UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ASSESSMENT OF THE MAINTENANCE PRACTICES OF THE MECHANICAL ENGINEERING WORKSHOPS IN THE SISSALA EAST DISTRICT OF THE UPPER WEST REGION OF GHANA

INUSAH ALIDU GBANHA

AUGUST, 2017

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AUGUST, 2017

DECLARATION

STUDENT'S DECLARATION

I, INUSAH ALIDU GBANHA, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: …….

DATE: …….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: Mr. C.K NWORU

SIGNATURE: ……

DATE: ……

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DEDICATION

I dedicate this work to my mother Alidu Alijata, my wife Boribi Hajuamua and my daughter Gbanha Alidu Zafreen.

TABLE OF CONTENT

Contents……Pages
DECLARATION....ii
ACKNOWLEDGEMENT....iii
DEDICATION....iv
TABLE OF CONTENT....v
LIST OF TABLES....ix
ABSTRACT....x

CHAPTER ONE:GENERAL INTRODUCTION....1
1.1 Background of the Study....1
1.2 Statement of the Problem....4
1.3 Aim of the Study....6
1.4 Objectives of the Study....6
1.5 Research Questions....6
1.6 Significance of the Study....7
1.7 Scope of the Study....8
1.8 Organization of the Thesis....8

CHAPTER TWO:LITERATURE REVIEW....9
2.1 Introduction of the Study....9
2.2 Definitions and Meaning of Maintenance....9
2.2.1 Concept of Maintenance....11
2.2.1 Maintenance Culture....15
2.3 Types of Maintenance....17
2.3.1 Planned Maintenance....18
2.3.1.1 Corrective Maintenance....18
2.3.1.3 Preventive Maintenance....21
2.3.1.5 Proactive Maintenance....22
2.3.1.4 Improvement Maintenance....22

2.3.1.5 Contract Maintenance 23
2.3.2 Unplanned Maintenance 24
2.3.2.1 Emergency 24
2.3.2.2 Breakdown (run-to-failure) 24
2.4 Maintenance test and Procedure in Engineering Industries 25
2.4.1 Routine Maintenance 25
2.4.2 Maintenance Testing 25
2.4.3 Diagnostic Testing: 26
2.5 Maintenance Practices in Ghana 26
2.6 Importance of Instituting Regular Maintenance Practices in Ghana 27
2.6.1 Minimization of Downtime 27
2.6.2 Improvement in total availability of the system 28
2.6.3 Extended useful life of the equipment 28
2.6.4 Safety of the Personnel 28
2.6.5 Reduction in Costs 28
2.7 Challenges of Implementing Proper Maintenance Practices in Ghana 28
2.7.1 Effect of Shut-downs 29
2.7.2 High Cost of Spare Parts 29
2.7.3 Failure of maintenance Staff to retain Knowledge and Skills Acquired 30
2.7.4 Lack of Adequate Funds Committed to Maintenance 30
2.7.5 Reluctance of contractors to replace defective Parts 30
2.7.6 Lack technical persons to repair certain machines 31
2.7.7 Lack of computerized maintenance management system in place 31
2.7.8 Poor Maintenance Task Execution 31
2.7.9 Poor Maintenance Strategy and Policy 32
2.8 Maintenance Management 32
2.8.1 Maintenance Organizations and types of Maintenance Organization 33
2.8.1.1 Centralized Maintenance Organisation 33
2.8.1.2 Decentralized Maintenance Organisation 33
2.8.1.3 Partially Decentralized 33
2.8.2 Effectiveness of Maintenance Organization 34

2.8.2.1 Team Spirit 34
2.8.2.2 The Plant Engineer 35
2.8.2.3 Philosophy 35
2.8.2.4 Policy 35
2.8.2.5 Clear Enunciation of Functions 35
2.8.2.6 Span of Control 36
2.8.2.7 Development of Subordinates 36
2.9 Strategies to Improve Maintenance Practices in Ghana 37
2.9.1 Introduction of Computerized Maintenance Management Systems (CMMS) 37
2.9.2 Introduction of Reliability-Centered Preventive Maintenance 38
2.9.3 Introduction of Prediction Tools for Solving Maintenance Problems 39
2.9.4 Introduction Fault Tree Analysis (FTA) 39
2.10 Summary of Literature Review 39

CHAPTER THREE:RESEARCH METHODOLOGY 40
3.1. Introduction 40
3.2 Research Design 40
3.3 Sources of Data 41
3.4 District Profile 42
3.5 Target Population 42
3.6 Sample and Sampling Technique for the Study 43
3.7 Data Collection Instruments 44
3.7.1 Data Collection Procedure or Administration 45
3.8 Pre-Testing of Questionnaire 46
3.9 Validity and Reliability of Questionnaire 46
3.10 Data Analysis 47
CHAPTER FOUR:DATA ANALYSIS AND DISCUSSION OF RESULTS 48
4.2 Demographic Information of Respondents 48
4.3 Maintenance Activities carried out in the Workshops 51
4.4 Maintenance Practices 59
4.5 The importance of conducting regular maintenance practices in engineering workshops . 60

4.6 Challenges of implementing maintenance practices in engineering workshops 62
4.7 Summary of Analysis and Discussion of Data 64

CHAPTER FIVE:SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION 65
5.2 Summary of Findings 65
5.2.1 Maintenance practices being carried out by the mechanical engineering workshops 65
5.2.2 Challenges involved in implementing maintenance practices in mechanical engineering workshops 66
5.2.3 Importance of Carrying out Regular Maintenance Practices in mechanical engineering workshops 66
5.3 Conclusion 66
5.4 Recommendations 67

REFERENCES 69
APPENDIX 72

LIST OF TABLES

Table 4.1 Gender Representation of Respondents……..50

Table 4.2 Educational Qualification of Respondents……..52

Table 4.3 Working Experience of Respondents……..…53

Table 4.4 Untaken of Regular Maintenance on Workshop Equipment……...54

Table 4.5 Often times maintenance is carried out in the workshop…….54

Table 4.6: Presence of Maintenance Schedule in the Workshop……..…55

Table 4.7: Experiences of Breakdowns in the Workshops…….….56

Table 4.8: Respondents View on the Importance of Carrying Out Regular Maintenance…….….57

Table 4.9: Employing Preventive Maintenance Practices……..……..57

Table 4.10: Performance Daily Routine Maintenance Checks…….58

Table 4.11 Number of Days it takes to fix a Problem……..……59

Table 4.12: Training Programs Organized on Maintenance…….……59

Table 4.13: Organisation of Retraining on the use and Maintenance of Equipment…….……..60

Table 4.14 Maintenance Practices Normally by Practices Mechanical Workshops……....62

Table 4.15: Importance of Carrying out Regular Maintenance Practices in Workshops…….64

Table 4.16: Challenges of Implementing Regular Maintenance Practices in Engineering Workshop…66

ABSTRACT

Maintenance is important to the success and continuity of firms, particularly in the changing society as ours. The effectiveness and the survival of organizations are largely enhanced by the ability of management to ensure that there is functional equipment, lands and buildings, infrastructure and fixtures. In the manufacturing setup, there is wear and tear of machines and equipment in the periods of usage that require sufficient maintenance to enhance their useful life. This ensures reliability of the machines and equipment in the production plants as to uninterrupted production runs. However, most manufacturing firms in Ghana have lost their effectiveness and productivity, because of poor maintenance practices. It is in this light that the study attempts to assess the maintenance practices of mechanical engineering workshops in Sissala East District of the Upper West region. Descriptive survey design was used for the study and this was deemed appropriate for the study because it is versatile and practical and it identifies present conditions and points to recent needs of the mechanical engineering companies. The sample technique adopted for the study was purposive sampling technique which implies that only particular group of people were contacted for the study. Questionnaires were the main data collection instruments used to gather the data for study. A total 72 people were sampled for the study. After several analysis from the data gathered, it was established that maintenance practices instituted in the firms are limited to performing regular diagnosis on machines before use, performing periodic inspection of equipment, putting in place all proper tooling activities, personnel and plant protection, conducting regular conditioning monitoring and oil analysis. The study also established that firms encounter numerous challenges in trying to institute regular maintenance practices which include high cost of maintenance parts , lack of adequate funds committed to maintenance and long bureaucratic process involved in processing maintenance order for maintenance projects. The study recommends that manufacturing companies should always allocate maintenance budget to cater for any unforeseen repairs or replacement of equipment.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Many industries, companies and engineering workshops are wasting much production time and spending huge sums of money to reduce breakdowns and ensure that all machines and equipment are maintained in order to ensure continuous production. The effective maintenance of workshop machinery ensures sustainability of equipment; promote lifespan of machines, keep proper functioning, improves safety practice in workshop, avoid break down and increase profitability.

Maintenance is crucial to prolonging the serviceability and life span of industrial equipment; but technological pressures today are forcing firms to use ever sophisticated machinery in their production operation. Special continuing programmes are required to provide relevant knowledge, understanding and skills to service specialized equipment and keep them abreast of developments in manufacturing industry (Mishra and Pathak, 2004). As a result major changes are occurring in the way maintenance is organized and implemented in industry (Ahuja and Khamba, 2007, Uzan and Ozdogan, 2012), and computerized maintenance management systems (CMMS) are now commonplace in many countries (Tsang, 2002).

According to Alhmann (1998), maintenance is the total of activities serving the purpose of retaining the production units or retaining them to the state considered necessary for fulfillment of their production function. British standard glossary (1993) also defines maintenance as a business function that serves and supports the primary process in an organization. It is defined as the combination of all technical and associated administrative actions intended to retain an item in, or restore it to, a state in which it can perform its required function. Traditionally, maintenance was an

activity that was put into action to solve production problems. Its objective was to keep the process running. Nowadays, many firms are realizing a need for the use of proper maintenance of production facilities and systems. Industrial plants, machines and equipment are becoming technologically more advanced and at the same time more complex and difficult to control (Stephen, 2000). Therefore, the importance of the maintenance function has been greater than before, due to its role in maintaining and improving availability, performance efficiency, on-time deliveries, safety requirements and overall plant productivity (Alhmann, 1998; Al Najjar, 1998; Cooke, 2000).

Dhillon (2009) indicated that maintenance philosophy has evolved from reactive to preventive and latter to proactive approach. However, maintenance function is still largely seen as a "necessary evil" by many companies and workshops. According to Kelly (2003), the nature of maintenance work has changed as a result of a huge increase in the number and variety of physical equipment to be maintained, increasing automation and complexity, new maintenance techniques as well as changing views on maintenance organization and responsibility. Maintenance function is not more only to maintain but also to enhance the process or the plant operation system as a result of turnaround planning. Thus rather than restoring or trying to restore the equipment to its original performance, planning turnaround could be aimed at to enhance the process.

Zhou et al., (2006) opined that the maintenance process adds to customer value in terms of profit, quality, time and service. Therefore, the maintenance function has become essential for a manufacturing organization to maintain its competitiveness (Al-Najjar and Alsyouf, 2004). Without a well maintained equipment, a plant will be at a disadvantage in a market that requires low-cost products of high quality to be delivered quickly (Stephen, 2000; Swanson,2003; Cholasuke et al., 2004). Kamoun (2005) emphasized that as enterprises and customers count on the availability,

reliability and quality of service of corporate assets, any compromise in these areas will lead to both decreased revenues and increased costs.

As a matter of fact, the total losses due to maintenance omission or ineffectiveness have been highlighted by practitioners and researchers (Madu, 2000; Mirghani, 2001; Mitchel, 2002). In order to assess the maintenance practices in their countries, several researchers have conducted surveys and studies. For example, a study was conducted in Hong Kong to assess maintenance practices reveal that, out of the total cost of ($ 370,000) borne by industries, ($94,000) was attributed to improper maintenances not being implemented. In (Eti,Ogaji,2006), a study on maintenance practices and challenges was conducted for Nigerian public industries and it was established that industrial items that was lost through improper maintenance practices costed the federal Government of Nigeria close to 50 million dollars ($50,000000).

Bob (2007) reported that wasted energy from faulty or poorly maintained compressed air systems cost US industry up to $3.2 billion annually. Alsyouf (2006) showed in a case study that there is the potential, in an ideal scenario, to improve a company's return on investment (ROI) by about 9%. This figure represents a projected US$ 8.4 million loss in profits that is caused by planned inoperative time and overall equipment effectiveness (OEE) elements. At least 14% of the potential improvements in ROI are directly related to the contribution of maintenance functions to lost profit, which is due to unplanned stoppages and bad quality caused by maintenance-related problems. However, maintenance tasks are becoming increasingly more complex. A typical manufacturing system consists not only of mechanical components, but also of other elements such as electronic, hydraulic, and electromechanical systems, software and human beings. This means that disturbances and deviations in the production process may occur due to different factors such as the failure of significant components of equipment, the quality of purchased material and spare

parts, design, manufacturing process control, management systems and human error (Holmberg, 2001).

Another Research conducted within the Kumasi Metropolis on some recognized manufacturing firms, some of which manufacture for export, showed that majority (70%) use manual equipment for production, 20% semi-automated, and 10% fully automated equipment (Adejuyigbe, 2006).

Today's market conditions place great emphasis on variety, performance and quality of products. In order to meet these requirements manufacturers have been compelled to utilize complex and sophisticated machines. Over time, the driving need to meet and improve on the requirements has shifted the trend of manufacturing to high levels of automation (Raouf and Ben-Daya, 1995). The objective behind automation is to achieve higher productivity and profit in order to effectively stay competitive in business. It is believed that Annual maintenance costs as a fraction of total operating budget varies across industries but typical values range between 20% to 30% of total production costs (Gebauer., 2008), meaning that if they are reliable and well maintained, manufacturing equipment can make a very significant contribution to company performance.

1.2 Statement of the Problem

Notwithstanding the fact that manufacturing companies have introduced various forms of maintenance alert system to their machines which are being operated by experts and non-experts alike, there seems to be an unpredictable increase in machine breakdowns leading to low productivity and high cost of running workshops. These breakdowns do not only lead to loss of revenue but also make the workshops not to meet production schedules which have led to a breach of trust and public confidence on the workshops and the professionals at large. Also, there is still an information gap on maintenance activities being undertaken within industries in Ghana. Amoako-

Gyampah et al., (2001) and Adejuyigbe, (2006) report that there is still some inefficiencies in the level of maintenance practices that takes place within the industries in the Kumasi metropolis. Again, there is a general perception that Ghanaians lack a culture of maintenance (Afranie, 2004) and as a result do not employ any maintenance policies or strategies in their manufacturing firms. There is some research to support the notion that in developing countries manufacturing companies find it easier to replace than to maintain because of lack of skill (Söderbom, 2000). In effect, Government agencies and industries in and around the Sissala East district do not employ maintenance practices but are only focused on replacing defective parts. It is believed that this attitude has led to the plethora of renovations and replacements of structures and equipment which has cost the nation dearly in monetary terms and has stunted national growth (Obeng-Odoom and Amedzro, 2011). The type of maintenance strategy adopted, equipment and technology employed, the role of the maintenance personnel, training details used in these industries are either outmoded or do not met requirement. Optimal maintenance policies aim to provide optimum system reliability/availability and safety performance at lowest possible maintenance costs. Therefore, it is important for maintenance engineers and crafts persons to promote the improvement and adoption of effective maintenance. Though maintenance may be costly, most mechanical and auto mechanical workshops have resorted to reactive maintenance because of lack of qualified maintenance personal, production pressure and lack of education or plan of maintenance. These support the views of (Keith, Higgins & Lindley 2008) when they asserted that, maintenance is an activity carried out for any equipment to ensure its reliability to performing its function to an unforeseeable future. For this reason, this research seeks to provide insight into the maintenance practices of mechanical engineering workshops of Sissala East District in the Upper West Region of Ghana.

1.3 Aim of the Study

The aim of the study is to assess the maintenance practices of the mechanical engineering workshop within Sissala East District of Ghana.

1.4 Objectives of the Study

The specific objectives of the study are;

i. To assess the maintenance practices being carried out by the mechanical engineering workshops in the Sissala East District.
ii. To identify the challenges involved in instituting maintenance practices in the mechanical engineering workshops of the Sissala East District.
iii. To examine the importance of implementing maintenance practices in the mechanical engineering workshop of the Sissala East district of the Upper West Region.

1.5 Research Questions

The research questions formulated for the study were:

i. What are some of the maintenance practices in the mechanical engineering workshops in the Sissila East District?
ii. What are the challenges involved in implementing maintenance practices in the Sissila East District of the Upper East Region?
iii. What is the importance of implementing regular maintenance practices at the mechanical engineering workshop in the Sissila East District?

1.6 Significance of the Study

The completion of this study would yield the following benefits;

1. This research work would give information about the status of maintenance practices in the various mechanical engineering workshops in the Sissala East District of the Upper West Region. It will give information on the type of maintenance policies and intervention adopted in the Sissala East District.
2. Another significant aspect of this research will be to find alternatives and better maintenance practices that can enhance machine lifespan, increase production, reduce risk of operation, increase chances of meeting production delivery deadlines and maintain safety at workplace.
3. The research will be beneficial to researchers and students who will like to research into the area of maintenance and also contribute to the body of knowledge in the sector.
4. The result of the study would serve as a stimulus for people and industries to start providing contract maintenance services and equipment to individuals and organizations. Other services that can be rendered include maintenance training for staff.
5. The outcome of the study would serve as a basis for industries and organizations to assess and utilize maintenance practices in Ghana.

1.7 Scope of the Study

This research work will specifically explore the status of maintenance practices happening in the Sissala East district of the Upper West district.

1.8 Organization of the Thesis

This research work is organized into five chapters. Chapter One is the introduction which included the background to the study, the statement of the problem, aims and objectives of the study, research questions, significance of the study and the organization of the study. Chapter two covers the review of related literature on maintenance practices in the Ghanaian industry. It enumerated the theories and concepts available on maintenance, types of maintenance, maintenance management strategy, importance of maintenance and maintenance performance measurement. Chapter Three deals with the methods used to conduct the research and how the data for the study was analyzed and presented. It includes the research design, target population, sampling technique and sample size, data administration and procedure, research instruments, pre-test, viability and reliability and data analysis. Chapter Four centers on data presentation, analysis and discussion of findings. Chapter Five covers the summary of findings, conclusion, and recommendations for the study and suggested areas for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter of the study discusses reviews of related literature gathered for the study. It will specifically talk about the concept of maintenance, types of maintenance, maintenance procedure, importance of maintenance, maintenance management, challenges hampering effective maintenance practices, effects of not instituting maintenance practices and finally strategies that can be adopted to improve maintenance practices in industries.

2.1 Definitions and Meaning of Maintenance

Good maintenance engineering is essential to the success of any manufacturing or processing operation. One of the major components to a company's success is to possess a quality maintenance department that can be depended upon to discover systematic flaws and recommend solid, practical solutions (Damewood, 2010).

There are many definitions of maintenance but a more comprehensive one given by Telang and Telang (2010) defined it as "the combination of all technical and related administrative actions including supervision, with an aim to retain an item in, or restore it to a state in which it can perform a required function". This definition clearly identifies two distinct activities in maintenance; the technical and the administrative. The technical activities are grouped under maintenance engineering and deal with the actual tasks carried out on equipment while the administrative activities are grouped under maintenance management and basically deal with the management aspects of maintenance. It is worth noting that an optimum and efficient interaction between the two fields is necessary to achieve best results. Maintenance management has become

more predominant and has become a major factor in achieving overall productivity in industrial organizations (Telang and Telang, 2010). Maintenance has evolved from non-recognized function which comprised of simple tasks such as cleaning, lubrication and simple repairs to being an important element in industrial management and productivity. The need for maintenance engineering and management is increasingly becoming important to manufacturing industries due to rising prices of equipment, systems, machinery and infrastructure (Telang and Telang, 2010). Again, this need is also growing because of intricate computerized manufacturing and production systems with their requisite modern equipment which is becoming complex and requiring a host of personnel, skill and related systems to manage them (Damewood, 2010). To put the situation in perspective, before 2006, the United States of America spent approximately US$300 billion annually on plant maintenance and operations alone (Dhilion, 2006). Further, many other factors including ruthless competitive market forces, strict supply schedules and quality controls, legislation-backed safety and environmental regulations have added to the already grave situation (Telang and Telang, 2010).

Manufacturing companies, the global economy and the world as a whole, have undergone significant changes and there is competition everywhere. The world has turned global and competition is everywhere. These new challenges have led to deep transformations in companies thereby affecting maintenance as well. As a result of this transformation, maintenance has come to a position of enhanced and well-deserved importance, due to its incidence on overall company competitiveness (Santiago, 2010). When maintenance in an organization is neglected it leads to ever frequent breakdowns which result in costly repairs and faster deterioration of valuable and

usually expensive equipment and inevitably has far reaching detrimental consequences on production as a whole. This makes a high state of maintenance efficiency not only desirable but also very obligatory for industrial well-being at all levels and even at the national level (Gopalakrishnan & Banerji, 2004).

2.2.1 Concept of Maintenance

PrEN (1996) defines maintenance as the combination of all technical, administrative and managerial actions during the life cycle of an item which is intended to retain it in, restore it to a state in which it can perform a required function. The concept of maintenance actually began just in the eve of the Second World War. Industries did not have a mechanical level because of the equipment were either over designed or too simple. The consequences of failure did not have a strong influence on them and the effect was also neglected (Alsyouf, 2007). Due to this, the industrial equipment were running until failure occurred and when this happened it was either replaced or repaired. Thus the mentality was: "fix it when it breaks". In the first approach of maintenance no actions were taken to detect the onset of failure neither to prevent failures, this approach can be described as reactive maintenance (Alsyouf, 2007).

During the Second World War things began to turn around and everything changed dramatically due to shortage of manufacturing manpower and an increasing demand on production (Kister and Hawkins,2008). As a result, the mechanization increased and the manufacturing facilities changed to be more complex (Alsyouf, 2007). To meet the growing demand for war materials, customer goods and to compensate to the manpower shortages, the technology within manufacturing was forced to develop more mechanization (Kister and Hawkins, 2008). Cost, longevity and availability were now regarded as important factors to achieve the business objectives and therefore,

maintenance was considered as a technical manner and became a task of the maintenance department (Alsyouf, 2007). The equipment reliability was now important and production downtime became everybody's concern. The newfound stature of maintenance allowed the maintenance organization to develop and implement periodic, planned and preventive programs (Kister and Hawkins, 2008).

The manufacturing facilities became even more automated and complex during the 1970s (Alsyouf, 2007). Reliability, availability and maintainability, as well as quality, safety, environment and multi-skilling were now considered very important. Condition monitoring, condition based maintenance and maintenance management information systems began to be used in the industry. Condition based monitoring became easier to use in industry due to automation and development in information technology, and maintenance became more integrated and was no longer an isolated function (Alsyouf, 2007).

The beginning of the 1980s had many systematic concepts been proposed, such as Total Productive Maintenance (TPM) and Reliability Centered Maintenance (RCM) (Alsyouf, 2007).The middle and corporate level management have until recently, ignored the impact of the maintenance operation on production costs, bottom-line profit and product quality. The general opinion has been that "nothing can be done to impact maintenance costs" or "maintenance is a necessary evil". The developments of computer-based instrumentation or microprocessors have provided the means to manage the maintenance operation due to the fact that it can be used to monitor the operating condition of plant equipment and systems. Unnecessary repairs can with this technique be reduced

or even eliminated, catastrophic machine failures can be prevented and the negative impact of the maintenance operation on the profitability can be reduced (Mobley, 2004).

It was not until the late 1990s that maintenance gained recognition as potential profit generator. This is, despite the fact that in many industries maintenance amounts for a substantial sum and the maintenance personnel sometimes comprises a significant number of the total work force (Waeyenbergh & Pintelon, 2002). The focus today is, due to globalization, to create internal and external partnership between maintenance and other elements in the supply chain, for example are maintenance involved when designing and improving the production process, and helping the purchasing department to select the original equipment manufacturer. Monitoring the deviations in both the quality of the product and the machine condition are now more emphasized (Alsyouf, 2007).

Maintenance has now become more and more part of the integrated business concept and there is a growing trend towards outsourcing, also a shift from failure-based to use-based maintenance and increasingly towards condition-based maintenance. Availability, reliability and safety in the production plants are now more emphasized (Waeyenbergh & Pintelon, 2002). An increasingly number of companies now replaced the current reactive, "fire-fighting" maintenance strategy with proactive strategies such as predictive and preventive maintenance and also with aggressive strategies such as TPM in order to achieve world-class performance (Swanson, 2001).

Companies now undertake efforts to reduce costs and at the same time improve quality and productivity, a part of these efforts commonly includes an examination of the maintenance function. For many operations within a producing company are effective maintenance critical due to the fact that it extends equipment life, increase equipment availability and retains equipment in proper

condition. Poorly maintained equipment may conversely lead to more frequent failures of the equipment, low utilization rate of the equipment and delayed production schedules. Equipment that is malfunctioning or misaligned may cause a higher scrap rate or produce products with a questionable quality. In addition does the equipment need to be replaced more often due to shorter life-cycles, which also is a consequence of poor maintenance (Swanson, 2001).

Maintenance has traditionally been considered as a necessary evil, but it is in fact rather a centre of profit than just unavoidable and unpredictable expense (Alsyouf, 2007). If effective maintenance policies are used, failures can be reduced to a minimum level which can result in great savings. Therefore, due to its role in the corporate long-term profitability, more and more significance is put on maintenance. The production and its operational aspects such as quality, costs, capacity, safety and environment are influenced by maintenance of the equipment. But, due to the fact that maintenance is considered to be a support process for production it is difficult to mark its impacts. The perceived maintenance performance level depends on the applied perspective (Alsyouf, 2007). Different departments within the organization have according to (Alsyouf, 2007) different views:

For example the Accountants is responsible for the maintenance performed in terms of costs Top management is only interested in budget performance of the maintenance and, the Engineers are only focused on the technicalities involve in the maintenance process while the team Production sees the maintenance performance in terms of equipment availability and support responsiveness. Thus, there is a lack of common language (Alsyouf, 2007).

2.2.1 Maintenance Culture

According to *Eti,* Ogaji, & Probert *(2006)* culture tends to mature (occasionally in unwanted way) as the external environment evolves. Such desirable environmental changes have included the information technology revolution, rapid technological breakthrough, lowering cultural barrier or difficulty to communication as well as rising communal values. In addition, organization should be devoted to building a supportive cultural environment (in addition to growth, responsibility, and undeniably vision) also taking into account employees as individuals (rather than just general workers) are essential requirements for achieving optimistic organizational culture and of course high quality maintenance.

From a maintenance perspective, the most significant influence on the culture of maintenance is the top management, and thus should be able to create and maintain an internal environment in which the employees can become completely involved in achieving organizational objectives. For a successful and sustainable maintenance program, development and proficiency building of top managers are decisive. It is coherent to provide an environment and a culture that add to employee's well-being, rather than exhausting their satisfaction Eti et al (2006).

The concept of maintenance culture focuses on the design and implementation of a technical procedure that supports the prevention or correction of premature failure of engineering systems with least cost and time without compromising the system performance and safety parameters. Developing good maintenance culture in industries requires a human resources organizational framework. The strategies would be based on definite corporate focus and objectives while the functionality of the human element depends on factors like qualification, motivation, inter-personal relationships, training and retraining. It has been found that a good production system is usually

backed up by an effective maintenance system; therefore, evaluating maintenance culture is an important ingredient in the effort to enhance profitability in the manufacturing industries (Kelly, 1997 and Sodiki, 2001). Usman (1998) grouped maintenance into two classes consists of preventive maintenance and corrective maintenance. Maintenance carried out at predetermined intervals in order to reduce the likelihood of an item not meeting acceptable condition is referred to as preventive maintenance. This maintenance is necessary in order to extend the life and improve the overall availability of the equipment (Sharma and Bahadoorsingh, 2005). It involves a number of component tasks that could be broadly classified either as performance monitoring or maintenance tasks. The performance monitoring tasks include inspection and non-destructive testing (NDT) while the maintenance tasks include lubrication, routine cleaning, adjusting of machines and minor components replacement (Tomlingson, 1993).

Maintenance has been classified as follows: breakdown, routine, planned, preventive, predictive, corrective, design out maintenance, total productive maintenance and contracted out maintenance (Westerkamp, 1999). The type of maintenance that can be employed by any industry depends on the maintenance objectives of that industry. Also, the specific and operational objectives of maintenance are determined by the nature of the organization's business. Therefore, in order to ensure effectiveness, the objectives of maintenance must be clearly defined to be understood by all stakeholders in the organization. Maintenance is primarily:

- to sustain equipment and facilities as designed, in a safe, effective operating condition;
- to ensure production targets are met economically and on time;
- to prevent unexpected breakdown of machinery and equipment
- to extend the useful like of equipment; and

- to ensure the safety of personnel using the system.

The need for reliability and dependability of equipment as well as compulsion to save cost in all areas are satisfied by these objectives. The United Nations Industrial Development Organization's report on maintenance and repairs in developing countries indicated that one of the strongest factors responsible for poor utilization of installed machines and equipment was the considerable downtime of machinery resulting from breakdowns and stoppages. The poor maintenance of these physical facilities accelerated deterioration and shortened their useful life. The report also noted that improving maintenance culture in developing nations would be one of most important and effective methods of stimulating industrial development (World Bank, 1995). Therefore, in this work, the maintenance culture in Sissala East District of the Upper West Region was evaluated in order to proffer solutions to the maintenance problems facing most industries in developing countries and recommend appropriate maintenance culture to facilitate continuous improvement of the system.

2.3 Types of Maintenance

The need for maintenance is predicated on actual or impending failure-ideally, maintenance is performed to keep equipment and system running efficiently for at least design life of the component(s). As such practical operation of a component is time-based function. Also, Kamoun (2005) suggests that nothing would last forever and all equipment has associated with it some predefined life expectancy or operational life. Therefore the design life of most equipment requires periodic maintenance in order to keep it in shape to ensure proper functioning. Below are the types of maintenance.

According to Mobley (2004) are there two types of maintenance management that are typically utilized by industrial and process plants which are unplanned maintenance and planned maintenance.

2.3.1 Planned Maintenance

Planned maintenance is required that system is improves on the routine maintenance system and requires the maintenance work to be planned in advance. It is carried out with forethought, control and records to a predetermined plan. Emphasis is placed on the equipment's needs and the expected requirements from the machine. The system is centered on recommendations made by the equipment manufacturers. Instructions for maintenance in this system are more detailed and thorough (Gopalakrishnan and Banerji, 2004). Generally all planned maintenance systems includes activities that plan, record and control all work done to keep a plant at acceptable maintenance levels. This includes long range planning and day-to-day maintenance work planning. It uses results in making effective time and cost estimates which brings about saving in time and cost by improving the control mechanism (Gopalakrishnan and Banerji, 2004). Planned maintenance can be broken down into three major maintenance systems: predictive, improvement and corrective maintenance systems.

2.3.1.1 Corrective Maintenance

It is type of maintenance carried out after a fault has recognized and corrected which is intended to put an item into a state in which it can perform its required function. This management type is simple and straightforward, "fix it when it breaks" (Mobley, 2004), i.e. the things are fixed either after failure or during failure (Moubray, 1997). This maintenance type is emergency, repair,

unscheduled and remedial tasks (Mobley, 2004). This method has been a major part of the maintenance operations since the first manufacturing plant was built, and it sounds reasonable on the surface. But it is actually a no-maintenance approach of management. It is also the most expensive one due to high machine downtime, low production availability, high overtime labor costs and high spare parts inventory cost (Mobley, 2004). The corrective technique does not take any maintenance action until equipment failure. This maintenance management philosophy is rarely used altogether without any preventive tasks (i.e. lubrication and adjustments). Still, in a corrective environment, the equipment are not rebuilt nor repaired in greater extent until it fails to operate (Mobley, 2004).

2.3.1.2 Predictive Maintenance

Predictive maintenance is a maintenance technique that applies regular evaluation of actual operating conditions of equipment, production systems and plant management functions to optimize total plant operation (Mobley, 2008d). It is an emerging maintenance strategy that is being employed in the engineering industries in recent times. The objective of this system is to gain the ability to predict an impending failure well in time thus avoiding failures which could cause penalty costs and even create health and safety hazards (Gopalakrishnan and Banerji, 2004). To achieve this objective condition monitoring condition-based monitoring or reliability centered maintenance is a prerequisite (Tse, 2002). This is because its implementation is based on the application of two methods of monitoring; statistical based monitoring and condition-based monitoring. Statistical-based monitoring is a tool in reliability-centered maintenance which uses statistical approaches to determine the maintenance plan (Adjaye, 1994) while condition monitoring is a method of extracting information from equipment which enables the maintenance engineer to indicate its

condition in quantitative terms. When it is effectively applied, this maintenance system can identify most of the factors that limit the effectiveness and efficiency of the whole plant. The output of a predictive maintenance programme is data which should be effectively acted on to derive its benefits (Zhou et *al*., 2006; Mobley, 2008d). According to (Moubray, 1997) predictive maintenance is basically to check if something is failing or about to fail. Predictive maintenance is, according to (Daley, 2008), maintenance intended for optimists, it is based on the belief that it is possible to find failures and take action before it occurs. Predictive maintenance is therefore proactive, i.e. the tasks are performed before a failure occurred and thereby the failure is prevented. Conditions that can cause deterioration and lead to failure are searched for in predictive maintenance (Daley, 2008).

Tasks designed to find potential failures are known as *on-condition* tasks (Moubray, 1997). They are called on-condition tasks because the items which are inspected are left to perform operation *on the condition* that they continue to meet the specified performance standard (Moubray, 1997). Predictive maintenance is the means of improving product quality, productivity, and overall effectiveness in production and manufacturing plants (Mobley, 2004). Predictive maintenance is an attitude or philosophy which uses the actual operating condition of equipment and systems within a plant to optimize total operation of the plant. Equipment is used to monitor the condition of other equipment, for example changes in vibration characteristics or changes in temperature, and these techniques are known as *condition monitoring* (Moubray, 1997). A predictive maintenance management program which is comprehensive utilizes the most cost-effective techniques in a combination to obtain the condition of critical equipment. Maintenance activities are then scheduled based on the data obtained on an as-needed basis. This will normally reduce maintenance cost and also provide the ability to optimize the equipment availability (Mobley, 2004).

2.3.1.3 Preventive Maintenance

The preventive tasks mean replacing components or overhauling items at fixed intervals (Moubray, 1997) that is, to premature equipment damage and prevent unscheduled downtime that would result in repair or corrective activities. This approach to maintenance management is predominantly recurring or time-driven tasks performed to maintain acceptable levels of availability and reliability (Mobley, 2002).

Preventive maintenance can, according to the standard prEN 13306 (1998) be divided into three divisions:

Preventive maintenance consists of performance and parameter monitoring and the subsequent actions. The performance and parameter monitoring may be scheduled, on request or continuously. Machine rebuilds and repairs are in preventive maintenance scheduled based on MTTF statistic or the bathtub curve (Mobley, 2004). There is a great variety in the actual implementation of preventive maintenance, but one thing which is valid for all preventive maintenance programs is that they are time driven. This means that the tasks are based on hours of operation or elapsed time (Mobley, 2004). Comprehensive preventive maintenance programs schedule repairs, adjustments machine rebuilds for all critical equipment while more limited programs only consist of minor adjustments and lubrication. The scheduling guideline for these programs is the common denominator due to that all preventive maintenance management programs assume that equipment will degrade within a certain period of time (Mobley, 2004). The problem with the preventive approach to maintenance is that the operation mode and plant-specific variables have a direct impact on the normal operating life of equipment. For example does the mean time between failures (MTBF) vary between a pump handling water and one handling abrasives (Mobley, 2004).

2.3.1.5 Proactive Maintenance

Moubray (1997) defines proactive tasks as tasks undertaken before a failure occurs, in order to prevent the item from getting into a failed state. These tasks embrace what is traditionally known as 'predictive' and 'preventive' maintenance." This is in contrary to corrective tasks which deal with the already failed state. Proactive maintenance is based on theoretical risk analyses. Proper countermeasures are taken to avoid failures (WCM overview). The characteristics of proactive maintenance are a control over the maintenance resources. With the advent of correct maintenance scheduling and planning procedures the understanding of what is required of the maintenance resources weekly often change vast and rapid. The weekly planning period can often later extend to monthly planning periods (Smith and Hawkins, 2004).

According to Moubray (1997) are there a whole family of maintenance tasks which do not belong to either of the above categories. One example of this is a periodically activation of a fire alarm which simply is a check of if it works. Tasks like this are known as functional checks or failure finding tasks.

2.3.1.4 Improvement Maintenance

This is a maintenance system which is aimed at reducing or eliminating entirely the need for maintenance. One important classification of this type of maintenance is design out. With this type of maintenance system, equipment are so designed as to need the least possible maintenance because long term repair or replacement can be very expensive (Gopalakrishnan and Banerji, 2004; Mobley, 2008a).

2.3.1.5 Contract Maintenance

Currently, there is a trend towards outsourcing for maintenance service. This is due to the need for greater specialization in technical aspects, or due to company strategy of focusing on key business areas (Santiago, 2010; Telang & Telang, 2010). Regarding this type of strategy, organizations take the following into consideration when contracts are being drafted to ensure that acceptable quality of services is rendered (Santiago, 2010):

- the specifications of the service
- the qualifications of the suppliers and their quality levels
- types of contracts and of course the criteria for supervision
- approval and acceptance of the service rendered

Some of the typical situations that may require the need for third party contractors include the following:

- where it is not financially viable to establish a maintenance department with its attendant infrastructure and staff
- where special permits / licenses are needed before maintenance can be done. For example in cases of fire, use of explosives and high tension electric fittings
- where the company does not have access to spare parts, even on the open market

The benefits of outsourcing maintenance activities include better and faster work done, exposure to outside specialists and greater flexibility to adopt new technologies (Tsang, 2002). Other benefits include reduction in staff leading to reduction in labour costs, employment of specialized and experienced expertise which results in effective maintenance done and savings in expenditure on related tools, facilities and staff are some of the benefits of implementing contracted out

maintenance (Telang & Telang, 2010). There can also be some downsides to implementing this maintenance system.

First, there can be cost escalation which would result in budgetary problems. Again, occasionally, the contractor can be discovered to be incompetent and even sluggish after the contract has been awarded. Further, quality of the maintenance activity can sometimes be ignored since the contractor has nothing to lose after having signed the contract. Finally, contract workers may steal company technology and indulge in pilferage.

2.3.2 Unplanned Maintenance

Unplanned maintenance refers to the repair, replacement or restoration activities performed on a machine or facility after the occurrence of a failure in order to bring it to, at least, its minimum acceptable condition. The tasks which are undertaken under this system are mainly event driven (Mobley, 2004). The major maintenance systems under unplanned maintenance tasks are emergency and breakdown (run-to-failure).

2.3.2.1 Emergency

This is maintenance carried out as fast as possible in order to bring a failed machine or facility to a safe and operationally efficient condition. Usually failures which have occurred and require attention are unexpected (Gopalakrishnan and Banerji, 2004).

2.3.2.2 Breakdown (run-to-failure)

This maintenance is also referred to as repair maintenance (Gopalakrishnan and Banerji, 2004), this system of maintenance is only undertaken when the machinery or equipment has failed (Mobley,

2004). In this system of maintenance less concern is given to operating conditions of critical plant machinery; the major focus is how quickly the machine can be returned to service. This method, however, is both ineffective and the most expensive. The cost involved in utilizing this maintenance system is at least three times that of the planned maintenance systems (Mobley, 2008a). Other maintenance types under the unplanned maintenance system are rebuilds, repairs and remedial (Mobley, 2008a).

2.4 Maintenance test and Procedure in Engineering Industries

Generally, carrying out maintenance activities fall into three categories: Carrying out maintenance especially in industries that had to do with a number category of maintenance that needs to be done. They are:

2.4.1 Routine Maintenance

In this category of maintenance activities that are conducted while equipment and systems are in service. These activities are predictable and can be scheduled and budgeted. Generally, these are the activities scheduled on a time-based or meter-based schedule derived from preventive or predictive maintenance strategies. Some examples are visual inspections, cleaning, functional tests, measurement of operating quantities, lubrication, oil tests and governor maintenance.

2.4.2 Maintenance Testing

This category maintenance procedure talks about activities that involve by using test equipment to assess condition in an offline state. These activities are predictable and can be scheduled and

budgeted. They may be scheduled on a time or meter basis but may be planned to coincide with scheduled equipment outages. Since these activities are predictable, some offices consider them "routine maintenance" or "preventive maintenance." Some examples are governor alignments and balanced and unbalanced gate testing.

2.4.3 Diagnostic Testing:

This maintenance procedure also talks about activities that involve using test equipment to assess the condition of equipment after unusual events, such as equipment failure/ repair/replacement or when equipment deterioration is suspected. These activities are not predictable and cannot be scheduled because they are required after a forced outage. Each office must budget for these events. Some examples are governor troubleshooting, unit balancing, and vibration testing.

2.5 Maintenance Practices in Ghana

In Ghana and in most developing countries maintenance work normally depends on the ability to solve problem, the core element of maintenance skills therefore is knowledge of the equipment and its mode of failure *(Gasskov 1992).* In most developing countries, take Ghana for example, breakdown maintenance has continued to triumph in almost every enterprise both private and public. And effort to introduce or implement preventive maintenance has been hindered by the negative thought of the cost involved.

According to *Eti et al. (2004),* the misguided opinion about maintenance in developing countries in African is that traditionally, management of companies regards maintenance as an expense that can easily be reduced in relation to overall business cost. It is however assumed that machine shouldn't

be checked or inspects for future breakdown why it is still working, instead remain inactive until emergency occurs.

Theoretically, preventive maintenance has the proficient of minimizing downtime or preferably eliminating unwanted stoppages due to machine/ equipment failure as well as enhancing machine availability and reliability. However, achieving these benefits entail a high level of skills commitment. Although some multinational companies in DCs (e.g. Cadbury, Guinness, Nestle etc) have a good maintenance policy and do provide vocational training program on maintenance at their own designated centers, which is often too constricted, thus not addressing the most important components of maintenance (maintenance organization and spare parts management). In addition, because of the constriction of the said vocational training, there is less significant effect on the long run, since maintenance has become an element of the economy growth in most DCs *(Gasskov 1992).*

2.6 Importance of Instituting Regular Maintenance Practices in Ghana

Benefits that can be derived from a well-organized maintenance system include minimization of downtime, improvement in total availability of the system and extended useful life of the equipment, safety of personnel and reduction in costs.

2.6.1 Minimization of Downtime

A properly organized maintenance schedule helps to prevent failures and hence minimizes downtime (Mishra and Pathak, 2006).

2.6.2 Improvement in total availability of the system

Increased availability usually leads to an increase in output and also improvement in the quality of products. Increased availability and high reliability of well-maintained machines also improves the morale of workforce in the long run (Cooke, 2003; Mishra and Pathak, 2006).

2.6.3 Extended useful life of the equipment

The useful life of equipment is also dependent on nature of maintenance applied. Cost effective and optimum maintenance prolongs life of equipment (Mishra & Pathak, 2006; Franklin, 2008).

2.6.4 Safety of the Personnel

Random failure of machinery can cause unnecessary injury to personnel. Proper maintenance of equipment can and will prevent injuries. This saves the company in terms of financial resources such as hospital bills and compensations among others (Franklin, 2008).

2.6.5 Reduction in Costs

Good maintenance practices result in improved reliability of machines within the plant. Improvement in reliability also leads to reduction in maintenance costs. As breakdowns become fewer, maintenance spending in the area of materials, labour, contractors and spare parts among others also decrease leading to overall reduced cost of maintenance (Franklin, 2008).

2.7 Challenges of Implementing Proper Maintenance Practices in Ghana

Despite the proper maintenance practices can contribute to the overall business performance through their impact on the quality, efficiency and effectiveness of a company's operations, there

are many challenges facing Ghanaian organisations in the implementation of proper maintenance practices. These are now briefly discussed in turn.

2.7.1 Effect of Shut-downs

The relationship between production and maintenance has been literally considered as a conflict in optimal decisions. These conflicts may result in an unsatisfied demand in production due to the interruptions resulting from the preventive maintenance interventions or workstation failures. Another common complaint is that when production resumes after a shut-down equipment generally operate sub-optimally, leading to a significant portion of first production turning out defective. But this problem can be solved by carefully and correctly doing the settings after each repair activity.

2.7.2 High Cost of Spare Parts

The study finds that increasing cost of spare parts, coupled with delays in their delivery poses a challenge to the cost-effectiveness of the maintenance function. Whereas this might be due to run-away inflation in Ghana, it is possible to gain in other areas by taking advantage of the existence of economic dependencies to maintenance costs, e.g. due to economies of scale or positive economic dependence, which implies that combining maintenance activities is cheaper than performing maintenance on components separately. This positive dependence has been considered in various maintenance models. On the other hand, and as a caveat, grouping maintenance may also lead to higher costs, e.g. due to manpower restrictions.

2.7.3 Failure of maintenance Staff to retain Knowledge and Skills Acquired

Low retention of knowledge and skills by maintenance staff after training is a key challenge facing firms. Maintenance operatives sometimes fail to repair machines on which they have been given training. Ineffective methods of training and transferring skills used by firms drives the increasing need for contract maintenance, a strategy that sometimes tends to increase costs.

2.7.4 Lack of Adequate Funds Committed to Maintenance

Another factor which inhibits the proper institution of maintenance practices tend reflect on managements lack of understanding of the importance of the maintenance function and its crucial impact on company profitability is the issue of lack adequate funds committed to the maintenance department. This underlines the need for optimal maintenance policies aimed at providing optimum system reliability/availability and safety performance at lowest possible maintenance costs to offset the effects of this problem.

2.7.5 Reluctance of contractors to replace defective Parts

Firms using the services of maintenance contractors report that contractors in Ghana are usually representatives of foreign companies; and a major challenge facing them is the representatives' reluctance to replace defective parts supplied. Even when they agree to send replacement it takes too long to receive the supplies, thus increasing overall production costs.

2.7.6 Lack technical persons to repair certain machines

It has being established that some machinery that is being used by some particular companies or industries required special technical persons to repair them. In that regard companies would be required to contact an expert from the equipment's country of origin which are too expensive to do or takes time to fly the person in thereby slowing production.

2.7.7 Lack of computerized maintenance management system in place

Labib (2004) articulate that there is an increase in the amount of information available and an increasing requirement to have his information on hand and in real time for decision making indicates the need to have a computerized maintenance management system to help maintenance management by support condition based monitoring, track the movements of spare parts, allow workers to report faults faster and improve communication between operation and maintenance personnel as well as provide maintenance managers with information to have better control of their department. However, these systems are present in most Ghana industries especially district assemblies.

2.7.8 Poor Maintenance Task Execution

Poor maintenance task execution is one the most factors that hinders maintenance practices in Ghana public sectors companies especially. Public institutions in Ghana have failed to establish maintenance quality performance standard framework and task which are identified and clearly defined. Responsibilities are not put clear and there is no team work approach. Moreover, most of the public institutions have not been using properly performance benchmark system in identifying their gaps and establishing correctives measures.

2.7.9 Poor Maintenance Strategy and Policy

Most of the public companies in Ghana are only focused on their integrate business objectives so maintenance operation strategies have not been integrated to meet business requirement. Because of that there is proactive measures being put in place to forestall any unforeseen breakages in the public sector but only enhance reactive maintenance.

2.8 Maintenance Management

In general, the goal of any organization is to increase profitability by providing quality products, prompt or complete service as well as swift delivery. In today's competitive business, been successful often entail how well a company is able to make change and adapt to those changes swiftly. This can be seen as a way/ technique of dealing with out- fashioned or out-of-date managerial approach and other forms of managerial practices.

According to *(Wireman 1990)* Maintenance as a support function together with asset management can be a driving force in this regards in two major ways, i.e. by decreasing the cost of running plant and machine while also increasing capability. Hence, with the growth of mechanization and automation, which mean that component could fail at any given time leading to interrupted operations, availability and reliability becomes a keyword. *Al-Najjar (2007)* expressed that company should be able to utilize its valuable and rare resources efficiently and effectively to attain the long-term high profitability, regardless of which prospective, outside-in (i.e. external factors, such as emerging of companies, partnership and market structure) and inside-out (i.e. internal factors, such as company's resources, competence and differentiation) that is adopted or implemented by the company's management. In addition, the negligence of maintenance and its role in production processes allows swift degradation of machine and its resultant product quality.

2.8.1 Maintenance Organizations and types of Maintenance Organization

There are three types of maintenance organizations; centralized, decentralized and partially decentralized (Gopalakrishnan and Banerji, 2004; Santiago, 2010).

2.8.1.1 Centralized Maintenance Organisation

The centralized maintenance organization is usually found in small and compact factories where inter-unit and inter-departmental communication is fast. This type of organization is placed under the chief maintenance manager who is of the same rank as the production manager, both of whom report to the general manager (Gopalakrishnan and Banerji, 2004).

2.8.1.2 Decentralized Maintenance Organisation

The decentralized maintenance organization is recommended for companies which are large and whose units are located in far areas making inter-unit communication difficult. In this type of organization, there is a separate maintenance set up for each unit and functions. The head of the unit is the production chief who can be selected either from the production or the maintenance streams depending on the seniority and sustainability among the available personnel in either streams of specialization (Gopalakrishnan and Banerji, 2004).

2.8.1.3 Partially Decentralized

The partially decentralized organization is a modified form of the decentralized organization and also suitable for large plants with far flung units. With this type of organization, the day-to-day maintenance of equipment is carried out by a group of maintenance workers who are attached to, and are responsible to, the production manager of that unit. However, important maintenance

functions like planning and scheduling of maintenance work, drawing up of schedules, master-process sheets, work specification, documentation, maintenance costing, major overhauls, procurement of spare parts, are all kept directly under the chief maintenance manager. Organizations like this serves the needs of the production manager (Gopalakrishnan and Banerji, 2004). Today's trend is to have mixed organizations, with some sectors decentralized and partly centralized, acting in a supporting role to all the decentralized sectors, to better face changing realities (Santiago, 2010).

2.8.2 Effectiveness of Maintenance Organization

For a maintenance department to fulfill its role efficiently, it is important to have an organization which is balanced, rationalized and healthy to manage and control in plethora of activities (Gopalakrishnan and Banerji, 2004). In order to achieve this objective, certain factors would have to be given due consideration. Chief among the parameters include (Gopalakrishnan and Banerji, 2004):

2.8.2.1 Team Spirit

The organization consists of people and it is wise to bring them together to work as a team. This can be done with generation and sustenance of team spirit. Where team spirit exists work is done easily with little confusion.

2.8.2.2 The Plant Engineer

It is good leadership that can bring people together and instill as well as sustain the necessary team spirit that will encourage the team to work. The onus of keeping the team spirit going rests on the shoulders of the plant / maintenance engineer. Basically, he or she should be technically competent, knowledgeable and cost conscious to be an effective and efficient leader of the team; and should also be able to plug all loop-holes which lead to waste of time, talent and effort.

2.8.2.3 Philosophy

All maintenance departments must have a philosophy and policies to regulate its activities. These must be reflected honestly and sincerely by the deeds and actions of each person within the department.

2.8.2.4 Policy

Once a philosophy has been adopted for use, the policies of the organization should be documented for use. These policies should be clearly understood by its users as guidelines for user who falls within its framework. Policies may be formal or informal and have to be regularly assessed, reviewed and updated to reflect the changing activities of the department. Policies may cover issues such as maintenance of plant, machinery salary and hours of work among others.

2.8.2.5 Clear Enunciation of Functions

One of the major hindrances to team work is distorted or loose definitions of functions, responsibilities and authority. To avoid confusion and duplication of effort and functions it is

important that subordinates are made to know the scope and limit of their positions in very clear terms. This will promote better and healthier functioning of the organization (Gopalakrishnan and Banerji, 2004, Telang and Telang, 2010).

2.8.2.6 Span of Control

In order to avoid wasted employee effort and lack of effective monitoring there should be a reasonable numerical proportion between the supervisor and the supervised. This is because there is a limit to the number of people an individual can supervise effectively. Given the nature of work and levels of the people being supervised it is important that the ratio is correctly ascertained to optimize the supervision time, employee talent.

2.8.2.7 Development of Subordinates

Man is the most important cog in the wheel of the machinery of production and has to be handled with utmost sensitivity and care. Staff must be trained and regularly updated on current maintenance practices to manage and maintain the complex machines employed in modern manufacturing (Gopalakrishnan and Banerji, 2004). Today, a good maintenance technician must now be trained in: automation, instrumentation, electronics, electricity, hydraulics, pneumatics, mechanics, industrial safety, quality, computer science, and language skills, besides the specific knowledge of the process, which is fundamental in order to understand the operation of whatever he must maintain (Santiago, 2010). Generally, the less educated and skilled the worker is the more supervision he would need. When more enlightened subordinates are left on their own they tend to improve in their growth and development (Gopalakrishnan and Banerji, 2004).

2.9 Strategies to Improve Maintenance Practices in Ghana

There are many concepts of maintenance strategies that have been developed by individuals especially one that has to do with total productive maintenance but the one that has been held by many authors which is a company-wide approach to plant or equipment care that involves the active participation of more than just the maintenance department working on maintaining and improving overall equipment effectiveness (Bamber et *al*, 1999: Mobley, 2008j). The major objective for the implementation of total productive maintenance is to continuously improve the availability and prevent the degradation of equipment and hence achieve maximum effectiveness (Mobley, 2008j).It is a maintenance strategy that couples the principles of maintenance engineering and total quality management (TQM). The benefits gained by implementing this hybrid maintenance strategy have made it a prime strategy to be adopted for the enhancement of maintenance quality of products and processes (Pramod et *al*., 2006). It is considered by many authors as a strategy that is indispensable to manufacturing companies in their efforts at attaining a world-class manufacturing status; a status which will help them gain competitive advantage in the ever increasing global competitive environment (McKone et al., 2001; Ahuja and Khamber, 2007). Again, it facilitates cost reduction and improves quality and delivery of maintenance (McKone et al., 2001).

2.9.1 Introduction of Computerized Maintenance Management Systems (CMMS)

CMMS is computerized management software whose primary purpose is to capture the maintenance history of an organization. Basically, most CMMSs perform the basic function of raising work order to cover repairs and maintenance of buildings, plants and equipment as well as provide a scheduling facility for planned preventive works for maintainable assets. They can also be

customized to collect costing details for labour and materials related to the work performed. (Burton, 2001)

According to Nyman and Levitt (2009) it also supports and fosters the following:

- efficiency of maintenance resources (both hourly and salaried), thereby lowering unit cost
- improvement of responsiveness and service to internal customers
- improvement of asset reliability, capacity assurance, and equipment up time
- better delivery performance and product quality to external customers
- lower unit costs and increased profitability

These systems are now a necessary part of managing and controlling assets, plant and equipment maintenance in modern manufacturing, facilities and service industries (Burton, 2001). CMMS has the advantage of being a system which can serve as a platform for the successful implementation of Total Productive Maintenance, Reliability-Centered Maintenance and the other major maintenance systems for effective maintenance and achievement of organizational goals (Olszewski, 2008; Crain, 2003).

2.9.2 Introduction of Reliability-Centered Preventive Maintenance

This maintenance system is a process which is systematically used to identify all the functions and functional failures of assets. The process also identifies all likely causes for these failures and then proceeds identify the effects of these likely failure modes and to identify in what way those effects impact the plant. The data collected is then analyzed to determine the most appropriate maintenance task to apply (Wikoff, 2008; Mobley, 2008).

2.9.3 Introduction of Prediction Tools for Solving Maintenance Problems

Unlike other industrial activities, maintenance is a problem solving activity which includes resolving what has already occurred, predicting what can occur and taking appropriate steps to counter it as well as reduce its effects. Usually, faults leading to failure are statistical in nature and modern tools such as Fault Tree Analysis and Failure Modes and Effects Analysis are used to solve them. These tools analyze collected data and use the process information to solve or prevent the problem (Telang & Telang, 2010).

2.9.4 Introduction Fault Tree Analysis (FTA)

Fault Tree Analysis is a method that identifies all possible causes of a particular system failure mode. It considers the failure of system components acting alone or in combination and provides a basis to calculate the possibility of occurrence. This tool has the advantages of identify the most probable causes of failures or faults without applying trial and error, providing a means for qualitative and quantitative reliability analysis and facilitating the improvement of subsequent designs of equipment.

2.9.5 Summary of Literature Review

The above discussions have briefly focused on the various aspects of maintenance management. Maintenance is expected to play even much bigger role in years to follow, as industries and public institutions worldwide are going through an increasing and stiff competition and increased automation of plants. The down time cost for such systems is expected to be very high. To meet these challenges, maintenance has to use latest technology and management skills in all spheres of activities to perform its effective role profitable in the sustenance of the Ghanaian economy.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter therefore describes the methods and procedures used in collecting the appropriate data for analysis. It would be based on the following sub-topics: research design, sources of data, population, sampling techniques, instruments for data collection and data collection procedures, validity of data collected and data analysis.

3.2 Research Design

This research seeks to assess the maintenance practices of engineering workshop at the Sissala East District of Upper West Region. The research design used in the study is a descriptive survey. According to (Agyedu, Donkor & Obeng, 2012) research design represents the overall strategy that would be used to undertake or investigate a research endeavour which is used to obtain evidence to answer research questions. It constitutes the general plan that would be used to answer a research questions. These were purposely used to cater for the analysis of both quantitative and qualitative data. According to Gay (1987), the descriptive survey method involves collecting data in order to test hypothesis or to answer questions concerning the status of a study. The descriptive survey design approach was adopted which is directed towards determining the nature of maintenance engineering workshops as it existed at the time of study.

The descriptive sample survey has also been recommended by Babbie (2001) for the purpose of generalization from a sample of population so that inferences can be made from some attributes, behavior and characteristics of the population. Descriptive survey design was deemed appropriate for the study because it is versatile and practical, in that, it identifies present conditions

and points to recent needs. Again attempts were made to determine the incidence, distribution and interrelationship among technical and economic variables. Moreover, it would make it much easier to survey, interpret, synthesize, and integrate data in a bid to examine the implications and interrelationships identified in the study.

The choice of this design was further motivated by the fact that descriptive research or survey aims mainly at describing, observing and documenting aspects of a situation that naturally occurs (Polit and Hungler (1995). The study therefore used a non-experimental design which is descriptive in nature.

A quantitative technique of research design was used to address the research problems under study. It will attempt by measuring the amount of data gained from the study through statistical manipulation or through testing of hypothesis through numbers. It comprises opinions of target groups of interest to a study in a structured manner to ensure that hard facts can be drawn from outcomes of a study. In line with this study, questionnaire served as the quantitative basis for the survey.

3.3 Sources of Data

Both primary and secondary data were used for this study. Primary data for the study included personal data of respondents to questionnaire and face-to-face interviews with some of the staffs and customers of Toyota Ghana Limited. Secondary data was collected from various sources. This includes scholarly journals, reports, educational guides and text books. Data from magazines and website of the industries within the company as well as different organizations of the same interest were used. Ghauri and Gronhaug (2005) cited in Brulot (2007) argue that the main advantage of using secondary data is enormous savings in resources, time and money. In General, it is more

expensive to use secondary data than Primary data. Secondary data can be used to compare with what exist in other districts in relation to the company which is being used for the study. Unlike primary data, Secondary data generally provides a source of data that is both permanent and available in a form that may be check easily by others. However, the primary data used was collected from the Sissala East District Assembly using questionnaires.

3.4 District Profile

Sissala East District is one of the nine (9) districts in the Upper West Region of north Ghana. The capital is Tumu. It is located in the North -Eastern part of the Upper West Region of Ghana. To the north is Burkina Faso. Its western neighbors are the Sissala West and Daffiama-Bussie-Issah constituencies. The Wa East and Mamprugu Moagduri constituencies continue round the south and to the east are the Kasena Nankane West and Builsa South constituencies.

3.5 Target Population

The target population for the study consisted of management and staff of Sissala East District of the Upper West region. Population in this context refers to the complete set of individuals (subjects) having common observable characteristics in which the researcher was interested in. According to Sekeran (1990) population refers to the entire group of people, events or things of interest that the researcher wishes to investigate. In this instance however, the estimated population contacted for the study managements and staff of the maintenance department of the Sissala East district of the Upper West region. The rationale for this selection is based on the fact they were available and accessible at the time of conducting the study.

3.6 Sample and Sampling Technique for the Study

Sample is a subset or part of the total population that could be studied. Sampling is used to make an estimate of the characteristics of the population as a whole. The study adopted the use of non-probabilistic sample approach because not all elements in the population are expected to partake in the study. The study adopted the use of one sampling technique to sample out the respondents for the study. The sampling technique used for sampling out the management and staff of the sample population was purposive sampling technique. It is an example of non-probability sampling which implies that not every element of the population had an opportunity of being included in the sample for the study. Since the study involved only management and staff of the maintenance department of the district assembly, it was proper and convenient to settle on purposive sampling technique. This limited generalization of the results of the study (Burns & Grove 2001). This supports the view of De Vos (1998), as well as LoBiondo-Wood and Haber (1998) who both describes purposive sampling as the use of readily accessible persons in a study. A sample size of seven-five (75) made-up of managements and staff of selected engineering workshops within the Sissala East District were used for the study.

3.7 Data Collection Instruments

The data collection instruments used included questionnaires and documentary sources such as internet, books, and journals. Questionnaires guides were designed for management, engineers and other staff of the district assembly. Again, a little observation was also conducted to ascertain the state of some of the equipment in the maintenance department. The questionnaire is a set of written questions on a given problem, which the respondent is required to answer in writing by using a close-ended type. This close-ended type provides answers in an alternative form and the respondents have to choose from the given alternatives.

A combination of data collection tools were employed to gather data from respondents in the district for the survey. These include the administration of structured and semi-structured questionnaire for the collection of primary data. The questionnaire for the survey featured a mixture of questions that were common in terms of issues relating to maintenance issues in Ghana.

The questionnaire for the study was divided into three sections. The first set of items sought to find the personal information of the respondents, followed by items on maintenance procedures and practices. Secondly, it was also sought to find out the main challenges that confront the district from implementing regular maintenance in the district and also to examine some of the importance of carrying out regular maintenance in a company. Finally, the study again sought to find out some of the measures put in place to encourage regular maintenance in the Sissala East district. Open-ended and closed ended question forms were used. The closed ended question forms were subdivided questions that are structured questions with response alternatives. The open-ended question forms

gave the respondents an opportunity to express themselves on the issues and give a basis for their answers.

3.7.1 Data Collection Procedure or Administration

Data collection process involved the administering of questionnaire and note taking. In included a visit to the maintenance department of the Sissala East district of the Upper West region. The self – administered questionnaire was intended to be hopefully understood and completed by the respondents, 'unaided" or with the minimum "guidance". Besides, it developed trust and perceived as less threat. The questionnaires were taken to the maintenance department of the district for respondents to answer. The respondents were then given thirty minutes to answer the questionnaires. The researcher personally supervised the responds in answering the questionnaires. However, the closed ended forms made it easy for the researcher to handle and analyse the results quickly.

Again, observation check lists made up of various mechanical equipment parts categorized under engine parts, transmission systems, steering and suspension systems, body and chassis systems and electrical systems were used to record observations by ticking in order to establish observable items, for example, engine block, gasket, push rods, gears, shafts, cross rod, hubs and other machine tools used to produce items in the workshops as well as some of deserted vehicles under repairs in the assembly.

3.8 Pre-Testing of Questionnaire

Pre-testing of questionnaire provides not only a measure of the correctness and interpretation of the questionnaires but also an opportunity for discovering new aspects of the problem to be studied. Before finalizing the questionnaire, a design trial of 25 questionnaires was administered at a selected area within the Sissala East District. On the basis of this some modifications and additions were made. The pre-testing led to the removal of some errors and ambiguities before the final administration was performed.

According to Joppe (2000), validity determines whether the research instrument truly measures what it was intended to measure. To ensure the validity of the questionnaire it was given to the supervisor who took his precious time, went through the document and gave the necessary suggestions and corrections to ensure that its content is valid to the research. The study also solicited the expertise of some Senior Lecturers from the Department of Design and Technology Education of the University of Education, Winneba – Kumasi.

3.9 Validity and Reliability of Questionnaire

Validity and reliability in research is the degree of stability exhibited when measurement is repeated under identical conditions (Naoum, 1998) Research validity refers to whether the researcher actually measured what was supposed to measure and not something else. Reliability means that responses to the questionnaire were consistent (Naoum, 1998). The researcher took the following steps in order to ensure the validity of the data. The questionnaire was based on information obtained from literature review. This was to ensure that it was a representation of all various elements in the study ((Naoum, 1998). The questions were formulated in simple language for easy understanding. The researcher gave the questionnaire to colleagues for peer review. It was also

given to the supervisor to scrutinize to ensure its validity. The colleagues and supervisor added some questions and certain aspects of the questionnaire were rephrased for clarity. The questionnaire was administered and collected by the researcher himself. This helped clarify where participants did not understand. Questionnaires were then printed out for distribution according to the sample selected.

3.10 Data Analysis

The data collected were edited and examined for completeness and consistency using both qualitative and quantitative method to analyze the data. Frequencies and percentages were used to analyze findings where necessary, using statistical package for social scientist (SPSS) and Microsoft Excel. The data was first coded to allow for analysis. The field data was processed by editing; coding, classification and tabulation to present a cleared view for analysis. The coding was necessary for efficient analysis of data. For this research work, coding decisions were taken at the designing stage of the questionnaire. The field data was processed by editing; coding, classification and tabulation to present a clear view for analysis. Data was then presented in the form of tables and charts for ease of interpretation and discussion.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

This chapter of the study presents the analysis of data and discussion of results gathered for the study. The analysis of data is necessary after collecting the data research which will make it possible for the interpretation of results, discussions and drawing of conclusions for the study. Analysis of the data collected was done using statistics methods such as frequency distribution tables, percentage, mean and descriptive analysis for easy interpretation. A total of ninety (90) questionnaires were administered to the survey respondents and eight-two (82) questionnaires were completed and returned. However, seven (7) questionnaires were not properly completed and as such did not form part of the analysis. After all, seventy-five (75) respondents were used as sample for the study and therefore constituted a response rate of 83.3%.

4.1 Demographic Information of Respondents

Demographic information of respondents include gender of respondents, age distribution of respondents, educational qualification of respondents and working experience of respondents.

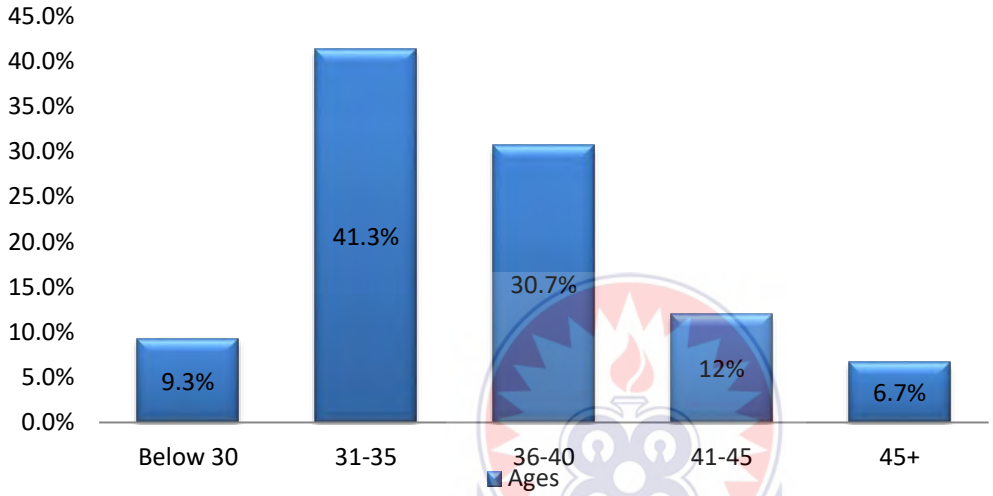
Table 4.1 Gender Representation of Respondents

Response	Frequency	Percentage
Male	64	85.3%
Female	11	14.7%
Total	**75**	**100**

(Source: Field Survey,2017)

Table 4.1 shows the gender representation of respondents to the study**.** From the total number of 75 respondents, 64 respondents representing 85.3% were male whereas 11 respondents representing 14.7% were female. This indicates that there is a huge gender disparity between staff working at mechanical engineering workshops of the Sissala East district in the Upper East region.

Figure 4.1: Age Distribution of Respondents



(Source: Field Survey, 2017)

Figure 4.1 illustrates the age distribution of respondents to the study. From the data gathered, out of the total respondents of 75, 31 respondents representing 41.3% were between the ages of 31-35 while 23 respondents representing 30.7% were between the ages of 36-40 and 9 respondents representing 12% were between the ages of 41-45. On the other hand, 7 respondents representing 9.3% were below the age of 30 and 5 respondents representing 6.7% of the total respondents were above the age of 45. This implies that the study was primarily dominated by middle age group which indicates that they are very strong and therefore have the capacity and the ability to carry out regular maintenance in the mechanical engineering workshops always.

Table 4.2 Educational Qualification of Respondents

Respondents	Frequency	Percentage
SSSCE/NVTI/	18	24%
Diploma	29	38.7%
Degree	21	28%
Post-Graduate	7	9.3%
Total	**75**	**100**

(Source: Field Survey,2017)

Table 4.2 outlines the highest educational qualification of respondents to the study. From the table it can be deduced that out of the total respondents of 75, 29 respondents representing 38.7% had diploma certificate while 21 respondents representing 28% had degree certificate and 18 respondents representing 24% had either SSSCE/NTVI/ certificate to their credit. However, only 7 respondents representing 9.3% of the total respondents had post graduate certificate to their credit. This indicate that majority of respondents are quite educated and have therefore acquired the requisite technical know-how to be able carry out all forms maintenance in the mechanical engineering workshop.

Table 4.3 Working Experience of Respondents

Responses	Frequency	Percentage
2 years and Below	10	13.3%
3-6	22	29.3%
7-10	28	37.3%
10+	15	20%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.3 presents number years of working experience of respondents. Out of the total respondents of 75, 28 respondents representing 37.3% had between 7-10 years of experience in the workshop while 22 respondents representing 29.3% had between 3-6 years of experience in the workshop and 15 respondents representing 20% had more than 10 years of experience in the workshop. On the other hand, only 10 respondents had below 2 years of experience in the workshop. This indicates that respondents have enough working experience in the workshops to know and understand the level of maintenance practices being undertaken by various engineering workshops within the Sissala East district.

4.3 Maintenance Activities carried out in the Workshops

This section assess respondents views as to whether they understand maintenance and hand any knowledge on maintenance as well as the existence of some kind maintenance activities going on in the various workshops.

Table 4.4 Untaken of Regular Maintenance on Workshop Equipment

Response	Frequency	Percentage
Yes	36	48%
No	39	52%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.4 shows respondents' view as to whether maintenance activities are carried out on the workshop equipment. From the total respondents of 75, 39 respondents representing 52% answered "No" to the fact that regular maintenance is not being carried out in the their various workshops

whereas 36 respondents representing 48% responded Yes to the fact that regular maintenance practices is being carried out in the workshops. This indicates that majority of respondents revealed that they do not perform regular maintenance in their workshop which indicates that regular maintenance is lacking in most of the workshops within the Sissala East district.

Table 4.5 Often times maintenance is carried out in the workshop

Response	Frequency	Percentage
Once in a month	4	5.3%
Every 3 month	9	12%
Every 6 month	19	25.3%
When there is a break down	43	57.3%
Total	**75**	**100**

(Source: Field Survey,2017)

Table 4.5 illustrates how often regular maintenance is carried out in the workshops. According to the data on the table, 43 respondents out of 75 representing 57.3% confirmed that maintenance is only carried out in their workshops when there is a breakdown in their machinery while 19 respondents representing 25.3% indicated that regular maintenance is carried out in every 6 months and 9 respondents representing 12% confirmed that regular maintenance is carried out in every 3 months. However, only 4 respondents representing 5.3% revealed that regular maintenance of their machinery and equipment is carried in every month. This is indicates that there is a shortfall of regular maintenance being carried out in the mechanical engineering workshops of the district because as many as 82.6% of the respondents only either carry out regular maintenance when there is a breakdown or regular maintenance is carried out in every six months. This revelation goes

against the findings of Banjoko (2009) when stated that workshops that involves mechanical equipment and machinery should adopt preventive maintenance strategy which "involves the regular or periodic check and servicing of the machines, tools and other facilities used in the production process so as to delay or prevent the breakdown or the total failure of the facilities.

Table 4.6: Presence of Maintenance Schedule in the Workshop

Response	Frequency	Percentage
Yes	34	45.3%
No	41	54.7%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.6 shows the views of respondents as to the presence of maintenance schedule in the workshops around the Sissala East District. Out the total respondents of 75, 34 respondents representing 45.3% answered “yes” to the fact that their workshops have maintenance schedule whereas 41 respondents representing 54.7% answered “No” to the fact that there is no maintenance schedule in their workshops. Statically, the table shows that majority of respondents do not have maintenance schedules in their workshop therefore do not conduct regular maintenance practices on their equipment and machinery.

Table 4.7: Experiences of Breakdowns in the Workshops

Response	Frequency	Percentage
Yes	63	84%
No	12	16%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.7 shows respondents views as to whether they experience breakdowns of their equipment or machinery in their workshops. From the data gathered, 63 respondents out the total of 75 representing 84% answered "Yes" to the fact that they experience breakdowns in their workshop whereas 12 respondents representing 16% answered No to the fact that they do not experience breakdowns in their workshop. This goes to prove that many mechanical engineering workshops in the Sissala West district do experience regular breakdowns of their machinery and equipment as a result of not carrying out regular maintenance on their machinery and equipment.

Table 4.8: Respondents View on the Importance of Carrying Out Regular Maintenance

Response	Frequency	Percentage
Yes	66	88%
No	9	12%
Total	**75**	**100**

(Source: Field Survey,2017)

Table 4.8 shows respondents' view on the importance of carrying out regular maintenance practices in their workshops. From the data gathered, 66 respondents out of the total respondents of 75 representing 88% answered yes to the fact that it is important to carry out regular maintenance in

mechanical engineering workshops whereas 9 respondents representing 12% indicated that it is not important to carry out regular maintenance practices in mechanical engineering workshops. As a matter of fact, majority of respondents responded to the fact that carrying out regular maintenance in mechanical engineering workshops is very importance in order to avoid frequent breakdowns which might affect productivity.

Table 4.9: Employing Preventive Maintenance Practices

Response	Frequency	Percentage
Yes	29	38.7%
No	46	61.3%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.9 shows respondents' view as to whether they employ preventive maintenance practices in the workshops. According to the data gathered from the total respondents of 75, 29 respondents representing 38.7% answered "yes" to the fact that they employ preventive maintenance practices in their workshops whereas 46 respondents representing 61.3% answered "No" to the fact they do not employ maintenance practices in their workshops. This clearly means that majority of mechanical engineering workshops do not employ the use of preventive maintenance practices which contravenes the finding of (Birolini, 2010) when he opined that failure to ensure regular and periodic preventive maintenance will result in loss of operation due to failures of the machines or equipment highlighted the aspects of availability and reliability of the systems' safety.

Table 4.10: Performance Daily Routine Maintenance Checks

Response	Frequency	Percentage
Yes	26	34.7%
No	49	65.3%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.10 shows respondents' view as to whether they perform daily routine maintenance checks. The data gathered shows that out of the total respondents of 75, 26 respondents representing 34.7% indicated that they perform daily routine maintenance on their machinery and equipment whereas 49 respondents representing 65.3% responded that they do not perform daily routine maintenance checks on their equipment and machinery. Statistically, the data on the table shows that majority of respondents do not perform daily routine maintenance checks on their machinery and equipment.

Table 4.11 Number of Days it takes to fix a Problem

Response	Frequency	Percentage
7 days	9	12%
2 -3 weeks	14	18.6%
1 month	21	28%
More than 1 month	31	41.3%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.11 shows the numbers of days it takes for respondents to fix a problem. Out of the total respondents of 75, 31 respondents representing 41.3% indicated that it takes more than 1 month for them to fix a problem while 21 respondents representing 28% indicate that it takes 1 month for them to fix a problem and 14 respondents representing 18.6% indicated that it takes between 2-3

weeks for them to fix a problem. However, only 9 respondents representing 12% indicated that it takes 1 week (7 days) for them to fix a problem when there is a breakdown. This clearly means that it takes between 1 month or more for majority of respondents to fix a problem when there is breakdown which often arises as a result of non-performance of daily routine maintenance checks on their equipment and machinery.

Table 4.12: Training Programs Organized on Maintenance

Response	Frequency	Percentage
Yes	34	54.7%
No	41	45.3%
Total	**75**	**100**

(Source: Field Survey, 2017)

Table 4.12: presents respondents view as to whether training programs are being organized for them**.** From the total respondents of 75, 34 respondents representing 54.7% answered yes to the fact that training programs are being organised for them whereas 41 respondents representing 45.3% answered No to the fact that they do not organize training programs. This analysis indicates that most of the mechanical engineering workshops do not organised training programs on maintenance for its workers.

Table 4.13: Organisation of Retraining on the use and Maintenance of Equipment

Response	Frequency	Percentage
Every 6 months	9	12%
Yearly	13	17.3%
Two Years +	19	25.3%
Never	34	45.3%
Total	**75**	**100**

(Source: Field Survey,2017)

Table 4.13 Shows respondents view as to whether retraining on the use and maintenance of equipment is organized in the various workshop. From the data gathered, out of the total respondents of 75, 34 respondents representing 45.3% answered that retraining on the use and maintenance of equipment is never organized for them in their workshops while 19 respondents representing 25.3% said retraining is organized for them in every two years or more and 13 respondents representing 17.3% also confirmed that retraining is organized for them in every year. On the other hand, only 9 respondents representing 12% indicated that retraining is organized for them in every 6 months. Statistically, this means that majority of engineering workshops in the Sissiala West District is do not organize retraining on the use and maintenance of machinery and equipment which is in contrast with the views of Haroun and Duffuaa (2009) when they opined that firms should capitalize on opportunities and solve performance effectiveness and efficiency problems through the selection of the right persons with the appropriate capabilities, supported by continuing training and good incentive schemes.

4.4 Maintenance Practices

This section discusses the types of maintenance practices being untaken by the various mechanical engineering workshops within the Sissala East District. To able to assess the types of maintenance practices and those that respondents rate as the most important to implement, a 4-point likert scale was used to rate the opinion of respondents. The scale values for the ratings was given as, Strongly Disagree = SD, Disagree = D, Agree = A, Strongly Agree = SA which is presented in table 4.14 below.

Table 4.14 Maintenance Practices Normally by Practices Mechanical Workshops

Maintenance Practices	N	SD	D	A	SA	Mean	Std. Deviation
Putting in place all proper tooling activities	75	1(1.3%)	11(14.7%)	32(42.7%)	31(41.3%)	3.24	.750
Conducting condition monitoring and oil analysis	75	5(6.7%)	20(26.7%)	31(41.3%)	19(25.3%)	2.85	.881
Perform periodic inspection of equipment	75	3(4%)	4(5.3%)	27(36%)	41(54.7%)	3.41	.773
Replacement of worn out and damaged parts	75	7(9.3%)	20(26.7%)	40(53.3%)	8(10.7%)	2.65	.797
Performing regular diagnosis on machines before use	75	2(2.7%)	6(8%)	25(33.3%)	42(56%)	3.43	.756
Regular cleaning and painting of equipment	75	3(4%)	20(26.7%)	49(65.3%)	3(4%)	2.69	.615
Recording and reporting adjustments, repairs and replacements	75	14(18.7%)	24(32%)	37(49.3%)	-------	2.31	.771
Planned Lubrication	75	16(21.3%)	22(29.3%)	31(41.3%)	6(8%)	2.36	.910
Inspection and maintenance of all emergency, personnel and plant protection	75	5(6.7%)	7(9.3%)	55(73.3)	8(10.3%)	2.88	.677
Adjustments of machines and equipment	75	15(20%)	25(33.3%)	32(42.7%)	3(4%)	2.31	.838

Source: Researcher's Field Survey, 2017, Mean > 2.5, accepted

The data in Table 4.14 indicates that ten (10) items are the key maintenance practices indicators for performing regular maintenance practices in mechanical engineering workshops in the Sissala West District. Statistically, the study indicated that 7 practices were the highest ranked key maintenance practices which are: Performing regular diagnosis on machines before use ($\bar{x}$=3.43), Performing periodic inspection of equipment ($\bar{x}$=3.41), Putting in place all proper tooling activities ($\bar{x}$=3.24), Inspection and maintenance of all emergency, personnel and plant protection ($\bar{x}$=2.88), Conducting regular condition monitoring and oil analysis ($\bar{x}$=2.83), Regular cleaning and painting of equipment($\bar{x}$=2.69), Replacement of worn out and damaged parts ($\bar{x}$=2.65). Considering the 95% confidence level, Planned Lubrication ($\bar{x}$=2.36), Recording and reporting adjustments, repairs and replacements ($\bar{x}$=2.31) and Adjustments of machines and equipment ($\bar{x}$=2.31) were the 3 least rated key maintenance practices captured by the study.

4.5 The importance of conducting regular maintenance practices in engineering workshops

The second research question survey was designed to evaluate the major importance of carrying out regular maintenance practices in the mechanical engineering workshops. A list of the most important practices was sourced from an extensive literature review. Table 4.16 summarises the responses of the respondents working with mechanical engineering workshops within the Sissala West District regarding the importance of carrying out regular maintenance practices in engineering workshops. The analysis was based on the respondents rating for the key maintenance practices importance for each item in the questionnaire, with a rating of; "1" = strongly disagreed, "2" = disagreed, "3"= agreed, "4"= strongly agreed.

Table 4.16:Importance of Carrying out Regular Maintenance Practices in Workshops

Variables	N	SD	D	A	SA	Mean	Std. Deviation
To sustain equipment and facilities as designed in a safe and effective operating condition	75	4(5.3%)	7(9.3%)	26(34.7%)	38(50.7%)	3.31	.854
To ensure production targets are met economically and on time	75	21(28%)	26(34.7%)	28(37.3%)	-------	2.09	.808
To prevent unexpected breakdown of machines	75	8(10.7%)	8(10.7%)	50(66.7%)	9(12%)	2.80	.788
To extend the useful life of working equipment	75	5(6.7%)	7(9.3%)	48(64%)	15(20%)	2.97	.753
To ensure the safety of personnel using the system	75	13(17.3%)	43(57.3%)	19(25.3%)	-------	2.08	.653
To ensure the reliability and dependability of equipment	75	10(13.3%)	13(17.3%)	48(64%)	4(5.3%)	2.61	.787
To prevent deterioration and shorten the useful life of the equipment	75	5(6.7%)	13(17.3%)	35(46.7%)	22(29.3%)	2.99	.862
To have a better spare part control, greater work safety and lower manufacturing cost	75	18(24%)	24(32%)	38(50.7%)	--------	2.20	.805
To prevent more production interruptions	75	12(16%)	19(25.3%)	34(45.3%)	10(13.3%)	2.56	.744

Source: Researcher's Field Survey, 2017, Mean > 2.5, accepted

As depicted in Table 4.16, the highest mean rating of the importance of conducting regular maintenance practices were rated as follows: To sustain equipment and facilities as designed in a safe and effective operating condition (mean=3.31), To prevent deterioration and shorten the useful life of the equipment (mean=2.99), To extend the useful life of working equipment (mean=2.97), To prevent unexpected breakdown of machines (mean=2.80), To ensure the reliability and dependability of equipment(mean=2.61) and To prevent more production interruptions (mean=2.56). However, the lowest rated importance of carrying out regular maintenance practices

in mechanical engineering workshops was identified as To have a better spare part control, greater work safety and lower manufacturing cost (mean=2.20), To ensure production targets are met economically and on time (mean=2.09) and To ensure the safety of personnel using the system (mean=2.08)

4.6 Challenges of implementing maintenance practices in engineering workshops

In order to examine the perceived effects of quality performance indicators on public sector construction projects, respondents were asked to rate the level of how quality performance indicators impact public sector construction projects with "4" as being strong agreed, "3" agreed, "2" as disagreed and "1" as strongly disagreed. Table 4.17 presents the means of standard deviations with regards to the challenges militating against the implementation of maintenance practices.

In the questionnaire, the respondents were asked to identify the critical challenges of implementation of maintenance practices, based on their experience, using a rating of "4" as being strong agreed, "3" agreed, "2" as disagreed and "1" as strongly disagreed

Table 4.17 : Challenges of Implementing Regular Maintenance Practices in Engineering Workshop

Challenges	N	DS	D	A	SA	Mean	Std. Deviation
High cost of maintenance parts	75	6(7.8%)	9(11.7%)	26(33.6%)	34(44.2%)	3.17	.935
Lack of Adequate funds committed to Maintenance	75	5(6.5%)	10(13%)	37(48.1%)	23(29.9%)	3.04	.845
Lack of technical persons to repair certain machines	75	18(23.4%)	28(36.4%)	29(37.7%)	------	2.15	.783
Poor maintenance task execution	75	12(15.6%)	30(39%)	32(41.6%)	1(1.3%)	2.29	.749
Poor maintenance strategy and policy	75	8(10.4%)	15(19.5%)	27(35.1%)	25(35.2%)	2.92	.983
Failure of maintenance staff to retain knowledge and skills acquired	75	18(23.4%)	37(48.1%)	20(26%)	-------	2.03	.716
Lack of computerized maintenance management system in place to quickly detect faults	75	9(11.7%)	23(29.9%)	35(45.5%)	8(10.4%)	2.56	.842
Reluctance of contractors to replace defective parts	75	29(37.7%)	26(33.6%)	20(26%)	--------	1.88	.805
Long bureaucratic Process	75	7(9.1%)	29(37.7%)	32(41.6%)	7(9.1%)	2.52	.795

Source: Researcher's Field Survey, 2017, Mean > 2.5, accepted

The result in Table 4.17 shows that the dominant perceived challenges of implementing regular maintenance practices in engineering workshops were gathered as follows: High cost of maintenance parts (mean=3.17), Lack of Adequate funds committed to Maintenance(mean=3.04), Poor maintenance strategy and policy(mean=2.92), Lack of computerized maintenance management system in place to quickly detect faults (mean=2.56), Long bureaucratic Process involved in processing maintenance order (Mean=2.52).

On the other hand, the least rank perceived challenges of carrying out regular maintenance practices are: (mean = 2.63), Poor maintenance task execution (mean=2.20), Lack of technical persons to repair

certain machines (mean=2.15), Failure of maintenance staff to retain knowledge and skills acquired (mean=2.03) and Reluctance of contractors to replace defective parts (mean=1.88)

4.7 Summary of Analysis and Discussion of Data

The chapter of the discussed and gave coherent analysis of data collected to answer the various objectives the study was set to achieve. It elaborates the key maintenance practices appropriate for measuring the smooth running of mechanical engineering workshops and the critical challenges to inhibiting the implementation of regular maintenance practices in engineering workshops. The study further discusses the importance of carrying out regular maintenance practices in mechanical engineering workshop.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

The aim of the study is to assess the maintenance practices of the mechanical engineering workshop within Sissala East District of the Upper West region of Ghana. This chapter focuses on the findings of the study, conclusions drawn from the main findings and finally recommendations made for the study. The chapter is constituted into three main sections. The first section which deals with the summary of the main findings emanating from the data collected from the field as well as the contribution this study makes to knowledge on the phenomenon under studied. The second section concentrated on conclusions of the study with specific reference to the main findings drawn from the study. The last section has to do with the recommendations to address the issues emerging from the study and recommendation for further study.

5.1 Summary of Findings

The presentation of the main findings of the study was presented according to the specific objectives set for the study.

5.1.1 Maintenance practices being carried out by the mechanical engineering workshops

The study revealed that the key maintenance practices for maintaining mechanical engineering equipment and machinery are performing regular diagnosis on machines before use, Performing periodic inspection of equipment, Putting in place all proper tooling activities, Inspection and maintenance of all emergency, personnel and plant protection, Conducting regular condition

monitoring and oil analysis, Regular cleaning and painting of equipment and Replacement of worn out and damaged parts.

5.1.2 Challenges involved in implementing maintenance practices in mechanical engineering workshops.

High cost of maintenance parts, Lack of Adequate funds committed to maintenance, Lack of computerized maintenance management system in place to quickly detect faults, long bureaucratic Process involved in processing maintenance order for maintenance to take place were the key challenges hampering effective maintenance in mechanical engineering workshops.

5.1.3 Importance of Carrying out Regular Maintenance Practices in mechanical engineering workshops

The study also confirmed that the key importance of conducting regular maintenance in engineering workshop were to sustain equipment and facilities as designed in a safe and effective operating condition, To prevent deterioration and shorten the useful life of the equipment, To extend the useful life of working equipment, To prevent unexpected breakdown of machines, To ensure the reliability and dependability of equipment and To prevent more production interruptions.

5.2 Conclusion

The manufacturing industries in Ghana continue to suffer from lack of regular maintenance practices leading to breakdown of most manufacturing equipment and machinery which has also lead to the collapse of many companies as results of improper maintenance strategies, lack of

maintenance funds committed to maintenance, high cost of maintenance parts and Lack of computerized maintenance management system in place to quickly detect faults experienced across mechanical engineering workshops in Ghana.

One of the driving forces behind maintenance manufacturing firms is the continuous improvement in technological development. The issues here that concern maintenance most are the concept of process of innovation which has to do with the development of new technologies. This is not seen to be encouraging technology adoption of manufacturing firms especially small and medium firms (SMEs) in Ghana with obsolete manufacturing processes. Small and medium manufacturing firms may lack the capacity to improve productivity through acquiring new technologies.

It is importance however to state that implementing regular maintenance practices in mechanical engineering workshops will help sustain equipment and facilities as designed in a safe and effective operating condition, prevent unexpected breakdown of machines, extend the useful life of working equipment and ensure the reliability and dependability of equipment.

5.3 Recommendations

With the key findings emanating from this study and the conclusions drawn as the bases, the following recommendations are made.

- Mechanical engineering workshops should introduce the use of computerized maintenance system which will help detect fault easily.
- Mechanical engineering workshops should introduce prediction tools for solving maintenance problems
- Manufacturing companies should always allocate maintenance budgets to cater for any unforeseen repairs or replacement of equipment.

- Mechanical engineering workshops should provide retraining opportunities to its technical staff at least in every six months.
- Manufacturing companies should bring in third-party technician when the need arises.

REFERENCES

Adejuyigbe, S.B., (2006) Industrial Automation in Ghanaian Industries (The Case of Kumasi Metropolis), Journal of Engineering and Applied Sciences. Medwell Online, ANSInet Vol.1 No. 4, pp 383-393.

Adjaye, R.E., (1994) ‘‘Design and Optimized Operation with Reliability Centered Maintenance’’, IEE Conference on Electrical Safety in Hazardous Environment, No. 399, pp. 165-71.

Afranie, S., 2004, Maintenance of Residential Buildings in Ghana: Analyses of Problems, Causes and Policy Interventions, Journal of Applied Science and Technology. ISSN: 0855-2215

Agyedu, G.O Donkor, F & Obeng, S.Y. (1999). *Teach Yourself Research* , Kumasi Geobell Publishers

Ahuja, I. P. S. and Khamba, J.S., (2007) An Evaluation of TPM Implementation Initiatives in an Indian Manufacturing Enterprise, Journal of Quality in Maintenance, Vol.13, No.4

Al-Najjar, B., (1996) Total Quality Maintenance: An Approach for Continuous Reduction in Costs of Quality Products, Journal of Quality in Maintenance Engineering,. 2 (3), 1996, pp. 4-20.

Al-Najjar, B., and Alsyouf, I. (2004),"Measuring maintenance performance using a balanced scorecard approach", *Journal of Quality in Maintenance Engineering*, 12 (2),pp 133 -149

Babbie, E. & Mouton, J. 2001. *The practice of social research. Cape Town*: Oxford University Press.

BSI. 1984. Glossary of Maintenance Terms in Terotechnology. London: British Standard Institution (BSI), BS 3811.

Cooke, F. L., (2003), Plant Maintenance Strategy: Evidence from Four British Manufacturing Firms, Journal of Quality in Maintenance Engineering, Vol. 9,No.3

Damewood, C. L., 2008, What is Maintenance Engineering?, [http://www.wisegeek.com/what-is-maintenance-engineering.htm] (Accessed on 12th September,2010)

Dhillon, B. S., (2006) Maintainability, Maintenance, and Reliability for Engineers, CRCPress,[http://www.crcpress.com/product/isbn/9780849372438;jsessionid=DQGlsasgl2PS7BQpjxjkaw (Accessed on 12109th September,2010)

Eti MC, Ogaji S.O, Probert, S.O (2006). Development and implementation of preventive-maintenance practices in Nigerian industries. Appl.Energy, 83(10):1163-1179.

Gay, L.R. (1987). *Educational research competence for analysis and application* (3rd ed), Columbia, Ohio: Merrill Publication Company.

Ghauri, P. and Gronhaug, K. (2002). *Research Methods in Business Studies* Harlow: Pearson Education.

Gebauer, A. T., (2008), Computerised Planning and Scheduling, in: Mobley, R. K., Maintenance Engineering Handbook, 7th Edition, McGraw Hill Companies Inc.,USA, pp. 172-206

Gopalakrishnan, P., and Banerji, A. K., (2004) Maintenance and Spare Parts Management, Prentice Hall of India, New Delhi

Holmberg K, Adgar A, Arnaiz A, Jantunen E, Mascolo J, Mekid S(2001). E maintenance. London: Springer.

Kamoun, K., (2005), A cost model of industrial maintenance for profitability analysis and benchma rking. International Journal of Production Economics, 79(1), 15–31.

Kelly, E., (2003) Terotechnology, A Modern Approach to Plant Engineering, IEE Proc., Vol. 129, Pt. A, No. 2, March 2003

Kister, T., and Hawkin, R.,(2008), Estimating Repair and Maintenance Costs, in: Mobley R. K., Maintenance Engineering Handbook, 7th Edition, McGraw Hill Companies Inc.,USA, pp. 312-315

Madu, C.N., (2000), Competing through maintenance strategies. International Journal of Quality & Reliability Management, 17(9), 937-948.

Mishra, R. C., and Pathak, K. (2006).*Maintenance Engineering and Management* (4th Ed).New Dehli: Prentice Hall of India, p. 82-89.

Mitchell, J. S. (2002),"From Vibration Measurements to Condition-Based Maintenance", *Sound and Vibration*, Vol 41, No 1, pp 62.

Mobley R. K., 2004, Maintenance Fundamentals, Second Edition, Elsevier Butterworth-Heinemann, 200 Wheeler Road, Burlington, MA 01803, USA

Moubray, J. (1997). Reliability-Centred Maintenance. 2nd ed. Oxford: Butterworth-Heinemann.

Obeng-Odoom, F., and Amedzro, L.(2011).Inadequate Housing in Ghana. *UrbaniIzziv*, *2*(1), 127-137.

Polit, K. M. & Hunger, G. S. (1993). *Research design and methods*. Australia Yale University Press.

Sharma, R. K., and Bahadoorsingh, K.(2005),"Systematic failure mode effect analysis (FMEA) using fuzzy linguistic modelling", *International Journal of Quality & Reliability Management*, Vol 22, No 9, pp 986-1004.

Smith R. and Hawkins B., (2004), Lean Maintenance. [Electronic] Elsevier Inc.

Söderbom, M., (2000), What Drives Manufacturing Exports in Africa, Evidence from Ghana,Kenya andZimbabwe,[http://wwwwds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2004/04/28/000265513_2004 28170206/Rendered/PDF/28745.pdf] (accessed on the 18 of October, 2010)

Swanson, L., (2003), Linking maintenance strategies to performance. International Journal of Produ ction Economics, 70(3), 237-244.

Telang A. D. and Telang A., 2010, Comprehensive Maintenance Management: Policies, strategies and Options, PHI learning Private Limited, New Dehli, India

Tsang, A. H. C. (2002).Strategic Dimensions of Maintenance Management. *Journal of Quality in Maintenance*, *8*(1), 7-39.

Tse, P.W., 2002, ‘‘Maintenance Practices In Hong Kong and the Use of the Intelligent Scheduler’’, Journal of Quality in Maintenance Engineering, Vol. 8 No. 4, pp. 369-80

Raouf, A. and Ben-Daya, (1995) Total Maintenance Management: A Systematic Approach, Journal of Quality in Maintenance Engineering, Vol. 1, No. 1, 1995,pp. 614

Uzan, A.,and Ozdogan, A. (2012). Maintenance parameters based production policies Optimization. *Journal of Quality in Maintenance Engineering*, *18*(3), 295-310.

Usman N.D, (1998). Maintenance culture and its impact on the construction of residential buildings in Nigeria. J.Environ. Sci. Resourc. Manage. 4 (8):92-103.

Wireman, T., (2010), Benchmarking Best Practices in Maintenance Management (2nd edition). [Electronic] New York: Industrial Press Inc.

Zhou, X., Xi, L., and Lee, J.(2006). A Dynamic Opportunistic Maintenance Policy for Continuously Monitored Systems. *Journal of Quality in Maintenance*, *12*(3), 294-305.

APPENDIX
UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

DEPARTMENT OF MECHANICAL TECHNOLOGY EDUCATION

QUESTIONNAIRE FOR MAINTENANCE OFFICERS

I am a final year Post Graduate Student of the University of Education Winneba-Kumasi campus pursuing a Master of Technology Degree in the Department of Mechanical Technology Education. The questionnaire seeks views on the maintenance culture of mechanical engineering workshops in the Sissala East District in the Upper East Region. It is purely for academic purposes therefore you are assured of confidentiality so please answer the questions as frankly as you can by ticking [√] or marking appropriately in the of box provided.

Section A: Demographic Information

1. Gender a. Male [ ] Female [ ]
2. Educational Level a. SSSCE/NVTI [ ] b. HND/Dip [ ] c. Degree [ ] d. Postgraduate [ ]
3. Age of Officers a. Below 30 [ ] b. 31-35 [ ] c. 36-40 [ ] d. 41-45 [ ] e. Over 46 [ ]
4. Working Experience a.2 years and Below [ ] b. 3-6 [ ] c.7-10 [ ] d. 10+ years [ ]

Section B: **Maintenance Activities**

5. Do you undertake regular maintenance on your workshop equipment?
   a. Yes [ ] b. No [ ]

6. How often do you carried out maintenance in your workshop?
   (a) Monthly [ ] (b) Every 3 month [ ] (c) Every 6 months [ ] (d) When there is a break down

(7) Do you have a maintenance schedule in your workshop?

(a) Yes [ ] (b) No [ ]

8. Do you normally experience breakdown in your workshop?

(a) Yes [ ] (b) No [ ]

9) Do you think it is important to conduct regular maintenance in the workshop?

(a) Yes [ ] (b) No [ ]

10. Do you employ preventive maintenance practices in the workshop?

(a) Yes [ ] (b) No [ ]

11) Do you follow the daily routine maintenance checks in your workshop?

(a) Yes [ ] (b) No [ ]

12. In the event of breakdown, how long does it take to fix the problem**?**

(a) 1-7 days [ ] (b) 2-3 weeks [ ] (c) 1 months [ ] (d) 1month+ [ ]

13. Have you ever had any training on maintenance**?**

(a) Yes [ ] (b) No [ ]

14. How often do you normally organize retraining on the use and maintenance of equipment?

a) Every 6 weeks b) Every 3 Month c) Every three months d)Yearly

Regular Maintenance Practices Normally carried out in the workshop

Maintenance Practices	Strongly Agree	Agree	Disagree	Strongly Disagree
Putting in place all proper tooling activities				
Conducting condition monitoring and oil analysis				
Perform periodic inspection of equipment				
Replacement worn out and damaged parts				
Performing regular diagnosis on machines before use				
Regular cleaning and painting of equipment				
Recording and reporting adjustments, repairs and replacement				
Planned Lubrication				
Inspection and maintenance of all emergency, personnel and plant protection equipment				
Adjustments of machines and equipment				

Importance of Carrying out regular maintenance in your workshop

Variable	Strongly Agree	Agree	Disagree	Strongly Disagree
To sustain equipment and facilities as designed, in a safe and effective operating condition				
To ensure production targets are met economically and on time				
to prevent unexpected breakdown of equipment				
to extend the useful life of working equipment				
to ensure the safety of personnel using the system.				
To ensure the reliability and dependability of equipment				
To prevent deterioration and shorten the useful life of equipment				
Better spare parts control, greater work safety and lower manufacturing cost				
Prevent more production interruptions				

Challenges of implementing regular maintenance in your workshop

Challenges	Strongly Agree	Agree	Disagree	Strongly Disagree
High cost of maintenance parts				
Lack of Adequate funds committed to Maintenance				
Lack of technical persons to repair certain machines				
Poor maintenance task execution				
Poor maintenance strategy and policy				
Failure of maintenance staff to retain knowledge and skills acquired				
Lack of computerized maintenance management system in place to quickly detect faults				
Reluctance of contractors to replace defective parts				
Long bureaucratic process				