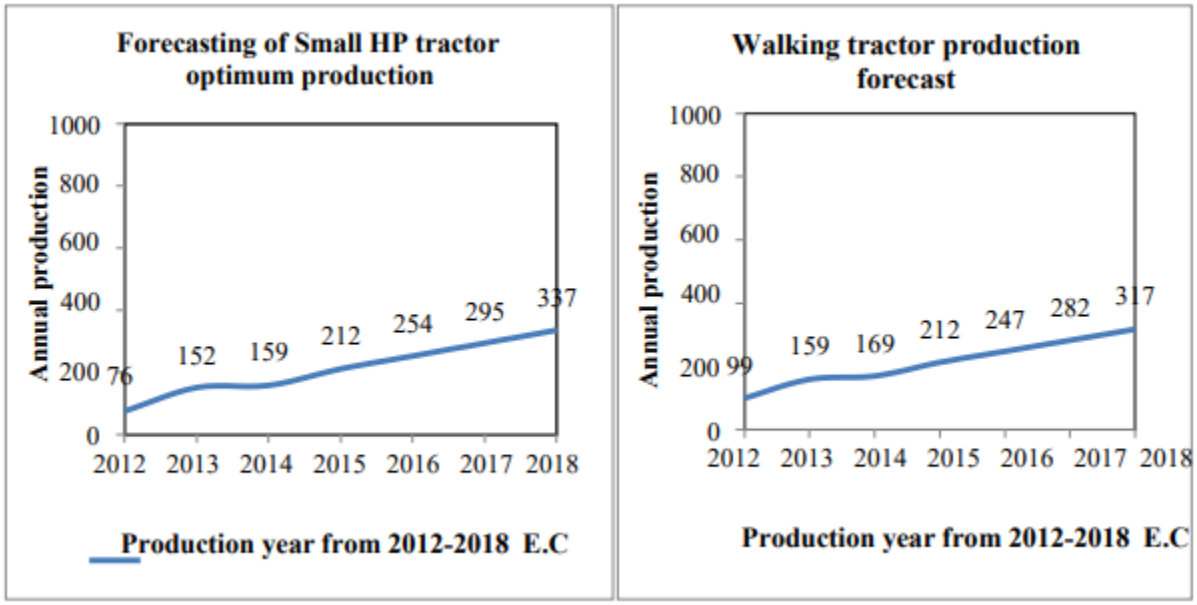


Figure 4.14 the forecast with the past and current market trend of tractor

Based on the challenges and promising hopes at the case company the six proposed measures forwarded as a basic input to increase the performance of the case company. Here are six inventory features must or should have to be used to sustain in the market and increase the performance of AAMI:

1. Fine tuning forecast planning with past and current market trends
2. Inventory tracking
3. Scalability of the existing inventory management system
4. Assessment of the stock level and demand on the production line
5. Integrations and coordination between departments
6. Application of automatic and efficient Replenishment

Besides the forecasting process and proposed inventory management system it was important to use the above key point which was vital for sustainable inventory management in industries. The basic features of the proposed optimum annual production forecast were using the past and present demand of tractors then forecast the present and future events of production. The current inventory management in the AAMI was very poor as mentioned in the questionnaire result, so it is important to scale up the existing inventory control and management system by tracking

inventory. Inventory tracking monitors where a company's inventory resides in the supply chain. Inventory tracking also provides a company with data on how much inventory it owns, where its inventories exist, the status of its inventories (damaged, returned, rejected, on hold) and it helps deter theft and loss. The following flow chart shows the proposed inventory management which is the combination of different types of factors affecting the performance of the case company. The brief description was designated as follows in the flow chart.

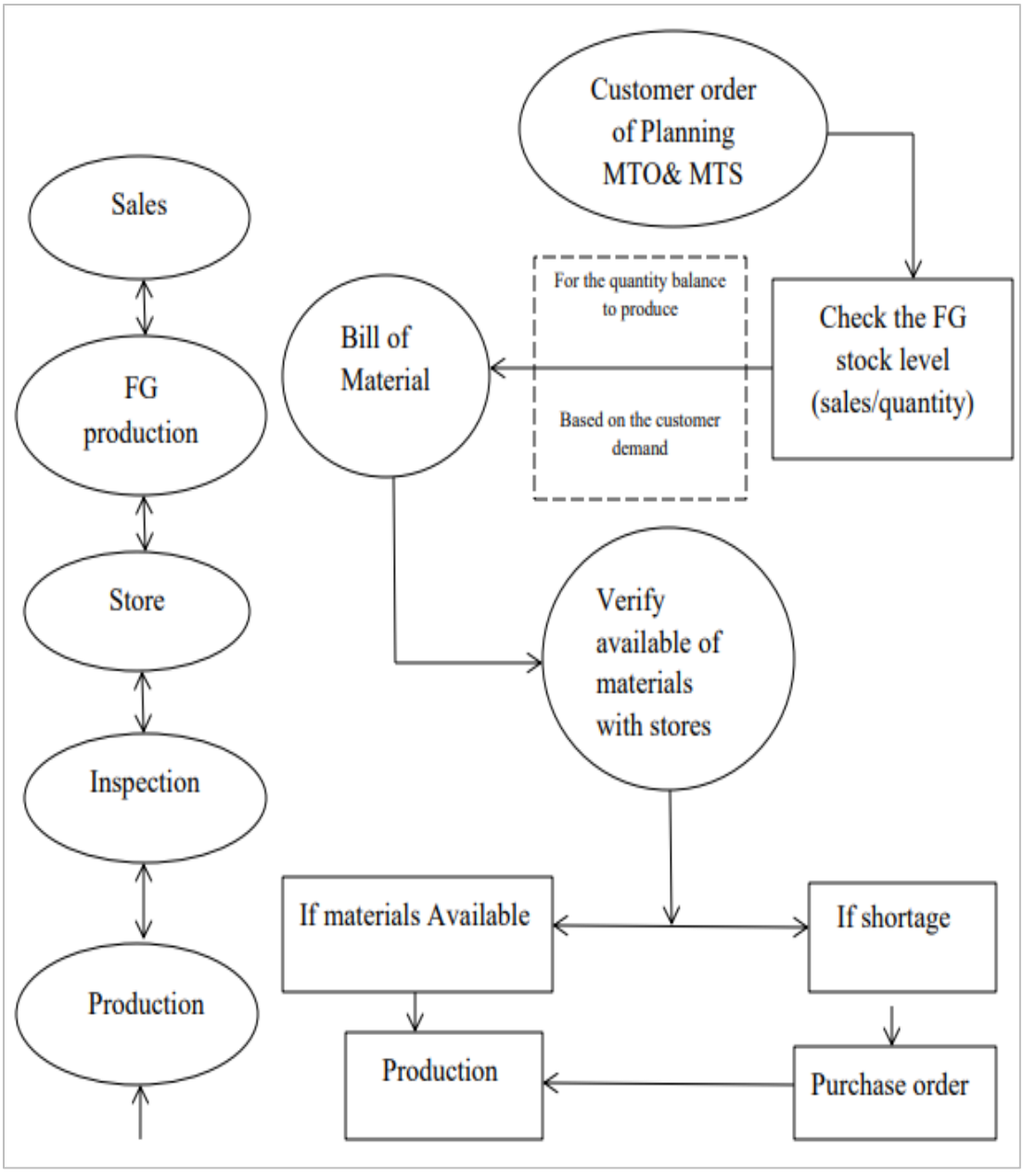


Figure 4.15 proposed inventory management flow chart

CHAPTER-5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

This thesis analyses the impact of sustainable inventory management on the performance of the example firm by applying it to the AAMI. For primary data, questioners and interviews were employed, whilst for secondary data, recorded files were used. The pertinent data were used for the study of inventory management. The results of the questions' usage of the Likert scale approach indicate that the firm has the largest stock level, that a sound inventory management system is lacking, and that the inventory management system in general is subpar. Besides the above general view the highest ranked values in the questionnaire was for the ability to manufacture reliable and quality products and which become mean value of 3.82 and a standard deviation of 0.914 whereas the rate of conversion of raw material inventory in finished goods and having the mean value of 3.72 and a standard deviation of 1.059. The extent or supply of raw material inventory has mean value of 3.23 and a standard deviation of 1.404. The other question was the level of customer complains in the quality of finished machineries have mean value of 2.79, substituting the import spare part inventory when shortage of raw material inventory occurs 2.78 mean value.

1. Application of effective inventory control technique have mean value of 2.69, whereas existence or shortage and overage of work in progress inventories variability of the customer orders and production amount in the purchasing of raw material inventory have mean value of 2.36 and 2.24 respectively. The summary of the questioner's findings reveals that while AAMI produces dependable and high-quality goods, the industry's raw material supply was not sustainable and the majority of its inventories were not immediately usable, which increased material waste due to the case company's prolonged existence. Highest HP tractors, medium HP tractors, small HP tractors, and walking tractors were the highly created final items.
2. The results shows there are several problems in the company due to miss manged inventory and un-sustained supply of raw material and market demand fluctuation. Currently, AAMI facing different kinds of problems out of them the following problems are selected and which are the reasons for the above miss managed inventory conditions.

The over stock situations leads to improper inventory level which causes a lot of problems and rise the effort to manage the increase of inventory level and to enhance resource utilization and to improve the general performance of AAMI. The leading finished products AAMI manufacture was different type of HP tractors. to classify the inventory ABC analysis used to categorize raw material inventories in to A-items, B-items and C-items based on their volume or quantity and items value or price.

- A-items having 16.48% in quantity and shares 70.82% in value and which were considered as highly important materials.
- B-items having 26.37% in quantity and shares 19.94% in values and which were considered as moderately important materials.
- C-items having 57.14% in quantity and shares 9.24% in values and which were considered as less important materials.

We may infer from the aforementioned categorization that it was easier and more straightforward to monitor and control inventories when the overstock condition was controlled using the item's value and quantity. The A-items demand more care and the C-items significantly require less attention to manage the capital investments on spare parts due to the overstock condition and waste of resources for overstaying at the firm. This claim is backed up by the questionnaire respondents, who concur that AAMI's buying department has performed poorly when it comes to the importation of replacement parts.

3. The basic limitations related to sustainable inventory management system was lack of efficient inventory management in multiple locations, if this problem solved location known and inventory tracking becomes more effective. The other limitations are lack of efficient demand forecasting, stock level balancing or the overstock and understock conditions, variability of customer orders, lack of implementing effective inventory control techniques and lack of substitution of import spare parts are identified as the main limitations for application of sustainable inventory management in AAMI. The above basic limitations are considered as the cause for poor inventory control and managements system and affects the performance of the company.

From the proposed inventory management strategy we conclude that the annual production optimization plays a crucial role by balancing the demand and production amount. Based on the

annual demand the production optimization proposed to reduce the effect of under stock and overstock conditions for tractors. The forecasted trend curve shows the optimum demand of tractor in 2018 E.C expected as 2184 and it increase in average 85.8% from the past 2012 E.C annual production year. Finally inventory tracking, scalability of existing inventory management , balancing the stock level, integrations and coordination between departments and effective replenishment are proposed to be the appropriate strategies to overcome the challenges of poor inventory management system in AAMI.

5.3 Recommendations

The agricultural machinery demand increase from time to time so it was important to solve problems related with inventory control and management in AAMI. The fluctuation in the demand as previously discussed there was different kinds of challenges exists in the AAMI mainly related with the level of stock and other challenges affecting the wellbeing of the factory. Based on the above factors which affecting the performances of AAMI the following recommendation were forwarded:

- Production must be tracked based on the customer orders
- Manage the stock level based on the research result stated above
- Use automated replenishment
- Minimize the west based on this research
- Use scientific and more economic inventory management techniques
- The result of this research should be cheeked for its implementation

The effective inventory control techniques should be used such MRP and it is framework to help industries to plan operations, control their inventory and organize their logistics. MRP can be used for both Make-To-Stock and Make-To-Order manufacturing, so the researcher recommended MRP for effective inventory control and management in the case company. If this method used it ensures that AAMI have the right quantity of materials at the right time for production to take place. In addition, if MRP integrated with enterprise resource planning (ERP) it save time, gives structure to their planning process and eliminates errors. Having an MRP system in place allows industries to keep up with increasing demand and become more modernized and efficient in its processes.

REFERENCES

Anh Chi Phan, H. T. (2019). Effect of Total Quality Management Practices and JIT Production Practices on Flexibility Performance: Empirical Evidence from International Manufacturing Plants. *Journal of sustainability, 1-22.*

B.E Flores and D.C Why bark. (1986). Multiple Criteria ABC Analysis. *International Journal of Operations and Production Management, 6(3), 38-6.*

Booysen, F., Van Der Berg, S., Burger, R., Von Maltitz, M., & Du Rand, G. (2008). Using an asset index to assess trends in poverty in seven Sub-Saharan African countries. *World Development, 36(6), 1113-1130.*

Carvalho, J. (1984). Archival application of mathematical sampling techniques. Records management quarterly, 18(1), 18-63.

Croppenstedt, A., Demeke, M., & Meschi, M. M. (2003). Technology adoption in the presence of constraints: *the case of fertilizer demand in Ethiopia. Review of Development Economics, 7(1), 58-70.*

Dhoka, D., & Choudary, Y. L. (2013). ABC classification for inventory optimization. *IOSR Journal of Business and Management, 15(1), 38-41.*

Endashaw, E. (2016). Assessment of Product Supply Chain Management for Market Competitive Advantage in Case of Yes Food and Beverage PLC. *Doctoral dissertation, Addis Ababa University.*

Gardner Jr, E. S., & Diaz-Saiz, J. (2002). Seasonal adjustment of inventory demand series: a case study. *International Journal of Forecasting, 18(1), 117-123.*

H. Soni, Jayeshkumar Piroda, and J.J. Bhavshar. (2016). Analyazing Inventory Material Management Control Technique On Residential Construction Project. *International Journal of Advance Research and Innovative Ideas in Education, 2(3), 3071 - 3077.*

Heerink, N., van Keulen, H., & Kuiper, M. (2001). Economic policy and sustainable land use: recent advances in quantitative analysis for developing countries. Springer Science & Business Media.

Huang, Y. F. (2007). Economic order quantity under conditionally permissible delay in payments. *European Journal of Operational Research, 176(2), 911-924.*

Ilyas Masudin, M. S. (2018). Impact of Inventory Management and Procurement Practices on Organization's Performance. Journal of Business Economics, and Management Studies

J. Bulinksi, C. Waszkiewicz, and P. Buraczewski. (2013). Utilization of ABC/XYZ analysis in stock planning in the enterprise. Annals of Warsaw University of Life science, 61, 89-96.

Kemal, A. (2018). Productivity Improvement through Inventory Management Practices for Printing Industry: The Case of Yekatit Paper Converting PLC. Ethiopia: *Doctoral dissertation, Addis Ababa University.*

L. Thomas and S.S. Jayakrishnan. (2014). Development and Evaluation of Novel Inventory Management Software for Community Pharmacy Practice. *International Journal of Pharmaceutical Sciences and Research 2014, 2(4), 765-776.*

Lim, F. A. (2018). A Study on Inventory Management towards Organizational Performance of Manufacturing Company in Melaka. International Journal of Academic Research in Business and Social Sciences, 1217-1227.

Mabert, V. A. (2007). The early road to material requirements planning. Journal of Operations Management, 25(2), 346-356.

Mackelprang, A. W. (2010). Relationship between just-in-time manufacturing practices and performance: A meta-analytic investigation. Journal of Operations Management, 28(4), 283-302.

Maddah, B., & Jaber, M. Y. (2008). Economic order quantity for items with imperfect quality: revisited. *International Journal of Production Economics, 112(2), 808-815.*

Mehmet Soysala, Mustafa Çimen, Sedat Belbağ, and Ergül Toğrulb. (2019). A review on sustainable inventory routing. *Computers & Industrial Engineering, 132, 395-411.*

Keshavarz Ghorabaee, Mehdi, et al. "Multi-criteria inventory classification using a new method of evaluation based on distance from average solution (EDAS)." Informatics 26.3 (2015): 435-451.

Ndivhuwo Nemtajela and Charles Mbohwa. (2017). Relationship between inventory management and uncertain demand for fast moving consumer goods organisations. Science Direct, 8, 699 – 706.

Nzuza, Z. W. (2015). (2015). Factors affecting the success of inventory control in the Stores Division of the eThekwini Municipality, Durban: A case study (Doctoral dissertation).

Ogbo, A. I. (June 2014). The Impact of Effective Inventory Control Management on Organisational Performance*: A Study of 7up Bottling Company Nile Mile Enugu, Nigeria. Mediterranean Journal of Social Sciences, Vol 5 No 10.*

P.S. Vaisakh, J. Dileeplal and V. Unni. (2021). Inventory Management of Spare Parts by Combined FSN and VED (CFSNVED) Analysis. *International Journal of Engineering and Innovative Technology, Volume 3.*

Plaza, M., David, I., & Shirazi, F. (2018). Management of inventory under market fluctuations the case of a Canadian high tech company. *International Journal of Production Economics, 205, 215-227.*

Rodrigues, A. M. (2005). Estimation of global and national logistics expenditures: 2002 data update. Journal of business logistics, 26(2), 1-16.

S. Mitra, S.K. Pattanayak, P. Bhowmik. (2015). *International Journal of Mechanical and Industrial Engineering. 3(1), 76 - 81.*

S.A. Sagar and K.N. Agrawal. (2015). Productivity Improvement in a Tractor Trailer Manufacturing Plant Using Selective Inventory Control Model. International Journal of

Engineering Research, 3(2), 306-312.

Sarkar, B., Ahmed, W., Choi, S. B., & Tayyab, M. (2018). Sustainable inventory management for environmental impact through partial backordering and multi-trade- credit-period. Sustainability, 10(12), 47-61.

Shah, P. S. (2018). A Hybrid MRP-JIT Production Planning and Control System. International Journal of Computational Engineering Research (IJCER), 29-37.

Shang, J. S. (2008). Manufacturing planning and control technology versus operational performance: an empirical study of MRP and JIT in China. International journal of Manufacturing Technology and Management, 4-29.

Tejesh, B. S. S., & Neeraja, S. J. (2018). *Warehouse inventory management system using IoT and open source framework. Alexandria engineering journal, 57(4), 3817- 3823.*

Vrat, P. 2014. Basic Concepts in Inventory Management. Springer Texts in Business and Economics, In: Materials Management, edition 127, chapter 2, pp. 21-36, Springer.

Wilson, R. T. (2010). Poultry production and performance in the Federal Democratic Republic of Ethiopia. *World's Poultry Science Journal, 66(3), 441-454.*

World Bank. (2012). agribusiness indicators: Ethiopia. Washington DC: International Bank for Reconstruction and Development.

Yu, M. C. (2011). *Multi-criteria ABC analysis using artificial-intelligence-based classification techniques. Expert Systems with Applications, 38(4), 3416-3421.*

Zattnaik, S.; Nayak, M.M.; Abbate, S.; Centobelli, P. Recent Trends in Sustainable Inventory Models: A Literature Review. *Sustainability* **2021**,

APPENDIX I

Adama Science and Technology University

Department of Mechanical Engineering School of Mechanical, Chemical, and Materials Engineering

Questionnaire

Dear Sir/Madam

I am a postgraduate student at ASTU in the department of Mechanical Design and manufacturing Engineering. This study is designed to gather information on "Investigation of sustainable Inventory and its challenges in the Adama Agricultural Machinery Manufacturing Industry "The research intended to analyze the main constraints related to the inventory management system in the Adama Agricultural Machinery Industry the tractors. this study is being conducted to fulfill a Master's degree in manufacturing engineering, so the information you provide is going to be used for academic purposes only,

As this thesis solely depends on your cooperation, your genuine voluntary response has significant value for the completion of the thesis.

Finally, I would like to thank you for your cooperation

Section I: General Information:

In this section the general information about the questionnaire respondents require to show the respondents assortment. ; Please kindly respond to the survey five questions:

1. Sex ☐ Female ☐ Male
2. Age: ☐ Less than 30 years ☐ 31-40 years ☐ 41- 50 years ☐ Greater than 50 years
3. Educational level: ☐ Under Diploma ☐ Diploma ☐ Degree ☐ Master's Degree & above
4. Years of experience : ☐ Below 1 year ☐ 1 to 5year ☐ 5to10 year ☐ above 10 year
5. Job position ----------

6. Specialization: ----------

Section II: The following questions are prepared using a Likert-type scale to examine the existing inventory management system at AAMI.

Note: The following nine questions were prepared based on the Likert-type scale; please kindly respond to the survey question.

1. What is the degree of implementation of effective inventory control techniques in the Adama agricultural machinery industry?
   a) Very less B) Less C) Moderate D) High E) Very high
2. What is the degree or capability of AAMI to manufacture reliable and quality products?
   a) Very less B) Less C) Moderate D) High E) Very high
3. What is the capability of AAMI to manufacture durable and competitive products compared with the imported goods?
   a) Very less B) Less C) Moderate D) High E) Very high
4. How do you see the supply of raw material inventory for sustainable manufacturing of agricultural machineries at the AAMI?
   a) Very less B) Less C) Moderate D) High E) Very high
5. How do you see the rate of conversion of raw material inventory in to finished goods?
   a) Very less B) Less C) Moderate D) High E) Very high
6. What is the level of customer complaints about the quality of finished machines in inventories??
   a) Very less B) Less C) Moderate D) High E) Very high
7. What are the existence, shortage and overage of work in progress inventories during assembly of agricultural machineries?
   a) Very less B) Less C) Moderate D) High E) Very high
8. The degree or variability of the customer orders and production amount in the purchasing of raw material inventory?
   a) Very less B) Less C) Moderate D) High E) Very high

9. What is the degree of substitution the imported spare part inventory when a shortage of the raw material inventory occurs at the AAMI?

a) Very less B) Less C) Moderate D) High E) Very high

Section III: - Open ended questionnaire

The following questions are expected as the main factors affecting sustainable inventory management system; please give your answers to the questions.

1. Does the effective inventory management practice have ever been tried in your company? If yes,
   a) Does it ensure the continuous production of goods? ----------
   b) What was the outcome of using it? ----------
   c) For how long does it practices? ----------
2. Does "**over-stock**" ever happen in the company? If yes,
   a) What do you think is a possible reason for that? ----------
   b) Can you say the company was effective in this situation? ----------
   c) What was the measurement taken? ----------
3. Do you think that the raw materials in the inventory allow the company to operate independently of their sources of supplies? For example, if a shortage in the supply of raw materials happened, would the company remain in the processing for a certain period of time?

   ----
4. Would you think that there are sufficient inventories of finished goods in the company? -----

   ----
5. Does the minimum and maximum amount of stock threshold (par levels) for each product are marked or known? For example, too little stock could cause overselling and too much could be cost-inefficient if the stock is not sold.

   ----
6. Is there any inventory management system or software that can help in forecasting the stock

needed for each product? If yes, are there hired specialized personnel working on inventory management software related? ----------

7. Is there ever inflexibility in the flow of ordered goods to the customer? And what is the lead time for certain specific goods ordered?----------
8. Has the company's the raw materials supply ever been delayed? If yes,
    a) What were its impacts?----------
9. Is there any "**dead-stock**", as time goes on, old products get out of fashion or season? (Dead-stock, meaning less-popular and slow-selling items).----------
10. It is known that certain products need more attention than others. Is there any such practice of analyzing the products based on the prioritization of goods by categorizing them in to **high-value**, **moderate-value**, and **low-value** products? ----------

Thanks for your consideration!

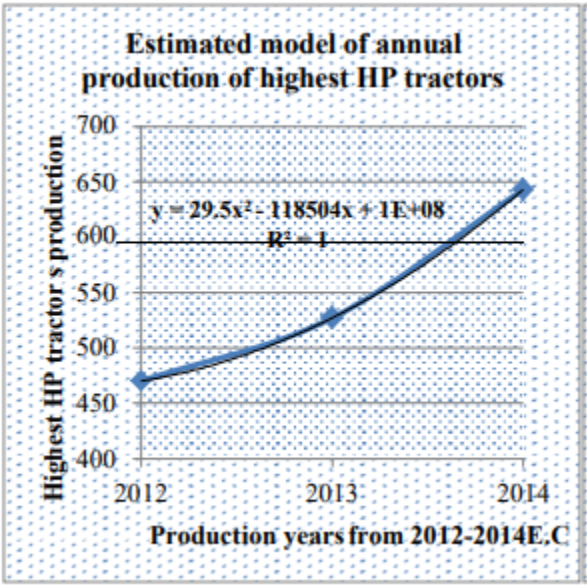
APPENDIX II

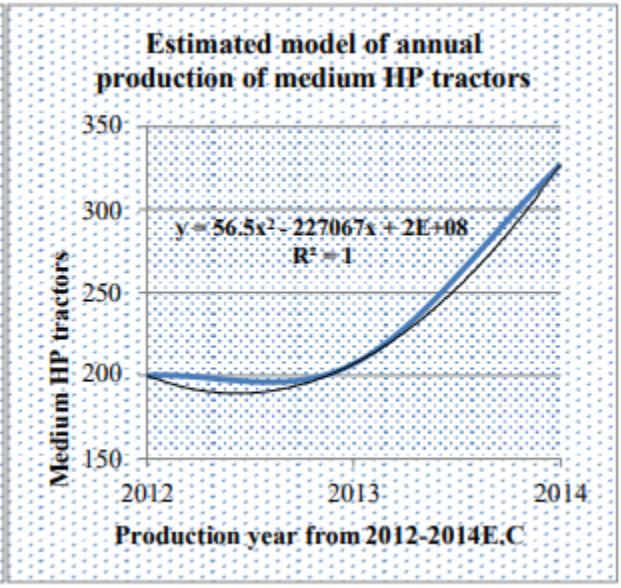
Interview questions

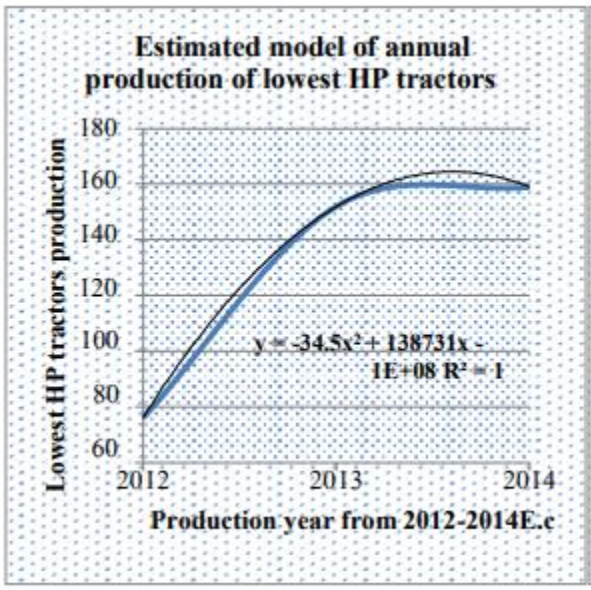
1. What documentation or reference do you have in the company to control the materials flow?
2. Does “under-stock” ever happen in the company?
3. How long does it takes for single and specific type of machinery to be handed over to the customer following the date of order?
4. What types of Agricultural machinery are produced by the company, and is there any machinery that makes it impossible to manufacture agricultural machinery at the current state of the factory?
5. What do you think of the company’s ability to remain competitive and efficient in the market in the future?
6. Do you have any practice of regular reconciliation of goods in the company?
7. Is there any practice with the FIFO technique? Meaning that oldest stock (first-in) gets sold first (first-out) in order to prevent “dead-stock”.
8. Is there any trend in calculating the total stocking cost of the company?
9. Is the procurement practice of the company modernized or not? For example, e-Procurement (internet-based procurement).

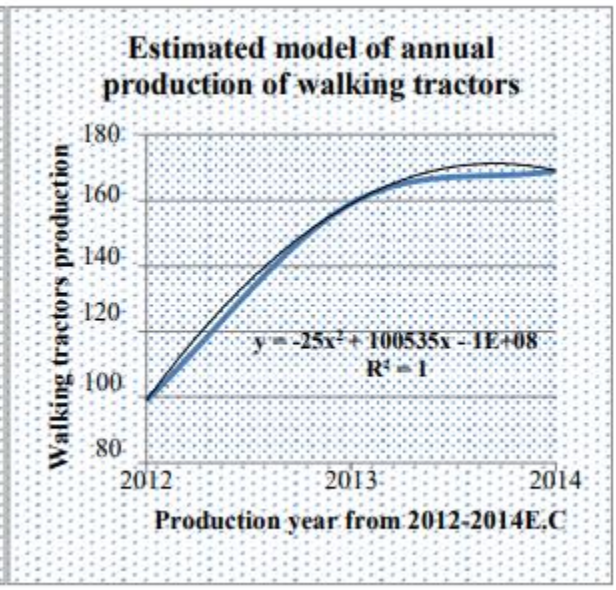
APPENDIX III

Tractors production prediction models









APPENDIX IV

Raw material inventory

No.	Inventories	Values in birr	Percentage	class
1	Clutch Disc	26,211,309.92	17.21%	A
2	Primary Fuel Filter	14,794,148.32	26.92%	A
3	Fuel Lift Pump Filter	14,682,010.42	36.56%	A
4	Engine Oil Filter	10,131,171.94	43.21%	A
5	Hydraulic Oil Filter On The Return Line	7,340,340.46	48.03%	A
6	Release Bearing	6,845,690.80	52.52%	A
7	Air Filter Main Element	4,606,990.41	55.54%	A
8	Air Compressor	4,052,375.69	58.20%	A
9	Rear Tire With Inner Tube	3,713,415.23	60.64%	A
10	Fuel Pump	2,733,646.17	62.44%	A
11	Hydraulic Control valve	2,729,067.01	64.23%	A
12	Release Lever	2,674,111.44	65.98%	A
13	Injector Nozzle	2,532,984.18	67.65%	A
14	Set Of Lamps	2,452,523.73	69.26%	A
15	Starter	2,385,280.69	70.82%	A
16	Set Of Oil Seals	2,311,188.10	72.34%	B
17	Cyklon Pre-filter	1,952,799.53	73.62%	B
18	Cylinder Head Gasket	1,947,447.04	74.90%	B
19	Brake Disc Set	1,912,828.05	76.16%	B
20	Front Tyre With Inner Tube	1,888,010.19	77.40%	B
21	Radiator	1,842,172.65	78.60%	B
22	Fan	1,827,486.12	79.80%	B
23	Bearing	1,531,986.06	80.81%	B
24	Main bearing Set (Kpl)	1,339,850.73	81.69%	B
25	Camshaft	1,245,783.51	82.51%	B
26	1-St And 2-Nd Gear Synchronizer	1,185,601.36	83.29%	B
27	Set Of Gauges	1,161,087.47	84.05%	B
28	Alternator	1,104,496.16	84.77%	B
29	Reverse Fork	1,097,466.67	85.49%	B
30	Auxiliary Gearshift Driving Gear Shaft Assembly	1,054,242.49	86.19%	B
31	Piston	1,045,914.23	86.87%	B
32	Gearbox Housing Assembly	1,045,541.09	87.56%	B
33	Set Of Panes	904,439.82	88.15%	B
34	Fuel Level Sender	865,628.31	88.72%	B

35	Main Gearshift Assembly	794,615.02	89.24%	B
36	R.H.Lift Arm Assay	781,625.41	89.75%	B
37	Fork	764,481.11	90.26%	B
38	Lever Spring	762,243.96	90.76%	B
39	R.H. Lift Rod	706,448.18	91.22%	C
40	Connecting Rod	704,698.18	91.68%	C
41	Crank Shaft	698,166.57	92.14%	C
42	Cylinder Block	667,483.27	92.58%	C
43	Cylinder Head	658,391.24	93.01%	C
44	I-Ii Gear Fork Head	652,719.65	93.44%	C
45	PTO Clutch Disc	609,094.61	93.84%	C
46	3-Rd And 4-Th Synchronizer	589,967.43	94.23%	C
47	Solenoid Starter	577,042.14	94.61%	C
48	Reduction Unit Synchronizer	569,101.27	94.98%	C
49	Piston Ring Assembly	512,164.51	95.32%	C
50	Iii-Iv Fork Shaft	502,519.71	95.65%	C
51	Transmission Shaft	488,513.14	95.97%	C
52	Control Assembly	487,593.71	96.29%	C
53	Hydraulic Pump "In Tandem"	460,743.37	96.59%	C
54	Front Axle Oil seal	452,167.23	96.89%	C
55	V-Belts	371,311.53	97.13%	C
56	Engine Stop Switch	352,988.21	97.36%	C
57	3-Point Linkage stabilizer	333,956.98	97.58%	C
58	Rim rear Tire	323,252.84	97.79%	C
59	Auxiliary Gearshift Driving Shaft	320,392.07	98.00%	C
60	Air Inlet Valve	294,757.64	98.20%	C
61	Rear Axle Oil Seal	293,216.06	98.39%	C
62	Oil Pressure Sender	218,839.23	98.53%	C
63	Oil Seal	194,523.81	98.66%	C
64	PTO Shaft and Oil Seal	188,463.86	98.78%	C
65	Clutch Cable	179,275.12	98.90%	C
66	Reverse Middle Shaft	162,103.13	99.01%	C
67	Steering Hydraulic Ram -L.H.	160,292.56	99.11%	C
68	Water Pump Assembly	148,824.67	99.21%	C
69	Coolant Temperature Sender	128,808.77	99.30%	C
70	Battery	105,835.48	99.37%	C
71	Iii Driving Gear	105,462.36	99.43%	C
72	Exhaust Valve	100,982.37	99.50%	C
73	Valve Spring/Inner	88,356.08	99.56%	C

74	Gear Z=49	85,607.05	99.62%	C
75	Reverse Driven Gear	81,051.57	99.67%	C
76	Auxiliary Gearshift Driving Gear	77,809.50	99.72%	C
77	Iii-Iv Shift Collar	73,423.21	99.77%	C
78	Orbitrol control Unit	64,865.12	99.81%	C
79	Sleeve	57,785.01	99.85%	C
80	Cooling System Thermostat	38,651.93	99.87%	C
81	Auxiliary Gearshift Bearing Cover	32,420.63	99.90%	C
82	Stop Sender	28,606.45	99.91%	C
83	Bush	25,634.29	99.93%	C
84	Iii-Iv Engaging Gear Seat	24,315.47	99.95%	C
85	Thrust Washer	22,920.62	99.96%	C
86	Auxiliary Gearshift Dial Head	13,731.09	99.97%	C
87	Engine Speed Hand Control Cable	12,110.06	99.98%	C
88	Spacer	11,067.96	99.99%	C
89	Thrust Ring	9,297.09	99.99%	C
90	I-Ii Gear Spacer	8,295.87	100.00%	C
91	Washer	3,814.19	100.00%	C

APPENDIX V

Finished goods inventory of 2014 E.C sales rank (source: - computed by using documented data from AAMI)

Finished goods inventory or tractors	Unit price (birr)	Quantity	Total price (birr)
130 HP tractor (RS1304)	1,297,806	65	84,357,407
80 HP tractor (RM 8014)	784,543	90	70,608,880
110 HP tractor	1,076,875	65	69,996,883
100 HP tractor (RC 1004)	972,212	65	63,193,766
120 HP (Model RS1204) tractor	1,142,312	55	62,827,164
65 HP medium tractor (RM 654)	557,819	110	61,360,141
180 HP tractor (18014 A)	2,766,527	20	55,330,533
80 HP tractor ursus 8014	695,934	75	52,195,084
50 HP medium tractor	418,679		43,961,305
1804 HP tractor (1804)	2,083,895	20	41,677,897
140 HP tractor (14014)	1,376,169	30	41,285,080
40 HP medium tractor -404	342,728	110	37,700,132
76 HP tractor (DV cabin)	621,674	40	24,866,965
90 HP tractor (CR)	875,331	22	19,257,292
35 HP tractors 3 cylinder	345,722	50	17,286,082
80 HP tractor –SWT	475,281	30	14,258,434
90 HP tractor (SWT)	552,433	25	13,810,825
100 HP tractor –SWT	665,792	20	13,315,830
76 HP tractor (super DV)	606,636	20	12,132,711
76 HP tractor (standard cabin)	525,646	15	7,884,694
30 HP tractors 2 cylinder	131,469	35	4,601,401
25 HP tractors 3 cylinder	124,938	32	3,998,012
65 HP medium tractor /DV	469,114	8	3,752,909
15 Horse power walking tractor	30,930	100	3,093,024
25 HP tractors 2 cylinder	118,516	24	2,844,388
18 HP tractors	91,716	20	1,834,329
8 Horse power walking tractor	23,984	70	1,678,848
30 HP tractors 3 cylinder	138,785	10	1,387,851
12 Horse power walking tractor	33,000	12	396,000

APPENDIX VI

Finished goods inventory rank by using items total quantity of items (source: - computed by using documented data from AAMI)

Finished goods inventory or tractors and pumps	Unit price (birr)	quantity	Total price (birr)
Centrifugal pump mounted on the walking tractor	10,500	334	598,500
Centrifugal pump /100 L/S with accessories	668,604	130	53,488,301
Centrifugal pump /55 L/S with accessories	424,646	110	55,203,980
Centrifugal pump /75 L/S with accessories	500,266	110	45,524,206
Centrifugal pump/ 16 L/S with accessories Diesel 3LD	55,652	105	18,587,825
180 HP tractor (18014 A)	2,766,527	100	55,330,533
1804 HP tractor (1804)	2,083,895	91	41,677,897
140 HP tractor (14014)	1,376,169	90	41,285,080
130 HP tractor (RS1304)	1,297,806	80	84,357,407
120 HP (Model RS1204) tractor	1,142,312	75	62,827,164
110 HP tractor	1,076,875	70	69,996,883
90 HP tractor (CR)	875,331	65	19,257,292
100 HP tractor –SWT	665,792	65	13,315,830
100 HP tractor (RC 1004)	972,212	65	63,193,766
90 HP tractor (SWT)	552,433	57	13,810,825
80 HP tractor (RM 8014)	784,543	55	70,608,880
80 HP tractor ursus 8014	695,934	50	52,195,084
80 HP tractor –SWT	475,281	40	14,258,434
76 HP tractor (standard cabin)	525,646	35	7,884,694
76 HP tractor (super DV)	606,636	32	12,132,711
65 HP medium tractor /DV	469,114	30	3,752,909
76 HP tractor (DV cabin)	621,674	30	24,866,965
65 HP medium tractor (RM 654)	557,819	25	61,360,141
50 HP medium tractor	418,679	24	43,961,305
40 HP medium tractor -404	342,728	22	37,700,132
25 HP tractors 2 cylinder	118,516	20	2,844,388
25 HP tractors 3 cylinder	124,938	20	3,998,012
30 HP tractors 2 cylinder	131,469	20	4,601,401
30 HP tractors 3 cylinder	138,785	20	1,387,851
35 HP tractors 3 cylinder	345,722	20	17,286,082

18 HP tractors	91,716	15	1,834,329
15 Horse power walking tractor	30,930	12	3,093,024
12 Horse power walking tractor	33,000	10	396,000
8 Horse power walking tractor	23,984	8	1,678,848