ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY SCHOOL OF MECHANICAL, CHEMICAL AND MATERIALS ENGINEERING

DEPARTMENT OF MECHANICAL AND VEHICLE ENGINEERING

A Case study on Improvement of Vehicle Maintenance Management System:

For Wonji Shoa Sugar Factory

MSc Thesis

Submitted to the School of Mechanical, Chemical and Materials Engineering in Partial Fulfillment of the Requirements for the Award of the Degree of Masters of Science in Vehicle Engineering

BY

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ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY SCHOOL OF MECHANICAL, CHEMICAL AND MATERIALS ENGINEERING

MECHANICAL SYSTEMS AND VEHICLE ENGINEERING PROGRAM

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CANDIDATE'S DECLARATION

I hereby declare that the thesis work which is being presented in the paper entitled **"A Case Study on Improvement of Vehicle Maintenance Management System for Wonji Shoa Sugar Factory"** in partial fulfillment of the requirements for the degree of master of science in Automotive Engineering is an authentic record of my own work carried out from Sep, 2015 to June, 2016 under the supervision of Dr. Perumalla Janaki Ramulu, department of Mechanical System And Vehicle Engineering Program, Adama Science And Technology University, Adama, Ethiopia.

The matter embodied in this paper has not been submitted by me for the award of any other degree or diploma. All relevant resources of information used in this paper have been duly acknowledged.

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This is to certify that the above declaration made by candidate is corrected.

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Dr. Perumalla Janaki Ramulu (PHD) Date

(Advisor)

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ABSTRACT

Most of Ethiopian sugar factories vehicle maintenance management system is considered as weak activity. For developing and implementing vehicle maintenance management system in the factories can increase their vehicle maintenance effectiveness, reliability by minimizing failure. The main objective of this study is to examine the existing vehicle maintenance of **Wonji Shoa Sugar Factory (WSSF)** and recommend better maintenance management system that enhances vehicle availability with reasonable maintenance cost. The author believe upon implementation of the recommended maintenance management system, availability of vehicles for transportation and useful life are expected to increase due to minimizing of down time and abuse.

A scientific approach to vehicle maintenance management system helps Wonji Shoa Sugar Factory to meet objectives. Vehicle maintenance management system is concerned with the direction and organization of the action to reduce breakdown by better scheduled maintenance, ensuring maximum fuel economy, ensure proper tools, equipment and shop facilities in order to control the availability and performance of factory vehicles. The source of the data for the study are: questioner, unstructured interview, survey of previous relevant works, consultation and personal observation at the case factory, data collection from performance reports, and maintenance log book. By analyzing these data, using table, charts, and diagrams of the research could easily identify what the major problems and their causes to the existing vehicle maintenance management system in Wonji Shoa Sugar Factory. The maintenance can be improved by providing proper training to the vehicle drivers, mechanics and other maintenance workers, on the light of preventive and corrective maintenance philosophy, less downtime of vehicles and low investment of spare parts by recommendations in the maintenance management system development.

Keywords: ***Vehicle maintenance management, Maintenance planning, maintenance program, Scheduling Work***

ACRONYMS

AS	Annual Service
AV	Availability
CBM	Conditional Based Maintenance
CM	Corrective Maintenance
DT	Down Time
ESC	Ethiopian Sugar Corporations
FESD	Field Equipment Service Department
HDV	Heavy Duty Vehicle
MDH	Maintenance Department Head
MP	Maintenance Program
OEM	Original Equipment manufacturer
PM	Preventive Maintenance
VMMS	Vehicle Maintenance Management System
WSSF	Wonji Shoa Sugar Factory

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INTRODUCTION

Vehicle maintenance management system which is one way of improving productivity through capital resource is defined as a set of activities or tasks that are related to preserving equipment in a specified operating condition , or restoring failed vehicle (machine) to a normal operating condition[4,6]. Maintenance is the combination of all technical, administrative and managerial actions during the life cycle of an item in intended to retain it in, or restore it to, a state in which it can perform the required function [3]. Performing vehicle maintenance activities requires the use of resources such as skilled manpower, spare parts, tools, appropriate working environment and management system. Vehicle maintenance tasks or activities ranges from simple cleaning operations and lubrication to performing condition monitoring, as well as planning and scheduling maintenance resources. If the vehicle maintenance management system of wonji shoe sugar factory gets proper attention, breakdown and down time can be reduced by a substantial amount which makes possible the factory productive and profitable.

1.1 Background of the Factory

Wonji Shoa sugar factory is found at Oromiya Regional State near Adama Town at 110 Kilo Meters from Addis Ababa. Commencing production in 1954 it is the oldest and the pioneer in the history of Ethiopia's sugar industry. And Shoa Sugar Factory constructed in 1962 is the second oldest and both, being obsolete, have stopped production since July, 2012 and July, 2013 respectively. The two factories constructed by the Holland Company known as Hangler Vonder Amsterdam (H.V.A) had a capacity of producing 7,500 quintals or 750 tons of sugar a year. The sugarcane plantation land of these two factories was 7,000 hectares out of which 1,000 had been planted by out growers.

In a bid to replace these two oldest factories with a new and modern one, an expansion project had been carried out both in the cane cultivation field and the factory since 2010. And, the factory plant expansion project has come into its completion in July, 2013. Accordingly, the newly built and highly automated Wonji/Shoa Sugar Factory will initially have a capacity of crushing 6,250 tons of cane a day and producing 174,946 tons of sugar per annum which with further expansion will reach up to 12,500 TCD maximizing its production to 220,700 tons of

sugar a year. The new plant will initially have a capacity of producing 10,000 meter cube ethanol per annum that with further expansion will reach 12,800 meter cube. By the end of the GTP period the factory would be able to contribute 21.15 megawatt electric powers to the national grid in addition to satisfying its own demand which is around 10 megawatt. Its agricultural expansion project is currently being carried out around the areas known as Wakie Tiyo, Welenchiti and North Dodota areas. The factory, with the help of this agricultural expansion project, will have 16,000 hectares of sugarcane plantation field in total. Till December 2014 the total cane cultivation field of the factory has reached 11,026 hectare. And, the entire factory's sugarcane field cultivated with the agricultural expansion project is owned by out grower farmers of the surrounding area.

1.2 Background of the Study

Ethiopia, like other countries require continuous improvement in agriculture, manufacturing and service sectors, in accomplishing the development in these sectors, the transportation system by vehicle play vital role. Efficient and economical operations of transport system require proper maintenance and a significant portion of operation cost. Transportation is that of vehicle maintenance used by enterprise to deliver product and services. The failure of their vehicle service can cause serious social and economical consequences. Vehicle failures are rectified through corrective maintenance actions while preventive maintenance actions are used to reduce the recurrence of failure. All these maintenance actions resulted in additional cost. Therefore maintenance must be done so as to achieve the objective of the factory.

The factory under consideration (Wonji Shoa Sugar Factory) is one of the organizations engaged in different type of vehicle transportation service. The factory has more than 58 years of experience in different type vehicle transportation service. It plays indispensable role in producing sugar to the country. But from time to time the factory faced increasing downtime of vehicles, and repair costs, too many obsolescence and financial losses. Basic vehicle maintenance is a fundamental part of a machine's work in some courtiers, while in others it is only consulted when a vehicle is already showing signs of malfunctioning. Preventive maintenance is also concepts of a machine's job, but this is not possible in the case of vehicles that are not regularly maintained by a machine. One misunderstood aspect of

preventive maintenance is scheduled replacement of various parts, which occurs before failure to avoid for more expensive damage.

1.3 Statement of the Problem

In many vehicle maintenance providers, in Ethiopia, the vehicle maintenance record keeping and failure analysis culture is very poor. Maintenance is performed without any manual procedure on breakdown based; this decreases the economic service life of vehicles and lacks critical information on the vehicles' status, for its replacement or disposal. WSSF follows reactive and minor lube types of maintenance. This causes higher down time, road call accidents and more obsolete vehicles. The main problems observed in Wonji Shoa Sugar Factory in relation to vehicle maintenance management system are follows: reactive and minor lube type of maintenance. As a result, the factory cumulative losses become increasing year for year. This is because; the maintenance procedure is not according to the points which can be derived from proper maintenance record and analysis. Hence the thesis work seeks to improve the current maintenance management system. The maintenance procedure is not according to the points which can be derived from proper maintenance record and analysis. The factory experienced the higher down time, maintenance cost and operating cost of the vehicle is increasing year after year due to:

- Weak maintenance work planning and work order system
- Lack of preventive based maintenance
- Lack of spare part management
- Improper handling of tools, and equipments
- Improper record maintenance on used equipment
- Lack of knowledge to understand vehicle manual
- Poor human resource management

The above mentioned problems in Wonji Shoa Sugar Factory can be minimized by applying effective maintenance management system. This thesis is made improvements on the existing maintenance system and strives to find a way to reduce, if possible to eliminate the costs and

the losses, and improved by implementing properly planned vehicle maintenance management system.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of this study is to improve vehicle maintenance management system for Wonji Shoa Sugar Factory

1.3.2 Specific Objectives of the Study is to

- Identify the problems in the existing vehicle maintenance management system.
- Identify existing maintenance problems and suggest measures for improvements.
- Assess the problems related to planned maintenance procedure scheduling to the maintenance work.
- Improve a new maintenance plan and schedule for minimizing the maintenance cost.
- Recommend improved vehicle maintenance management system.

1.4 Significant of the Study

Vehicle maintenance management system becomes significant in the transportation system because to save social and economical aspects to the nation. This work is to make the factory competitive in terms of cost effectiveness and quality wise improved maintenance and maintenance management, skilled work force improvement maintenance management system that can reduce down time of vehicle and decrease maintenance cost and increase vehicle performance by which increase the factory productivity. So the recommendation of this study will help the factory to establish an efficient maintenance management system to improve its vehicle maintenance and so as to compete with other factory by giving proper vehicle maintenance and transport service.

1.5 Scope of the Study

The scope of the study centers on the problems of WSSF to use maintenance management system and suggest possible solutions.

The work will compass WSSF producing factory's maintenance system, maintenance effectiveness and maintenance resource utilization. But, the paper cannot provide a complete answer to every maintenance management problem in the factory.

1.6 Limitation of the study

This work is limited to the study of maintenance management system for the production operation of the factory.

The researcher also faced difficulty in obtaining adequate and sufficient reference from the respected factory which is relevant to the topic of the study.

The research study covered in this work does not apply any type of software development for analyzing the study; yearly data for the period of three years should be used.

2. LITERATURE REVIEW

2.1 Definitions of Maintenance

Maintenance can be defined as those activities required to up-keep a facility in as built condition, so that it continues to have its original productive capacity [7] Depending on designer limitation of life span, manufacturer recommendations, age and service conditions of equipment/vehicle, it is possible to adopt the particular maintenance types along with their implementation interval. According to the Oxford Dictionary, "maintenance is defined as, 'the act of maintaining or the state of being maintained; the work of keeping something in proper condition; upkeep". In the context of industrial sector, maintenance can be defined as actions to control the deterioration process leading to the failure of a system, which is often called "preventive maintenance", and the restoring of the system to its operational state through corrective actions after the occurrence of failure, often called "corrective maintenance". From the above definitions, it can be seen that maintenance is necessary to keep any product or system, with a finite life span, operating at an acceptable level, so as to support the needs of the user or organization. Maintenance may be categorized in to the following major types [7]:

1. Conditioned based maintenance: is a maintenance activity conducted to prevent failures before it happens using sensing, measuring, or condition monitoring devices to detect wear stages.

2. Corrective maintenance: corrective maintenance covers all maintenance activities that are carried out in order to correct (repair) a fault in equipment/ vehicle. It may include emergency or break down maintenance.

3. As required maintenance: "as required maintenance is simply doing maintenance works as the need develops (arise**).** This type of maintenance is applied for non-critical equipments.

4. Preventive maintenance: PM is done to prevent the occurrence of failures and to detect failures before they develop to break down or disturbances in operation (product/service) Preventive maintenance has become a term with broad definition. The generic definition of PM is any planned maintenance activity that is designed to improve equipment life and avoid any unplanned maintenance activity. In its simplest form it can be compared to the service schedule for vehicle. There are certain tasks scheduled at varying frequencies, all designed to

keep the vehicle from experiencing any unexpected breakdowns. PM activities that help to avoid failure of equipment are listed in [19] as follows:

- Equipment inspections to uncover deficiencies before failure and in sufficient time to plan deliberate repairs;
- Non-destructive testing techniques (predictive maintenance) to detect equipment deterioration and monitor equipment to note abnormal operation;
- Routine maintenance such as lubrication to reduce friction that causes heat, wear, misalignment, or seizure;
- Routine, cleaning and adjusting done in conjunction with inspection or lubrication, or performed by frontline operators;
- Replacement of minor components to reduce chances of more important components failing;

It is recommended that maintenance being cause and effect situations, it is logical that efforts be directed towards correction of the causes, rather than continuing to treat the effects [12]. Therefore, it is feasible and economical to adopt a mechanism by which maintenance is conducted to prevent the cause of failures and detect the failures before it occurred. It is recommendable to adopt preventive maintenance when:

- Corrective maintenance cannot be justified
- Condition based maintenance cannot be applied and
- As required maintenance effects cannot be tolerated

In preparing this thesis, concepts are drawn and ideas are incorporated from various works of different authors whose contributions have been significant in the development of maintenance function, and maintenance management. The works of the authors' quoted in [7], [9], [10], [12], [15] and [21, 20& 24] can be summarized as follows:

- Maintenance department shall be organized based on some universal truths and modified to adopt it to different sizes and sections according to the following parameters:
  - ¾ Particular technical, geographical and personnel situations involved
  - ¾ State of training and reliability work
  - ¾ Available facilities
  - ¾ Plant size and type
  - ¾ Company policy

- ¾ Industry wide and sectional precedent

- Maintenance work shall be as much as possible preventive
- Maintenance planning and control system is crucial for implementation and cost effectiveness of maintenance
- Computerized maintenance management system is necessary
- Maintenance system can be centralized or decentralized

Theories and facts described in their work relevant to maintenance management system are assessed and adopted to solve the identified problems of vehicle maintenance of WSSF.

The objectives of standardization, codifications and their application or economic benefits, which are adopted in this thesis work are stated, [4]. Additionally, he has shown the three categories of equipment life. These are economic life, profit life, and physical life. "The physical life is the age which the equipment/vehicle is exhausted and can no longer produce/ give service. At this point it will usually be abandoned or scraped; Profit life is the life over which it can earn a profit; retention beyond that point will create loss. The economic life of a machine/vehicle is the life, which maximizes profit over the lifetime of the factory.

The framework of maintenance workflow system and the accompanying formats in their work is presented in, [5] & [7]. These systems and formats with that of WSSF vehicle maintenance management system were used in development of maintenance work flow system of WSSF. Ideas and concepts relevant to forecasting of spare parts requirement is incorporated in this thesis [25]. In a similar manner the objectives of spare parts management that have been shown in [8] works are assessed and relevant concepts are incorporated.

Dolce [3] listed in his work basic factors that have to be considered in vehicles replacement strategy. The replacement strategy was based on analysis of life cycle costs. The concepts are assessed and incorporated in this work.

In motor vehicles fixed-time replacement of major parts is becoming complex due to accelerated wear of these parts, as a result of operation in hazardous condition or abuse by drivers in addition to deviations of useful life from the mean. Thus in most service manuals of motor vehicles and earth moving equipments, a preventive maintenance program based on fixed time replacement of fast moving items, gaskets, filters, seals, lubricants and condition based replacement or overhaul of complex items and sub-units are recommended.

The replacement or inspection intervals are given in mileage or distance traveled in KM for vehicles, and in operating hours for earth moving equipments and or other equipments.

In general, most literature on maintenance states that the objectives of maintenance management shall be to develop systematic procedure of planning, execution and evaluation of maintenance with objectives of increasing equipment/ vehicle availability by decreasing down time due to breakdowns.

2.2 The status of maintenance

In the United States, it was estimated that in 1979 over $200 billion was spent on maintenance. However, more disturbing than the amount was the fact that approximately one-third of that total was spent unnecessarily. As we continue to the present, there has been no significant change in maintenance policy, indicating the unnecessary cost trend is probably still one-third and the largest change in the maintenance costs is the amount. Since 1979 maintenance cost has risen between 10 and 15% per year. If this amount is calculated, it is very likely that the maintenance expenditures in the United States are now over one-half a trillion dollars per year. Where do these unnecessary costs occur in maintenance? How can they be controlled? These questions can best be answered by looking at some statistics. According to Wireman [8 & 9]:

Less than 4hr/day (out of a possible 8) are spent by maintenance crafts men performing hands-on work activities. This figure is even more alarming when it is realized that the majority of maintenance organizations are performing as few as 2 hr of hands-on work. It is not that these individuals are lazy or shrinking job responsibilities. It is the fact that they are not provided the necessary resources by management to perform the assigned job tasks. Providing these resources becomes important to increasing maintenance productivity and producing substantial maintenance labor savings. If we would view maintenance salaries as a resource, $20 per hour is paid and only utilizing this resource at a 50% level; that is a tremendous cost waste. Only about one-third of all maintenance organization uses a job planner to plan maintenance activities. Most experts agree this is one of the largest potential for cost savings in the maintenance area. It is estimated that planned versus unplanned work may have a cost ratio as high as 1:5 performing a $100 planned work could save as much as $400 over performing the same job in unplanned mode.

The majority of all maintenance organizations either are dissatisfied with or do not have work orders systems. This is one of the critical indicators of the status of a maintenance organization. If a maintenance organization does not have a work order system in place that works properly, it is impossible to measure or control maintenance activities. Of companies that have work order systems (one-third of all companies) only about one-third track the work orders in a craft backlog format (actual 10% of total organizations). This format will permit the manager to make logical staffing decisions based on how much work is projected for each craft. Being able to justify employment levels to upper management is a necessary function of good maintenance management. Of companies that have work order system, only one third compared their estimates of the work order labor and materials to the actual figures. Again, this means only about 10% of all organizations carry out some form of performance monitoring. Successful maintenance management requires performance monitoring. Of the companies with work order system that allows for feedback, only one-third, again about 10% of all companies, perform any failure analysis on their breakdowns. Most of the other companies are just parts changers. For an operation to be cost effective, good practice in failure analysis must be followed.

Over time, another key indicator, in the United States averages about 14.1% of the total time worked by maintenance organizations. This figure is almost three times what it should be. Since maintenance is working so much overtime, it again indicates the reactive situation that is standard in the industry. Reducing overtime is essential if a maintenance organization is to be truly cost effective.

Preventive maintenance, another major part of any successful maintenance program, is presently satisfying the needs of about 22% of the maintenance organizations. This again illustrates major problems for the maintenance organizations. Without successful preventive maintenance programs, maintenance can only react to given situation. Preventive maintenance allows the organization to plan better and reduce maintenance costs. Over three-fourths of the organizations need major improvements in this area.

Related to preventive maintenance, almost three-fourths of the organizations have some form of lube routes and procedures. While this fact seems to be positive on the surface, it is not. Many of the organizations feel that preventive maintenance is nothing more than lube routes and procedures. So once they have these developed, they stop. However, preventive

maintenance encompasses much more than lube-routes. To be successful, maintenance organizations must go beyond the preliminaries and fully develop preventive maintenance programs.

One final fact related to preventive maintenance is the lack of coordination between operations/ facilities and maintenance. Almost three-fourths of all organizations experience problems in coordinating preventive maintenance with the operations/facilities group. The problem is with communication. Either the maintenance organization has not communicated the need for the preventive maintenance or the operation/facilities group is not listening. Good, credible communication must be established if preventive maintenance is to be effective.

Second only to maintenance labor is the cost of maintenance materials. Depending on the type of operations / facility maintenance, materials can range between 20 and 70% of the maintenance budget.

To manage maintenance successfully, materials must be given close scrutiny.

Many companies try to remedy maintenance materials problems by over stocking the storeroom. This is a problem because most will not take in to account that inventory carrying costs are over 30% of the price of the items per year. So, for example, the cost of carrying $1 million inventory is over $300,000.00 per year. It is for this reason the inventories must be kept low, while still providing for a satisfactory level of service.

A third point of concern for maintenance materials is that maintenance is only responsible for their inventory in about 50% of the organizations. This means the other 50% of the time, another body is telling maintenance department what they should stock and how many they can issue.

While most thus agree that maintenance costs are high, they do not know how high they are for their own site. In most cases, the costs of maintenance repairs are calculated as the cost of maintenance labor and the maintenance materials to effect the repair. What larger figure that is not added is the cost of lost production/service. The range for this cost may be from 2 to 15 times the cost of the maintenance repair. The average is usually 4 to 1. So while a maintenance repair in labor and materials may be 10,000.00, the actual cost is really closer to 50,000.00. In fact, it is estimated that in the next several years the annual maintenance cost will exceed the amount spent on yearly new capital investment.

2.3 The essential of maintenance

“Components, sub-units, subsystems, systems of equipment and vehicles are designed, manufactured and assembled from processes raw materials and energy by the aid of human labor and necessary tools. Their manufacturing and assembling process follow scientific laws in an economic way that will be achieved by maximizing performance and quality vehicles reducing costs. Furthermore, in order to continuously perform their intended mission or be available to perform their mission when needed, the following factors have to be analyzed and determined thoroughly during, manufacturing and assembling process.

These factors are:

Reliability:-The ability of an item to perform a required function under stated conditions for a stated period of time. With this regard, during designing, manufacturing and assembling activities, care must be taken in order to maintain high reliability of operations at an accepted added cost.

Maintainability:-The ability of an equipment/vehicle under stated conditions of use to be retained or restored to a state in which it can give its original performance, when maintenance is performed under stated conditions and using stated procedure and resources.

Availability:-The ability of equipment/vehicle to function properly, despite occurrence of failures, disturbances and limitations in the maintenance resources.

Human factor (ergonomics): -human factors refer to the design of a system or a product/service with the human being in mind that is the design for operability and ease of maintenance. Considerations include physical dimensions of the human body, human sensory factors (sight or vision, hearing, feel or touch, smell, physical factors the effects of environmental stress on the body) and psychological factors pertaining to the human mind emotions, traits, attitudinal response, and behavioral patterns as they relate to job performance.

With the above consideration, during designing, manufacturing and assembling of parts, components, sub units, subsystems and systems of equipment or a vehicle are manufactured for a limited life span. If errors are committed during designing, manufacturing and assembling process, the expected life span of the machine systems, sub systems, sub-units and components will be less than the expected life. Thus, in order to prolong the expected service life of equipment/vehicle or rectify the intended problem encountered especially during

manufacturing and assembling, it is necessary to conduct maintenance activities on equipment/vehicles.

2.4 Maintenance Management System Objectives

Maintenance management is concerned with the good control of the maintenance function and its related areas in order to best assist the objectives and goals of the entire organization. It is a combination of all technical and administrative actions to retain an item in, or restore it to the state which it can perform its requirements under normal stated operating conditions. In short, maintenance management can simply be defined as managing the maintenance activities to ensure the availability of equipment and facilities and keeping the downtime to a minimum. As such, maintenance management supports the effective operation process by eliminating and reducing the frequency and severity of equipment failures.

With the changes in the maintenance and the management techniques, there is a need to provide an integrated approach that pulls together all of the design tools and maintenance tools that exist into an integrated whole. This requirement is in the form of Maintenance Management System, which when properly organized and established, is able to provide personnel at all levels access to real-time information.

2.5 Maintenance Management System Framework

The fundamental approach of Maintenance Management System can be viewed as a closed loop which is repeated in a continuous improvement program of maintenance and information procedures. The Deming concept of Plan-Do-Check-Act is a common approach[20] used by firms for recording of data, accounting for costs, developing management information, updating equipment information, providing work ordering system, control of preventive maintenance program and providing management control reports. Brief reviews of the events that occur during each of the loop are as indicated below:

Plan: make plans to improve a given activity;

Do: carrying out the plans;

Check: follow-up or feedback actions;

Act: making corrections if necessary.

This sets out a systematic approach for businesses to adhere to so as to ensure good planning, productivity and efficiency of maintenance. To ensure that a Maintenance Management System functions properly, several other sub-systems are necessary. These sub-systems

includes topics such as equipment breakdown analysis, planning and scheduling of maintenance work, budget and forecasting, inventory control, training, accounting, work order system, work standards, and data collections. The list mentioned is not exhaustive but is considered to be more critical in the proper functioning of a Maintenance Management System.

2.6 Work Order Records/systems

A Work Order System is the essential tool for keeping track of documents used to record equipment maintenance tasks and provides the most important source of information for the maintenance analysis and the writing of PM procedures. In other words, a good work order system, with management commitment to its use, should produce quantifiable feedback on overall maintenance performance, job and plant cost, and equipment history. These above mentioned documents are called work order forms and there are several types and uses for them, according to the particular needs of each company. The basic purposes of the Work Order System according to Herbaty [13] are as indicated below to:

- provide a means for screening and authorizing work.
- Provide cost data segregated in a logical manner.
- Provide feedback information on repetitive failures for analysis purposes.
- Provide a tool to facilitate planning and scheduling of maintenance work.
- Facilitate control of productivity and performance of predictive and preventive maintenance.

In most instances, different organization has varying needs. Therefore, the work order system and its form used will vary across firms. Some general guidelines that apply to all systems are listed as follows [24]:

- Work order forms should be numbered and at least three copies are needed in connection with the control system.
- Only authorized supervisors approved by management can initiate work requests. A list of designated supervisors' names should be supplied to the work order section of the maintenance department.
- Work orders are initiated only in the maintenance department. The work request and/or work order form should be the basis for transmitting of crafts concerned. information to all

- The work order is the basis for reporting time and material charges.
- The work order is the basis for accumulating records of job estimates and actual costs for control and for improving estimates.
- The work order is the basis for work backlog reporting to control the size of the maintenance work force.
- Despite the general guidelines mentioned above, certain functions are still vital for achieving an efficient work order system as mentioned by Wireman [24] and Herbaty [17]. These functions include work order number and definitions, work order scheduling, setting job priorities and work order forms.

2.7 Work Order Number and Definitions

The work order number acts as a collection point for all information about the equipment requesting maintenance work. A number is assigned to each maintenance work request, be it planned, unplanned, emergency, or preventive maintenance. This number identifies the specific maintenance request, the equipment's maintenance charges (labor, material, etc.) and its history information. With the number defined on the work order form, the definition and description of the work to be performed and its priority rating must be assigned. The setting of the priorities of jobs will be discussed under Setting Job Priorities.

2.8 Work Order Scheduling

Proper scheduling of the work request will enable estimation of many variables required for the maintenance work such as man-hours, the skill type, and the materials required. This helps the scheduler in better planning of the maintenance workforce and also estimation of the cost involved.

2.9 Setting Job Priorities

In the case of a priority rating system, it brings objectivity and professionalism into the planning and scheduling of maintenance work. For example, the customer requesting should set this assigned rating but the priority rating may be reassessed and possibly changed according to some set guidelines. The priority and type of work should be coded to ensure consistency in assigning of the priority rating and identifying of the importance of the work. For instance, a more urgent repair work for equipment with a higher priority rating will affect the scheduling of other jobs.

2.10 Summary Reports

Information from the work order forms of completed jobs are input into the reports. Maintenance department will then use the information to tabulate and churn out summary reports in order to look at areas like maintenance cost, equipment criticality determination, maintenance costs by type, equipment failure analysis, etc

Standards and improvement goals can be set with the information supplied by the summary reports. Any below standard values can be investigated by referring to the individual work order. Furthermore, the summary reports can also be used to assist in compiling various reports, such as the Annual Equipment maintenance Report, the Monthly Parts Usage Report by Equipment and the monthly year-to-date. Major Problem Reports Herbaty [17], which highlight information for the long term or a specific period of time. Annual equipment maintenance report summaries the cost incurred for the year by equipment number.

2.11 Understanding Maintenance Planning

In the implementing of a maintenance plan, the terms preventive maintenance and predictive maintenance are often used by those working in the maintenance engineering department. With the implementation of preventive maintenance and predictive maintenance, planning and scheduling of maintenance work will ensure lower cost and better quality of the maintenance work than when maintenance work is performed on an emergency or unscheduled basis.

2.11.1 Planning

Planning is the determination of all necessary elements required to perform a task in advance of performing the job. It is the heart of good inspection and preventive maintenance. Good planning ensures proactive maintenance strategies to provide effective maintenance to the equipment. All maintenance work should be planned so that the quality and cost effectiveness of the work is assured. To put it simply, planning is to provide an accurate description of what is needed, e.g. manpower, tools, materials, and equipment, at the proper time before the job is started. Good planning of maintenance function should include:

- A general plan on the distribution of labor throughout the various departments under “normal” operating conditions.
- Detailed planning and scheduling of major events taking place during the year such as major overhauls or rebuilds, large construction jobs, major preventive maintenance tasks and vacations of maintenance workforce. Preventive

maintenance tasks should include routine maintenance, preventive maintenance, general repairs and emergency maintenance.

- Required spare parts, tools and other supply from the standpoint of the business organization, the planning can be divided into three

2.11.2 Long Range Planning

Long range planning is to provide plans for future activities and improvements to the maintenance function and can be for a period of five years or more. The primary purpose of long range planning is to keep the maintenance objectives, policies, and procedures updated so as to support the objectives of the company. Long range planners, usually reporting directly to the president or vice president, must have good knowledge of sales and operation forecast. As such, they are either from the upper management level or can be the maintenance manager.

2.11.3 Short Range Planning

Short range planning is concerned with the annual plan of operation of the maintenance function. This plan will specify how the maintenance workforce will operate during the coming year and will also provide detailed plans for major rebuilds or overhauls, upgrading, construction jobs, vacation planning, and also any changes to the production plan. Short-range plans should include preventive maintenance of periodic inspection, shutdown planning, general repairs and non-destructive testing which is commonly known as predictive maintenance. The list of common actions for short range planning is as indicated below

- ✓ Periodic Inspection
- ✓ Shutdown Planning
- ✓ General Repairs
- Daily Job Planning
- Analysis of Job
- Common PM Actions

It can be emphasis that good planning of the maintenance function will assure productive use of the available resources such as manpower, materials, equipments, etc. It will also ensure that maintenance actions are on schedule, and that the execution is carried out effectively and productively. Planning of the maintenance function must be performed throughout the three levels of planning, namely, long range, short range and daily planning.

The various actions in each level of planning will require decision making and consensus among all involved before implementation. This is to achieve overall commitment and team spirit, even during times of trouble.

2.12 Scheduling

Scheduling is an important tool for ensuring high labor productivity and the orderly accomplishment of maintenance tasks and actions. Scheduling is the action to arrange for the availability of all the planned elements prior to the job execution. Two-way communication between the operation and the maintenance department is critical so as to ensure that any maintenance plans are made known to the operation department in advance.

It is equally important to ensure that the planned elements or resources are properly scheduled so as to perform the job adequately. The typical elements required to perform a job are listed below [17]:

- Labor
- Material
- Equipment
- Safety
- Lockouts
- Tools and
- Instructions

To ensure that all the planning effort is efficiently implemented, all the various maintenance actions and tasks such as general repairs and overhauls, preventive maintenance, lubrications, and routine maintenance must be all scheduled. Scheduling of maintenance work can be divided into two main types, namely long range scheduling and short range scheduling. The definition and properties of these two methods of scheduling are as indicated below:

2.12.1 Long Range Scheduling

Long range maintenance scheduling, or master scheduling, is sometimes referred to as working ahead of the schedule or forecasting. Forecasting is often employed in conjunction with planning to help identify the desirable implementation dates, which often can be as long as ten weeks ahead. This lead-time will ensure that the required personnel are made aware of the proposed timing of the job and also allows for sufficient time for the planning actions to be performed on time [14].

2.12.2 Short Range Schedule

Short-range schedule can be divided into weekly or daily schedules and is constructed from the long-range schedules to provide for the orderly introduction of emergency work as it occurs and the routine maintenance work. Short-range schedule permits the comparison of labor and material resources with work requirements. As such, in the event that there are more emergency repair works in a week, the subsequent weeks or weeks' schedule can be modified to complete unfinished work from the current week' s schedule [19]. According to Niebel [23], about 85% of the weekly schedule is based on general repairs and overhauls, preventive and routine maintenance work while the remaining 15% is held open for emergency work. However, if emergency work is occurring regularly and utilizing more than 15% of the work force, an effort should be made to determine the causes.

2.12.3 Weekly Scheduling

In the planning of a weekly schedule, it is often useful to employ a two-week schedule [19].

The reason is that the planning function will not only provide for the work to be completed in the current week, but also for the subsequent week. In this way, there will always be a backlog of two weeks of work orders scheduled according to the priority. In the event of no emergency work being requested and the weekly schedule is running ahead of time, advance planned work can be brought forward for scheduling [17].

The second week schedule is more of an announcement used to point out subsequent jobs and tasks that is coming up. Weekly schedule meetings should be held to assist the planners and the related departments on the types of works that have been scheduled and also to confirm that all the required craft, materials and tools are available [19]. It must be understood that the weekly schedule should be realistic and should provide for an allowance for absenteeism. This will prevent the occurrence of lack of manpower required to perform the weekly scheduled tasks.

"Approval" of the recommended weekly schedule in advance by operation is a good way of ensuring that successful execution of a well planned schedule.

2.12.4 Daily Schedule

The daily work schedule is compiled from the weekly schedule by the maintenance supervisor and is to be distributed the day before the schedule task. The need for such a schedule is due to unforeseen changes in the planned weekly schedule. The reasons may be due to some

planned work taking more time than anticipated, shortages in materials or parts, high rate of absenteeism or unexpected high rate of emergency work [23].

From this daily schedule, the jobs are assigned to craftsmen through work orders. The work orders will provide all relevant details such as materials, special tools, a checklist of items requiring performing of maintenance work, and also a feedback column. The daily schedule allows for better control of the maintenance workforce and also caters to any emergency repairs to be performed so as to keep the downtime or severity of the equipment to a minimum.

2.12.5 Scheduling Format

In the process of scheduling maintenance work for any time frame, the planner/scheduler must have taken into consideration several areas as to Herbaty [17]:

- Allocating of manpower
- Scheduling of work
- Estimating
- Managing of the manpower pool
- Managing capacity and workload fluctuations
- Control of backlog

2.13 Allocating Manpower

In allocating manpower, the first step of the scheduling process is to prepare a labor assignment sheet for each of the area maintenance units/groups as it is essential in the preparation of the short or long-range schedule. These sheets, showing the distribution of labor by craft, should be updated monthly and should include areas such unit capacity, routine assignments, unavailable time, non routine assignments. A typical labor assignment sheet is shown in Figure 2.1. The various areas on the labor assignment sheet are explained as follows:

Unit Capacity: This is the number of permanently assigned personnel times 8 hours a day. Pooled personnel or external contractors should not be included in this figure.

Routine Assignments: Routine assignment should be divided into two categories namely, fixed assignments and variable assignments

Fixed: Assignments can further be divided into preventive maintenance assignments and other fixed assignments. The preventive maintenance assignments are normal preventive work performed on equipment that is stated in the preventive maintenance instructions. The manpower needed according to prior planning should be set aside and left undisturbed. For

other fixed assignments, which are known maintenance work such as lubrication, replacement of minor parts, janitorial work, etc and manpower can easily be calculated and set aside.

Unavailable Time: This is the average time spent by the crew on absenteeism, vacations, sick leave, coffee time, union business, etc. This figure can be obtained from past experience and knowledge of the current situation.

Non Routine Assignments: A non routine assignment determine the amount of labor available for any non routine jobs, and is equal to the equation as indicated below.

Non routine assignments = Unit capacity – Routine assignments – Unavailable time.

This category of work comprises practically all of the preplanned workload and is the major scheduling task of the planner/scheduler.

2.14 Managing Capacity and Workload Fluctuations

The workload in any maintenance unit can be subdivided into fixed and variable categories. Fixed categories include preventive maintenance and routine maintenance while variable assignments include minor and major repairs, absences, vacation and sick leave according to Herbaty [17]. The labor capacity available for any of these fixed and variable loads is itself a variable as labor availability can be affected by:

- Absenteeism, vacations and sick leaves
- Labor transferred to emergency jobs
- Labor transferred to higher priority jobs
- Inability to obtain material or equipment

In other words, the labor capacity to meet the needs and demands of any load is dynamic and constantly changing. Therefore, the labor capacity must be constantly and closely monitored and adjusted to balance the load and capacity. Some common remedies include working overtime, borrowing men with similar crafts from manpower pool and seeking external contractors.

2.14.1 Estimating

Estimating should be performed on all non-routine work orders. As to Herbaty [17] the main purposes and reasons of estimating are:

- To facilitate scheduling of the week's work
- To provide a basis for checking job productivity.

The estimated and actual job costs will show up on the completed work order printout. Any major difference in the values can be due to incorrect estimating or other reasons.

- To provide a basis for work order approval as unknown cost figures will make approval difficult.
- For backlog control. The summation of each work order estimate provides a measure of the size of the backlog.
- To help in controlling low productivity caused by incorrect crew allocation.

2.14.2 Scheduling of Work

Scheduling of tasks depends mainly on the criticality and priority of jobs, and the amount of manpower available. Routine and preventive maintenance tasks should have priority over others as unmentioned equipment will have higher chance of failure, thereby creating additional problems or failures. All necessary tools, materials and equipments for the performing of maintenance tasks should be made available before scheduled work order is released.

2.14.3 Managing the Manpower Pool

The maintenance workforce will be divided into units or groups and each leaded by a foreman. The workload for these groups will vary on any given day and this is due to breakdowns, changes in priorities, nature of jobs, and a wide variety of other reasons.

Furthermore, the group capacity available to perform the work will also vary for various reasons such as absences, vacations, sick leaves, transfers to emergency or higher priority jobs, terminations, etc. Therefore, planning and scheduling of maintenance work must take into account all these manpower factors and make necessary adjustments to balance load capacity. The adjustments that can be performed are as indicated below:

Insufficient Capacity/Excess Load

- Schedule more backlog work
- Inter-unit transfer
- Bring forward selected preventive maintenance tasks
- Allocation of manpower pool labor
- Schedule deferred maintenance tasks

The above mentioned adjustments are some suggestion and will not definitely work for any individual business. Careful considerations must be taken into account before coming to a conclusion.

2.14.4 Control of Backlog

A record of backlog should be maintained so as to plan for vacations, to facilitate the work planning effort and to make decisions on manpower including the need to hire fire or alter the human resources in each maintenance group. Absence of documentation of backlog may result in overload of tasks and may degrade the condition of the unspecified equipments [13].

2.15 Maintenance Cost Control

Preventive maintenance is an operating cost necessary in ensuring that operational targets are met. The benefits of an improved maintenance helps to increase revenues by increasing equipment performance due to high efficiency, improve return of assets by reducing the need for expensive capital upgrades and increasing output due to high availability. In terms of operation, maintenance will to increase enable the uptime or availability of equipment, to ensure attaining of high productivity and quality level. Budgeting is paramount importance to control the various necessary costs in maintenance. Often is done by comparing man- hours used, labor cost accrued, material cost accumulated, and total cost committed. The output of these costs is equipment, buildings or facilities maintained, activities performed, or jobs completed. In order to control cost, effective use of labor, tools and materials must be adhered to ensure a smooth operation of production equipment. There are some common facts that people should know about maintenance cost control as indicated below according to Tomlingson [19]: Most maintenance departments have a relatively stable work force, and total labor cost variations are primarily due to overtime.

Material costs are determined by volume of equipment that must be maintained and the speed at which the equipment consumes spare parts and materials. Therefore, an increase of emergency repairs will require more spare parts and materials than normal routine and preventive maintenance programs.

- Labor costs in maintenance are incurred by the need to install spare parts and performing the various maintenance tasks. However, a maintenance department doing mostly emergency work usually works less productively as more labor is consumed and the quality of work will tend to be poor as the works are performed in reactive mode.
- Maintenance supervision tends to help in control of costs due to the efficiency with which spare parts and materials are installed. Thus, the control of labor on their quality and performance will become a vital maintenance activity.

- ❖ Better control of individual jobs is achieved through planning and scheduling. The result will be completed jobs in less elapsed time, often with a reduction in cost and with less consumption of manpower. Another significant improvement is that downtime will be reduced and uptime is increased.
- ❖ With quality supervision, maintenance supervisors are able to control the quality of t job and also maintain the potential benefit of planning. Supervision also tends to result in better productivity and quicker completion of work.
- ❖ Successful cost control requires a work order information system that provides information to judge performance and guide corrective actions.

Overall, it is vital for businesses to administer a system of good maintenance cost control to assist in controlling of the labor and materials resources.

2.15.1 Reducing Maintenance Cost

With good planning and scheduling of the maintenance efforts, the maintenance department should look at ways of reducing the overall maintenance cost without affecting the efficiency of the maintenance function. With good implementation of procedural maintenance actions, the discovery of problems before failure occurs is possible. The final result will be less costly repair and less downtime. This will indirectly reduce the rate of repairs and lower the use of spare parts.

Furthermore, a good repair history record that highlights the chronic, repetitive problems and leads to their permanent correction can be helpful.

It is important for a business to impose a strict adherence to a regular PM Service schedule to help to extend equipment life. Operation can also contribute to reducing the rate of parts consumption by making equipment available for scheduled major repairs, as this is also a sign of confidence in the maintenance program. One direct cost that will affect the maintenance function is labor. In situation of immerse absenteeism, overtime is required for planned jobs. This explains why successful businesses often have good human resource system that curbs absenteeism which will affect the overall productivity and morale of the firm.

To summaries, a successful cost reduction program requires the following to be established according to Tomlingson [19]:

- ❖ Maintenance work must be approved before it is performed.
- ❖ All the maintenance work must be planned according to its scope, criticality, cost, etc.

- ❖ Planned work must be prioritized
- ❖ Planned and prioritized work must be scheduled
- ❖ Schedule of major work should be subjected to labor allocation and deferred if not certain.

Use of manpower should be scrutinized; performance to be measured and any questionable use of labor should be justified by maintenance supervision.

From the above, we can see that immense planning efforts are required to contribute to a successful cost reduction.

2.16 Maintenance Controls

Control of the maintenance function is vital to achieve the set targets and objectives. During the performance auditing, several questions should be raised for the maintenance controls. These questions, as determined by Wireman [23] include:

1. Is the maintenance utilization report used?
2. Is crew absenteeism closely monitored?
3. Does overtime exceed 5% of the total man-hours worked?
4. Are external contractors used for routine jobs?

For the first two questions, the reply should yield positive answers while negative answers to the last two questions will be desirable. In the event of discrepancies, actions needs to be taken in the indicated area and the planning and control areas should be firmed up. Emphasis should be placed on improving planning and increasing craft efficiencies. Improvements on planning and scheduling functions must be made if productivity of employees has to increase. For excessive overtime scenario, a common situation known as “fire-fighting” or reactive style of maintenance is occurring and this is not cost effective at all. More often, the maintenance crews are rushing to finish up on repair works and thus, overtime is needed to ensure that all routine and preventive maintenance are performed. A solution will be to place more emphasis on PM and predictive maintenance such as equipment testing and inspections to help detect imminent failures in advance. By uncovering the problems early, the emergency repair rate will be lowered eventually and the gradual improvement of the excessive overtime situation. Wireman [20] also cited that the use of external contractors on routine or repetitive jobs is a waste of resources and should be avoid wherever possible.

If the workload is such that the workforce cannot cover the routine jobs, there may be a need to increase the staff number or to revamp the manpower utilization to remedy the situation.

As such, external contractors should only be used on large projects or when in-house expertise is unavailable temporarily. If the expertise of a certain craftwork is creating a loophole of requiring constant external contractor work, a good solution will be to select personnel to undergo craft training to fill the gap.

2.16.1 Maintenance Backlog

According to Tomlingson [19], there are two purposes for having maintenance backlog. They are to keep track of the rate of new maintenance work being generated and also to help in determining the proper size and mix of the types of craftwork of the workforce. An increase in the amount of backlog may be due to poor work order planning, poor record keeping, and poor scheduling practices. The following questions should be asked while considering the maintenance backlog:

a. Does the backlog forecast the required downtime?

b. Is the work prioritized for each craft?

c. Are the priorities properly applied and reliable?

d. Is the backlog used to control the size of the workforce?

The answer to the questions should reflect the conditions of the work order backlog. The work requests should be planned and scheduled each day, considering the priorities, the require completion dates, the availability of craft workers, materials, and equipment.

In the event that backlog becomes a problem, assigning accountability for the different functions should help to eliminate the problem. However, it must be remembered that that inefficient maintenance operation for years cannot be expected to change overnight. A gradual implementation program must be used to help ease the old habits so that personnel will have the time to adapt and change. Another solution will be to increase the size of workforce to counter the increasing amount of backlog. However, this solution doesn't counter the "root" of the problem; that is the rational for the increase of backlog. Adding of personnel can sometimes worsen the situation, as the imminent problems are not solved.

3. METHODOLOGY

3.1 Introduction

This chapter covers different aspects of methodologies used during the research. It presents the different options available to carry out the study and gives reasons why a particular method was selected at different stages of the project. A lot of data collection was involved in the project; hence the way the collection was made can affect the outcome of the project. For this reason, the data collection methods selected during the study work is also discussed here. The data used for this study were obtained both from primary and secondary sources. Primary data were collected through observation, questionnaire, interview field investigation and observation. The secondary data were collected from factory work requests books, remark books and factory annual reports. Generally descriptive survey methods were used. Each paragraph details the motivation for the methodology choice made for the study. The chapter ends by summarizing the overall research plan and details of the path taken in the study.

3.2 Research Approach

Research is an active, diligent and systematic process of inquiry in order to discover, interpret or revise facts, events, or theories, or to make practical applications with the help of such facts, laws or theories. The scope of the research process is to produce some new knowledge. This in principle can take three main forms:

1. **Explanatory Research**: testing hypotheses and theories that explain how and why a phenomenon operates as it does.
2. **Constructive research**: a new solution to a problem can be developed.
3. **Empirical research**: empirical evidence on the feasibility of an existing solution to a problem can be provided.

In this particular study, the researcher used two forms of research. The data collected from the documentations, reports. ***Questionnaires***, ***interviews*** and ***observations*** are used to justify the proposed solution. Therefore, this study can be categorized partly as an empirical research and partly as constructive research.

Empirical Research Methods: are classes of research methods in which empirical observations or data are collected in order to answer particular research questions. While primarily used in academic research, they can also be useful in industrial researches.

Empirical Research: normally starts with some previously set theory, which the researcher develops to explain and/or predict what, happens in the real world. The purpose of the research is to test the theory and possibly refine it. Initially a research question is formulated.

The first attempt made during the research was to have the overall picture of the research area. The researcher job demands his presence in the factory for more than 45 company working days. This helps him to recognize the actual problem areas and associated causes.

Therefore the research is intended to answer the following questions;

- What are the current practices of the factory which greatly contributing to the resource losses?
- What are the main methods which can be implemented to measure control and finally reduce the maintenance resource loss?
- What measures should be taken to improve labor productivity (maintenance productivity)
- What suggestion can be given to the respective responsible authorities from the study?
- What recommendations can be drawn from the study?

In attempting to address these research questions, the following steps are carried out during different phase of the study:

- Literature survey
- Close observation of the procedures practiced in the maintenance department.
- Pointing out and identification of the possible potential areas of waste.
- Cause and effect analysis of the problem.
- Present the study results

3.3 Research Method

The method used when collecting, processing and analyzing the gathered information can be either quantitative or qualitative research method.

Quantitative Research Methods: collect numerical data (data in the form of numbers) and analyze it using statistical methods.

Qualitative Research Methods: collect qualitative data (data in the form of text, images, sounds) drawn from observations, interviews and documentary evidence, and analyze it using qualitative data analysis method.

Qualitative methods tend to be more appropriate in the early stages of research and for theory building. Quantitative methods tend to be more appropriate when theory is well developed, and for purposes of theory testing and refinement. In practice, no research method is entirely qualitative or quantitative. For example, a survey may collect qualitative as well as quantitative data using open-ended questions; an experiment may include observations of participant behavior as well as measures of response time and accuracy; a case study may incorporate quantitative data (e.g. system usage statistics) as well as qualitative data (e.g. interviews with users).

The selection of an appropriate research method is critical to the success of any research project, and must be driven by the research question and the state of knowledge.

The most common quantitative methods are:

- **Experiment:** apply a treatment, measure results (before and/or after). This is the only method that can demonstrate causal relationships between variables.
- **Survey:** ask questions i.e. face to face interview, telephone, mail, and internet.
- **Historical data:** look for patterns in historical data.

The most common qualitative methods are:

Case study: observations carried out in a real world setting. The objective is to immerse oneself in the situation and gain a realistic understanding of the phenomena in its natural setting. Case study research excels at bringing us to an understanding of a complex issue or

object and can extend experience or add strength to what is already known through previous research.

Case studies emphasize detailed contextual analysis of a limited number of events or conditions and their relationships. Researchers have used the case study research method for many years across a variety of disciplines. Researcher Robert K. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used.

Critics of the case study method believe that the study of a small number of cases can offer no grounds for establishing reliability or generality of findings. Others feel that the intense exposure to study of the case biases the findings. Some dismiss case study research as useful only as an exploratory tool. Yet researchers continue to use the case study research method with success in carefully planned and crafted studies of real-life situations, issues, and problems.

Action Research: apply a research idea in practice, evaluate results, and modify idea. It is more of a combination of an experiment and case study.

The nature of the present study requires both quantitative and qualitative information to obtain best results and to propose important recommendation. Both kinds of methods have also been used to support conclusions made in this thesis. Mixing qualitative and quantitative research methods is called triangulation method. While most researchers develop expertise in one style, the two types of methods have different, complementary strengths and when used together can lead to a more comprehensive understanding of a phenomenon.

To analyze the data, majorly descriptive methods and SPSS were used. During analysis Pareto Principle was used to determine the major contributors for unplanned down times.

A work sampling methodology was developed and implemented to measure maintenance workforce efficiency.

In order to analyze annual budget of MSF for training its technical personnel, the researcher uses expenditures per employee and expenses by percentage of payroll for MSF.

3.3 Methods of Data collection

In order to achieve the objectives of the study the methodologies followed are:

i. **Literature survey:** To be familiar with the concepts of maintenance, maintenance management system and performance improvement, literature review should be carried out. Articles and journals are also should be reviewed to reinforce the current maintenance practices of the factory.

ii. **Data collection:** In this study work the data were collected from maintenance managements, mechanics and drivers. The assessment was done through circulating questionnaires, non structure interview and direct observation of the factory. Review of available data in Wonji shoa Sugar factory such as general operating costs and maintenance costs, types of maintenance practices, frequency of breakdown including road calls, resource consumption will be collected and examined. Direct observation of maintenance process of the factory and non structured interviews with technical personnel, supervisors, store men as well supply and maintenance managers assist to identify the problems.

iii. **Existing system analysis and system design**:-after identifying the problems in the factory, recommendation should be presented which enable to improve maintenance management system.

DATA ANALISIS AND DISCUSSOIN

The objective of data collection in this thesis was to know the existing condition of the factory maintenance management system and identifying problems related to maintenance planning and control system that reduced vehicle service operation, vehicle maintenance cost and vehicle downtime. The data obtained from making structural and non structural interviews for the top management, technical head, mechanics and drivers. Direct physical observations in garages maintenance condition, reports, procedure manuals, and responses to questionnaires were analyzed and presented in this chapter.

4.1 Data collected from different work section of the factory

- The existing maintenance management system of the factory,
- The existing work flow of maintenance,
- Number of maintenance worker and their qualification in maintenance department,
- Total number of vehicles/ machineries,
- Annual Maintenance costs,
- Maintenance plan and schedule of vehicle,
- Maintenance condition and downtime

Figure 1: WSSF Organizational structure and set up

WSSF is one of the oldest sugar factories that contribute a lion's share on the sugar production and job opportunity creation to the citizen. The factory has a plan of maintenance schedule though it suffers with lack of systematic maintenance organizational structure is not up to date and maintenance procedures pass through ups and downs which are resulted in absence of effectiveness and efficiency.

The overhaul activities of the factory are managed and administrated by the general manager. The factory is organized with different departments and it is directed and controlled by the factory board (Ethiopian sugar corporation Board) which is shown in fig. 4.2.2.The factory has three divisions, namely agricultural division, factory division, finance and human resource division and different departments. The top management organized in team, the management team consists of general manager, agricultural operation manager, and human resource and finance manager. Out of two activities i.e. factory activity and agricultural activity, the second one plays the greater role in production of sugarcane. Under this activity, land preparation, plantation, harvesting and field equipment service are included. For the production of sugar and molasses agricultural machineries/vehicles take a lion share. From the beginning of land preparation to the last step to transportation of sugarcane to the factory these field equipment/vehicles require a great maintenance attention. They should be handled

and kept properly. Miss handling of enormous amount of these vehicles will result to loss and reduction of sugar products. Health care of vehicles will optimize the production of sugar, unless the factory gradually leads to shut down.

4.2 Existing Organizational Structure of the WSSF

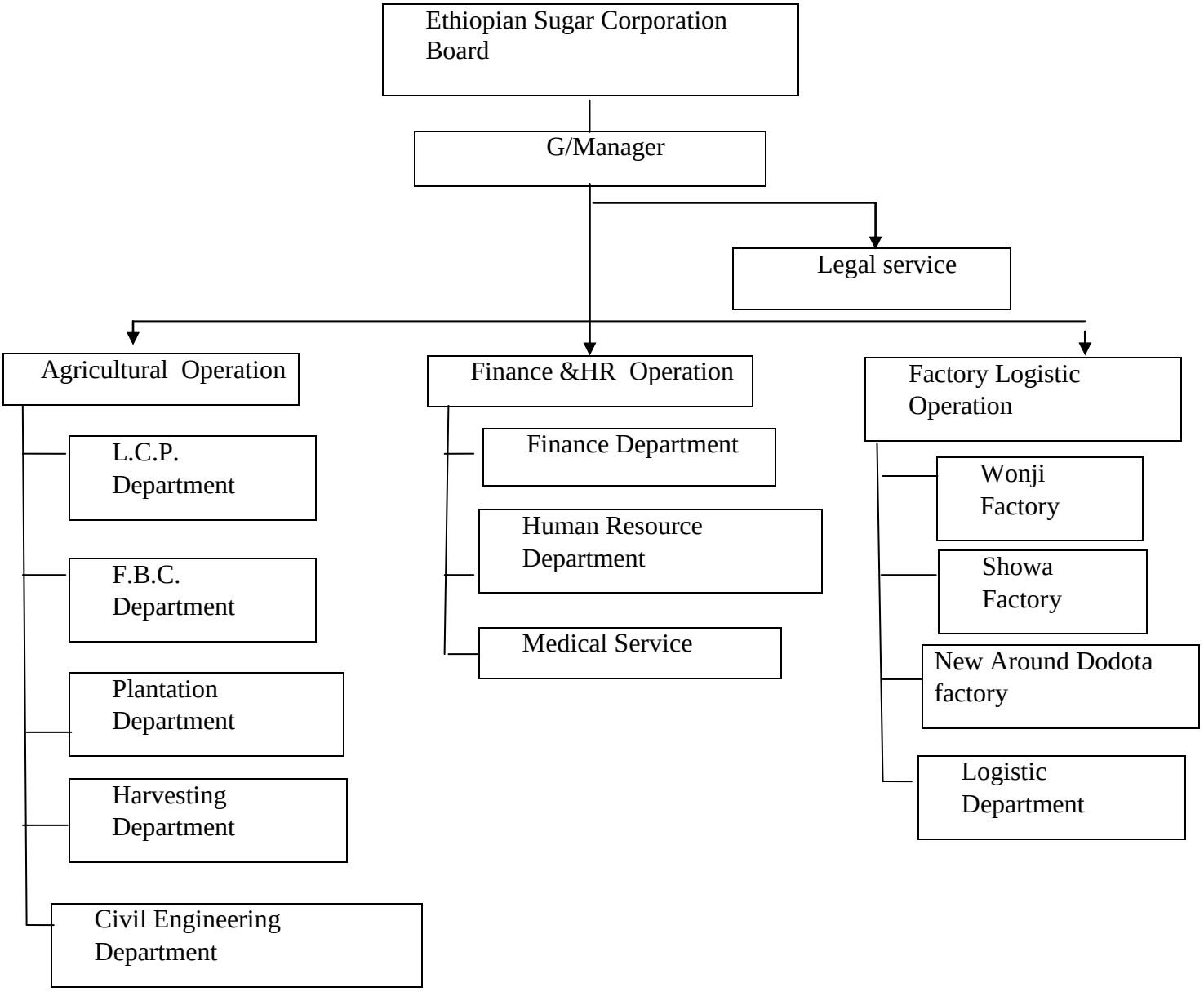

Figure 2: Existing Organizational Structure of the WSSF

4.3.1 Objective of the factory

According to the council of ministers' regulation No.89/1992 the objectives of WSSF are the following:

- To grow sugar cane and exploit other sugar yielding points.
- To process and produce sugar products and sugar bye products
- To study, plan and implement various sugar development programs
- To carry out scientific, industrial and agricultural research and survey to enhance its programs
- To possess and develop fulfill its purposes
- To distribute and sell locally and export sugar and similar products including non-sugar products from its farm and factories
- To engage in other industries, conductive to the attainment of its purposes.

4. 3.2 Mission:

Creating modern technology and capable human resource so as to develop the nation's potential to the sectors produce sugar, sugar bi-products and co-products and take remarkable foreign market share and support the nation's economy beyond satisfying domestic demand.

4.3.3 Vision:

Stand as one among ten leading countries of the world in sugar industry in 2023 based on a sustainable growth.

4.3.4 WSSF Sugar Production capacity

The production capacity of the factory for 2014/15 fiscal year was stated in Table 1

Table 1: Fiscal year production capacity of factory

Product	Sugar	Desta candy	Molasses
Unit of measurement	Ton	Ton	Liters
Required out put	13600	500	1261440
Achievable	14231.2	443.3	1265350
Achieved	12764.5	396	1199454

Seasonal working hours, effective working hours, down hours (time), utilization capacity and availability of the vehicles are roughly analyzed in respective of all vehicles.

Effective Working Hours:The hours taken on effective work of vehicles and it is expressed as:

Effective working hours(X) = total planned working hours- downtime in hours.

Downtime are categorized into two these are, non-operational downtime which includes idle time during drivers shifting tea break and urination (getting toilet) and operational downtime. The latter one is the idle time which happened as a result of vehicle failure and the time taken to corrective maintenance.

Utilization Capacity: This is expressed in percentage symbolized as **X, Y, Z.**

X-represents effective working hours in percentage as expressed above and,

$$X = \frac{\text{Effective working -hour}}{\text{Total Working Hours}} * 100$$

Y- Represents non-operational downtime which expressed as:

$$\mathbf{Y} = \frac{\text{Non-operational downtimes}}{\text{Total working hours}} * 100$$

Z- Represents operational downtime which expressed as:

$$\mathbf{Z} = \frac{\text{Operational down hours}}{\text{Total working hours}} * 100$$

4.4 Data collection and analysis by questionnaire

In WSSF, there are 225 employees as indicated in App -E Among these employees are the follows:

Table 2: WSSF vehicle maintenance department employees

	Job title	Amount
1	Maintenance team leader	1
2	Planner	2
3	Senior and junior Auto engineer	10
4	Lead Auto mechanic	15
5	Auto mechanic IV	13
6	Auto mechanic III	39
7	Auto mechanic	22
8	Auto mechanic I	67
9	Assistance Auto mechanic I	32
10	Welder III & II	8
11	Laborer	5
12	cleaner	3
13	Clark	3
14	Lubricant distributer	2
15	Driver (lowbed) & operator	3
	Total	225

To know employees responses 60 questionnaires were distributed only 54 employees have returned their feedback. So these individuals were taken as a sample to evaluate the major maintenance problems in the factory. The questionnaire, which was distributed to these employees, attached in the App-A. The current situation of WSSF Vehicle Maintenance Management employees can be analyzed based on the summarized above tables 2

4.5. Data Analysis from the Questioner

The aim of gathering information through questioner is to understand the problem of maintenance cost higher down time because of frequently failed the vehicles. Since it is impossible to cover the population of the factory, Only sample of 15 professional workers who have been related to the technical operation. Maintenance head, planner technical foreman and the rest 45 sample workers are mechanics and drivers

Describe systematically who has participated on the questionnaire and interview, their response are organized in the next.

4.6 Raw Data Respondent Gender Level

Table 3: Distribution of Gender level

	Gender	responses	Percent of total
1	Male	57	95
2	Female	3	5
	Total	60	100

4.7 Raw Data Respondent Educational Level

Table 4: Distribution of educational level

	Educational level	responses	Percentage of total
1	High school (below grade 12)	12	20
2	Certificate /level/Diploma& advanced	40	66.67
3	Under graduates/1st degree	6	10
4	Post graduates/masters/2nd degree	0	0
5	any other	2	3.33
	Total	60	100

4.8 Raw Data Respondent Occupational standard /level

Table 5: Distribution of occupational standard /level

	Occupational standard	Responses	Percentage of total
1	Department/ section head	1	1.67
2	Supervisor	4	6.67
3	Forman	4	6.67
4	Senior mechanic	10	16.66
5	Junior Mechanic	30	50
6	Driver	11	18.33
	Total	60	100

4.9 Raw Data Respondent Maintenance work experience

Table 6: Distribution of maintenance work experience

	work experience	responses	Percentage of total
1	1-5 year	10	16.67
2	6-10 year	30	50
3	11-20year	12	20
4	Above 21 year	8	13.33
	Total	60	100

4.10 Distribution of Maintenance Work Questionnaire.

Table 7: Distribution of maintenance work questionnaire

Q1. The Factory applies preventive maintenance (PM) system*?*

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	10	22.22	22.22	22.22
	No	35	77.78	77.78	100
	Total	45	100	100	

Q2. Are you always doing a planned maintenance system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	7	15.5	15.5	15.5
	No	38	84.5	84.5	100
	Total	45	100	100	

Q3. Have you taken training on maintenance system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.4	44.4	44.4
	No	25	55.6	55.6	100
	Total	45	100	100	

Q4. Do you maintain all type of vehicle in your work department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	6	13.33	13.33	13.33
	No	39	86.67	86.67	100
	Total	45	100	100	

Q5. Does the management give attention to the maintenance department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	5	11.11	11.11	11.11
	No	40	88.89	88.89	100
	Total	45	100	100	

Q6. Have you done corrective maintenance (CM) system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	36	80	80	100
	No	9	20	20	20
	Total	45	100	100	

Q7. Have you done predictive maintenance system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	12	26.67	26.67	26.67
	No	33	73.33	73.33	100
	Total	45	100	100	

Q8. Have you done preventive maintenance (PM) system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	15	33.33	33.33	33.33
	No	30	66.67	66.67	66.67
	Total	45	100	100	100

Q9. Do you think that preventive maintenance increases the life of the vehicle?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	40	88.89	88.89	88.89
	No	5	11.11	11.11	11.11
	Total	45	100	100	100

Q10. Are there efficient spare parts available for replacing worn out or broken parts?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	14	31.11	31.11	31.11
	No	31	68.89	68.89	68.89
	Total	45	100	100	100

Q11.Do you think that a well planned maintenance procedure minimizes the breakdown of vehicles?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	30	66.67	66.67	66.67
	No	15	33.33	33.33	25
	Total	45	100	100	100

Q12. Is there a lubrications program that makes sure equipments lubricated routinely and properly with the proper lubricants?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.5	44.5	44.5
	No	25	55.5	55.5	55.5
	Total	45	100	100	100

Q13. Is there adequate documentation, parts lists, manuals, and drawings are readily available, and used in maintenance planning on factory?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	10	22.22	22.22	22.22
	No	35	77.78	77.78	77.78
	Total	45	100	100	100

Q14. The preventive maintenance inspection /task checklist is checked to insure completeness?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	9	20	20	20
	No	36	80	80	80
	Total	45	100	100	100

Q15. Corrective and preventive maintenance activity is increases the work life of engines?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	38	84.5	84.5	84.5
	No	7	15.5	15.5	15.5
	Total	45	100	100	100

Q16. If there is standard maintenance plan, the vehicle downtime due to mechanical and electrical will be minimizes?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	30	66.67	66.67	66.67
	No	15	33.33	33.33	33.33
	Total	45	100	100	100

Q17. Do you think that a system of scheduled, planned or preventive maintenance tries to minimize the problem of breakdown maintenance?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	30	66.67	66.67	66.67
	No	15	33.33	33.33	33.33
	Total	45	100	100	100

Q18. The factory has perfect maintenance shop/work area arrangements?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.5	44.5	44.5
	No	25	55.5	55.5	55.5
	Total	45	100	100	100

Q19. The factory has good quality of maintenance tools?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	18	40	40	40
	No	27	60	60	60
	Total	45	100	100	100

Q20. Do you get the full benefit of effective maintenance; it needs good supervision and administration of maintenance department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	7	15.5	15.6	15.5
	No	38	84.5	84.5	84.5
	Total	45	100	100	100

Q21. Are you aware of your maintenance personnel spend their time to accomplish their jobs?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.44	44.44	44.44
	No	25	55.55	55.55	55.55
	Total	45	100	100	100

Q22. Are you aware of the spare parts consumption in the maintenance department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	13	28.89	28.89	28.89
	No	32	71.11	71.11	71.11
	Total	45	100	100	100

Q23. Have you balance your spare parts inventory regarding with carrying cost and ordering cost?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	6	13.33	13.33	13.33
	No	39	86.67	86.67	86.67
	Total	45	100	100	100

Q24. Do you like to implement maintenance management system us suggested by us in your factory?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	40	88.89	88.89	88.89
	No	5	11.11	11.11	11.11
	Total	45	100	100	100

Q25. Do you receive weekly maintenance report from the maintenance department?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	7	15.56	15.56	15.56
No	38	84.44	84.44	84.44
Total	45	100	100	100

Q26. Are you awer of how much time is lost due to problem of PM and corrective maintenance?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	11	24.44	24.44	24.24
No	34	75.56	75.56	75.56
Total	45	100	100	100

Q27. Do you record the man hours which are spent in preventive and breakdown maintenance?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	7	15.56	15.56	15.56
No	38	84.44	84.44	84.44
Total	45	100	100	100

Q28. Do you record the time spent (man power) for maintaining the vehicle as soon as the maintenance works finished?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	8	17.78	17.78	17.78
No	37	82.22	82.22	82.22
Total	45	100	100	100

Q29. Do you wear safety clothes while you are maintaining vehicles?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	40	88.89	88.89	88.89
No	5	11.11	11.11	11.11
Total	45	100	100	100

Q30. After finishing breakdown maintenance work, the maintained vehicle stops after one hour? How do analyze for this problem?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	25	55.5	55.5	55.5
No	20	44.5	44.5	44.5
Total	45	100	100	100

Q31. Are you doing any preventive maintenance work on holiday?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	6	13.33	13.33	13.33
No	39	86.67	86.67	86.67

Total	45	100	100	100

Q32. Do you report to your boss in case a maintenance problem arises beyond your capacity?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	28	62.22	62.22	62.22
No	17	37.78	37.78	37.78
Total	45	100	100	100

Q33. Do you regularly clean and lubricates the vehicle?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	23	51.11	51.11	51.11
No	22	48.89	48.89	48.89
Total	45	100	100	100

4.11 Back Ground of the Interview

Another instrument used in this study was interview. It was employed as instrument of data collection in order to get additional information from the concerned personnel of the factory that is vehicle maintenance workers and operators. The interview questions that were prepared by the researcher were unstructured type. The interview was department head, planner, foreman, mechanic and driver on face- to- face basis with investigator asking questions and listening to the responds of the employees from observations and non-structure interview.

4.11.1 Regarding Maintenance Activity

Maintenance practice of the factory did not include replacing worn out parts or parts which finished life time. The factory maintenance section did not do the job later even though. It was one of the principles of preventive maintenance i.e. replacing parts which finished their life time before vehicles could break down. Housekeeping and equipment cleanliness were given greater emphasis in the maintenance activities the production division and technical division had not good understanding of factory maintenance activity. They had also not that good understanding that production cost would be reduced when good maintenance was undertaken. The factory workers, specially the most important operation to keep the vehicle in good condition in the cleaning a vehicle was one of the best ways to check for abnormalities improvement condition of vehicles, that they must cleaned, lubricated, checked and inspected in the planned interval.

4.11.2 Regarding Preventive Maintenance Interview

Respondent respond that the PM program requires further improvements. This is a clear indicator of unplanned maintenance. Higher level of overtime indicates that the reactive situation that is standard in the maintenance process the factory. due to lack of planned inspection and PM , lack of training for operation personnel and lack of genuine spare parts: the factory pays great losses.

4.11.3 Regarding Downtime Hours Interview

From the researcher's point of view, WSSF did not attain such organized maintenance status log books showed high amount of breakdown maintenance. For the last three years existing annual maintenance plan show in (Table 2) was not revised. Operators had neither any role in PM nor revising the maintenance plan on weekly, monthly or yearly. The goal of PM is to reduce all types of downtime. And all types are analyzed together. PM recommends down time unscheduled related down time be 2% t or less of total operating hour.

4.12 Regarding Training Program Interview

There are a few on-job training courses developed to bridge the skill gap between workers. The department does not assign clear figure (in number and type) for training, rather they accept their share from top management.

4.13 Regarding Maintenance Inventory

Up on interview supervisors and maintenance technicians about the role of the maintenance department in inventory and purchasing, the majority of the respondents confirmed that the department participated only in checking inventory items just before receiving to store. Additionally the inventory department doesn't have technical staffs for handling easily damaged stokes. Therefore the factory lose a considerable amount of money due to lack of proper handling and several out of specification items are stoked even though the maintenance department rejected during checking the inspections just before receiving by the inventory department. Based on the responses the maintenance inventory needs major improvements.

5. PROBLEMS AND SOLUTION

5.1 Existing vehicle maintenance management problem of the factory

The following points are seen to be the major vehicle maintenance problems of the factory:

- One of the most problems in WSSF vehicle maintenance department is that the effort and attitudes of the factory toward the improvement of maintenance function is very low. (App-B. Q5). If the commitments of the top managers concerning the improvements of maintenance activities are low it will be very difficult to attain the goal the factory.
- In addition to the above problems the availability of maintenance tools/equipments in both quality and quantity in the work shop is very low. The available workshops tools are also centralized for scattered work shop. This is one of the factors which increase the downtime of the vehicles in the work shop. Lack of proper tools and instruments for repair and diagnosis of failure is also the other cause for most maintenance delay.
- In the existing situation of WSSF, the extent of maintenance shop works areas arrangement is not good to carry out effective maintenance. Without logical shop arrangement, it is very difficult to speed up the maintenance tasks; and as the result the down time of vehicles will be increased which greatly affects the sugar production.
- On the other hand the managerial chain in making decision of the existing maintenance activities is not comfortable.
- No safety precautions such as fire extinguishers, ventilators, and air conditioners are not available in the workshop. As it is known the climatic condition of Wonji Showa is very hot to perform maintenance activities in the workshop.
- No vehicle disposal and replacement regulation according to manufacturers manual is applicable.
- Most of the maintenance activities carried out in the factory is incomplete. High garage load and lack of skilled manpower are the main reasons for this incomplete maintenance.
- Since the percentage of PM program performed against vehicles manufacturers' manual is very low, almost all vehicles maintenance system in the factory is breakdown mode. Almost all vehicles are not tested engine oil analysis as recommended in the

manufacturer's manual. In addition vehicles tested for failure analysis I the case breakdown is not practiced in the factory. By making engine oil analysis after specified mileages or time the condition of some mating parts (like the clearance between piston and cylinder) can be well determined. In case of failure analysis the cause of failure should be known to take corrective actions to avoid redundancy of maintenance.

- No adequate training program is arranged for each category of workers including leader, planner and supervisors. As it is indicated in App-A 90% of the employees do not join higher educational (University) levels. Only 66.7% of the work force has technical school diploma 10% first degree, and 0 %t workforce has second degree (masters) in WSSF Vehicle maintenance department. Therefore in this type of working environment adequate training has to be given to encourage people to attain the objective of the factory. Otherwise it will be very difficult to get qualified workers. Continuous training for maintenance personnel is very essential to improve the skills of the labor force. If equipment complexity increases faster than the technical capability of craftsmen, the gap will cause a decline in production.
- Finally availability and application of job order description in the factory is not satisfactory. If the maintenance job is not described and reported well, the significance of maintenance departments cannot be seen or analyzed. They do not know exactly how high the maintenance cost is. Therefore in addition to labor and spare part cost the downtime cost should be clearly reported and corrective action should be taken to make the maintenance system so as to increase the productivity of the factory.

The existing maintenance system of the factory works preventive maintenance and corrective maintenance minimum practice of PM system. The respondent responds (Appendix-B.Q11) The factory is not following a well-planned and systematic way of maintaining vehicles (machines). The other problem faced the factory is lack of spare parts to maintain the breakdown of the vehicles and for overhaul maintenance the finance department not purchased spare parts timely and regularly some vehicles are not properly maintained and they stop now and then. (App-A.Q5) 89% of the respondents concluded that the management does not give attention to the maintenance section. The management should have given considerable attention to the maintenance department for the achievement of the target sugar production. The other problem faced by the maintenance department is lack of spare parts to

maintain the breakdown of vehicles and for overhaul maintenance (APP-A.Q10) which is feedback from employees of the factory indicated that there is 69% of the respondents conclude that there is lack of spare parts to replace worn out and broken parts of the vehicles. From this we can see that the management has not given importance to the maintenance work of purchasing spare parts regularly. The other problems the researcher views on the WSSF those vehicles faced problems and frequently failed due to the maintenance follow unplanned maintenance procedures then the vehicle should be followed planned maintenances and according to the developed and newly plan PM program of each vehicle.

In the factory some vehicles are not properly maintained and they stop now and then. This is due to unplanned PM and spare parts problem. If there is no regular PM means high consumption of spare parts will be seen in any vehicle. Unskilled maintenance workers are also one of the problems of the maintenance section. So training to the maintenance workers should be the basic and the primary aim for the factory. The creativity of the maintenance worker will be increased. If those vehicles well maintained the possibility of breakdown and frequently failed vehicles minimized, spare parts consumption may also decreased, the maintenance cost and operation cost decreased finally the factory sugar productivity maximized. The problems encountered due to improper maintenance management system practiced in WSSF are summarized as follows:

1. Lower operational performance of the vehicles than normal.
2. High frequency of road calls due to breakdown led to customer dissatisfaction. There are two kinds of customers in maintenance department of WSSF; external and internal customers, internally, the operation department and general service are the major customers; while any types of maintenance request from the external rather than the factory itself is known as external customers. The type of maintenance activities practiced in Table 4 is break down maintenance which covers about 96.26 % of the total maintenance activities.

Table 8: Summary of reasons for vehicles downtime and garage loads

Description	2005budget year E,C		2006budget year E,C		2007budget year E,C	
	Vehicle day	Percent	Vehicle day	Percent	Vehicle day	Percent
Routine PM	110	1.81	2476	1.96	950	2.97
General breakdown	5848	96.26	23568	97.11	29552	92.32
Lack of spare parts	422	6.94	692	2.85	2476	7.74
Total No of vehicles available	300		352		372	
Garage load in %	19		20		24	

Routine PM accounts 1.81% only. This leads to the failure of high frequency of the maintenance part s of the vehicles like engine, gearbox and differentials which need higher spare parts cost and much time to maintain. (Table 8) the vehicle expected service life is mainly decreased by the failure of these major components of the vehicles. Frequent breakdown and accidents are caused by lack of PM. these have lowered the availability of vehicles for operation.

Availability: is the ratio of time (hour per day) needed for operating the vehicle to the time actual consumed for operating and expressed as:

$$\text{Availability} = \frac{\text{Actual operating time (day)}}{\text{Scheduled operating time}}$$

$$= \frac{\text{Scheduled working time (day)} - \text{unplanned downtime}}{\text{Scheduled working time}}$$

3. Higher maintenance day than normal and hence increased garage loads (Table)The maintenance reasons for this were described below:

3.1 The factory does not have its own machine shop to perform repairs and recondition activities like cylinder boring operation, crankshaft grinding operation and chassis aligning tools.

Table 9: Major vehicle parts frequency of failure and road calls

	Duration	Total no of vehicle available	Engine failure	Gearbox failure	Diff failure	Total
1	2005 budget year E.C (July2012-June2013)	275	154	35	37	226
2	2006 budget year E.C (July2013-June2014)	276	153	40	38	231
3	2007 budget year E.C (July2014-June2015)	286	165	45	40	250
	Total	837	472	120	115	707

3.2 The other reason for this is the longer chain of managerial functions to perform maintenance activities.

3.3 The third reason higher maintenance day is the shortage of spare parts due to lack of well planned and control of spare parts in the store. Since high frequency of break down occurs the cost of spare parts becomes much higher than the capacity of the factory. From the collected data the total spare part cost for the past three years were about 58 million Ethiopian birr (table 10). To forecast the spare part cost in the following years, which should be more or less the same as those of the previous years, the current maintenance management system is unable to do it because it is still in breakdown mode.

3.4 Table 10: Summary of Maintenance Cost Analysis

Budget year	Spare part cost	personnel cost	Oil &lubricant cost	Tire cost	Total
2007-2008 E.C	20,697,577.32	20,348,466.09	12,271,053.01	22,500,758.71	**75,817,855.13**
2006-2007 E.C	19,454,000.00	19,929,679.60	11,206,950.00	21,103,420.40	**75,694,050.00**
2005-2006 E.C	17,778,600.00	18,236,711.60	10,686,255.00	19,986,532.03	**66,688,098.63**
Total	**57,930,177.32**	**58,514,857.29**	**34,164,258.01**	**73,690,711.14**	**214,200,003.76**

Accordingly, 2476 vehicle days were wasted in the garage due to the lack of spare parts to make them operational. One can easily convert the vehicle day in to money as follows:

One round trip in the distance a vehicle covers in travelling between Addis Abeba and Djibouti 1654km. This distance took an average of 7.56 days according to the maintenance report of the factory in the year 2014/15 G.C.

The income that could be generated in transporting one metric ton in converting one km was 0.63 birr.

The average load one vehicle can carry in the indicated distance = 15 tons. Therefore, the loss (L) of money caused by downtime due to shortage of spare part is about

L= 2476/7.56 * 15* 0.63*1654 = 5,058,904.9 Birr.

3.4 The fourth reason for high maintenance day is that there is no priority of jobs in the factory (App-A Q26). It is observed that many vehicles were wasting their time due to minor problems which can be solved easily without causing a great loss to the factory.

In general the higher downtime of the vehicle highly affecting the sugar production of the factory. According to the factory report from July 2014-June 2015, 29552 vehicle days were planned for maintenance activities. But the actual vehicle days were for maintenance in this specific time is 15967.this shows that 29552 vehicle days were r recorded as unplanned downtimes. One can convert these days into money as follows as done in 3.3 above

11658/7.56*35*0.63*1654/2= 28120067 Birr

4. Low profit due to higher maintenance cost: when maintenance costs becomes higher than normal the overall expense of the factory due to this cost increased.

5. Lack of well trained maintenance staff (App-A Q9)

6. Incomplete maintenance: the main reason for incomplete maintenance observed in the factory is the higher garage loads. When the garage loads becomes increased the maintenance manager forces the maintenance technicians to complete the work at any cost with fall in the quality. The other reason is higher frequency of breakdown. Since the mode of maintenance is just fixing or replacing the failed parts in the vehicle without considering related parts, the frequency of breakdown of major components in engine and transmission box is very high (table -9).

7. Lack of well organizes workshops: maintenance work shops were scattered at longer distance from each other. Much time is wasted by travelling among this workshops (App-A). This has caused high load time to perform maintenance operation. In order to avoid the existing problems due to poor and inefficient management of fleet maintenance and spare parts, it is a very essential to establish appropriate maintenance management system. Otherwise the factory MMS in the dynamic factory will be under question

The main target of the study is to improve the vehicle maintenance management system to increase vehicle availability by proposing solutions to the existing problems as it is taken from the collected data the following are identified as a major problems that reduce available of the vehicle.

- ❖ Annual maintenance planning and scheduling.
- ❖ Work shop facility.
- ❖ Improper handling of equipment and vehicles by drivers.
- ❖ No codification.
- ❖ No proper usage of manual.
- ❖ Lack of preventive maintenance.
- ❖ More downtime.

The study will propose solutions for the identified problems as follows

5.2 Anticipation Solution for outstanding problem

There are a lot of operational and technical problem in WSSF vehicle maintenance management as indicated in earlier chapters. These problems are serious. Hence they can hamper the competitive power of specific firm. The most common problems and their anticipated solutions are as follows:

5.2.1 Age of the Vehicles

An important criterion of maintenance planning to be kept in mind is the age of the vehicle in use. As aging occurs, the needs for maintenance increase quantum-wise. This is the factor that must need particular attention in any factory. The specific problem that should be addressed in WSSF vehicle maintenance department is the old age of the vehicles/ machines and as a result, the factory tried to replace few vehicles/ machineries that have been running for the last 25 years require frequent maintenance and body repair which obviously reduces operational running time. As a result it is increased maintenance expense. Therefore, the fact that it has not been able to replace them has put the factory at a competitive disadvantage and ultimately at risks for its survival. Therefore the factory should replace these aged vehicles to avoid crisis in the operational performance.

5.2.2 Cost Improvement

The first question that comes to every one's mind: when break down occurs how expensive is the breakdown? For all assessments eventually costs are related. To know the extent of breakdown expenditure, one has to accurately work out of the exact cost, arising out from a break down. Labor cost, cost of replacements and spare parts are the major factors that bring great loss to WSSF as everyone recognizes it from chapter-4. However the other aspect, namely impact cost; could well be even more and needs to be taken carefully into account. For example along with the loss of production one must calculate in terms of idle time of operation. The replacement of parts and repair are determined after the breakdown has occurred and the part are physically checked. For this reason vehicles to be repaired will take longer period than expected time. The actual cost of idle time can be calculated only by knowing the time taken by the vehicle to get repaired and to be put into operation. In order to improve the existing problem in maintenance activities conducted regarding to cost controlling in WSSF, establishment of PM system is indispensable. Then, it should be

followed by top management is commitments for implementation of maintenance activities, maintenance time and spare parts requirement are earlier determined.

5.2.3 Improvements of Maintenance Support facilities and Infrastructure

The creation of support facilities and infrastructure to cater the demands of the entire range of maintenance activities is not only very expensive but may also be time consuming. It is also quite like that the creation of an expensive facility for once created can be used for several years to avoid similar problems in the future. It was known the factory did not establish the maintenance facility like cylinder boring machine, crankshaft grinding machine and body and chassis aligning machines. The absence of these facilities had brought great loss by making high downtime which lowered the operation and expensive cost to pay for the maintenance action. Therefore for the organization, it is better to purchase and install such facilities and train the crafts personnel of such type of facilities and infrastructure to facilitate maintenance management in the factory. The other factor that need to be carefully considered are the internal facilities that need to be created to support the designed system, also their cost and the possibility that they have to depend on external sources like Original Equipment manufacturer (OEM) the facilities offered by them like location, proximity to other factory locations, lead time needed to obtain their help and also the facilities available in the geographical location for concerned maintenance availability and quality.

5.3 Improvements of Trained Manpower

In WSSF the maintenance organization is not yet able to acquire the necessary skill to repair or rectify the failed components /systems. The main reason for this is that the educational level of the main staff is very low (App-B) only 10% the man power completed university level education. Among them only 1.67% the manpower from the department were bachelor degree holders. Further there were not even quit confident about their diagnostic abilities to pin point a fault as and when it arose. As designing maintenance system and its implementation for an organization are difficult and complex tasks by their nature, the challenge for the factory is there in the existing situation. Therefore recruiting educated and well trained personnel is a must to assure the existence of the organization in the competitive market. Furthermore continuous and adequate training should be planned to cope up with dynamic technology for maintenance technician.

5.3.1 Recommended Maintenance Manpower

The determination of requirements for manpower involves identifying how many people are required and what skills they should posses. Based upon the new design of maintenance organization every scheduled and breakdown maintenance in the factory can be done as indicated in App-E to use the maintenance power effectively. Based up on this the recruitment of experienced and well trained personnel to accomplish the categorized job is advisable.

Table 11 : Recommended Maintenance Manpower

No	Heading	Job Title	Total no
I	Maintenance head	Manager	1
		Secretary	2
	Total		**3**
	Preventive Maintenance	Section Head	1
		Lead Mechanic	2
		Senior mechanic	5
		Mechanic	10
		Junior mechanic	15
		Grease man	5
		Washer	5
	Total		**43**
	Breakdown maintenance	Section Head	1
		Lead Mechanic	2
		Senior mechanic	5
		Mechanic	10
		Junior mechanic	15
	Total		**33**
	Planned	Oil and grease section head	1
		Grease and lubricant person	5
		Senior Tire repair	5

	maintenance	Tire repair man	10
	Total		**21**
II	Inspection And Maintenance Planning	Section head	1
		Inspector supervisor	2
		maintenance inspector	5
		Planner and controller	10
		Data encoder	5
		Gran and forklift operator	5
	Total		**28**
III	Electrical maintenance	Section head	1
		Lead electrician	2
		Auto electrician	5
		Battery man	5
		Industrial electrician	10
	Total		**23**
IV	Body, Chassis and Upholstery	Section head	1
		Body repair chief	5
		Lead body man	5
		Body man	10
		Painter	3
		Assistant painter	3
		Leaf spring repairer	7
		Upholstery man	5
		Radiator repair man	5
	Total		44
		Section head	1
		Engine shop chief mechanic	5

V	Rebuild Division	Senior mechanic	5
		Mechanic	10
		Junior mechanic	20
		Lead injection pump repairer	2
		Injection pump repair man	5
		Lead machinist	2
		Machinist	5
		Lead power train mechanic	2
		power train mechanic	5
	Total		**62**
Grand total			**257**

5.4 Improvement of preventive maintenance

Preventive maintenance is predetermined work performed to a schedule with the aim of preventing the wear and tear or sudden failure of equipment components. The major goals of PM are to solve and keep the vehicle from breakdown on the road, to catch minor problem before they become major expenses to prevent premature wear and tear by keeping parts from wearing each other away and by removing objects that could damage the vehicles interior and its occupants, and to safeguards warranties and guaranteed on your vehicles and parts. PM helps to:

- Protect vehicles and prolong the useful life of parts equipments.
- Improve system reliability.
- Decrease cost of spare part replacement.
- Decrease downtime.
- Reduce injury and increase safety.

Mechanical, process or control equipment failure can have adverse results in both human and economic terms. In addition to the downtime and the costs involved to repair and/or replace vehicles parts or components, there is a risk of injury to operators, and of acute exposures to

chemical and /or physical agents. Therefore, PM is a very important ongoing accident prevention activity, which should be integrated into operations/ product manufacturing process.

Preventive maintenance is a must for all equipment and passenger-carrying vehicles are no exception. A strict maintenance and inspection program is as necessary as fuel in the tank, if the vehicle is expected to provide dependable service. Properly maintained equipment last longer, cost less to operate, is involved in fewer accidents and provides more trouble-free service. Effective preventive maintenance (PM) services must be performed repeatedly as governed by preventive maintenance intervals and schedules.

5.5 Design of Vehicles preventive Maintenance

In this chapter, preventive maintenance is discussed. It is the care and servicing by individuals involved with maintenance to keep vehicles/machineries in satisfactory operational state by providing for systematic inspection, detection, and correction of

5.6 Maintenance scheduling

Maintenance schedules are prepared for preventive maintenance activities. It is the sequential arrangements by which maintenance is going to be conducted. In general, maintenance scheduling comprises the task to be performed, when to be performed? Where to be performed? Who will perform the task? And the required resources and estimated completion time. The schedule consists of vehicle number and the date of inspection and completion time. Preparation of maintenance scheduling requires an experienced planner who can put every maintenance activities according to their chronological order, decide required human and material resources and estimate completion time of the activities. Therefore, for the successful accomplishment of PM in WSSF, it is mandatory to establish maintenance scheduling procedure. The craft worker s staffing should be determined strictly by the backlog of work for each craft. Craft backlog is the amount of work that is documented as needing to be performed by the craft. The work that is counted in the backlog is only the work that is ready to schedule or that can be performed at present time. The formula to calculate the backlog is as follows

$$\text{Back log (in weeks)} = \frac{\text{Total planned hours ready to schedule}}{\text{True craft capacity}}$$

The true craft capacity is the total hours scheduled for the craft for a week minus scheduled interruptions. Scheduled interruptions should include average hours spent on emergencies,

5.7 Maintenance planning and control system

It was observed that maintenance planning and control system was not developed and

practiced so as to utilize the existing vehicles in proper manner. For the effective and efficient implementation of preventive maintenance system, it is mandatory to plan, schedule and control every maintenance activity done in the enterprise. Planning scheduling and controlling preventive maintenance activities are the basis for increased maintenance productivity and motivating the maintenance workers. Here it should be noted that there are other problems beyond the scope of this thesis, which needed further studies.

5.7.1 Maintenance planning

Planning is the determination of all necessary elements required to perform a task in advance of the job start time. It is the heart of good inspection and preventive maintenance; therefore, it is necessary for the maintenance personnel to know the volume of task to be performed by then vehicle each year, month, week and day in order to plan true preventive maintenance. This helps the maintenance personnel to identify the time when the vehicle is free to undertake maintenance. Thus, the cooperation and coordination of operation department with the maintenance department including supplies department is the key for the successful performance of planed maintenance. The requirement of maintenance planning emanates from the fact that planned activities are more cost effective than unplanned maintenance.

5.8 Improving spare parts management

Organizing spare parts management means so that, right spare parts are always in the right place at the right time, quality and quantity. The stoking system should be well designed or organized to facilitate the supply of spare parts and to decrease the delay in retrieval of the required item. The spare parts cost must also be considered. It is the largest main cost of maintenance department. Some problems are seen in planning spare parts. Several vehicles are stopped working because of absence of spare parts. Most spare parts ordering takes place in an urgent way because the vehicles are waiting for parts to be available. This is the main reason for the maintenance cost increment in the factory vehicle maintenance department. As recommended, the supply department should be under the control of the maintenance department because easy to take inventory, which means how much is stocked and needed, to plan quantity and quality of the spare parts.

5.9 Application of standardization

Standardization is briefly described as grouping of similar equipments and vehicles according to their application, model or size [5]. Categorization of equipments and vehicles by their application (duties) are the major classes in which equipment of similar function are grouped together. In the case of WSSF the revenue buses are grouped in one category and the supporting light vehicles in another category. In the same way the remaining workshop equipments and tools are grouped in their respective category. Further classification of WSSF's vehicles can be conducted depending on their make and model to suit for maintenance and spare parts planning. The classification of size based on weight, power of engine, passenger carrying capacity (seats) and some other engineering measures are some of the bases for vehicles and equipments standardization. Thus, the categorization of equipments/vehicles in to sub-classes that helps to utilize the same parts and subassemblies are one of the final goals of standardizing system development.

As we have seen, the vehicles can be classified as for their purpose, makes, models and duties. It could be Tractor, Machineries, Loader, small cars and workshop equipment and tools. Since there are few varieties of vehicles, standardization is not a big problem for WSSF but it is wise to understand that coding is even more facilitating. In this section the factors that should be considered in establishing the system and the merit of its effective and efficient applications are to be forwarded. Furthermore the maintenance system should also make the job easier. From the current situation at WSSF, it was observed that there was no clear standardization regarding the maintenance system due to unplanned maintenance system even though there was having excessive varieties of vehicles in the factory.

Excessive variety and lack of standardization creates the following problems:

- More budget to purchase and supply spare parts
- More number of technicians/higher multi-skilled
- Higher efficiency in maintenance management system
- Difficulty to have more sufficient suppliers of spares parts

From the current situation, it was observed that there is no big problem due to excessive variety of vehicles or equipments. Excessive variety and lack of standardization creates the following problems:

- Larger downtime due to waiting for spare part
- Larger lead time of spare orders
- Higher maintenance cost due to small lot size of spare parts
- Higher paper works to order parts
- Higher number of deadline vehicle that are waiting for repair and spare parts supply
- Higher investment cost
- Higher stock value
- Higher lead time of spare orders etc.

In order to minimize such problems, it is necessary to develop and implement good standardization.

5.10 Economic benefits of standardization

The economic benefits gained through establishing and implementing standardization system are presented below:

Reduction in the investment of equipment and spare parts: when equipment and vehicles are closed of spare parts that can related by good standardization, it is possible to reduce investment costs Investment cost reduction is obtained by holding lower stock values Investment cost reduction is obtained by holding lower stock values of spare parts that can be utilized to minimum down time cost.

Cheaper and less difficult to adequate supply of spare parts: standardization helps to reduce the paper work to order and purchase parts. Due to fewer values of stored parts and subassemblies while effective standardization system is developed and carrying cost is undoubtedly reduced.

Small stock values of subassemblies and repair kits to be stored: when well-organized and good equipment standardization system is developed, it is possible that parts and repair kits are commonly utilized. This helps to store minimum stock values of parts and subassemblies that may be stored if the owned equipment varies in size, model and make that cannot utilized parts commonly.

Lower maintenance cost: when owned equipment/vehicles are closely related, the technician will maintain similar equipments and vehicles and become specialized in repairs as

well as in trouble shooting. Thus, standardization aids to lower training cost than when equipment and vehicles varies in size, make and model management system.

Lower operating cost: when equipment and vehicles are closely related in size, make and model, it is easier to replace operators in case of illness, absence or retirement. Thus, effective and efficient standardization resulted in lower training of operators and overhead cost. But due to lack of maintenance management system WSSF did not use such advantages. Even though WSSF has no several verities of vehicles, standardizing the existing system will benefit now and in the future. Further it remedies some of the problems in maintenance management system. Hence, it is recommended that WSSF should develop a good standardization system based on their:

- Application, Function
- Make, size and Model

This can undoubtedly contribute to minimize the existing problems of maintenance

5.11Workshop Facilities

In factories that are engaged in vehicle maintenance like WSSF, the importance of sufficient workshop is inevitable. In this aspect WSSF has sufficient workshop area with proper ventilation and light intensity, but the problem is, the shops are not well organized Cabinets and benches are not provided; consequently components are put in the floor improperly. Some of the sections such as engine and gearbox repair, painting and others look like stores of obsolete items due to improper cleanness, hence low working atmosphere. Tools and parts are not properly kept in toolbox but everywhere dispersed. This is also cause safety problems and waste of time to find tools and parts. Cranes and pulleys are old and without proper safety. Now it is better to purchase hydraulic jacks and modern lifting equipments. Generally even if there is sufficient workshop area, shop organization and tool handling is very poor, hence, great attention is required.

Store:-there is one main store for stocking spare parts under the supply department. In the store there are spare parts and stationery items. Spare parts are stored in-group and according to part number. The group identifies to which type of spare is belonging i.e. TRACTOR, Lobed, Fiat, Small cars, and workshop equipment or stationery items. Under each group parts are stored in part number. Store keeping and arrangement is good because these are also kept in shelves and parts number. In addition to the part number it is recommended to put spare

parts in alphabetical order to facilitate easy finding of parts without wasting time. Cycle counting of Spare parts is every year, but it is recommended to be in half a year base Having presented the existing situation of workshops, equipments and tools of WSSF, the following comments and recommendations are made:

There are sufficient workshop equipment and machinery to assist the current maintenance and repair activities. But it is observed that the equipment and machinery are very old and working beyond their service life, this influences the quality of maintenance and efficiency of technical personnel. Therefore it is budget provided year by year

Since preventive maintenance is taken as a main means to solve the maintenance problems, it is necessary to purchase equipments and tools, which help to accomplish preventive maintenance. Specially to know vehicles status, it is better to have engine diagnostic and performance testing equipments or provide this in contract base taking either of the economical one.

Due to absence of special tools and testing instruments in the shop of WSSF, conditions of vehicles are not properly monitored, as a result higher frequency of breakdown maintenance are occurred. Service shops with no special tools like WSSF, there are events that parts are broken unnecessarily, burnt or struck by a large hammer, which may decrease hardness or deform, increase charge of exchange parts during disassembling. In similar manner there is unstable tensioning or fittings, causing imperfect and expensive services at the time of assembling. This cannot be avoided even with skilled technicians in the absence of proper tools and equipments. These are main problems that WSSF currently facing. So it is recommended to equip the workshops with modern equipments and tools.

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Based on the finding in chapter four, vehicle maintenance management in WSSF needs much improvement. Vehicle maintenance department of this factory should be well equipped with resource to assure the cost effective availability of vehicle to increase productivity of sugar. As it is seen in the section (chapter-4), Maintenance has great impact on productivity increment but it has received not much attention in the factory management (ESC).

In this chapter it is concluded that in WSSF vehicle maintenance management system most of work order generated from breakdown of vehicles which shows most of the maintenances activities are dominated by corrective action rather than preventive. One of the main causes of the problems is lack of effective vehicle maintenance management system. These vehicle maintenance management system problems can be minimized by:

- Having technical professional (skilled) manpower and organizational structure.
- Good spare parts planning and control system.
- Having replacement and disposal
- Implementing proper preventive maintenance.KJL
- Improving recording and reporting methods with information system.
- Use of proper technology and adopt appropriate training.
- Motivating vehicle maintenance workers.

The existence of high percentage of poor and bad status of vehicles reveals the problem of maintenance management system Vehicles in poor status are allocated to operation without proper maintenance in order to cover the route allotted; as a result considerable number of vehicles are operating with financial loss. Lack of preventive maintenance, shortage of spare parts, low quality of spare parts, and absence of performance measurement, improper data with non motivating salary recording and analysis are evidenced. Higher frequency of repair and accidents caused deterioration of the vehicles from time to time; consequently most of the

vehicles do not give the expected service after repaired. It is sufficient to see the serviceability of the vehicles in 1998 budget year which is 57%. Therefore the problem is severe; it is a question of survival. Technical personnel are working solely on their experience without training. Furthermore there are excess employees with non motivating salary.

6.2 Recommendation

In order to solve the existing problem of maintenance management of the factory, it is recommended to implement the preventive maintenance program. Successful implementation of the program and other related works is highly dependent on the commitment of top management and availability of resources (budget, skilled manpower and reliable suppliers for spare parts). The main tasks to be performed in the implementation process are expressed as follows:

1. Maintenance department should be conduct orientation and training to the task groups about the problems revealed in the maintenance and solution to be implemented.
2. Training should be necessary for maintenance personnel. In order to develop and implement planned and efficient training program. It is vital to know the types and level at which training should be conducted.
3. Prepare and distribute formats to conduct preventive maintenance programs/activities. Think for possible automation of data processing of maintenance activities such as database control annual preventive maintenance and spare parts requirement planning.
4. Conduct a panel for department heads and open a discussion about the existing problems in maintenance work. The general manager or the maintenance department head could present the prevailing problem in maintenance. At this time the major problems that contribute to the current situation of maintenance problems and related issues will be discussed. In the seminar it is expected that participants should came to a conclusion that the problems could be solved.
4. Estimate and allocate the necessary budget and resources by the maintenance department, to run the required activities such as preventive maintenance program and spare parts to perform the PM. Plan and conduct training on maintenance and spare parts planning and scheduling which are basis for PM implementation.

- Collect and prepare manuals and procedures.
- Order spare parts based on PM and predicated follow generally.

5. Established task groups that can perform and lead different activities to implement sound

maintenance management system. Among them a team consists of inspectors and supervisors experienced in vehicle inspection and testing is must. This team is playing great role in investigating the status of the vehicles.

6. Collect /purchase and identify references, manuals and other important documents / records necessary for conducting preventive maintenance programs.
7. Start PM program for the vehicle in good status. Inspect and test the vehicles in the fair status and perform maintenance on them depending on the inspection report selectively.
8. Daily, weekly, and monthly checklist should be available for every vehicle to be inspected by maintenance department. The frequency of inspection should consider the vehicle history as well as factors like status of vehicle. Here the maintenance department should have at least one dedicated planner, who can manage this work. To have effective PM schedule.
9. After selection and maintenance, to the PM program (start PM on fair vehicles).
10. Evaluate and monitor the program for implementation as per the objective set.
11. Mechanics should be responsible for vehicles and the work place by considering every breakdown as a disgracing activity. Taking responsibility means taking action. When breakdown occurs,
12. WSSF vehicle maintenance management should plan effective spare parts management system by classifying them based of their contribution to annual costs as consumable, standard, and special spare part for every vehicle to facilitate the ordering process and inventory control

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Appendix- A. Questionnaires

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY SCHOOL OF MECHANICAL THERMAL AND VEHICLE ENGINEERING

(VEHICLE ENGINEERING PROGRAM)

Questionnaires

Research Title:-Improvement of Vehicle Maintenance Management System

A Case of Wonji Shoa Sugar Factory

The aim of this questionnaire is to gather data and information then perform analysis in the area of Maintenance Management System in the factory and came up with possible solution and recommendations. The findings and recommendation of this research study will serve as an input for WSSF Wonji Shoa Sugar Factory. Therefore, your corporation in filling out the questioner is highly valuable to the success of the research.

I would like to provide in advance my heartfelt appreciation for your cooperation.

General direction

1. Do not write your name.

2. Mark 'X' in the box your choice.

Part I: Personal Information

1. Sex Male ☐ Female ☐

2. Educational back ground

Below grade 12 ☐ 1st Degree ☐

Level (Diploma) ☐ 2nd Degree ☐

Specify, if any other ----------

3. Occupational standard/ level

Department/ section head ☐ supervisor ☐ Forman ☐

Senior mechanic ☐ Junior Mechanic ☐ Driver ☐

4. Maintenance work experience

1- 5 Years ☐ 11- 20 Years ☐

6- 10 Years ☐ above 21- Years ☐

PART2: Maintenance Practice

1. The Factory applies preventive maintenance (PM) system?

   Yes ☐ No ☐

2. Are you always doing a planned maintenance system?

   Yes ☐ No ☐

3. Have you taken training on maintenance system?

   Yes ☐ No ☐

4. Do you maintain all type of vehicle in your work department?

   Yes ☐ No ☐

5. Does the management give attention to the maintenance department?

   Yes ☐ No ☐

6. Have you done corrective maintenance (CM) system?

   Yes ☐ No ☐

7. Have you done predictive maintenance system?

   Yes ☐ No ☐

8. Have you done preventive maintenance (PM) system?

   Yes ☐ No ☐

9. Do you think that preventive maintenance increases the life of the vehicle?

   Yes ☐ No ☐

10 Do you think that a well planned maintenance procedure minimizes the breakdown of vehicles?

   Yes ☐ No ☐

11 Are there efficient spare parts available for replacing worn out or broken parts?

   Yes ☐ No ☐

12 Are there vehicles (machines) that are out of work, due to spare part problem?

   Yes ☐ No ☐

13 Is there a lubrications program that makes sure equipments lubricated routinely and properly with the proper lubricants?

   Yes ☐ No ☐

14 Is there adequate documentation, parts lists, manuals, and drawings are readily available, and used in maintenance planning on factory?

Yes ☐ No ☐

15 The preventive maintenance inspection /task checklist is checked to insure completeness?

Yes ☐ No ☐

16 Corrective and preventive maintenance activity is increases the work life of engines?

Yes ☐ No ☐

17 If there is standard maintenance plan, the vehicle downtime due to mechanical and electrical will be minimizes?

Yes ☐ No ☐

18 Do you think that a system of scheduled, planned or preventive maintenance tries to minimize the problem of breakdown maintenance?

Yes ☐ No ☐

19 The factory has perfect maintenance shop/work area arrangements?

Yes ☐ No ☐

20 The factory has good quality of maintenance tools?

Yes ☐ No ☐

21 The factory has enough maintenance equipments (tools)?

Yes ☐ No ☐

22 A system of scheduled, planned or preventive maintenance tries to minimize the problem of breakdown maintenance?

Yes ☐ No ☐

23 Do you get the full benefit of effective maintenance; it needs good supervision and administration of maintenance department?

Yes ☐ No ☐

24 Are you aware of how your maintenance personnel spend their time to accomplish their jobs?

Yes ☐ No ☐

25 Are you aware of the spare parts consumption in the maintenance department?

Yes ☐ No ☐

26 Have you balance your spare parts inventory regarding with carrying cost and ordering cost?

Yes ☐ No ☐

27 Do you like to implement maintenance management system us suggested by usin your company?

Yes ☐ No ☐

28 Do you receive weekly maintenance report from the maintenance department?

Yes ☐ No ☐

29 Are you aware of how much time is lost due to problem of preventive and corrective maintenance?

Yes ☐ No ☐

30 Do you record the man hours which are spent in preventive and breakdown maintenance?

Yes ☐ No ☐

31 Do you record the time spent (man power) for maintaining the vehicle as soon as the maintenance works finished?

Yes ☐ No ☐

32 Do you wear safety clothes while you are maintaining vehicles?

Yes ☐ No ☐

33 After finishing breakdown maintenance work, the maintained vehicle stops after one hour? How do analyze for this problem?

Yes ☐ No ☐

34 Are you doing any preventive maintenance work on holiday?

Yes ☐ No ☐

35 Do you report to your boss in case a maintenance problem arises beyond your capacity?

yes ☐ No ☐

36 Do you regularly clean and lubricates the vehicle?

Yes ☐ No ☐

PART 3-Strutured Questionnaires for Factory Maintenance

For Manager and Supervisor

1. Is there a good relationship between the production department and maintenance department to achieve quality vehicle maintenance?

Yes ☐ No ☐

2. Are the production department reports immediately if any breakdown happens?

Yes ☐ No ☐

3. Do you think that planned maintenance system increases the quality and quantity of the products?

Yes ☐ No ☐

4. Do you have documentation like history card record, man-hour, spar consumed?

Yes ☐ No ☐

5. Is there an absolute commitment on long-term basis to improve the quality and reduce the cost of maintenance among top management?

Yes ☐ No ☐

6. Are the technology and skill level required to maintain the vehicles and machineries consistent with the average skill level of the employees in the maintenance department?

Yes ☐ No ☐

7. Is there a direct linkage between the master production schedule and preventive maintenance schedule?

Yes ☐ No ☐

APPENDIX-B Answer of Questionnaires

Raw Data Respondent Educational Level

Table 4.4, distribution of Gender level

	Gender	responses	Percent of total
1	Male	57	95
2	Female	3	5
	Total	60	100

Raw Data Respondent Educational LevelTable 12:Distribution of educational level

	Educational level	responses	Percentage of total
1	High school (below grade 12)	12	20
2	Certificate /level/Diploma& advanced	40	66.67
3	Under graduates/1st degree	5	8.33
4	Post graduates/masters/2nd degree	1	1.67
5	any other	2	3.33
	Total	60	100

Raw Data Respondent Occupational standard /level

Table 4.6, distribution of occupational standard /level

	occupational standard	responses	Percentage of total
1	Department/ section head	1	1.67
2	Supervisor	4	6.67
3	Forman	4	6.67
4	Senior mechanic	20	33.33
5	Junior Mechanic	20	33.33
6	Driver	11	18.33
	Total	60	100

Raw Data Respondent Maintenance work experience

Table 4.7, distribution of maintenance work experience

	work experience	responses	Percentage of total
1	1-5 year	10	16.67
2	6-10 year	12	20
3	11-20year	30	50
4	Above 21 year	8	13.33
	Total	60	100

Table 4.8, distribution of maintenance work questionnaire

Q1. The Factory applies preventive maintenance (PM) system*?*

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	10	22.22	22.22	22.22
	No	35	77.78	77.78	100
	Total	45	100	100	

Q2. Are you always doing a planned maintenance system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	7	15.5	15.5	15.5
	No	38	84.5	84.5	100
	Total	45	100	100	

Q3. Have you taken training on maintenance system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.4	44.4	44.4
	No	25	55.6	55.6	100
	Total	45	100	100	

Q4. Do you maintain all type of vehicle in your work department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	6	13.33	13.33	13.33
	No	39	86.67	86.67	100
	Total	45	100	100	

Q5. Does the management give attention to the maintenance department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	5	11.11	11.11	11.11
	No	40	88.89	88.89	100
	Total	45	100	100	

Q6. Have you done corrective maintenance (CM) system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	36	80	80	100
	No	9	20	20	20
	Total	45	100	100	

Q7. Have you done predictive maintenance system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	12	26.67	26.67	26.67
	No	33	73.33	73.33	100
	Total	45	100	100	

Q8. Have you done preventive maintenance (PM) system?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	15	33.33	33.33	33.33
	No	30	66.67	66.67	66.67
	Total	45	100	100	100

Q9. Do you think that preventive maintenance increases the life of the vehicle?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	40	88.89	88.89	88.89
	No	5	11.11	11.11	11.11
	Total	45	100	100	100

Q10. Are there efficient spare parts available for replacing worn out or broken parts?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	14	31.11	31.11	31.11
	No	31	68.89	68.89	68.89
	Total	45	100	100	100

Q11. Do you think that a well planned maintenance procedure minimizes the breakdown of vehicles?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	30	66.67	66.67	66.67
	No	15	33.33	33.33	25
	Total	45	100	100	100

Q12. Is there a lubrications program that makes sure equipments lubricated routinely and properly with the proper lubricants?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.5	44.5	44.5
	No	25	55.5	55.5	55.5
	Total	45	100	100	100

Q13. Is there adequate documentation, parts lists, manuals, and drawings are readily available, and used in maintenance planning on factory?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	10	22.22	22.22	22.22
	No	35	77.78	77.78	77.78
	Total	45	100	100	100

Q14. The preventive maintenance inspection /task checklist is checked to insure completeness?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	9	20	20	20
	No	36	80	80	80
	Total	45	100	100	100

Q15. Corrective and preventive maintenance activity is increases the work life of engines?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	38	84.5	84.5	84.5
	No	7	15.5	15.5	15.5
	Total	45	100	100	100

Q16. If there is standard maintenance plan, the vehicle downtime due to mechanical and electrical will be minimizes?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	30	66.67	66.67	66.67
	No	15	33.33	33.33	33.33
	Total	45	100	100	100

Q17. Do you think that a system of scheduled, planned or preventive maintenance tries to minimize the problem of breakdown maintenance?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	30	66.67	66.67	66.67
	No	15	33.33	33.33	33.33
	Total	45	100	100	100

Q18. The factory has perfect maintenance shop/work area arrangements?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.5	44.5	44.5
	No	25	55.5	55.5	55.5
	Total	45	100	100	100

\

Q19. The factory has good quality of maintenance tools?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	18	40	40	40
	No	27	60	60	60
	Total	45	100	100	100

Q20. Do you get the full benefit of effective maintenance; it needs good supervision and administration of maintenance department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	7	15.5	15.6	15.5
	No	38	84.5	84.5	84.5
	Total	45	100	100	100

Q21. Are you aware of your maintenance personnel spend their time to accomplish their jobs?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	20	44.44	44.44	44.44
	No	25	55.55	55.55	55.55
	Total	45	100	100	100

Q22. Are you aware of the spare parts consumption in the maintenance department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	13	28.89	28.89	28.89
	No	32	71.11	71.11	71.11
	Total	45	100	100	100

Q23. Have you balance your spare parts inventory regarding with carrying cost and ordering cost?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	6	13.33	13.33	13.33
	No	39	86.67	86.67	86.67
	Total	45	100	100	100

Q24. Do you like to implement maintenance management system us suggested by us in your factory?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	40	88.89	88.89	88.89
	No	5	11.11	11.11	11.11
	Total	45	100	100	100

Q25. Do you receive weekly maintenance report from the maintenance department?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	7	15.56	15.56	15.56
	No	38	84.44	84.44	84.44
	Total	45	100	100	100

Q26. Are you aware of how much time is lost due to problem of preventive and corrective maintenance?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	11	24.44	24.44	24.24
	No	34	75.56	75.56	75.56
	Total	45	100	100	100

Q27. Do you record the man hours which are spent in preventive and breakdown maintenance?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	7	15.56	15.56	15.56
	No	38	84.44	84.44	84.44
	Total	45	100	100	100

Q28. Do you record the time spent (man power) for maintaining the vehicle as soon as the maintenance works finished?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	8	17.78	17.78	17.78
	No	37	82.22	82.22	82.22
	Total	45	100	100	100

Q29. Do you wear safety clothes while you are maintaining vehicles?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	40	88.89	88.89	88.89
	No	5	11.11	11.11	11.11
	Total	45	100	100	100

Q30. After finishing breakdown maintenance work, the maintained vehicle stops after one hour? How do analyze for this problem?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	25	55.5	55.5	55.5
	No	20	44.5	44.5	44.5
	Total	45	100	100	100

Q31. Are you doing any preventive maintenance work on holiday?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	6	13.33	13.33	13.33
	No	39	86.67	86.67	86.67
	Total	45	100	100	100

Q32. Do you report to your boss in case a maintenance problem arises beyond your capacity?

		Frequency	Percent	Valid percent	Cumulative percent
Valid	yes	28	62.22	62.22	62.22
	No	17	37.78	37.78	37.78
	Total	45	100	100	100

Appendix-C: Existing Organizational Structure of the WSSF

Existing Organizational Structure of the WSSF

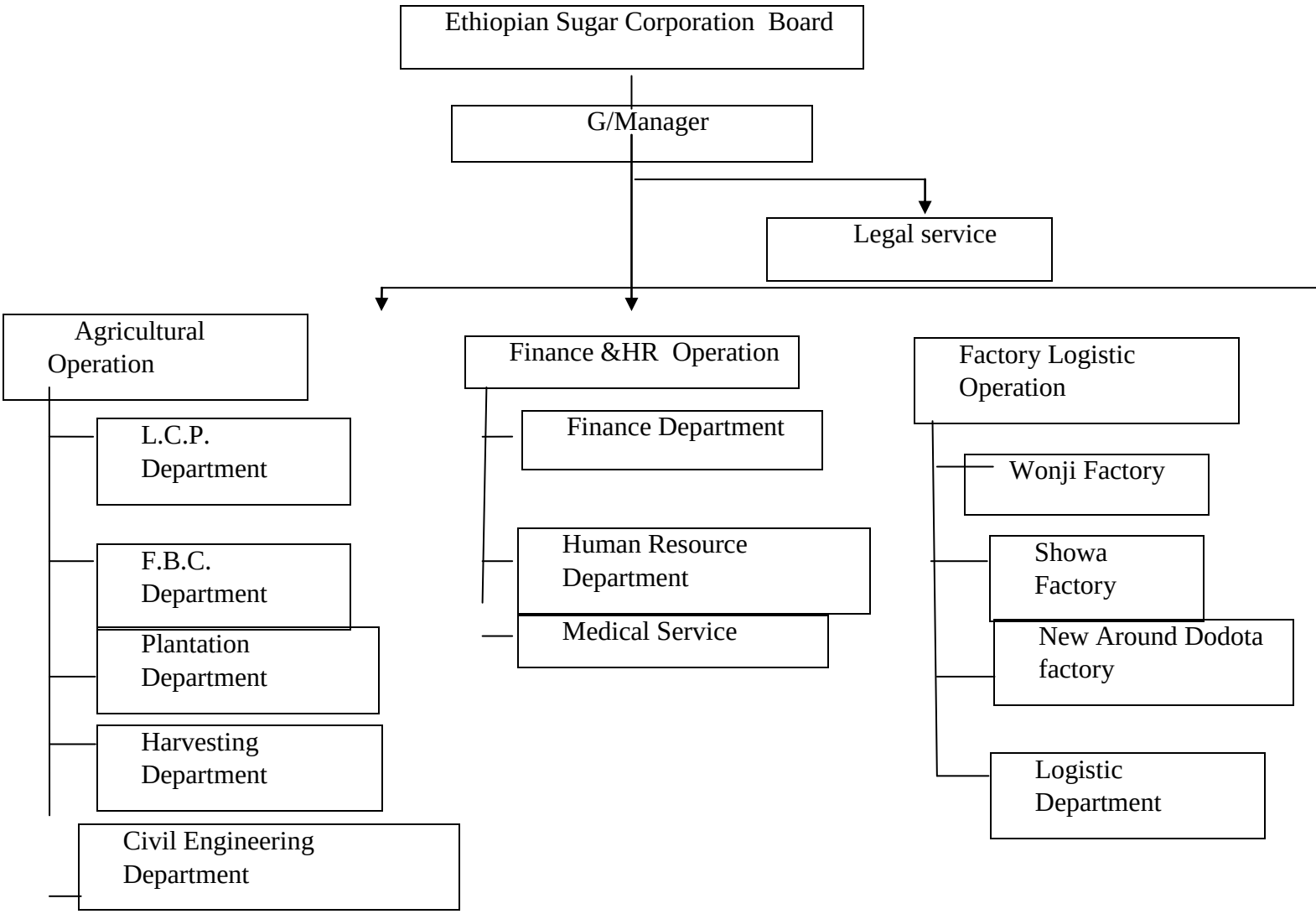

Fig . 1 Existing Organizational Structure of the WSSF

The factory is found at Oromiya Regional State near Nazareth Town at 110 Kilo Meters from Addis Ababa. Commencing production in 1954 it is the oldest and the pioneer in the history of Ethiopia's sugar industry. And Shoa Sugar Factory constructed in 1962 is the second oldest and both, being obsolete, have stopped production since July, 2012 and July, 2013 respectively. The two factories constructed by the Holland Company known as H.V.A had a capacity of producing 750,000 quintals of sugar a year. The sugarcane plantation land of these two factories was 7,000 hectares out of which 1,000 had been planted by out growers.

In a bid to replace these two oldest factories with a new and modern one, an expansion project had been carried out both in the cane cultivation field and the factory since 2010. And, the factory plant expansion project has come into its completion in July, 2013. Accordingly, the newly built and highly automated Wonji/Shoa Sugar Factory will initially have a capacity of crushing 6,250 tons of cane a day and producing 174,946 tons of sugar per annum which with further expansion will reach up to 12,500 TCD maximizing its production to 220,700 tons of sugar a year. The new plant will initially have a capacity of producing 10,000 meter cube ethanol per annum that with further expansion will reach 12,800 meter cube. By the end of the GTP period the factory would be able to contribute 21.15 mega watt electric powers to the national grid in addition to satisfying its own demand which is around 10 mega watt.

Its agricultural expansion project is currently being carried out around the areas known as Wakie Tiyo, Welenchiti and North Dodota areas. The factory, with the help of this agricultural expansion project, will have 16,000 hectares of sugarcane plantation field in total. Till December 2014 the total cane cultivation field of the factory has reached 11,026 hectare. And, the entire factory's sugarcane field cultivated with the agricultural expansion project is owned by out grower farmers of the surrounding area.

Appendix- D WSSF Vehicles/Machineries

DIFFERENT TYPES OF WSSF VEHICLES/MACHINERIES					
	SMALL VEHICLES	**PLATE No**	219	**CNH New Holland tractor**	**WT-0152**
1	**Toyota hilux S/C**	**LV-0002**	220	**CNH New Holland tractor**	**WT-0153**

2	**Toyota hilux S/C**	**LV-0003**	221	**CNH New Holland tractor**	**WT-0154**
3	**Toyota hilux S/C**	**3-18063**	222	**CNH New Holland tractor**	**WT-0155**
4	**Toyota hilux S/C**	**3-18064**	223	**CNH New Holland tractor**	**WT-0156**
5	**Toyota hilux S/C**	**3-24426**	224	**CNH New Holland tractor**	**WT-0157**
6	**Toyota hilux 4WD**	**3-22846**	225	Johon Deer tractor	**WT-0158**
7	**Toyota hilux 4WD**	**3-22847**	226	Johon Deer tractor	**WT-0159**
8	**Toyota Mini-Bus**	**3-26868**	227	Johon Deer tractor	**WT-0160**
9	**Toyota Ambulance**	**3-08186**	228	Johon Deer tractor	**WT-0161**
10	**Toyota Ambulance**	**3-24545**	229	Johon Deer tractor	**WT-0162**
11	**Toyota Land Cruser**	**3-26844**	230	Johon Deer tractor	**WT-0163**
12	**Toyota Land Cruser**	**3-26845**	231	Johon Deer tractor	**WT-0164**
13	**Toyota Land Cruser**	**3-26846**	232	Johon Deer tractor	**WT-0165**
14	**Toyota Land Cruser**	**3-26847**	233	Johon Deer tractor	**WT-0166**
15	**Toyota Land Cruser**	**3-13407**	234	MF TRACTOR	**WT-0170**
16	**Mitsubishi s/c**	**LV-0007**	235	MF TRACTOR	**WT-0171**
17	**Mitsubishi s/c**	**LV-0008**	236	MF TRACTOR	**WT-0172**
18	**Mitsubishi s/c**	**LV-0010**	237	MF TRACTOR	**WT-0173**
19	**Mitsubishi D/C**	**3-08211**	238	MF TRACTOR	**WT-0174**
20	**Mitsubishi D/C**	**3-08217**	239	BELL tractor	**WT-0177T**
21	**Mitsubishi s/c**	**3-08219**	240	BELL tractor	**WT-0178T**
22	**Mitsubishi s/c**	**3-08220**	241	BELL tractor	**WT-0179T**
23	**Mitsubishi s/c**	**3-08221**	242	BELL tractor	**WT-0180T**
24	**Mitsubishi s/c**	**3-28172**	243	BELL tractor	**WT-0181T**
25	**Mitsubishi D/C**	**3-28173**	244	BELL tractor	**WT-0182T**
26	**Mitsubishi D/C**	**3-28174**	245	KAT tractor	**WT-188K**
27	**Mitsubishi s/c**	**3-28175**	246	KAT tractor	**WT-189K**
28	**Nissan Patrol**	**3-32334**	247	KAT tractor	**WT-190K**
29	**Nissan Patrol**	**3-32335**	248	KAT tractor	**WT-191K**
30	**Ford Ranger**	**3-29218**	249	KAT tractor	**WT-192K**
31	**Ford Ranger**	**3-29219**	250	YTO TRACTOR	**WT-0193**
32	**Ford Ranger**	**3-29220**	251	YTO TRACTOR	**WT-0194**
33	**Ford Ranger**	**3-29221**	252	YTO TRACTOR	**WT-0195**
34	**Ford Ranger**	**3-29222**	253	YTO TRACTOR	**WT-0196**
35	**Ford Ranger**	**3-29223**	254	YTO TRACTOR	**WT-0197**
36	**Suzuki Liana**	**3-23729**	255	YTO TRACTOR	**WT-0198**
37	**Nissan P/U D/C**	**3-37289**	256	YTO TRACTOR	**WT-0199**
38	**Nissan P/U D/C**	**3-37290**	257	YTO TRACTOR	**WT-0200**
39	**Nissan P/U D/C**	**3-37291**	258	**YTO TRACTOR**	**WT-0201**

40	Nissan P/U D/C	3-37292	259	YTO TRACTOR	WT-0202
41	Nissan P/U D/C	3-37293	260	YTO TRACTOR	WT-0204
42	Nissan P/U S/C	3-37294	261	YTO TRACTOR	WT-0205
43	Nissan P/U S/C	3-37295	262	YTO TRACTOR	WT-0206
44	Nissan Die. Cargo Tr	3-37667	263	YTO TRACTOR	WT-0207
45	Nissan Die. Cargo Tr	3-37669	264	YTO TRACTOR	WT-0208
46	Cacciamalli Bus	3-22071	265	KAT tractor	WT-0209
47	Mitsubishi Cargo Truck	3-23567	266	KAT tractor	WT-0210
48	Nissan Dump Tr.	3-08179	267	KAT tractor	WT-0211
49	Nissan Dump Tr.	3-18218	268	KAT tractor	WT-0212
50	Nissan Cess pit	3-19574	269	KAT tractor	WT-0213
51	Iveco Low bed	3-30885	270	KAT tractor	WT-0214
52	DAEWOO C. TRUCK	3-33641	271	KAT tractor	WT-0215
53	DAEWOO C.TRUCK	3-33642	272	KAT tractor	WT-0216
54	DAEWOO D. TRUCK	3-36855	273	KAT tractor	WT-0217
55	DAEWOO D. TRUCK	3-36856	274	KAT tractor	WT-0218
56	DAEWOO D. TRUCK	3-36857	275	**MOTER CYCLES**	PLATE No
57	DAEWOO D. TRUCK	3-36858	276	MZ Motor cycle	MB-0007
58	DAEWOO D. TRUCK	3-36860	277	MZ Motor cycle	MB-12
59	DAEWOO D. TRUCK	3-36861	278	MZ Motor cycle	MB-0013
60	DAEWOO D. TRUCK	3-36862	279	YAMAHA M/CYCLE	MB-0018
61	DAEWOO D. TRUCK	3-37062	280	YAMAHA M/CYCLE	MB-0031
62	DAEWOO D. TRUCK	3-37063	281	YAMAHA M/CYCLE	MB-0033
63	DAEWOO D. TRUCK	3-37065	282	YAMAHA M/CYCLE	MB-0034
64	DAEWOO D. TRUCK	3-37066	283	YAMAHA M/CYCLE	MB-0042
65	DAEWOO D. TRUCK	3-37067	284	YAMAHA M/CYCLE	MB-0043
66	DAEWOO D. TRUCK	3-37068	285	YAMAHA M/CYCLE	MB-0044
67	DAEWOO D. TRUCK	3-37070	286	YAMAHA M/CYCLE	MB-0045
68	DAEWOO D. TRUCK	3-37071	287	YAMAHA M/CYCLE	MB-0046
69	DAEWOO D. TRUCK	3-37072	288	YAMAHA M/CYCLE	MB-0047
70	DAEWOO D. TRUCK	3-39864	289	YAMAHA M/CYCLE	MB-0048
71	DAEWOO TANKER	3-37064	290	YAMAHA M/CYCLE	MB-0049
72	DAEWOO TANKER	3-37069	291	YAMAHA M/CYCLE	MB-0050
73	ISUZU BUS	3-40001	292	YAMAHA M/CYCLE	MB-0051
74	ISUZU BUS	3-40002	293	YAMAHA M/CYCLE	MB-0052
75	Toyota Land Cruser	3-42070	294	YAMAHA M/CYCLE	MB-0053
76	Toyota Land Cruser	3-42071	295	YAMAHA M/CYCLE	MB-0054
77	Toyota Land Cruser	3-42072	296	YAMAHA M/CYCLE	MB-0055
78	Toyota Land Cruser	3-42073	297	SUZUKI M/CYCLE	MB-0056
79	Toyota Land Cruser	3-42074	298	SUZUKI M/CYCLE	MB-0064

80	**Toyota Land Cruser**	**3-40275**	299	**SUZUKI M/CYCLE**	**MB-0068**
81	**Toyota Land Cruser**	**3-42076**	300	**SUZUKI M/CYCLE**	**MB-0069**
82	**Toyota Land Cruser**	**3-42077**	301	**SUZUKI M/CYCLE**	**MB-0070**
83	**Toyota Land Cruser**	**3-42078**	302	**SUZUKI M/CYCLE**	**MB-0071**
84	**Toyota 4WD**	**3-42259**	303	**SUZUKI M/CYCLE**	**MB-0072**
85	**Toyota 4WD**	**3-42260**	304	**SUZUKI M/CYCLE**	**MB-0073**
86	**Toyota 4WD**	**3-42261**	305	**SUZUKI M/CYCLE**	**MB-0074**
87	**TOYOTA 4WD D/C**	**3-55550**	306	**SUZUKI M/CYCLE**	**S - 5-1-05**
88	**TOYOTA 4WD D/C**	**3-55507**	307	**SUZUKI M/CYCLE**	**MB-0075**
89	**TOYOTA 4WD D/C**	**3-55506**	308	**SUZUKI M/CYCLE**	**MB-0076**
90	**TOYOTA 4WD D/C**	**3-55548**	309	**SUZUKI M/CYCLE**	**MB-0077**
91	**TOYOTA 4WD D/C**	**3-55504**	310	**SUZUKI M/CYCLE**	**MB-0078**
92	**TOYOTA 4WD D/C**	**3-55549**	311	**SUZUKI M/CYCLE**	**MB-0079**
93	**TOYOTA 4WD D/C**	**3-55636**	312	**YAMAHA M/CYCLE**	**MB-0080**
94	**Toyota Land Cruser**	**3-56112**	313	**YAMAHA M/CYCLE**	**MB-0081**
95	**Toyota Land Cruser**	**3-56113**	314	**YAMAHA M/CYCLE**	**MB-0082**
96	**Toyota Land Cruser**	**3-56114**	315	**YAMAHA M/CYCLE**	**MB-0083**
97	**Toyota Land Cruser**	**3-56115**	316	**YAMAHA M/CYCLE**	**MB-0084**
98	**Toyota Land Cruser**	**3-56116**	317	**YAMAHA M/CYCLE**	**MB-0085**
99	**Toyota Land Cruser**	**3-56117**	318	**YAMAHA M/CYCLE**	**MB-0086**
100	**Toyota Land Cruser**	**3-56118**	319	**YAMAHA M/CYCLE**	**MB-0087**
101	**Toyota Land Cruser**	**3-56119**	320	**YAMAHA M/CYCLE**	**MB-0088**
102	**Toyota Land Cruser**	**3-56120**	321	**YAMAHA M/CYCLE**	**MB-0089**
103	**Toyota Land Cruser**	**3-56121**	322	**YAMAHA M/CYCLE**	**MB-0090**
104	**Toyota Land Cruser**	**3-56122**	323	**YAMAHA M/CYCLE**	**MB-0091**
105	**Toyota Land Cruser**	**3-56123**	324	**YAMAHA M/CYCLE**	**MB-0092**
106	**Toyota Coaster mid bus**	**3-58112**	325	**YAMAHA M/CYCLE**	**MB-0093**
107	**Bishoftu station wagon**	**3-55065**	326	**YAMAHA M/CYCLE**	**MB-0094**
108	**Bishoftu station wagon**	**3-55066**	327	**YAMAHA M/CYCLE**	**MB-0095**
109	**Bishoftu station wagon**	**3-55067**	328	**YAMAHA M/CYCLE**	**MB-0096**
110	**Bishoftu station wagon**	**3-55068**	329	**YAMAHA M/CYCLE**	**MB-0097**
111	**GuilinDaewoo mid bus**	**3-55069**	330	**YAMAHA M/CYCLE**	**MB-0098**
112	**GuilinDaewoo mid bus**	**3-55081**	331	**YAMAHA M/CYCLE**	**MB-0099**
113	**Bishoftu cross country bus**	**3-55033**	332	**YAMAHA M/CYCLE**	**MB-0100**
114	**Bishoftu cross country bus**	**3-55034**	333	**YAMAHA M/CYCLE**	**MB-0101**
115	**Bishoftu cross country bus**	**3-55079**	334	**YAMAHA M/CYCLE**	**MB-0102**
116	**Bishoftu cross country bus**	**3-55080**	335	**YAMAHA M/CYCLE**	**MB-0103**
117	**Fire fighting vehicle**	**FFV-01**	336	**YAMAHA M/CYCLE**	**MB-0104**
118	**Fire fighting vehicle**	**FFV-02**	337	**YAMAHA M/CYCLE**	**MB-0105**

119	Bishoftu double gabina	3-55100	338	**YAMAHA M/CYCLE**	**MB-0106**
120	Bishoftu double gabina	3-55097	339	**YAMAHA M/CYCLE**	**MB-0107**
121	Bishoftu double gabina	3-55098	340	**YAMAHA M/CYCLE**	**MB-0108**
122	Bishoftu double gabina	3-55045	341	**YAMAHA M/CYCLE**	**MB-0109**
123	Bishoftu double gabina	3-55099	342	**YAMAHA M/CYCLE**	**MB-0110/ET-0213**
124	Bishoftu double gabina	3-55046	343	**YAMAHA M/CYCLE**	**MB-0111/ET-0216**
125	Bishoftu double gabina	3-55044	344	**YAMAHA M/CYCLE**	**MB-0112/ET-0210**
126	mobile truck crane	MTC-0001	345	**YAMAHA M/CYCLE**	**MB-0113**
127	mobile work shop	MWS-001	346	**YAMAHA M/CYCLE**	**MB-0114**
128	ambulance	3-64234	347	**YAMAHA M/CYCLE**	**MB-0115**
129	Bishoftu HBT	**HBT-01**	348	**YAMAHA M/CYCLE**	**MB-0116**
130	Bishoftu HBT	**HBT-02**	349	**YAMAHA M/CYCLE**	**MB-0117**
131	Bishoftu HBT	**HBT-03**	350	**YAMAHA M/CYCLE**	**MB-0118**
132	Bishoftu HBT	**HBT-04**	351	**YAMAHA M/CYCLE**	**MB-0119**
133	Bishoftu HBT	**HBT-05**	352	**YAMAHA M/CYCLE**	**MB-0120**
134	Bishoftu HBT	**HBT-06**	353	**YAMAHA M/CYCLE**	**MB-0121**
135	Bishoftu HBT	**HBT-07**	354	**YAMAHA M/CYCLE**	**MB-0122**
136	Bishoftu HBT	**HBT-08**	355	**YAMAHA M/CYCLE**	**MB-0123/ET-0214**
137	Bishoftu HBT	**HBT-09**	356	**YAMAHA M/CYCLE**	**MB-0124/ET-0211**
138	Bishoftu HBT	**HBT-10**	357	**YAMAHA M/CYCLE**	**MB-0125/ET-0215**
139	Bishoftu HBT	**HBT-11**	358	**YAMAHA M/CYCLE**	**MB-0126**
140	Bishoftu HBT	**HBT-12**	359	**YAMAHA M/CYCLE**	**MB-0127**
141	Bishoftu HBT	**HBT-13**	360	**YAMAHA M/CYCLE**	**MB-0128**
142	Bishoftu HBT	**HBT-14**	361	**YAMAHA M/CYCLE**	**MB-0129**
143	Bishoftu HBT	**HBT-15**	362	**YAMAHA M/CYCLE**	**MB-0130**
144	Bishoftu HBT	**HBT-16**	363	**YAMAHA M/CYCLE**	**MB-0131**
145	Bishoftu HBT	**HBT-17**	364	**YAMAHA M/CYCLE**	**MB-0132**
146	**TRACTORS**	**PLATE No**	365	**YAMAHA M/CYCLE**	**MB-0133**
147	**MF TRACTOR**	**WT-0021**	366	**YAMAHA M/CYCLE**	**MB-0134**
148	**MF TRACTOR**	**WT-0022**	367	**YAMAHA M/CYCLE**	**MB-0135**
149	**MF TRACTOR**	**WT-0026**	368	**YAMAHA M/CYCLE**	**MB-0136**
150	**MF TRACTOR**	**WT-0027**	369	**YAMAHA M/CYCLE**	**MB-0137**
151	**MF TRACTOR**	**WT-0032**	370	**YAMAHA M/CYCLE**	**MB-0138**
152	**MF TRACTOR**	**WT-0033**	371	**YAMAHA M/CYCLE**	**MB-0139**
153	**MF TRACTOR**	**WT-0034**	372	**YAMAHA M/CYCLE**	**MB-0140**
154	**MF TRACTOR**	**WT-0035**	373	**DIFF. MACHENERIES**	**PLATE No**
155	**MF TRACTOR**	**WT-0036**	374	**CATERPILLAR**	**CT-0003**

156	**MF TRACTOR**	**WT-0037**	375	**CATERPILLAR**	**CT-0004**
157	**MF TRACTOR**	**WT-0038**	376	**CATERPILLAR**	**CT-0005**
158	**MF TRACTOR**	**WT-0039**	377	**CATERPILLAR**	**CT-0008**
159	**MF TRACTOR**	**WT-0040**	378	**KOMATSU**	**CT-0009**
160	**MF TRACTOR**	**WT-0041**	379	**KOMATSU**	**CT-0011**
161	**MF TRACTOR**	**WT-0042**	380	**KOMATSU**	**CT-0012**
162	**MF TRACTOR**	**WT-0043**	381	**DRAG LINE**	**CT-0013**
163	**MF TRACTOR**	**WT-0044**	382	**CASE EXCAVATOR**	**CT-0014**
164	**MF TRACTOR**	**WT-0045**	383	**DAEWOO EXCAC.**	**CT-0015**
165	**MF TRACTOR**	**WT-0046**	384	**NEW HOLL. DOZER**	**CT-0016**
166	**FNH TRACTOR**	**WT-0047**	385	**NEW HOLL. Excavator**	**CT-0017**
167	**FNH TRACTOR**	**WT-0049**	386	**CATERPILLAR**	**CT-0018**
168	**FNH TRACTOR**	**WT-0053**	387	**CATERPILLAR**	**CT-0019**
169	**FNH TRACTOR**	**WT-0054**	388	**KOMATSU**	**CT-0020**
170	**SAME TRACTOR**	**WT-0061**	389	**KOMATSU**	**CT-0021**
171	**SAME TRACTOR**	**WT-0062**	390	**cat D6R XL**	**CT-0023**
172	**SAME TRACTOR**	**WT-0063**	391	DOZER	CT-0024
173	**SAME TRACTOR**	**WT-0065**	392	**power plus EXCAVATOR**	CT-0025
174	**SAME TRACTOR**	**WT-0066**	393	**power plus dozer**	CT-0026
175	**SAME TRACTOR**	**WT-0067**	394	**CAMECO LOADER Johndeer**	**WT-0085**
176	**SAME TRACTOR**	**WT-0068**	395	**CAMECO LOADER Johndeer**	**WT-0086**
177	**SAME TRACTOR**	**WT-0069**	396	**CAMECO LOADER Johndeer**	**WT-0087**
178	**SAME TRACTOR**	**WT-0070**	397	**CAMECO LOADER Johndeer**	**WT-0088**
179	**SAME TRACTOR**	**WT-0071**	398	**CAMECO LOADER Johndeer**	**WT-0089**
180	**SAME TRACTOR**	**WT-0072**	399	**CAMECO LOADER Johndeer**	**WT-0090**
181	**SAME TRACTOR**	**WT-0073**	400	**CAMECO LOADER Johndeer**	**WT-0091**
182	**SAME TRACTOR**	**WT-0075**	401	**CAMECO Articulated tractor**	**WT-0095**
183	**SAME TRACTOR**	**WT-0076**	402	**CAMECO Articulated tractor**	**WT-0096**
184	**SAME TRACTOR**	**WT-0077**	403	**VOL.MOTOR GRADER**	**WT-0098**
185	**SAME TRACTOR**	**WT-0078**	404	**CAT. MOTOR GRADER**	**WT-0099**
186	**SAME TRACTOR**	**WT-0080**	405	**CAT. FRONT LOADER**	**WT-0100**
187	**SAME TRACTOR**	**WT-0081**	406	**KOM. FRONT LOADER**	**WT-0101**
188	**SAME TRACTOR**	**WT-0082**	407	**CAT. FORK LIFT**	**WT-0102**
189	**Belarus /NTAP/**	**WT-0083**	408	**KOM. FRONT LOADER**	**WT-0106**
190	BELL tractor	**WT-0117**	409	**DYNAPAC SOIL COM.**	**WT-0107**

191	BELL tractor	**WT-0118**	410	**BACK HOE LOADER**	**WT-0108**
192	BELL tractor	**WT-0119**	411	**CAT. MOTOR GRADER**	**WT-0109**
193	BELL tractor	**WT-0120**	412	Johon Deer tractor	**WT-0110**
194	BELL tractor	**WT-0121**	413	Johon Deer tractor	**WT-0111**
195	BELL tractor	**WT-0122**	414	Johon Deer tractor	**WT-0112**
196	BELL tractor	**WT-0123**	415	Case steiger tractor	**WT-0113**
197	BELL tractor	**WT-0124**	416	Case steiger tractor	**WT-0114**
198	BELL tractor	**WT-0125**	417	CAMECO LOADER Johndeer	**WT-0115**
199	BELL tractor	**WT-0126**	418	CAMECO LOADER Johndeer	**WT-0116**
200	BELL tractor	**WT-0127**	419	Johon Deer tractor	**WT-0137**
201	BELL tractor	**WT-0128**	420	Johon Deer tractor	**WT-0138**
202	BELL tractor	**WT-0129**	421	Versatile Tractor	**WT-0139**
203	BELL tractor	**WT-0130**	422	**Vermeer tractor**	**WT-0141**
204	BELL tractor	**WT-0131**	423	**Vermeer tractor**	**WT-0142**
205	BELL tractor	**WT-0132**	424	Johon Deer tractor	**WT-0167**
206	BELL tractor	**WT-0133**	425	Johon Deer tractor	**WT-0168**
207	BELL tractor	**WT-0134**	426	Johon Deer tractor	**WT-0169**
208	BELL tractor	**WT-0135**	427	Johon Deer tractor	**WT-0175**
209	BELL tractor	**WT-0136**	428	Johon Deer tractor	**WT-0176**
210	**New Holland tractor pusher**	**WT-0143**	429	Johon Deer tractor	**WT-0183**
211	**New Holland tractor pusher**	**WT-0144**	430	Johon Deer tractor	**WT-0184**
212	**CNH New Holland tractor**	**WT-0145**	431	Johon Deer tractor	**WT-0185**
213	**CNH New Holland tractor**	**WT-0146**	432	Johon Deer tractor	**WT-0186**
214	**CNH New Holland tractor**	**WT-0147**	433	Johon Deer tractor	**WT-0187**
215	**CNH New Holland tractor**	**WT-0148**	434	**front loader**	**WT-0203**
216	**CNH New Holland tractor**	**WT-0149**	435	cane staker	wt- 219
217	**CNH New Holland tractor**	**WT-0150**	436	cane staker	wt- 220
218	**CNH New Holland tractor**	**WT-0151**	437	xcmg cane staker	wt- 221

Appendix-E Report Format

□መስ□ መሣሪ□ች ጥገና ቡድን

የ ሩብ አመት ወ 2007 የሥራ አፈፃፀም ሪፖርት

ተራ.ቁ	የሥራው ዓይነት	መለኪያ	ክትት		ክንውን		ልዩነት %	
			□□ር	እስከ አሁን	□□ር	እስከአሁን	□□ር	እስከአሀ-ን
4.0	FESG							
4.1	Estate Car & MB maintenance sub group							
4.1.1	(Motor Cycles)							
ሀ	□አተሻ ሥራ (I)	በቁዓር	480	707	236	702	49.17	99.29
ለ	ሰርቪስ (S)	"	240	352	116	315	4	89.49

							8.33	
ሐ	ፅማሽ ክ□ካ (PO)	"	0	8	0	5	0.00	62.50
መ	ሙሉ ክ□ካ (CO)	"	0	3	0	0	0.00	0.00
ሠ	ድን. ብልሽት (CM)	"	180	278	49	188	27.22	67.63
4.1.2	የቤት መኪና		0	0	0	0	0.00	0.00
ሀ	□ተሻ ሥራ (I)	በቁጥር	792	1167	377	1113	47.60	95.37
ለ	ሰርቪስ (S)	"	370	557	169	505	45.68	90.66
ሐ	ፅማሽ ክ□ካ (PO)	"	0	19	0	15	0.00	78.95
መ	ሙሉ ክ□ካ (CO)	"	0	3	0	1	0.00	33.33
ሠ	ድን. ብልሽት (CM)	"	300	408	123	330	41.00	80.88
4.1.3	body		0	0	0	0	0.00	0.00
ሀ	ድን. ብልሽት (CM)	በቁጥር	120	180	64	200	53.33	111.11
4.2	Heavy equipment maintenance sub group		0	0	0	0	0.00	0.00
4.2.1	ትራክተር		0	0	0	0	0.00	0.00
ሀ	□ተሻ ሥራ (I)	በቁጥር	444	498	168	336	37.84	67.47

ለ	ሰርቪስ (S)	"	222	249	67	150	30.18	60.24
ሐ	ፅማሽ ክ□ካ (PO)	"	0	6	0	3	0.00	50.00
መ	ሙሉ ክ□ካ (CO)	"	0	1	0	1	0.00	100.00
ሠ	ድን. ብልሽት (CM)	"	407	461	94	317	23.10	68.76
4.2.2	ባለሰንሰለት ትራክተር		0	0	0	0	0.00	0.00
ሀ	□ኣ ተሻ ሥራ (I)	በቁዓር	164	200	62	146	37.80	73.00
ለ	ሰርቪስ (S)	"	82	103	25	62	30.49	60.19
ሐ	ፅማሽ ክ□ካ (PO)	"	0	9	0	5	0.00	55.56
መ	ሙሉ ክ□ካ (CO)	"	0	2	0	0	0.00	0.00
ሠ	ድን. ብልሽት (CM)	"	158	206	39	150	24.68	72.82
4.2.3	ተቀዓላ መሳሪ□		0	0	0	0	0.00	0.00
ሀ	□ኣ ተሻ ሥራ (I)	በቁዓር	28	64	0	35	0.00	54.69
ለ	ሰርቪስ (S)	"	444	518	136	389	30.63	75.10
ሐ	ፅማሽ ክ□ካ (PO)	"	0	11	0	22	0.00	200.00
መ	ሙሉ ክ□ካ (CO)	"	0	0	0	0	0.00	0.00
ሠ	ድን. ብልሽት (CM)	"	222	222	74	184	33.	82.88

							33	
4.3	Wheel Tractor maintenance sub group		0	0	0	0	0.00	0.00
4.3.1	ትራክተር		0	0	0	0	0.00	0.00
ሀ	□አተሻ ሥራ (I)	በቁጥር	680	910	312	805	45.88	88.46
ለ	ሰርቪስ (S)	"	340	455	136	324	40.00	71.21
ሐ	ፅማሽ ክ□ላ (PO)	"	0	10	0	7	0.00	70.00
መ	ሙሉ ክ□ላ (CO)	"	2	10	0	4	0.00	40.00
ሠ	ድን. ብልሽት (CM)	"	415	498	223	311	53.73	62.45
4.3.2	የአገዳ ጋሪ		0	0	0	0	0.00	0.00
ሀ	□አተሻ ሥራ (I)	በቁጥር	1792	1792	700	1160	39.06	64.73
ለ	ሰርቪስ (S)	"	0	0	0	0	0.00	0.00
ሐ	ፅማሽ ክ□ላ (PO)	"	0	70	0	72	0.00	102.86
መ	ሙሉ ክ□ላ (CO)	"	4	10	0	8	0.00	80.00
ሠ	ድን. ብልሽት (CM)	"	330	330	210	300	63.64	90.91
4.3.3	ል□ ል□ □ሪች		0	0	0	0	0.00	0.00
ሀ	□አተሻ ሥራ (I)	በቁጥር	102	102	39	81	38.2	79.41

							4	
ለ	ሰርቪስ (S)	"	0	23	0	19	0.000	82.61
ሐ	ፅማሽ ክ□ላ (PO)	"	0	0	0	0	0.000	0.00
መ	ሙሉ ክ□ላ (CO)	"	0	0	0	0	0.000	0.00
ሠ	ድን. ብልሽት (CM)	"	36	72	16	41	44.44	56.94
4.3.4	ተቀዓላ መሳሪ□		0	0	0	0	0.000	0.00
ሀ	□ኣተሻ ሥራ (I)	በቁዓር	76	142	38	132	50.000	92.96
ለ	ሰርቪስ (S)	"	38	71	19	62	50.000	87.32
ሐ	ፅማሽ ክ□ላ (PO)	"	0	0	0	0	0.000	0.00
መ	ሙሉ ክ□ላ (CO)	"	0	0	0	0	0.000	0.00
ሠ	ድን. ብልሽት (CM)	"	76	142	38	94	50.000	66.20
4.3.5	□□ሃ መሳቢ□ □ም□		0	0	0	0	0.000	0.00
ሀ	□ኣተሻ ሥራ (I)	በቁዓር	109	115	41	87	37.61	75.65
ለ	ሰርቪስ (S)	"	55	56	18	38	32.73	67.86
ሐ	ፅማሽ ክ□ላ (PO)	"	0	6	0	0	0.000	0.00
መ	ሙሉ ክ□ላ (CO)	"	0	1	0	1	0.000	100.00

ሠ	ድን. ብልሽት (CM)	"	110	125	48	86	43.64	68.80
4.3.6	ጀነሬተር		0	0	0	0	0.000	0.00
ሀ	□ስተሻ ሥራ (I)	በቁጥር	35	41	18	32	51.43	78.05
ለ	ሰርቪስ (S)	"	12	15	6	9	50.00	60.00
ሐ	ፅማሽ ክ□ካ (PO)	"	1	1	0	0	0.000	0.00
መ	ሙሉ ክ□ካ (CO)	"	0	0	0	0	0.000	0.00
ሠ	ድን. ብልሽት (CM)	"	31	37	17	22	54.84	59.46
4.3.7	ኮም□ሬሰር		0	0	0	0	0.000	0.00
ሀ	□ስተሻ ሥራ (I)	በቁጥር	13	19	6	18	46.15	94.74
ለ	ሰርቪስ (S)	"	4	6	2	5	50.00	83.33
ሐ	ፅማሽ ክ□ካ (PO)	"	0	0	0	0	0.000	0.00
መ	ሙሉ ክ□ካ (CO)	"	0	0	0	0	0.000	0.00
ሠ	ድን. ብልሽት (CM)	"	11	14	5	8	45.45	57.14
4.3.8	ተንቀሳቃሽ መበየጃ		0	0	0	0	0.000	0.00
ሀ	□ስተሻ ሥራ (I)	በቁጥር	1	1	1	1	100.0	100.00

							0 0	
ለ	ሰርቪስ (S)	"	2	2	3	4	150.00	200.00
	ፅማሽ ክ□ካ (PO)	"	0	0	0	0	0.000	0.00
መ	ሙሉ ክ□ካ (CO)	"	0	0	0	0	0.000	0.00
ሠ	ድን. ብልሽት (CM)	"	6	9	3	4	50.00	44.44
4.3.9	tyre repair		0	0	0	0	0.000	0.00
ሀ	ድን. ብልሽት (CM)	በቁጣር	1150	1450	657	1357	57.13	93.59
4.4	Auto Eletric maintenance sub group		0	0	0	0	0.000	0.00
ሀ	ድን. ብልሽት (CM)	በቁጣር	560	870	280	865	50.00	99.43

Machine Name_____ Model _____ Plate No. ----------

Date	Job order No	Store Code	Description and part No	Problem of/machines or Vehicle	Conception of spare part	Type of maintenance	Assigned forame	Assigned Mechanic	Starting Time	Finishing time	STD Time	Remark

በመ.መ.ጥ.የ---------- መስክ ጥገና ቡድን መከታተያ ቅጽ ሺፍት----------

ቀን	ተጠቃሚ ክፍሎች	የማሽን አይነት	የማሽን መለያ ቁጥር	የችግሩ ዓይነት	የጥገናው ዓይነት	የመካኒክ/የኤሌክትሪሻን ስም	የጀመረበት ሰዓት	የጨረሰበት ሰዓት	ስራው የፈጀው ሰዓት	ስታንዳርድ	

ማሳሰቢያ፦ ይህ ቅጽ ተሞልቶ ሲያልቅ ወደ ፕላኒንግ ክፍል መግባት አለበት

የሠራው የመካኒክ ስም
_____

ቀን
_____

ፊርማ _____

ያረጋገጠው ሀላፊ
_____

ቀን
_____

ፊርማ_____

አጠቃላይ በመስክ መሣሪያዎች ጥገና ቡድን ለአገዳ ቆረጣና አቅርቦት ቡድን የተዘጋጁ ማሽኖች ዝርዝ

Bell Tractors	YTO Tractors	KAT Tractors	HBT Power	HBT Trailer	Grab Loader	Dozer	Toyota	Motor Cycle	MIC
WT-117	WT - 195	WT - 209	2	1	WT-0035	CT-0021	3-56117	MB-0086	38 cane cart
WT - 118	WT - 003	WT - 210	3	2	WT-0088	CT-0019	3-56114	MB-0050	-
WT - 119	WT - 193	WT - 211	4	3	WT-0089	-	3-42073	MB-0048	-
WT - 121	WT - 194	WT - 212	5	6	WT-0090	-	3-42077	MB-0094	-
WT - 122	WT - 196	WT - 213	7	7	WT-0091	-	-	-	-
WT - 123	WT - 197	WT - 214	8	8	WT-0115	-	-	-	-
WT - 125	WT - 198	WT - 215	9	9	WT-0016	-	-	-	-
WT - 127	WT - 199	WT - 216	10	10	-	-	-	-	-
WT - 128	WT - 200	WT - 217	11	11	-	-	-	-	-
WT - 130	WT - 201	WT - 218	12	12	-	-	-	-	-
WT - 131	WT - 204	-	13	13	-	-	-	-	-
WT - 134	WT - 206	-	14	14	-	-	-	-	-
WT - 136	WT - 207	-	15	15	-	-	-	-	-
WT - 177	WT - 208	-	16	16	-	-	-	-	-
WT - 178	-	-	17	17	-	-	-	-	-
WT - 179	-	-	-	-	-	-	-	-	-
16 unit	14 unit	10 unit	15	15	7 unit	2 unit	4 unit	4 unit	38

			unit	unit					unit

APPENDIX –F Maintenance Request Format

መጸሶ WSSF	ወንጂ/ሸዋ ስኳር ፋብሪካ	Company Name:
Issue No.: 1	Title: □□ራዴ ክለ□ዊ የዘይት ማደያ ቅጽ	Document No.: OF/WSSF/022/01

መጸሶ WSSF	ወንጂ/ሸዋ ስኳር ፋብሪካ	Company Name:
Issue No.: 1	Title: □□ራዴ ክለ□ዊ የዘይት ማደያ ቅጽ	Documen OF/WSSF/022/019

ቁዓር ——————————

ቀን ——————————

የተሽከርካሪው ስም ——————————

□ስሌ□ ቁዓር ——————————

ቁዓር ——————————

ቀን ——————————

የተሽከርካሪው ስም ——————————

□ስሌ□ ቁዓር ——————————

ተራ ቁዓር	የዘይት ዓይነት	ብ□ት በሊትር በኪ/ግ
1	SAE 15W 40 ኢንጅን ለሁሉም	
2	SAE 30 ለካሚኮ ሀ□ትሮ□ሊ□	
3	SAE 90 /SEA 80W90/ ለቂር	
4	SAE 10 ለሀትሮ□ሊ□	
5	Dot-4 Dot-3 ለፍሬንና/ ለፍሪሲዬን	
6	ATF/DEXRON ለመሪ	
7	Grease ፅራሶ	
8	2-T ለሞተር ሳ□□ል	

9	DYNATRANS MPR ጆንደር 9330, 9410	
	የነዳጅ ዓይነት	
10	ቤንዚን	
11	ናፍጣ	

ተራ ቁጥር	የዘይት ዓይነት	ብዛት በሊትር በኪ/ግ
1	SAE 15W 40 ኢንጅን ለሁሉም	
2	SAE 30 ለካሚኮ ሀ□ትሮ□ሊ□	
3	SAE 90 /SEA 80W90/ ለዲር	
4	SAE 10 ለሀትሮ□ሊ□	
5	Dot-4 Dot-3 ለፍሬንና/ ለፍሪሲዬን	
6	ATF/DEXRON ለመሪ	
7	Grease ፅራሶ	
8	2-T ለሞተር ሳ□□ል	
9	DYNATRANS MPR ጆንደር 9330, 9410	
	የነዳጅ ዓይነት	
10	ቤንዚን	
11	ናፍጣ	

□□ሳፀ ስም ——————— □ርማ ———
□□ሳፀ ስም ——————— □ርማ ———

□□ቃፀ ስም ——————— □ርማ———
———

የአዳዩ ስም ——————— □ርማ ———
———

□ሹ□ር ስም ——————— □ርማ ———
□ርማ ———

□□ቃፀ ስም ——————— □ርማ—
—

የአዳዩ ስም ——————— □ርማ

□ሹ□ር ስም ———————

መጀመሪ WSSF	ወንጂ/ሸዋ ስኳር ፋብሪካ	Company Name:
Issue No.: 1	Title: □□ራዴ ክለ□ዊ የዘይት ማደያ ቅጽ	Document No.: OF/WSSF/022/019

መጀመሪ WSSF	ወንጂ/ሸዋ ስኳር ፋብሪካ	Company Name:
Issue No.: 1	Title: □□ራዴ ክለ□ዊ የዘይት ማደያ ቅ□	Document No.: OF/WSSF/022/019

ቁጥር ———————

ቀን ———————

የተሽከርካሪው ስም ———————

□ሰሌ□ ቁጥር ———————

ቁጥር ———————

ቀን ———————

የተሽከርካሪው ስም ———————

□ሰሌ□ ቁጥር ———————

ተራ ቁጥር	የዘይት ዓይነት	ብዛት በሊትር በኪ/ግ
1	SAE 15W 40 ኢንጅን ለሁሉም	
2	SAE 30 ለካሚኮ ሀ□ትሮ□ሊ□	
3	SAE 90 /SEA 80W90/ ለቴር	
4	SAE 10 ለሀትሮ□ሊ□	
5	Dot-4 Dot-3 ለፍሬንና/ ለፍሪሲዬን	
6	ATF/DEXRON ለመሪ	
7	Grease ፅራሶ	
8	2-T ለሞተር ሳ□□ል	
9	DYNATRANS MPR ጆንደር 9330, 9410	
	የነዳጅ ዓይነት	
10	ቤንዚን	
11	ናፍጣ	

የወሳጅ ስም ---------- ፊርማ ----------

□□ቃፀ ስም ———————— □ርማ————————

የአዳዩ ስም ———————— □ርማ ————————

□ሹ□ር ስም ———————— □ርማ ————————

ተራ ቁጥር	የዘይት ዓይነት	ብዛት በሊትር በኪ/ግ
1	SAE 15W 40 ኢንጅን ለሁሉም	
2	SAE 30 ለካሚኮ ሀ□ትሮ□ሊ□	
3	SAE 90 /SEA 80W90/ ለቴር	
4	SAE 10 ለሀትሮ□ሊ□	
5	Dot-4 Dot-3 ለፍሬንና/ ለፍሪሲዬን	
6	ATF/DEXRON ለመሪ	
7	Grease ፅራሶ	
8	2-T ለሞተር ሳ□□ል	
9	DYNATRANS MPR ጆንደር 9330, 9410	
	የነዳጅ ዓይነት	
10	ቤንዚን	
11	ናፍጣ	

የወሳጅ ስም ---------- ፊርማ -

□□ቃፀ ስም ———————— □ርማ—

የአዳዩ ስም ———————— □ርማ -

□ሹ□ር ስም ———————— □ርማ

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ቀን-_____

የስራ ትዕዛዝ ቁጥር----------

የሠሌዳ ቁጥር ----------

1.ተጠቃሚ ክፍል----------

2.ጥገናውን የጠየቀው ኦፕሬተር/ሾፌር ስም፡----------

3.ማሽነሪው ያጋጠመው ችግር፡----------

4.ትዕዛዙን የሞላው ሪሴብሽኒስት ስም፡---------- ፊርማ ---------- ስአት----------

5.የጥገና ንዑስ ቡድን----------

6.ስራውን የመራው ሱፐርቫይዘር ስም፡---------- ፊርማ ----------

7.የተከናወነው ስራ፡- ----------

8.ለስራው የተሠጠው ስታንዳርድ ስአት---------- **9.** ስራው የወሰደው ስአት ----------

10. ሥራዉ የጀመረበት ቀን---------- ስዓት---------- **11.** ያለቀበት ቀን ---------- ስዓት---

ስራውን የተከታተለው ሊድ መካኒክ ስም፡---------- ፊርማ፡-------- የሰራው ቴክኒሻን ስም --------- ፊርማ---

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የረዳት ቴክኒሻን ስም ---------- ፤----------፤የበያጅ ስም----------

ያረጋገጠው ሲኔር ሱፐርቫይዘር-፡----------

ማሳሰቢ□፡- **ይህ ቅፅ ስራው ተሰርቶ ሲጠናቀቅ ተሞልቶ** ዕቅድና ዝግጅት □**አል** በወቅቱ ሊቀርብ ይገባል፡፡

Company Name: WONJI/SHOA SUGAR FACTORY		
Issue No.:	Title: በመ.መ.ጥ.ቡ የስራ ትዕዛዝ	Document No.: OF/WSSF/022/002

ቀን----------

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የስራ ትዕዛዝ ቁጥር----------

የሠሌዳ ቁጥር ----------

1.ተጠቃሚ ክፍል----------

2.ጥገናውን የጠየቀው አፕሬተር/ሾፌር ስም፡----------

3.ማሽነሪው ያጋጠመው ችግር፡----------

4.ትዕዛዙን የሞላው ሪሴብሽኒስት ስም፡---------- ፊርማ ---------- ስአት----------

5.የጥገና ንዑስ ቡድን----------

6.ስራውን የመራው ሱፐርቫይዘር ስም፡---------- ፊርማ ----------

7.የተከናወነው ስራ፡- ----------

8.ለስራው የተሠጠው ስታንዳርድ ስአት---------- **9.** ስራው የወሰደው ስአት ----------

10. ሥራዉ የጀመረበት ቀን---------- ስዓት---------- **11.** ያለቀበት ቀን ---------- ስዓት---

ስራውን የተከታተለው ሊድ መካኒክ ስም፡---------- ፊርማ፡--------- የስራው ቴክኒሻን ስም ፊርማ---------

የረዳት ቴክኒሻን ስም ---------- ፤፤----------፤የበያጅ ስም----------

ተ.ቁ	በተሸከርካሪዉ ላይ ያሉ ንብረቶች	ብዛት /መጠን/	ተ. ቁ	የተሸከርካሪዉ ሁኔታ	ብዛት /መጠን/	መግለጫ
1	ትርፍ ጎማ		1	ጎን መስታወት		
2	ክሪክ		2	የፊት መስታወት		
3	የጎማ መፍቻ		3	የኋላ መስታወት		
4	የመኪና ሽራ		4	የተሳፋሪ መስታወት		
5	ሬድዮ		5	የውስጥ መስታወት		
6	ቴፕ		6	የፊት መብራት		
7	አንቴና		7	የኋላ መብራት		
8	የጎዳጅ ታንከር ክዳን		8	የውስጥ መብራት		
9	የራዲያተረር ክዳን		9	የፊት ፍሬቻ		
10	የእሳት ማጥፊያ		10	የኋላ ፍሬቻ		
11	ሌላ		11	ግጭት ያለዉ አካል		
12	ሌላ		12	ግጭት የሌለዉ		

				አካል		

ያረጋገጠው ሲኔር ሱፐርቫይዘር-፡----------

<u>ማሳሰቢ</u>□፡- **ይህ ቅፅ ስራው ተሰርቶ ሲጠናቀቅ ተሞልቶ** ዕቅድና ዝግጅት □**አል** በወቅቱ ሊቀርብ ይገባል፡፡

ከጥገናው በፊት ያስረካቢዉ ስም ---------- ፊርማ ----------

ከጥገናው በፊት የተረካቢው ስም ---------- ፊርማ ----------

ከጥገና በኋላ የተረከበው ስም ---------- ፊርማ ----------

ተ.ቁ	በተሸከርካሪዉ ላይ ያሉ ንብረቶች	ብዛት /መጠን/	ተ.ቁ	የተሸከርካሪዉ ሁኔታ	ብዛት /መጠን/	መግለጫ
1	ትርፍ ጎማ		1	ጎን መስታወት		
2	ክሪክ		2	የፊት መስታወት		
3	የጎማ መፍቻ		3	የኋላ መስታወት		
4	የመኪና ሽራ		4	የተሳፋሪ መስታወት		
5	ሬድዮ		5	የውስጥ መስታወት		
6	ቴፕ		6	የፊት መብራት		
7	አንቴና		7	የኋላ መብራት		
8	የነዳጅ ታንከር ክዳን		8	የውስጥ መብራት		
9	የራዲያተረር ክዳን		9	የፊት ፍሬቻ		
10	የእሳት ማጥፊያ		10	የኋላ ፍሬቻ		
11	ሌላ		11	ግጭት ያለዉ አካል		
12	ሌላ		12	ግጭት የሌለዉ አካል		

ከጥገናው በፊት ያስረካቢዉ ስም ---------- ፊርማ ----------

ከጥገናው በፊት የተረካቢው ስም ---------- ፊርማ ----------

ከጥገና በኋላ የተረከበው ስም ---------- ፊርማ ----------

□መሥሪ□ ቤቱ ስም ---------- ቀን ----------

□ሰሌ□ ቁጻ ር ---------- የመቀመጫ ብዛት ----------

የቻንሲ ቁጥር ---------- የተገዛበት ዓ.ም ----------

□ሞተር ቁጻ ር ---------- ዓይነት ----------

□ሞ□ል ቁጻ ር ---------- የተመደበበት ክፍል ----------

የተገዛበት ዋጋ ---------- የተሠራበት ዓ.ም ----------

የሚጠቀመው ነዳጅ ----------