PLANT MAINTENANCE STRATEGIES USED BY LARGE MANUFACTURING FIRMS IN KENYA

BY

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DECLARATION

I hereby declare that this research project is my own original work, and that it has not been presented in any other university/institution for any award.

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This Research Project has been submitted for examination with my approval as the University supervisor

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DEDICATION

I dedicate this project to almighty God who has given me wisdom and strength, and to my wife Pauline and son John for being supportive and patient during the course of the research project writing.

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ABSTRACT

The purpose of this study was to: establish the plant maintenance strategies used by large manufacturing firms in Kenya; establish the challenges large manufacturing firms in Kenya are facing in their effort to implement plant maintenance strategies and establish whether the maintenance strategies in large manufacturing firms in Kenya conform to world best maintenance strategies.

The targeted population was large manufacturing firms in Nairobi, Kenya whose estimated population is 80% of the total number of manufacturing firms registered with Kenya Association of Manufacturers. Stratified random sampling procedure was employed to select the respondents to represent the larger population. Primary data were collected through questionnaires and data analysis was done using descriptive statistics.

The study found out that large manufacturing firms in Kenya use a combination of both corrective and preventive maintenance strategies with corrective maintenance strategy as the most prominent within the firms. Large manufacturing firms in Kenya face numerous challenges in their effort to implement plant maintenance strategies. The challenges are grouped as: culture based, people based, tools and equipment based, financial based, systems and management based. Large manufacturing firms in Kenya plant maintenance strategies are progressing positively towards world best strategies.

The research has come up with recommendations that management has to invest in time, money and resources for a successful implementation of good maintenance strategies. Further research is also recommended to establish the reasons behind dominance of corrective maintenance strategies in manufacturing firms, the effect of plant maintenance strategies on the productivity of the firms and to expand the current research to include non manufacturing firms, buildings and other utilities.

CHAPTER ONE: INTRODUCTION

1.1 Background of Study

Productive and competitive maintenance strategies are needed to propel manufacturing firms to a global level. The strategies should cope with the dynamic needs of the external environment, consider shareholders interest, and discover the hidden but unused or underutilized resources (human resource, machines and equipments). Visser (1998) in his study has shown that firms which have adopted world class maintenance strategies and practices have the potential to meet their manufacturing demands. However, this alone cannot solve all the current needs of manufacturing firms but has the potential to be a major factor in making the firm competitive.

World class maintenance is geared towards a total participatory plant maintenance technique by all workers. It brings everyone, from equipment designer to operators, together to work towards safe and productive maintenance practices. Besterfield et al (2013) describe world class maintenance as keeping the current plant and equipment at its highest productive level through the inclusion of all areas of an organization. World class maintenance is a partnership between maintenance and production functions in the organizations to improve product quality, reduce waste, reduce manufacturing cost, increase equipment availability, ensure safety to all workers, enhance safe environment, and improve the company's competitiveness. Proper maintenance strategy and practice is one of the functions which protects the firm's investment, prolongs equipment life, leads to substantial savings to capital investment and hence contribute to firms increased revenue.

The most significant deficiency associated with the maintenance process in most plants is a "systemic" one; it is not a question of management competence, ability, or oversight, but simply a lack of management practices and systems to adequately manage maintenance resources (labor, material, machines and equipments) productively. At the most fundamental level, there is often a lack of a clear and consistent understanding of the strategic role that maintenance plays in overall plant and business unit performance

(through reliability and availability, quality of machines, and lower cost of running the machines), Besterfield et al (2013).

On the maintenance front in Kenya, major initiatives have been taken particularly after 1980s, in the emergence of the structural adjustment programs to help the manufacturing sector to compete in the global market, (Mulama, 2012). Initially due to protected and controlled economy, the Kenyan manufacturing firms chief executives did not pay much attention towards equipment related failures and losses, maintenance was viewed as a reactive problem fixing and an operating expense to be minimized. The global competition and the pressures from customers to reduce costs, defects and lead time have forced management to pay attention towards maintenance and related issues, (Kapil, 2013).

Kenyan manufacturing industries have struggled in their attempt to implement a world class maintenance strategy. Kenyan manufacturing firms have faced many obstacles or barriers in trying to successfully implement world class maintenance strategies. Different manufacturing firms have continued to implement various maintenance strategies to achieve the ultimate goals of reducing the overall operating cost and boosting the productivity of the plants. The companies which have implemented good maintenance strategies have shown that the challenges which Kenyan manufacturing firms face in implementation of maintenance strategies are critical and more effort should be put in place to address them, (Kariuki, 2013).

1.1.1 Plant Maintenance

Maintenance is defined as a set of organized activities that are carried out in order to keep an item in its best operational condition with minimum cost. The activities can either be corrective or preventive in nature. Plant maintenance refers to the methods, strategies, and practices used to keep an industrial factory/firm running efficiently. The general objective is to create a productive environment which is safe for all workers. Plant maintenance in a manufacturing firm has a huge economic potential if good strategies are in place together with good management, (Gillet, 2001). Maintenance cost can represent 10 – 40% of the production cost in a company. This cost is huge and should not be taken

for granted. Maintenance can only be competitive if there is good balance between, the corrective maintenance and preventive maintenance. If corrective maintenance is too frequent, the equipments and machines will not be available for production. On the other hand if preventive maintenance is too intensive, the maintenance cost escalates and if too little, it results to frequent corrective maintenance, (Maggard et al, 1992).

Pophaley & Vyas (2007) defined plant maintenance strategy as a long term plan, covering all aspects of maintenance management which sets the direction of maintenance management and contains firm's action plans for achieving a desired future state for the maintenance function. Maintenance strategy should be focused towards the long term achievement of the firm's objective of meeting its market demand and to be competitive. The firm should invest in resources (skills, assets, finance, relationships, technical competence, and facilities) that are required to make it compete globally. Compliance with government regulations on safety and environment, and world best practices in maintenance are core features in the strategy. The shareholders interest and the global objective of the firm are critical for the maintenance strategy to be successful.

1.1.2Manufacturing firms in Kenyan

Manufacturing is defined as the process of converting raw materials, components or parts into finished goods that meet consumer's expectation or specifications. Large manufacturing firms are therefore firms that engage people, machines and systems to convert raw materials, components or parts into finished goods.

Awino (2011) describes manufacturing as an important sector in Kenya that makes a substantial contribution to the country's economic development. It has the potential to generate foreign exchange earnings through exports and diversifies the country's economy. This sector has grown over time both in terms of its contribution to the country's gross domestic product and employment. Mulama **(**2012) had indicated that the average size of this sector for tropical Africa is 8 %; which is quite small compared to that of the industrialized nations, United Nations Industrial Development Organization (UNIDO) (1987). Kenyan manufacturing sector, value added (% of G.D.P) in 2012 was

10%, lower than world lower income indicator of 12%, World Bank Development indicator data (WBDI) (2014).

Kenyan manufacturing sector has drastically developed after the introduction of structural adjustment programs (SAP) in 1980s which liberalized the economy and encouraged competition among firms locally, regionally and internationally. Manufacturing firms in Kenya fall under the umbrella of Kenya Association of Manufacturers (KAM) established in 1959 as a private sector body. According to Kenya Association of Manufacturers directory (2011),80% of its membership is from Nairobi.

Large manufacturing firms in Kenya use different plant maintenance strategies in their maintenance functions to be productive. These strategies can basically be grouped into to two which are preventive and corrective maintenance with a number of concepts which can be divided into five: Reliability Centered Maintenance (RCM); Total Productive Maintenance (TPM); Root Cause Failure Analysis (RCFA); Terotechnology; and Total Quality Maintenance (TQMain).

1.2 Statement of the Problem

A lot of research has been done on maintenance strategies, maintenance practices and effects of maintenance on the productivity of manufacturing firms. In Europe the total value of maintenance budget is estimated to be approximately € 1500 billion per year and one third of these costs are wasted due to poor planning, overtime costs, and inferior use of preventive maintenance strategy. Despite the increase in demand for reliable production equipment, few manufacturing companies in Europe still do not embrace the importance of developing good maintenance strategies, which are believed to be key contributors to firms' revenue, (Slonnen, 2003).

In Nigerian industries, a study by Eti et al (2004) has shown that maintenance is not given high priority in manufacturing firms and hence plants are often underutilized and run at high costs. The problems arise due to the following: not many senior managers have pertinent knowledge and maintenance experience, there is no maintenance education course in Nigeria universities; and maintenance budgets are inadequate, also many firms regard maintenance as a cost centre rather than a business centre. These challenges are difficult to overcome but still maintenance is a major activity in the firms, accounting for up to 40% of total costs, in some of the Nigerian manufacturing firms.

In Kenya, a study of maintenance practices in KenGen indicate that the firm has in place good maintenance practices, though breakdown maintenances activities are extremely high. The high breakdown maintenances activities recorded are as a result of poor maintenance workmanship and contributes to about 13% of revenue loss incurred by KenGen (Karanja, 2012). A study by Kwambai, (2008) on Kenyan geothermal plants has revealed that: to optimize maintenance of Geothermal Power Plants (GPPs) of KenGen, Reliability Centered Maintenance should be applied to design the appropriate maintenance strategies, six sigma to address chronic problems and lean management to identify and eliminate wastes. A successful combination of the above has great potential to optimize maintenance processes in GPPs and to make the plants economical to run.

From the studies highlighted, inadequate attention has not been focused on Plant Maintenance Strategies used in large manufacturing firms in Kenya. This study seeks to fill the gap. This study will seek to address the following research questions: what are the maintenance strategies used by Kenyan manufacturing firms? What are the challenges faced in the implementation of good maintenance strategies used by Large manufacturing firms in Kenya and do Large manufacturing firms in Kenya maintenance strategies conform to the world best?

1.3 Objectives of the Study

The objectives of this research are:

i. To establish the plant maintenance strategies used by large manufacturing firms in Kenya.
ii. To establish the challenges large manufacturing firms in Kenya are facing in their effort to implement plant maintenance strategies.
iii. To establish whether the maintenance strategies in large manufacturing firms in Kenya conform to world best maintenance strategies.

1.4 Importance of the study

The findings of this study will enrich the existing knowledge on plant maintenance strategies and challenges in large manufacturing firms in Kenya. The results of the study will be quite useful to the researchers and academicians who seek to investigate more in the area of maintenance strategies in the large manufacturing firms in Kenya.

The findings of the study will come up with maintenance strategies used by large manufacturing firms in Kenya and challenges faced in implementation of strategies used. This will help the management of large manufacturing firms in Kenya to be aware of appropriate maintenance strategies applicable to their firms, the challenges facing the implementation of these strategies and necessary recommendations for improvements.

Most companies do not use world best benchmarks to gauge their maintenance function. The findings of this study will help maintenance practitioners like plant engineers and managers to appreciate the world best maintenance strategies and to realign their maintenance activities to match the word best.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter covers the literature on what entails plant maintenance functions, maintenance strategies for large manufacturing firms, maintenance challenges for large manufacturing firms, benchmarks for maintenance practices, and finally summary and conceptual framework.

2.2 Plant Maintenance Function

Gits (1994) describes industrial maintenance as a process that supports the production process, with principal responsibility of providing service to enable a firm to achieve its objectives. Maintenance management function like any other management function consists of planning, organizing, implementing and controlling maintenance activities.

Maintenance specific responsibilities vary from one firm to another; however, they generally include the following: keeping assets and equipment in good condition, well configured and safe to perform their intended functions. The activities performed include: preventive, predictive, corrective, overhauls, design modification and emergency maintenance in an efficient and effective manner. Controlling the use of spare parts, operating utilities and commissioning new plants also form part of maintenance, (Duffuaaet al, 1998).

Maintenance as function in the manufacturing firm has a huge economic potential. The plant maintenance cost can represent 10 – 40% of the production cost in a company, (Maggardet al, 1992). Coetzee (2004), emphasizes that the number is between 15 – 50%, and Bevilacqua et al (2000), found out that plant maintenance cost can represent as much as 15 – 70% of the total production. The above figures are indication of how plant maintenance is critical in the manufacturing firm' scosts and better strategies are required to give direction to maintenance process.

Some of the measures of maintenance performances are availability of machines, mean time between failures (MTTF) of machines, failure/breakdown frequency of machines, mean time to repair (MTTR) machine out of condition and production rate index. Maintenance productivity indicators measure the usage of resources like; labor, materials,

contractors, tools and equipment. These components also form various cost indicators, such as man power utilization and efficiency, material usage and work order, (Parida, 2007).

2.3 Plant Maintenance Strategies

Maintenance strategies are broadly grouped into to two; preventive and repairs maintenance.

2.3.1 Breakdown/Corrective Maintenance

Repairs or breakdown maintenance uses a reactive approach and only acts when the equipment or machine needs to be fixed, it has neither schedule nor routine maintenance task, and consists majorly of repair, restoration and replacement of parts or components. This strategy of maintenance is quite costly, it leads to downtime of production machines/equipment and replacement of a machine/equipment or part of it which is not always cheap, it requires substantial investment. The strategy is only useful in cases where the equipment or parts are required to run to fail, (Dhillon, 2002). Run to fail equipments have more competitive replacement cost to preventive maintenance and the function it performs, this includes equipments like electronic panel cooling fan motor.

2.3.2Plant Preventive Maintenance

Preventive maintenance on the other hand uses proactive and predictive approaches; it is carried out at predetermined intervals or according to prescribed criteria which are intended to reduce the probability of failure of equipment or component. Preventive maintenance strategy is regarded as predictive if more of on condition based approach is used and proactive if more activities target the monitoring and correction of root causes to equipment failures. This strategy is regarded as the best among the two because of lack of interference on the production process since fault is detected before it occurs and its elimination is planned in advance, it reduces quality costs, downtime and costs due to loss of sales. This maintenance strategy can become expensive if it is performed too frequently due to cost of manpower and spares, (Labib, 2004).

2.3.3 Plant Maintenance Concepts

Apart from the two major strategies, Plant maintenance practice has five concepts which work in conjunction with the strategies, they include: Reliability Centered Maintenance, RCM, Total Productive Maintenance, Root Cause Failure Analysis, RCFA, Terotechnology, and Total Quality Maintenance, TQ Main.

Reliability Centered Maintenance (RCM)is a process used to determine what must be done to ensure that any physical asset continues to do what its user wants it to do in its present operating context, (Kirby, 2012). Total Productive Maintenance (TPM) a concept developed in Japan is defined as productive maintenance involving total participation of everyone in the firm, (Mckonea 2001). Root Cause Failure Analysis (RCFA)is one of the most useful concepts, it is based on failures that have occurred in the past, corrective action is taken past the component stage and into the system deficiency, (Marquez, 2007)

Terotechnology, a common practice in UK is concerned with the specification and design for reliability and maintainability of plant, machinery and equipment, with their installation, commissioning, modification and replacement, and the feedback of information of design, performance and costs, (Stipet et al, 2004). Total Quality Maintenance (TQMain) is another concept which was introduced to help in monitoring and controlling deviations in a process condition and product quality, and for detecting failures in order reduce machine deterioration rate before the product characteristics are intolerably affected and to perform the required action to restore the machine/ process or particular part of it to good recommended working condition, (Williamson, 2006).

2.4 Plant Maintenance challenges

Maintenance function and its position in the manufacturing firm are heavily impacted by the following elements: type of business; like whether it is high tech, labor intensive, production or service; the objectives of the firm which may include like profit maximization, increasing market share and other social objectives; the size and structure of the organization; the culture of the organization, and range of responsibility assigned

to maintenance. All the above elements contribute majorly to the challenges faced by maintenance function, (Ahuja, 2008).

Maintenance challenges are numerous and can be grouped as; people based, culture based, equipment and tools based, financial based, system based and management based. People based challenges include: lack of skilled manpower and training for both production machine operators and maintenance personnel, lack of expertise to alter machine design. Culture based challenges include; negative organization work culture, firms resistance to change. Equipment and tools based challenges include: lack of appropriate tools, equipment and Machine Park with outdated technology. Financial based challenges include: control of maintenance cost and budgets and unwillingness to commit resources. System based challenges include: process related problems and none availability of standard operation procedures. Management based challenges include: maintenance leadership, procurement of maintenance spares and machines, inability to plan and design change and repair, (Prasat et al, 2013).

2.5 World best Maintenance strategies Benchmarks

Xerox Corporation defines benchmarking as the search for industry best practices which lead to superior performance. It is therefore critical for Kenyan manufacturing firms to seek for the best in the industry to compete in the market. Given in the Table 1 are some of the measurable world best maintenance strategy benchmarks.

Table 1: Best Maintenance Benchmarks

Best practice Maintenance Benchmarks	
Category	**Benchmark**
Yearly Maintenance Cost:	
Total Maintenance Cost/Total Manufacturing Cost	< 10-15%
Maintenance Cost/Replacement Asset Value of the Plant and Equipment	< 3%
Hourly Maintenance Workers as a % of Total	15%
Planned Maintenance:	

Planned Maintenance/Total Maintenance	> 85%
Planned & Scheduled Maintenance as a % of hours worked	~85-95%
Unplanned Down Time	~0%
Reactive Maintenance	< 15%
Run to Fail (Emergency + Non-Emergency)	< 10%
Maintenance Overtime:	
Maintenance Overtime/Total Company Overtime	< 5%
Monthly Maintenance Rework:	
Work Orders Reworked/Total Work Orders	~0%
Inventory Turns:	
Turns Ration of Spare Parts	> 2-3
Training:	
For at least 90% of workers, hours/year	> 80 hours/year
Spending on Worker Training (% of payroll)	~4%
Safety Performance:	
OSHA Recordable Injuries per 200,000 labor hours	< 20%
Housekeeping	~96%
Monthly Maintenance Strategies:	
Preventive Maintenance: Total Hours PM/Total Maintenance Hours Available	~20%
Predictive Maintenance: Total Hours PdM/Total Maintenance Hours Available	~50%
Planned Reactive Maintenance: Total Hours PRM/Total Maintenance Hours Available	~20%
Reactive Emergency: Total REM/Total Maintenance Hours Available	~2%
Reactive Non-Emergency: Total RNEM/Total Maintenance Hours	~8%

Available	
Plant Availability:	
Available Time/ Maximum Available Time	> 97%
Contractors:	
Contractors Cost/Total Maintenance Cost	35-64%

Source: Mitchell J.S (2007), Physical Asset Management Handbook, 6th Edition

2.6Plant Maintenance strategies for large manufacturing firms

Maintenance is defined as any activity carried out on an asset in order to ensure that the asset continues to perform its intended functions. Organizations use different maintenance strategies of which all are intended to overcome the problems which are related to machine and equipment breakdown. The strategic approaches commonly used in manufacturing industries are corrective maintenance and preventive maintenance strategies, (Pophaley, 2010).

The approach to corrective maintenance is totally reactive and only act when the equipment needs to be fixed. This strategy has no routine maintenance task and also described as non-scheduled or breakdown maintenance strategy. The activity may consist of repairing, restoration or replacement of components. This approach is costly; therefore it is only suitable for non-critical areas with low capital costs, slight consequences of failures, no safety risk, quick identification of failures, and fast repairs, (Starr,1997).

Wireman (1990) stated that comprehensive preventive maintenance program can be divided as follows: routine (lubrication, cleaning, inspection)which takes care of small problems before they cause equipment failure; proactive replacements done to deteriorating or defective components before they can fail; scheduled refurbishing which is done during a shutdown or outage to all known or suspected defective components when all are replaced; predictive maintenance is an advanced form of routine inspections using technologies like vibration analysis to predict a failure before it actually occurs; condition-based maintenance which is based on “real-time” inspection through sensors installed on the equipment which is complicated and expensive, therefore, huge

investment is required; and reliability engineering where design engineering studies are performed to discover possible modifications of the equipment to prevent failures from occurring.

According to Wireman (1990), preventive maintenance increases maintenance personnel costs as well as repair parts costs while on the other hand decreasing the costs for scrap or quality, downtime, and loss of sales. Firms should balance the two strategies in their effort to optimize the maintenance activities and costs, overdependence on one strategy leads to loss of revenue either through, high manpower ratio, excess spending on spares or unnecessary stoppages during production time.

2.6.1 Plant maintenance in other places of the world

In Malaysia, the study reveals that the quality of maintenance practices in the manufacturing firms are still far much below the world best. Very little attention is given to the productivity and maintenance of the machines. Planning guidelines for manufacturing firms to promote value addition and encourage equipment maintenance are not in place and the use of "knowledge workers" in the firms is crucial but not given a deserved attention, (Masjuki, 2001).

Plant maintenance strategy in Thailand involves mostly a low level of reactive maintenance or "fire fighting" behavior and most of manufacturing firms are in the process reducing reactive maintenance and increasing preventive, predictive and proactive maintenance due to good planning techniques being adopted. However, the percentage of preventive maintenance in Thailand is still low at 42-60% against the world best of not less than 85%. The study also indicates that improvement on proactive maintenance practice had significantly impacted on plant uptime and maintenance cost, (Roengchai, 2009).

A study of maintenance strategies in automobile industries in India has shown that before 1990s when the country's economy was protected and controlled, the automotive industry executives did not pay much attention towards equipment related failures and losses. Maintenance was viewed as a reactive problem fixing activity. Pressures from customers

to reduce costs, defects and lead time have forced management to pay attention towards maintenance and allied issues through improvement drives like world class maintenance. Tough competition from global players being faced on Indian automotive industries has forced the industry players to put more effort in reducing costs, improving quality, and offering more variety of products with improved services, (Maheshwari, 2013).

A study of Maintenance strategies of power plant operators in Germany has shown that maintenance is one of the parameters crucial to the total price of electricity and is also one of the parameters which can be actively influenced by the power plant operators. Up to 30% of all electricity generating costs accrue from maintenance. The systematic application of condition based maintenance is a requirement and plant specific improvement potentials can be achieved with the help of a best practices comparison and measures, (Graber, 2004).

The study on implementation of preventive maintenance programme in Nigerian, Egbin power plant between 2005 and 2009 has shown that availability of unit1 varies between 59.11% to 91.76%; unit 2, 64.02% to 94.53%; unit 3, 28.79% to 91.57%; unit 4, 80.31% to 92.76% and unit 5, 73.38% to 87.76% against the world best of over 95%. This was due to differences in their systems installation, maintenance practices and operation. Better objectives and specific targets are needed for the Egbin power station to improve maintenance management systems and productivity. This should be based on a new maintenance paradigm that will improve maintenance control and preventive maintenance activities. The management must formulate good strategies, make decisions and monitor progress against plans by collecting, retrieving and analyzing data, **(**Olayinka et al, 2011)

2.7 Challenges in plant maintenance strategies used by large manufacturing firms in Kenya

Kenyan large manufacturing firms face numerous challenges in their effort to implement maintenance strategies, addressing these challenges can influence their capability to produce quality products at a low cost and speed to reach customers in good time. The

challenges differ from one firm to the other and from one sector of the economy to the other.

Kenyan pool of available skilled maintenance technicians is diminishing and the existing maintenance workforce is aging and approaching retirement. This reality, coupled with the fact that Polytechnics have been converted to universities and none are coming up,has created a shortage of maintenance technicians in the industry. Machine operator without technical training background is believed to cause up to 85% of process related failures and 15% people related failures a tough fact to live in the current competitive world,(Ahuja, 2008). Finding, training and retaining skilled maintenance person has become a serious challenge in maintenance function in large manufacturing firms in Kenya.

“Keep the distance” is practiced in many organizations. Boundaries between management and non-management staff impede flow of information and foster indifference among employees. The same is true among the various departments of the organization. For example maintenance does not fully trust production to carry out autonomous maintenance. Top management unwillingness to adopt new ideologies in their firms have affected maintenance practices through application of outdated technologies and practices in carrying out maintenance activities, the firms needs to be fearless, and be ready to adapt and change with the environment to remain competitive, (Prasat et al, 2003).

Effective maintenance has changed significantly in recent years. Maintenance today is far more a technology based activity than it is a repair or ‘fix it’ activity; this has been so due to demand for a far greater emphasis on predicting and forecasting maintenance needs. Maintenance must be able to demonstrate a measurable return on investment and must be able to justify its existence by showing how effective maintenance reduces machine downtime, reduces overtime needed to meet production schedules, improves on-time delivery and improves the quality of the product. Maintenance function usually does not know how to rationalize their participation in the savings and this has contributed to unwillingness by management to commit resources to maintenance, (Gillet, 2001).

New maintenance concepts and practices implementation requires investment by the top management in terms of resources (personnel, materials, money and time), due to lack of convincing justification in most of the cases, management considers new concepts as an unnecessary expenditure and drain on firm's resources, thereby resisting calls for implementation of the same and finding out ways and means not to allocate budget for its implementation.

Standard Operation Procedures (SOP) is set of clearly written down instructions that document any activity followed by an organization. They document the way activities are to be performed to facilitate consistent conformance to technical and quality system requirements and assist an organization to maintain quality control and quality assurance processes, (United States Environmental Protection Agency, 2007). Clearly written down procedures ensure that the equipments are run properly and the probability of failure is minimized. Maintenance in organizations fail, not because of people, but because lack the systems, procedures, methodologies and disciplines to be successful. Maintenance activity, without the above will not work effectively. Kenyan manufacturing firms have inadequate capacity to prepare sufficient SOPs.

Effective maintenance organizations must have leadership that is able to plan, both strategically and tactically. This leadership must be able to create an environment of change which is not commonly found in most maintenance teams. Maintenance leadership must be able to convince the team that they need to think and work differently than they have in the past. Maintenance needs leadership that is driven by results, not activity. Maintenance manager must control the spending on spare parts and supplies which constitute up to 60% of maintenance cost, stop focusing on repair maintenance which consumes production time and focus on reliability centered maintenance, (Prasat et al, 2003).

In many manufacturing firms, sufficient time for maintenance of equipments is not given, pushing the maintenance crew to carry out the minimum maintenance required to restart the equipment and keep it running to meet the daily requirements, giving no space for innovation and creativity .There is also a general feeling within the manufacturing firms that the design given by the Original Equipment Manufacturer (OEM) is sacrosanct. This

has affected maintenance function in the area of creativity to run sustainable, efficient and reliable machines, (Prasat et al, 2003).

2.8 Summary and Conceptual framework

This section summarizes types of plant maintenance strategies used in large manufacturing firms, challenges faced by the firms in using the strategies, the gaps to be filled in the study, inputs and outputs of maintenance function.

2.8.1 Summary

From the literature above, maintenance process supports production process to be competitive and it constitutes not less than 10% of production cost. Maintenance strategies are broadly divided in to two: preventive and repairs maintenance strategies. There are five maintenance concepts; Reliability Centered Maintenance (RCM); Total Productive Maintenance (TPM); Root Cause Failure Analysis(RCFA); Terotechnology; and Total Quality Maintenance (TQMain). Different strategies and concepts are used by various large manufacturing firms meet their maintenance requirements.

Maintenance strategies used in the firms face numerous challenges which can be classified as: people based, culture based, equipment and tools based, financial based, system based and management based. Finally it is important for local manufacturing firms to benchmark with the world best strategies in maintenance to help increase the productivity of maintenance. Most firms still use outdated maintenance practices thereby affecting their productivity hence competitiveness. It is worth learning that implementation of good maintenance strategies are critical for Large manufacturing firms in Kenya to produce superior quality goods, with flexibility, within the shortest time possible and at competitive cost to meet consumers specification and expectation.

This study seeks to explore the strategies used in Kenyan manufacturing industries, challenges faced in using the strategies and the extent at which Kenyan manufacturing firms conform to world best maintenance strategies. The study is worthwhile since very few studies have been done in this area in Kenya. The only recent studies done were on KenGen maintenance practices; in thermal, geothermal and hydro power plants, and on maintenance practices on medical equipments in Kenyan public hospitals.

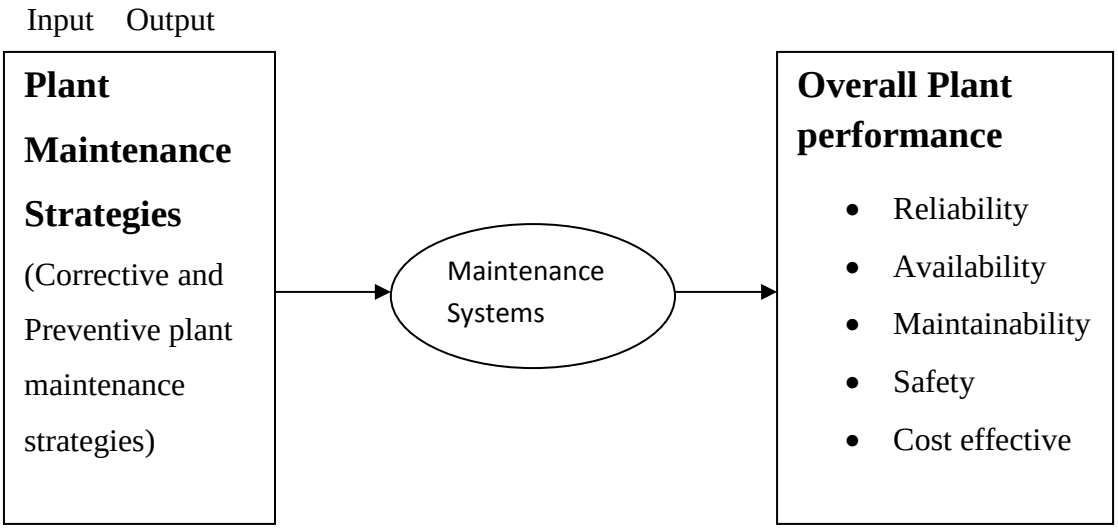
2.8.2 Conceptual framework

Plant maintenance is a secondary activity that aids a manufacturing firm to carry out production processes. Production is a function within the firm and the performance of the production function affects the firm's performance. On the other hand the performance of the maintenance system affects the production process.

Inputs or independent variables in the maintenance function are resources maintenance strategies containing elements like labor, materials, spares, tools, information, money and external services which are made available to the maintenance function through other functions like human resource function, procurement functions and others, within the enterprise and production systems. The maintenance system generates output or dependent variable in the form of plant overall performance with measures like availability of the plant, reliability of the plant, maintainability the plant and safety operation of the plant.

Maintenance system through maintenance strategies gets labor in terms of skill and experience; material in terms of maintenance consumables; spares in terms of machine and equipment spare parts; tools to help in carrying out maintenance activities; information regarding new technologies, training; money to invest in new technologies and services and external services like outsourcing maintenance services to support internal maintenance activities as given in the Fig 1. The maintenance system on receiving the inputs ensures that the machines are available, safe, reliable and maintainable for the production process to continue at a competitive cost. A successful production process, output, produces goods of quality to meet consumer's expectation and specification. The goods will generate revenue and hence profit for the firm.

Figure 1: Conceptual Model



Source: Researcher (2014)

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Design

The research involved a cross sectional survey of the large manufacturing companies operating in Kenya under Kenya Association of Manufacturers (KAM). The study adopted a descriptive approach because of its ability to describe and compare variables numerically. The focus was on large manufacturing firms in Nairobi, which comprises approximately 80% of KAM membership. According to Emory (1995), a survey is feasible when the population is small and variable hence the researcher is able to cover all the elements of the population. Therefore the survey of 80% of large manufacturing firms in Kenya was more productive.

3.2 Population of the Study

The population of the study in this research was large manufacturing companies in Kenya which are based in Nairobi and are members of Kenya Association of Manufacturers (KAM). According to KAM directory (2011), there is a population of 455 large manufacturing companies operating in Nairobi. KAM has classified the companies in sectors of operation as: energy, chemical, food and so on as shown in Table 2.

3.3 Sampling Design

Stratified random sampling method was used to come up with the sample. The population of large manufacturing firms was considered to be heterogeneous due to different manufacturing processes, therefore random sample would have been unrepresentative. Stratified random sampling involves selecting subjects 'in such a way that the existing subgroups in the population are more or less reproduced in the sample', (Mugenda & Mugenda, 2003). Cooper and Schindler (2006), has shown that this ensures that each manufacturing sub-sector is represented. Mugenda and Mugenda (2003) has indicated that at least 10% of the target population is important for the study, therefore the study used 10% of the target population as shown in Table 2.

Table 2: Sample Size

Sector	No. of firms (Population)	Percentage (%) of total	Respondents (Sample size)
Energy	42	9.2	4
Chemical	62	13.5	6
Food and Beverages	100	22	10
Plastics and Rubber	54	11.9	5
Building	6	1.3	1
Paper	48	10.5	5
Textile	38	8.4	4
Timber and Wood products	22	4.8	2
Motor Vehicle Assembly and Accessories	17	3.7	2
Metal and Allied	38	4.4	4
Pharmaceuticals and Medical Equipments	20	8.4	2
Leather products	8	1.8	1
Total	**455**	**100**	**46**

Source: Kenya Association of Manufacturers (KAM) Directory,(June, 2011).

The physical location of the firms in each stratum was established through Google maps and Kenya Postel Directories telephone directory. The firms located along the same road were selected and visited first to save on time and travelling cost. The firms on road with the highest number of firms falling in the same stratum were given priority and visited first to reduce the distance to be covered.

The respondents were the head of maintenance function for every manufacturing firm sampled. The head of maintenance being the function leader must be well versed with the firms' plant maintenance strategies and the overall firms' strategy.

3.4 Data Collection

The study used primary data. The primary data was the most appropriate in the study due to the following reasons: the researcher had greater control of the questions to be asked and could address specific issues, he could focus on both qualitative and quantitative issues and finally primary data gave unbiased, original and reliable data.

The data was collected through questionnaire. The questionnaire consisted of both open and closed ended questions that were designed to drive out specific responses for qualitative and quantitative analysis respectively. Structured questionnaire was used to allow for uniformity of responses to questions. The questionnaire had three sections. The first section contained questions on maintenance strategies used in the large manufacturing firms in Kenya; the second part was on the challenges faced in implementation of strategies used in large manufacturing firms in Kenya and third was on benchmarking maintenance strategies in large manufacturing firms in Kenya with the world best maintenance strategies.

The questionnaires were administered through drop and pick method of self-administered questionnaire. A self-administered questionnaire was desirable because of low cost, adequacy of time for respondents to give responses, it was free of interviewer's biases and a large number of respondents were reached (Kothari, 2004).

3.5 Data Analysis

Descriptive statistics including the mean and standard deviation were used to get information for the strategies used by large manufacturing firms in Kenya and the challenges large manufacturing firms in Kenya face in implementation of the strategies used.

The mean which is a measure of central tendency that describes how the data cluster around the central point was used as one of the tools of data analysis. The mean was calculated on Likert scale data describing the strategies and challenges. For a 5 point scale, a mean of 3 and above indicated that the strategy is popularly used by all the firms or the challenge is experienced by all the firms. The Standard deviation which describes the extent of spread of data values around the mean was also calculated on the same data

to establish the variability of the scores in the above condition. A lower value of standard deviation indicated consistency while a higher value indicated inconsistency.

For benchmarking the large manufacturing firms in Kenya plant maintenance strategies with the world best maintenance strategies, the mean of the plant maintenance strategies used by large manufacturing firms in Kenya was calculated. The ratio (R) was then calculated with respect to world best maintenance strategies. The ratios equal to 1 were indication of strategy conforming to world best maintenance strategy, otherwise it was not.

The linear correlation coefficient (r) was also calculated to determine the strength and direction of linear relationship between the world best plant maintenance strategies and plant maintenance strategies used by large manufacturing firms in Kenya. The value of rwas such that -1 <= r<= +1.

The results were calculated using the equation: $r = COV(X, Y)/\sigma_x*\sigma_y$

Where:

X = Plant maintenance strategies used by large manufacturing firms in Kenya.

Y = World best plant maintenance strategies.

σ_x= standard deviation of X variables.

σ_y = standard deviation of Y variables.

CHAPTER FOUR: DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter presents the analysis, findings and presentation of the study. The findings are presented in percentages, ratios, covariance, mean and standard deviations. A total of 58 questionnaires were dropped to respondents, one extra questionnaire to each sector. A total of 49 questionnaires were filled in and returned. This represented a response rate of 84% and 6% above the targeted sample size of 46 respondents.

4.2 General information

The general information considered in this study included professional background of respondents, gender, length of continuous service with the organization and the duration the organization has been in existence.

The study has revealed that 53% of the people heading maintenance function have engineering background while the remaining 47% are from different professional backgrounds, an indication of lack of commitment of senior management to assign professionals to handle maintenance activities. Among the respondents, 94% are male and 6% are female, a clear indication of male dominance in the field of maintenance. All heads of maintenance function have college education and above which could be due to the nature of responsibility and skills associated with maintenance. Most (85.7%) of the heads of maintenance functions have been in continuous service in their respective organizations for less than 5 years, 14.3% between 6 and 10 years, while none has served for more than 10 years. Most of the respondents did not respond to the question enquiring about the duration the company has been in operation. Only 6% responded with uncertain answers. The answers were like over 40 years, approximately 20 years and so on. The results are as tabulated in Table 3.

Table 3: Background information

Information		Frequency	Percentage
Professional background	Engineering	26	53
	Others	23	47
Gender	Male	46	94
	Female	3	6
Education background	college level and above	49	100
	Below college level	0	0
Length of continuous service	0 - 5 years	42	85.7
	Above 5 years	7	14.3
Duration company has been in operation	Response	6	6
	No response	43	94

4.3 Plant maintenance strategies used by large manufacturing firms in Kenya

One of the objectives of the study was to establish the plant maintenance strategies used by the large manufacturing firms in Kenya. The questions regarding the strategies were operationalised and the results were as given in Table 4.

4.3.1 Breakdown (corrective) maintenance strategy

Breakdown maintenance strategy is the most predominant strategy used by large manufacturing firms in Kenya. Table 4 below presents a summary of findings regarding the breakdown strategy.

Table 4: Breakdown maintenance strategy

	Maintenance strategies	Mean	Standard deviation	% of positive response
1.	Maintenance activities are carried out by work orders	4.8	0.5	100
2.	Work orders are generated by breakdown maintenances	4.6	0.8	98
3.	Large proportion of monthly maintenance hours available are used in reactive emergency maintenance.	3.94	0.71	93.9
4.	Spares parts are normally sourced with urgency.	3.7	1.1	80
5.	Contractors are always sourced without	3.3	1.3	69

	prior arrangements.			
6.	Equipments are run to fail	1.6	0.8	10

From the findings in Table 4, all firms (100%) use work orders to initiate maintenance activities with a mean of 4.8 on Likert scale and a standard deviation of 0.5. This is a positive process in that maintenance history can be gathered and the information can be used for future planning for spares, manpower and scheduled preventive maintenance. Majority of the work orders generated are for breakdown maintenance with98% of the respondents confirming this with a mean of 4.6 on Likert scale and standard deviation of 0.8, meaning that the practice is common across the large manufacturing firms in Kenya.

Large proportion (93.9%) of monthly maintenance hours available are used to perform reactive emergency maintenance with a mean of 3.94 on Likert scale and standard deviation of 0.71,a clear indication that this strategy is popular among large manufacturing firms in Kenya. The respondents have anonymously (80%) agreed that spare parts are normally sourced with urgency. A mean of 3.7 on Likert scale and a standard deviation of 1.1 are indication of fire fighting within the maintenance function. Sourcing contractors without prior notice is sign of reactive maintenance to take care of unplanned breakdowns. A good percentage (69%) of the respondents is in agreement that contractors are sourced without prior notice. A mean of 3.3 on Likert scale with a standard deviation of 1.3 is an indication of prevalence of the activity among the large manufacturing firms in Kenya.

The results also indicate that firms rarely run their machines to fail. Only 10% of the respondents run their machines to fail due to the nature of the design of the machines. A mean of 1.6 on Likert scale and standard deviation of 0.8 confirms that this strategy is not popular within the large manufacturing industries in Kenya.

4.3.2 Preventive maintenance strategy

Although breakdown maintenance strategy is seen to be the most dominant strategy, large manufacturing firms in Kenya also use preventive maintenance strategies to some extent. Table 5 presents a summary of findings regarding preventive maintenance strategies.

Table 5: Preventive maintenance strategy

	Maintenance strategies	Mean	Standard deviation	% of positive response
1.	Work orders are planned (labor, materials, checklists etc) before the outage.	3.4	1.5	65
2.	Monthly total available maintenance hours are dedicated to planned reactive maintenance.	3.36	1.05	71.4
3.	Monthly total available maintenance hours are dedicated to predictive maintenance.	3.2	1.2	51
4.	Programmed work is done as scheduled without any delay due to lack of materials.	3.2	1.1	53
5.	Failures in machines are detected before the machines fail.	3.66	1.44	69.4
6.	Work allocated to the maintenance team on a daily basis is preventive maintenance.	4.1	1.1	88
7.	Maintenance personnel spend free time on plant housekeeping.	4	1	94

Table 5 shows that the work orders are planned before the machines fail. This is a clear indication of planned preventive maintenance among large manufacturing firms in Kenya.Most of the respondents (65%) plan their preventive maintenance in advance. A mean of 3.4 on Likert scale and standard deviation of 1.5 are indication of popularity and acceptability of the strategy among the firms. The respondents (71.4%) are in agreement that total monthly available maintenance hours are dedicated to planned reactive maintenance. A mean of 3.36 on Likert scale and a standard deviation of 1.05 are indication of unanimous acceptance of the strategy among the firms.

Predictive maintenance strategy is not very popular among the manufacturing firms with 51% of the respondents being in agreement that the firms use this kind of maintenance strategy. A mean of 3.2 on Likert scale and standard deviation of 1.2 indicates the acceptability of the strategy among the firms. Programmed work sometimes fails to be done as scheduled due to lack of materials. Only 53% of the respondents agree that work

programmed does not delay due to lack of materials. A mean of 3.2 on Likert scale and standard deviation of 1.1 are indications that programmed work is done as scheduled without any delay due to lack of materials. Failures in machines are detected before the machines fail. Majority of the respondents (69.4%) are in agreement with the strategy. A mean of 3.36 on Likert scale and a standard deviation of 1.44 are indications of proactive preventive maintenance being popular among the large manufacturing firms.

There is general agreement that work allocated to the maintenance team on a daily basis is preventive maintenance. Most of the respondents (88%) are in agreement with the practice. A mean of 4.1 on Likert scale and standard deviation of 1.1 are indication of the popularity of the practice within the manufacturing firms. Another practice popular with the manufacturing firms is autonomous maintenance where 94% of the respondents are in agreement with the strategy that allows maintenance personnel to spend free time on plant housekeeping. A mean of 4.0 on Likert scale and standard deviation of 1.0 are clear indication of popularity of the strategy among the large manufacturing firms in Kenya.

4.4 Challenges in plant maintenance strategies used in large manufacturing firms in Kenya

Another objective of the study was to establish the challenges faced by the large manufacturing firms in Kenya in their effort to implement plant maintenance strategies used. The questions regarding the strategies were operationalised and the results were as given below.

4.4.1 Culture based challenges

Culture of the organization determines how the organization will handle issues especially new ideas and how it will relate to external environment. It determines how the organization wants to be viewed at any level. The Table 6 gives results on how culture affects the implementation of plant maintenance strategies in large manufacturing firms in Kenya.

Table 6: Culture based challenges

	Maintenance challenges	Mean	Standard deviation	% of positive response
1.	Culture of the organization affects maintenance activities.	3.28	1.61	55.1
2.	Negative work culture affects maintenance activities.	4.56	0.5	100
3.	Firms resistance to change culture affect maintenance activities	3.71	0.68	95.9

From the results in Table 6, 55.1% of the respondents are in agreement that culture affects the maintenance activities. A mean of 3.28 on Likert scale and a standard deviation of 1.61 are indications that there is a general consensus that culture of the organization affects plant maintenance strategy. Negative work culture affects maintenance activities negatively with 100% of the respondents in agreement. A mean of 4.56 on Likert scale and standard deviation of 0.5 are indications of strong concurrence among the respondents. Resistance to culture change is another factor affecting the implementation of maintenance strategies with 95.9% of the respondents in the agreement. A mean of 3.71 on Likert scale and standard deviation of 0.68 are indication of how the challenge is prevalent among the large manufacturing firms in Kenya.

4.4.2 People based challenges

People through their actions or failure to act affect maintenance activities. Lack of appropriate skills or basic technical skills affect the implementation of plant maintenance strategies in the large manufacturing firms in Kenya. The results are as presented in Table 7.

Table 7: People based challenges

	Maintenance challenges	Mean	Standard deviation	% of positive response
1.	People through their actions affect	3.46	1.14	69.4

	maintenance activities.			
2.	Lack of basic machine operation skills affects maintenance activities.	4.1	0.82	95.9
3.	Lack of basic technical training skills affects maintenance activities	3.75	1.4	83.7
4.	Lack of expertise training skills affects maintenance activities	4.06	0.79	98

The results in table 7 indicate that 69.4% of the respondents are in agreement that people through their actions affect maintenance activities. A mean of 3.46 on Likert scale and a standard deviation of 1.14 are indication of concurrence within the large manufacturing firms. Lack of skills like basic machine operation skills, basic technical skills and expertise skills affect maintenance activities. Most of the respondents (95.9%)are in agreement that lack of basic machine operation skills affects plant maintenance. A mean of 4.1 on Likert scale and a standard deviation of 0.82 are good indication the concurrence within the firms. Most of the respondents (83.7%) have indicated that lack of basic technical skills can affect maintenance activities. A mean of 3.75 on Likert scale and a standard deviation of 1.4 confirm the challenge. A huge percentage (98%) of the respondents are in agreement that lack of expertise training skills affects maintenance activities with a mean of 4.06 on Likert scale and a standard deviation of 0.79, hence a common challenge on maintenance in large manufacturing firms in Kenya.

4.4.3 Equipments and tools based challenges

Tools and equipments are some of the critical components in the execution of maintenance strategies. Lack or inadequate supply of them could be a big challenge in the implementation of the plant maintenance strategies used in large manufacturing plants. Table 8 gives the results on how equipment and tools based challenges impact on plant maintenance strategies used in large manufacturing firms in Kenya.

Table 8: Equipment and tools based challenges

	Maintenance challenges	Mean	Standard deviation	% of positive response
1.	Tools and equipments used in maintenance activities affect maintenance activities.	4.19	0.91	93.9
2.	Lack of tools affects maintenance activities.	4.29	0.76	93.9
3.	Outdated technology affects maintenance activities.	3.94	1.0	91.8

From Table 8, most of the respondents (93.9%) are in agreement that tools and equipments used in maintenance affect maintenance activities. A mean of 4.19 on Likert scale and a standard deviation of 0.91 are clear indication of how tools and equipment are critical to maintenance activities. Lack of tools could be a big challenge in the implementation of plant maintenance in large manufacturing firms in Kenya. Majority of the respondents (93.9%) are in agreement that lack of tools affects their maintenance activities. A mean of 4.29 on Likert scale and a standard deviation 0.76 are indication of general concurrence within the manufacturing firms. There is also a general consensus that outdated technology is a challenge in the implementation of maintenance of maintenance strategy with 91.8% of respondents being positive that it is a challenge. A mean of 3.94 on the Likert scale and a standard deviation of 1.0 are indication that most of the firms are in agreement that indeed it is a challenge.

4.4.4 Financial based challenges

All functions in the organization need finance to perform their daily activities. Maintenance as a function within the firm needs to be financially enabled to help it perform its core activities. Lack of financing or inadequate budget can impact negatively on the performance of maintenance function. Table 9 presents the results on financial

based challenges affecting the implementation of plant maintenance strategies used in large manufacturing firms in Kenya.

Table 9: Financial based challenges

	Maintenance challenges	Mean	Standard deviation	% of positive response
1.	Financial aspects constrain your maintenance activities	4.08	0.8	95.9
2.	Uncontrolled maintenance costs affect maintenance activities.	3.4	0.79	95.9
3.	Inadequate maintenance budget affects maintenance activities.	3.81	0.97	91.8
4.	Unwillingness by management to commit resources affects maintenance activities.	3.96	0.96	89.8

From Table 9, 95.9% of the respondents are in agreement that financial aspects constrain maintenance activities within large manufacturing firms in Kenya. A mean of 4.08 on Likert scale and standard deviation of 0.8 are clear indication of prevalence of this challenge within manufacturing firms in Kenya. Uncontrolled maintenance cost affects maintenance activities (mean of 3.4 on Likert scale and standard deviation of 0.79), inadequate maintenance budget is also a challenge in the implementation of plant maintenance strategies (mean of 3.81 on Likert scale and standard deviation of 0.97) and unwillingness of management to commit resources to maintenance activities also affect the implementation of plant maintenance strategies (mean of 3.96 on Likert scale and a standard deviation of 0.96).

4.4.5 System and management based challenges

Good and supportive management is a key to success in most of the firms. There must be good and appropriate system to run the firms and the management should always support the system. Table 10 presents the results on system and management based challenges

affecting the implementation of plant maintenance strategies used in large manufacturing firms in Kenya.

Table 10: System and management based challenges

	Maintenance challenges	**Mean**	**Standard deviation**	**% of positive response**
1.	Management systems have no effect maintenance activities	2.96	1.07	67.3
2.	Maintenance leadership can fail maintenance activities.	3.63	0.91	87.8
3.	Procurement of maintenance spares is a challenge in maintenance activities.	3.63	1.03	81.6
4.	Inability to plan has no effect in maintenance activities.	1.94	0.8	10.2
5.	Procurement of maintenance machines is a challenge in maintenance activities.	3.67	0.8	77.6
6.	Inability to design change has no effect in maintenance activities.	3.0	0.95	77.6
7.	Inability to repair machines in time has no effect in maintenance activities.	1.1	0.31	0

From Table 10, management systems have impact on maintenance activities. A reasonable percentage (67.3%) of the respondents disagree that management systems do not affect maintenance activities (mean of 2.96 and standard deviation of 1.07) Maintenance leadership is also a challenge with 87.8% of the respondents in agreement with a mean of 3.63 and standard deviation of 0.91.Inability to plan is another challenge arising from management. Only 10.2% of the respondents are in agreement that maintenance activities can be done without proper planning. A mean of 1.94 and standard deviation of 0.8 are clear indication that good and effective planning is mandatory for the success of maintenance strategies.

Procurement of maintenance spares and tools is a big challenge to maintenance process with 81.6% of the respondents in agreement with a mean of 3.63 and standard deviation of 1.03. Failure to repair machines in time could heavily impact on the maintenance activities with none of the respondents (0%) is in agreement that inability to repair machines in time does not affect maintenance activities. A mean of 1.1 on Likert scale and standard deviation of 0.3 are indication that speed of machine repair is essential in plant maintenance strategies. A good percentage (77.6%) of the respondents is in agreement that change of machine design does not impact on maintenance activities. A mean of 3.0 on Likert scale and standard deviation of 0.95 indicates the acceptability of the fact.

4.5 Benchmarking plant maintenance strategies used in large manufacturing firms in Kenya with world best strategies

The last objective of this study was to establish whether the maintenance strategies in large manufacturing firms in Kenya conform to world best maintenance strategies. Questions were asked regarding the plant maintenance strategies used in the industry and results were tabulated and compared with the word best strategies. Table 11 presents the results obtained from large manufacturing firms in Kenya.

Table 11: Benchmarking plant maintenance strategies used in Kenya with world best

Maintenance strategies	Bench mark	Actual	Ratio	Actual %	Bench mark %	Variance %
Maintenance activities are carried out by work orders	5	4.8	1.04	96	100	-6
Work orders are generated by breakdown maintenances	1	4.6	0.22	92	10	-82
Large proportion of monthly maintenance hours available are used in reactive emergency maintenance.	2	3.94	0.51	78.8	15	-63.8
Spares parts are normally	2	3.7	0.54	74	10	-64

sourced with urgency.						
Equipments are run to fail	1	1.6	0.63	32	10	-22
Contractors are always sourced without prior arrangements.	2	3.3	0.61	66	64	-2
Work orders are planned (labor, materials, checklists etc) before the outage.	5	3.4	1.47	68	90	-22
Monthly total available maintenance hours are dedicated to planned reactive maintenance.	5	3.36	1.49	67.2	85	-17.8
Monthly total available maintenance hours are dedicated to predictive maintenance.	3	3.2	0.94	64	50	14
Programmed work is done as scheduled without any delay due to lack of materials.	5	3.2	1.56	64	90	-26
Failures in machines are detected before the machines fail.	4	3.66	1.09	73.2	50	23.2
Work allocated to the maintenance team on a daily basis is preventive maintenance.	4	4.1	0.98	82	20	62
Injuries in a year are OSHA recordable injuries.	1	3.96	0.25	79.6	20	-57.6
Maintenance personnel spend free time on plant housekeeping	5	4	1.25	80	96	-16
Most monthly work orders are reworked.	1	4.5	0.22	90	0	-90
Workers attend training in a year	4	4.8	0.83	96	90	6
Use contractors dependent	3	2.8	1.07	56	35 - 64	0

on the total maintenance work load.						
COVARIANCE (r)	**0.142**					

From the results in Table 11, the findings are positive in the use of work orders to carry out maintenance activities with 96% of maintenance activities done through work orders against benchmark of 100%. Sourcing of contractors and use of contractors in relationship to maintenance workload are within the world best with 66% against 64% and 56% against 35 to 64% respectively. Hours dedicated to predictive preventive maintenance is also encouraging with 64% of the total available maintenance hours are used against world best of 50%. Detection of failures before machine fails is quite positive with large manufacturing firms in Kenya. About 73.2% of the failures are detected before the actual failure against a benchmark of 50%. Percentage of preventive maintenance work assigned to workers is quite high with large manufacturing firms in Kenya recording 82% against world best of 20%. Also large manufacturing firms in Kenya train most of their workers, with 96% of the workers receiving training annually against world best of 90%.

The results from the table indicate that corrective maintenance is the most prevalent strategy used by large manufacturing firms in Kenya. Most work orders (92%) are generated by breakdown against a benchmark of 10%. Reactive emergency maintenance work is 78.8% against benchmark of 15%. Sourcing of spare parts with urgency is at the rate of 74% against a benchmark of 10% and running of equipments to fail at the rate of 32% against a benchmark of 10%. Planning of maintenance activities is another area in which large manufacturing firms in Kenya are performing poorly. Planning of work orders before outage is at a 68% against benchmark of 90%, planned reactive maintenance is at 67.5% against a benchmark of 85% and planning for maintenance materials at 64% against a benchmark of 90%.

Of concern is rework of works orders which is quite high at a rate 90% against world best of 0%. OSHA recordable injuries are also quite high occurring at a rate of 79.6% against a benchmark of 20% injuries in a year.

Though large manufacturing firms in Kenya plant maintenance strategies are not matching word best, more effort is in place to help the firms conform to the world best, a covariance of 0.142 is clear indication of positive improvement.

4.6 Discussions

The study found out that only half of the personnel heading maintenance function have engineering training background and most of them have been in continuous service in one firm for less than five years. The emergence of generation "Y" has posed some serious challenges on the retention of employee. Marais (2013) on her study, "Retention and engagement of generation 'Y' engineers", argued that the demands of this generation like having good work identity, getting what they expect from the company and how they receive it in terms of personal development, promotion, growth, challenging work and work life balance is too much and makes them leave jobs after a very short time of service.

The maintenance function is dominated by male personnel with only less than 10% are women. For the past 20 decades, 20% of engineering graduates have been women, yet only 11% of practicing engineers are women. Compared with other skilled professions such as accounting, medicine and law, engineering has the highest turnover of women, (Nadya Faud, 2011).

Large manufacturing firms in Kenya use a combination of both corrective and preventive maintenance strategies. Striking a balance between the two strategies is critical since excessive use of any one of the strategies will be expensive in long run. Too much of preventive maintenance will lead to high labour and materials costs while too much of corrective leads to lack of production time and high rate of machine replacement, (Oyedepo et al, 2011).

Almost all firms use works order system to generate maintenance jobs. Use of a work order system guards against overlooked requests for work to be done and makes it easier to schedule workload, hiring needs, timely ordering of supplies and materials, manufacturing, packing and shipping. Its significance is to provide record of business

activity that can be accessed for budget planning purposes and in the event of legal proceedings, (Nyman, 2006).

Corrective maintenance strategy is the most prominent within the firms with the following indicators: most of the work orders are generated by breakdown maintenance, spares are sourced with urgency, reactive emergency maintenance are common, contractors are sourced without prior notice and equipments run to fail. Reactive Maintenance (Breakdown Maintenance).This maintenance philosophy allows machinery to run to failure, providing for the repair or replacement of damaged equipment only when obvious problems occur. Studies have shown that the costs to operate in this fashion are about ksh 1200 per horsepower (hp) per year. The advantages of this approach are that it works well if equipment shutdowns do not affect production and if labor and material costs do not matter, Low cost and less staff is required. Disadvantages are increased cost due to unplanned downtime of equipment, increased labor cost, especially if overtime is needed, cost involved with repair or replacement of equipment, possible secondary equipment or process damage from equipment failure and inefficient use of staff resources, Piotrowski (2001).

Preventive maintenance can be defined as actions performed on a time- or machine-run-based schedule that detect, preclude, or mitigate degradation of a component or system with the aim of sustaining or extending its useful life through controlling degradation to an acceptable level. From the results preventive maintenance strategy is also used by most of the large manufacturing firms in Kenya with the following pointers: work orders are being planned in advance, most of the maintenance hours are used in planned reactive maintenance, machine failures are detected before they actually fail, most of daily work allocation is preventive and free maintenance personnel time is spent on housekeeping a sign of autonomous maintenance. Advantages of this strategy are: it is cost effective in many capital-intensive processes, its flexibility allows for the adjustment of maintenance periodicity, it increases component life cycle, it is energy savings, it reduces equipment or process failure, it is estimated to be12% to 18% cost savings over reactive maintenance program. The disadvantages include: catastrophic failures are still likely to occur, it is labor intensive, it includes performance of unneeded maintenance, and it has

potential for incidental damage to components in conducting unneeded maintenance, NASA, (2000).

Large manufacturing firms in Kenya face numerous challenges in their effort to implement plant maintenance strategies. The challenges affect the productivity and effectiveness of maintenance function. The challenges are: culture based which comes about due to negative work culture and resistance to change; people based as a result of lack of machine operation skills, lack of basic technical skills and lack of expertise training; tools and equipment based include: lack of tools and use of outdated technology; financial based challenges include: uncontrolled maintenance costs, inadequate budgets and unwillingness of the management to commit resources; systems and management based challenges include: lack of effective management systems, ineffective procurement systems, ineffective planning, inability to change machine designs to suit the process and inability to repair machines in time.

Implementation of maintenance strategies used in large manufacturing firms is not easy. Management has to invest in time, money and resources for a successful implementation. The organization as a whole should be dedicated and committed to the course. This requires transformation of work culture. There should be free flow of communication and information both horizontally and vertically transcending all levels within an organization. Processes need to be standardized and maintenance needs to be planned. Routine maintenance activities require to be carried out by operators to allow maintenance personnel to schedule modification. Extensive training has to be given throughout the organization benefits of good maintenance systems, Poduval et al (2013).

Maintenance is a unique business process. To be successfully managed, it requires an approach different from other business processes. Unlike any other reference in its field, Benchmarking Best Practices in Maintenance Management provides a framework for managing maintenance with options that allow decision makers to select the most successful ways to manage their businesses (Wireman, 2010). The findings are positive in the use of work orders to carry out maintenance activities, sourcing of contractors and use of contractors in relationship to maintenance workload, hours dedicated to predictive

preventive maintenance, detection of failures before machines fail, preventive maintenance work assigned to workers and in training of their employees.

The results indicate that corrective maintenance is the most prevalent strategy used by large manufacturing firms in Kenya. Corrective maintenance could be one the cause of high production cost in Kenya. Most work orders are generated by breakdown and reactive emergency maintenance work. Sourcing of spare parts with urgency is prominent and machines are run to fail. Planning of maintenance activities is another area in which large manufacturing firms in Kenya are performing poorly, this could be due to presence of few employed professionals in the maintenance field. Of major concern are reworks of work orders which are quite high, this could be due to incompetence of the technicians and artisans or lack of effective training. Though most of the plant maintenance strategies in large manufacturing firms in Kenya are not matching word best strategies, there is positive effort in place to help the firms conform to the world best.

CHAPTER FIVE: CONCLUSIONS AND RECCOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions and recommendations from the data analysis and findings on research objectives. The chapter is structured into conclusions, recommendations, limitation of study and suggestions for further research.

5.2 Conclusions

The study has found out that large manufacturing firms in Kenya use a combination of both corrective and preventive maintenance strategies. Most large manufacturing firms in Kenya use works order system to generate maintenance jobs which is generally regarded as one of the best practice in the industry.

Corrective maintenance strategy is the most prominent within the large manufacturing firms in Kenya with high prevalence of reactive maintenance, outsourcing of contractors without prior notice, sourcing of spare parts with urgency and running some equipment to fail. Preventive maintenance strategy is also used by large manufacturing firms to some extent. The work orders are planned in advance, enough time is located to plan reactive and general preventive maintenance by most of the large manufacturing firms.

There are numerous challenges faced by large manufacturing firms in Kenya in their effort to implement plant strategies. The challenges are: culture based with negative work affecting the implementation of maintenance strategies most. People based challenges due to lack both technical and operation skills affect the implementation of maintenance strategies. Lack of or inadequate tools and equipment affect the maintenance activities. Lack of enough budgets to support maintenance activities makes it difficult to implement maintenance strategies. Finally laxity in the procurement and poor maintenance leadership affects the implementation of maintenance strategies.

Most of the maintenance strategies used by large manufacturing firms in Kenya are not matching the word best practice. However, the research has shown that large manufacturing firms in Kenya are moving towards world best strategies with areas like the use of work orders nearly matching the world best.

5.3 Recommendations

Management has to invest in time, money and resources for a successful implementation of good maintenance strategies. The firms should be dedicated and committed to plant maintenance. The firms should balance the maintenance strategies to get the optimum levels of corrective and preventive maintenance strategies. Routine maintenance activities are required to be carried out by machine operators to allow maintenance personnel to schedule modification and other forms of preventive maintenance programs.

Extensive training has to be given throughout the organization to impart skills and knowledge to help workers appreciate the benefits of good maintenance practices. There is a need for transformation of work culture which affects maintenance activities. Purchase of maintenance spares to be done in time and management to be committed in ensuring there is always enough budget for maintenance activities.

Marching maintenance strategies with the world best is a continuous process and it takes years to realize the benefits, the firms should therefore not lose hope but to find the maintenance practices that are beneficial to their firms. There should continuous review and improvement of the maintenance strategies to help the firms compete in the market.

5.3.1 Implication on Policy, Theory and Practice

From the study, it is obvious that large manufacturing firms in Kenya predominantly use corrective maintenance strategy. This could be one of the contributing factors to the high cost of production. The results of this research should be used to challenge large manufacturing firms in Kenya to improve on the maintenance strategies to make them compete globally.

The challenges will help the firms to formulate policies to address them and hence improve the effectiveness of plant maintenance practices in the large manufacturing firms in Kenya.

5.6 Limitations of the study

The study focused only on large manufacturing firms and did not consider service providers, buildings and other facilities not related to direct manufacturing hence

limitation of accuracy of data collected. Other respondents were busy and could not be reached to give information while others were hostile and could not be reached. Some of the respondents could not answer questions directly related to their jobs or their bosses' jobs. All these could have affected the quality of the data. The study only used descriptive statistics to analyze the data which may not give accurate results.

5.7 Suggestions for further research

Further research is recommended to establish the reasons behind dominance of corrective maintenance strategies in manufacturing firms, the effect of plant maintenance strategies on the productivity of the firms and to expand the current research to include non manufacturing firms, buildings and other utilities.

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APPENDICES

APPENDIX I: QUESTIONNAIRE

Kindly note that the questionnaire is designed to gather information for academic purpose only and information given will be treated with a lot of confidence.

Kindly give answers in the spaces provided by either ticking (√) in the box provided or writing in the space provided.

Section A: General information

1. What is your designation in the organization: ……
2. What is your gender?

Female [ ] Male [ ]

3. What is the highest level of education you have attained?
    a. Primary school level or equivalent [ ]
    b. High school or equivalent [ ]
    c. College level or equivalent [ ]
4. Length of continuous service with the organization? …….
5. For how long has your company been operation? ……...

Section B: Plant Maintenance Strategies used by Large Manufacturing Industries firms

Please indicate by ticking (√) in the appropriate box how frequently your company uses maintenance strategies listed in the table below on the scale of 1 to 5,**where 1= never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always.**

Answer the questions by ticking (√) in the box

	Maintenance strategies	**1**	**2**	**3**	**4**	**5**
1.	Maintenance activities are carried out by a work orders					
2.	Work orders are generated by breakdown maintenances					
3.	Large proportion of monthly maintenance hours available are used in reactive emergency maintenance.					
4.	Spares parts are normally sourced with urgency.					
5.	Contractors are always sourced without prior arrangements.					
6.	Equipments are run to fail					
7.	Work orders are planned (labor, materials, checklists etc) before the outage.					
8.	Monthly total available maintenance hours are dedicated to planned reactive maintenance.					
9.	Monthly total available maintenance hours are dedicated to predictive maintenance.					
10.	Programmed work is done as scheduled without any delay due to lack of materials.					
11.	Failures in machines are detected before the machines fail.					
12.	Work allocated to the maintenance team on a daily basis is preventive maintenance.					
13.	Injuries in a year are OSHA recordable injuries.					
14.	Maintenance personnel spend free time on plant housekeeping.					

15.	Most monthly work orders are reworked.					
16.	Workers attend training in a year.					
17.	Use contractors dependent on the total maintenance work load.					

Section C: Maintenance challenges in Large Manufacturing Firms in Kenya

Please indicate your level of agreement with the statements below regarding challenges facing maintenance activities in your company on the scale of 1 to 5**, where: 1= strongly disagree, 2 = disagree, 3 = not sure, 4= agree, 5 = strongly agree.** Answer the questions by ticking (√) in the box.

	Maintenance challenges	**1**	**2**	**3**	**4**	**5**
1.	Culture of the organization affects maintenance activities.					
2.	Negative work culture affects maintenance activities.					
3.	Firms resistance to change culture affect maintenance activities					
4.	People through their actions affect maintenance activities.					
5.	Lack of basic machine operation skills affects maintenance activities.					
6.	Lack of basic technical training skills affects maintenance activities					
7.	Lack of expertise training skills affects maintenance activities					
8.	Tools and equipments used in maintenance activities affect maintenance activities.					
9.	Lack of tools affects maintenance activities.					
10.	Outdated technology affect maintenance					

	activities affects maintenance activities.					
11.	Financial aspects constrain your maintenance activities					
12.	Uncontrolled maintenance costs affect maintenance activities.					
13.	Inadequate maintenance budget affects maintenance activities.					
14.	Unwillingness by management to commit resources affects maintenance activities.					
15.	Management systems have no effect maintenance activities					
16.	Maintenance leadership can fail maintenance activities.					
17.	Procurement of maintenance spares is a challenge in maintenance activities.					
18.	Inability to plan has no effect in maintenance activities.					
19.	Procurement of maintenance machines is a challenge in maintenance activities.					
20.	Inability to design change has no effect in maintenance activities.					
21.	Inability to repair machines in time has no effect in maintenance activities.					

APPENDIX II:

LARGE MANUFACTURING FIRMS IN NAIROBI, KENYA

Energy Sector		
A.I Records (Kenya) Ltd	Modulec Engineering Systems Ltd	Kenwestfal Works Ltd
Amedo Centre Kenya Ltd	Mustek East Africa	Kenya Power & Lighting Co. Ltd
AssaAbloy East Africa Ltd	Nationwide Electrical Industries	Kenya Scale Co. Ltd/ Avery Kenya Ltd
Aucma Digital Technology Africa Ltd	East African Cables Ltd	Kenya Shell Ltd
Avery (East Africa) Ltd	Optimum Lubricants Ltd	Power Technics Ltd
Baumann Engineering Limited	Libya Oil Kenya Limited	Reliable Electricals Engineers Ltd
PCTL Automation Ltd	Pentagon Agencies	Sanyo Armo (Kenya) Ltd
Centurion Systems Limited	Power Engineering International Limited	Socabelec East Africa
Digitech East Africa Limited	Eveready East Africa Ltd	Sollatek Electronics (Kenya) Limited
Manufacturers & Suppliers (K) Ltd	Frigorex East Africa Ltd	Specialised Power Systems Ltd
Marshall Fowler (Engineers) Ltd	Holman Brothers (E.A.) Ltd	Pentagon Agencies
Mecer East Africa Ltd	IberaAfrica Power (EA) Ltd	Synergy-Pro
Metlex Industries Ltd	International Energy Technik Ltd	Tea Vac Machinery Limited

Metsec Ltd	Kenwest Cables Ltd	Virtual City Ltd
Chemical Sector		
Anffi Kenya Ltd	Maroo Polymers Ltd	Imaging solution (K) Ltd
Basco Product (K) Ltd	Match Masters Ltd	Interconsumer Products Ltd
Bayer East Africa Ltd	United Chemical Industries Ltd	Odex Chemicals Ltd
Continental Products Ltd	Oasis Ltd	Osho Chemicals Industries Ltd
Cooper K- Brands Ltd	Rumorth EA Ltd	PolyChem East Africa Ltd
Beiersdorf East Africa td	Sadolin Paints (E.A.) Ltd	PZ Cussons Ltd
Blue Ring Products Ltd	Sara Lee Kenya Limited	Rayal Trading Co. Ltd
BOC Kenya Limited	Saroc Ltd	Reckitt Benckiser (E.A) Ltd
Buyline Industries Limited	Super Foam Ltd	Revolution Stores Co. Ltd
Carbacid (CO2) Limited	Crown Berger Kenya Ltd	Soilex Chemical Ltd
Chemicals & Solvents E.A. Ltd	Crown Gases Ltd	Strategic Industries Limited
Chemicals and Solvents E.A. Ltd	Decase Chemical (Ltd)	SupaBrite Ltd
Coates Brothers (E.A.) Limited	Deluxe Inks Ltd	Unilever Kenya Ltd
Coil Products (K) Limited	Desbro Kenya Limited	Murphy Chemical E.A Ltd
Colgate Palmolive (E.A) Ltd	E. Africa Heavy Chemicals (1999) Ltd	Syngenta East Africa Ltd
Johnson Diversity East Africa Ltd	Elex Products Limited	Synresins Ltd
Kel Chemicals Limited	European Perfumes & Cosmetics Ltd	Tri-Clover Industries (K) Ltd
Kemia International Ltd	Galaxy Paints & Coating Co. Ltd	Twiga Chemical Industries Limited
Ken Nat Ink & Chemical Ltd	Grand Paints Ltd	Vitafoam Products Limited
Magadi Soda Company Ltd	Henkel Kenya Ltd	

Food Sector		
Africa Spirits Ltd	Annum Trading Company Limited	Premier Flour Mills Ltd
Agriner Agricultural Development Limited	Aquamist Ltd	Premier Food Industries Limited
Bio Foods Products Limited	Capwell Industries Ltd	Trufoods Ltd
Belfast Millers Ltd	Brookside Dairy Ltd	Proctor & Allan (E.A.) Ltd
Bidco Oil Refineries Ltd	Candy Kenya Ltd	Promasidor (Kenya) Ltd
Breakfast Cereal Company(K) Ltd	British American Tobacco Kenya Ltd	Ltd Cadbury Kenya Ltd
Broadway Bakery Ltd	Centrofood Industries Ltd	Coca cola East Africa Ltd
C. Czarnikow Sugar (EA) Ltd	Confec Industries (E.A) Ltd	Corn Products Kenya Ltd
Crown Foods Ltd	Cut Tobacco (K) Ltd	Deepa Industries Ltd
Del Monte Kenya Ltd East	African Breweries Ltd East	African Sea Food Ltd
Carlton Products (EA) Ltd	UDV Kenya Ltd	Chirag Kenya Limited
Eastern Produce Kenya Ltd	Jetlak Foods Ltd	Mini Bakeries (Nbi) Ltd
Unga Group Ltd	E & A Industries Ltd	Usafi Services Ltd
Uzuri foods Ltd	Erdemann Co. (K) Ltd	ValuePak Foods Ltd
Excel Chemical Ltd	Farmers Choice Ltd	Karirana Estate Ltd
Miritini Kenya Ltd	Frigoken Ltd	Kenafric Industries Limited
Kenya Tea Development Agency Limited	W.E. Tilley (Muthaiga) Ltd	Kenya Wine Agency
Kevian Kenya Ltd	Highlands Canner Ltd	Koba Waters Ltd
Super Bakery Ltd	Kwality Candies & Sweets Ltd	Sunny Processor Ltd
Lari Dairies Alliance Ltd	Spin Knit Dairy Ltd	London Distillers (K) Ltd

Highlands Mineral Water Co. Ltd	Mafuko Industries Ltd	Homeoil
Manji Food Industries Ltd	Insta Products (EPZ) Ltd	Melvin Marsh International
Jambo Biscuits (K) Ltd	Mount Kenya Bottlers Ltd	Giloil Company Limited
Glacier Products Ltd	Kenblest Limited	Nairobi Bottlers Ltd
Global Allied Industries Ltd	Kenya Breweries Ltd	Nairobi Flour Mills Ltd
Global Beverages Ltd	Kenya Nut Company Ltd	NAS Airport Services Ltd
Global Fresh Ltd	Kenya Sweets Ltd	Rafiki Millers Ltd
Gonas Best Ltd	Nestle Kenya Ltd	Razco Ltd
Hail & Cotton Distillers Ltd	Nicola Farms Ltd	Re-Suns Spices Limited
Al-Mahra Industries Ltd	Smash Industries Ltd	Palmhouse Dairies Ltd
Alliance One Tobacco Kenya Ltd	Patco Industries Limited	Softa Bottling Co. Ltd
Alpha Fine Foods Ltd	Pearl Industries Ltd	Spice World Ltd
Alpine Coolers Ltd	Kenblest Limited	Nairobi Bottlers Ltd
Betatrad (K) Ltd	Kenya Breweries Ltd	Nairobi Flour Mills Ltd
Glacier Products Ltd	Kenya Nut Company Ltd	NAS Airport Services Ltd
Global Allied Industries Ltd	Kenya Sweets Ltd	Rafiki Millers Ltd
Pembe Flour Mills Ltd	Wrigley Company (E.A.) Ltd	
Plastic and Rubber		
Blowplast Ltd	Prestige Packaging Ltd	Haco Industries Kenya Ltd
Bobmil Industries Ltd	Hi-Plast Ltd	Prosel Ltd
Complast Industries Limited	Qplast Industries	Jamlam Industries Ltd
Blowplast Ltd	Kamba Manufacturing (1986)	Sumaria Industries Ltd
Prestige Packaging Ltd	Haco Industries Kenya Ltd	Prosel Ltd
Hi-Plast Ltd	Super Manufacturers Ltd	Keci Rubber Industries
Kenpoly Manufacturers Ltd	Techpak Industries Ltd	Nairobi Plastics Industries

Kentainers Ltd	King Plastic Industries Ltd	TreadsettersTyres Ltd
Nav Plastics Limited	KingwayTyres&Automart Ltd	Ombi Rubber
Uni-Plastcis Ltd	Wonderpac Industries Ltd	Packaging Masters Limited
L.G. Harris & Co. Ltd	ACME Containers Ltd	Plastic Electricons
Laneeb Plastics Industries Ltd	Afro Plastics (K) Ltd	Raffia Bags (K) Ltd
Metro Plastics Kenya Limited	Alankar Industries Ltd	Rubber Products Ltd
Ombi Rubber Rollers Ltd	Dune Packaging Ltd	Safepak Limited
Packaging Industries Ltd	Wonderpac Industries Ltd	Wonderpac Industries Ltd
L.G. Harris & Co. Ltd	ACME Containers Ltd	Plastic Electricons
Laneeb Plastics Industries Ltd	Afro Plastics (K) Ltd	Raffia Bags (K) Ltd
Plastics & Rubber Industries Ltd	Elgitread (Kenya) Ltd	Sameer Africa Ltd
Polyblend Limited	Elgon Kenya Ltd	Sanpac Africa Ltd
Polyflex Industries Ltd	Elgon Kenya Ltd	Sameer Africa Ltd
Polythene Industries Ltd	Eslon Plastics of Kenya Ltd	Silpack Industries Limited
Premier Industries Ltd	Five Star Industries Ltd	Five Star Industries Ltd
Central Glass Industries Ltd	General Plastics Limited	Springbox Kenya Ltd
KarsanMurji& Company Limited	Plastics & Rubber Industries	Polyblend Limited
Building sector		
Kenbro Industries Ltd	Manson Hart Kenya Ltd	Kenya Builders & Concrete ltd
Mombasa Cement Ltd Ltd	KarsanMurji& company ltd	
Paper sector		
Bag and Envelope Converters Ltd	Graphics & Allied Ltd	Associated Papers & Stationery Ltd
Bags & Balers Manufacturers (K) Ltd	Guaca Stationers Ltd	Autolitho Ltd

Bag and Envelope Converters Ltd	General Printers Limited	Paperbags Limited
Bags & Balers Manufacturers (K) Ltd	Primex Printers Ltd	Print Exchange Ltd
Brand Printers	Ajit Clothing Factory Ltd	Paper House of Kenya Ltd
Icons Printers Ltd	Interlabels Africa Ltd	Printpak Multi Packaging Ltd
Business Forms & Systems Ltd	Prudential Printers Ltd	Printwell Industries Ltd
Kartasi Industries Ltd	Punchlines Ltd	Jomo Kenyatta Foundation
Carton Manufacturers Ltd	Cempack Ltd	Kenafric Diaries Manufacturers Ltd
Conventual Franciscan	Friers-Kolbe Press	Kitabu Industries Ltd
Chandaria Industries Limited	Creative Print House	Kul Graphics Ltd
D.L. Patel Press (Kenya) Limited	Colour Labels Ltd	Label Converters
Colour Packaging Ltd	Dodhia Packaging Limited	Modern Lithographic (K) Ltd
Colour Print Ltd	East Africa Packaging Industries Ltd	SIG CombiblocObeikanKenya
Kenya Stationers Ltd	Elite Offset Ltd	Pan African Paper Mills (EA) Limited
Kim-Fay East Africa Ltd	Ellams Products Ltd	Ramco Printing Works Ltd
Paper Converters (Kenya) Ltd	English Press Limited	Regal Press Kenya Ltd
Textile Sector		
Africa Apparels EPZ Ltd	Kenya Trading EPZ Ltd	Spinners & Spinners Ltd Storm
Image Apparels Ltd	Le-Stud Limited Metro	Straightline Enterprises Ltd
Alltex EPZ Ltd	Kikoy Co. Ltd	Apparel Manufacturers Co. Ltd

FulchandManek& Bros Ltd	Le-Stud Limited Metro	Sunflag Textile & Knitwear Mills Ltd
Alpha Knits Limited	Midco Textiles (EA) Ltd	Tarpo Industries Limited
Apex Appaels (EPZ) Ltd	Mirage Fashionwear EPZ Ltd	Teita Estate Ltd
Baraka Apparels (EPZ) Ltd	MRC Nairobi (EPZ) Ltd	United Aryan (EPZ) Ltd
Bogani Industries Ltd	Ngecha Industries Ltd	Aryan (EPZ) Ltd
Bhupco Textile Mills Limited	Premier Knitwear Ltd	Thika Cloth Mills Ltd
Blue Plus Limited	ProtexKenya (EPZ) Ltd	Vaja Manufacturers Limited
Brother Shirts Factory Ltd	Riziki Manufacturers Ltd	UpanWasana (EPZ) Ltd
Embalishments Ltd	Yoohan Kenya EPZ Company Ltd	Rolex Garments EPZ Ltd
J.A.R Kenya (EPZ) Ltd	Silver Star Manufacturers Ltd	YU-UN Kenya EPZ Company Ltd
Timber Sector		
Economic Housing Group Ltd	Transpaper Kenya Ltd	Wood Makers Kenya Ltd
Eldema (Kenya) Limited	Twiga Stationers & Printers Ltd	Woodtex Kenya Ltd United
Furniture International Limited	Rosewood Office Systems Ltd	Hwan Sung Industries (K) Ltd
Shah Timber Mart Ltd	Shamco Industries Ltd	StatpackIndustriesLtd
Kenya Wood Ltd	Slumberland Kenya	Limited
Newline Ltd	Timsales Ltd	Taws Limited
PG Bison Ltd	Tetra Pak Ltd	
Motor Vehicle Assembly and Accessories		
Auto Ancillaries Ltd	General Motor East Africa Limited	Mutsimoto Motor Company Ltd
VarsaniBrakelining Ltd	Impala Glass Industries Ltd	Kenya Grange Vehicle Industries Ltd
Bhachu Industries Ltd	Megh Cushion industries Ltd	Pipe Manufacturers Ltd
Toyota East Africa Ltd	Chui Auto Spring Industries Ltd	Sohansons Ltd

Kenya Vehicle Manufacturers Limited	Labh Singh Harnam Singh Ltd	Unifilters Kenya Ltd
Mann Manufacturing Co. Ltd		
Metal and Allied		
Allied Metal Services Ltd	Morris &Co. Limited	Theevan Enterprise Ltd
KhetshiDharamshi&Co. Ltd	Rolling Mill Ltd	Specialized Engineer Co. (EA) Ltd
Alloy Street Castings Ltd	Nails & Steel Products Ltd	Sandvik Kenya Ltd
Apex Ltd	Nampak Kenya Ltd	Steel Structures Limited
ASL Steel Division Ltd	Orbit Engineering Ltd	Sheffield Steel Systems Ltd
ASP Company Ltd	Napro Industries Limited	Steelmakers Ltd
East Africa Foundry Works	Rolmil Kenya Ltd	Elite Tools Ltd
Alloy Street Castings Ltd	Booth Extrusions Limited	Steelwool (Africa) Ltd
Gopitech (Kenya) Ltd Heavy	City Engineering Works Ltd	Welding Alloys Ltd
General Aluminum Fabricators Ltd	Crystal Industries Ltd	Wire Products Limited
Gopitech (Kenya) Ltd Heavy Engineering Ltd Insteel Limited	Davis &Shirtliff Ltd	Viking Industries Ltd
General Aluminum Fabricators Ltd	Devki Steel Mills Ltd	Warren Enterprises Ltd
Engineering Ltd Insteel Limited	East Africa Spectre Limited	Tononoka Steel Ltd
Friendship Container Manufactures Ltd	Kens Metal Industries Ltd	Metal Crown Limited
Pharmaceutical and Medical Equipment		
Alpha Medical Manufacturers Ltd	Madivet Products Ltd	KAM Industries Ltd
Beta Healthcare International Limited	Biodeal Laboratories Ltd	Novelty Manufacturing Ltd
KAM Pharmacy Limited	Oss. Chemie (K)	Bulks Medical Ltd
Cosmos Limited	Laboratory & Allied Limited	Manhar Brothers (K) Ltd

Pharmaceutical Manufacturing Co.	Dawa Limited	Regals Pharmaceuticals
Elys Chemical Industries	Universal Corporation Limited	Gesto Pharmaceutical Ltd
Pharm Access Africa Ltd	GlaxoSmithkline Kenya Ltd	
Leather Products and Footwear		
Alpharama Ltd	Dogbones Ltd	Leather Industries of Kenya Limited
Bata Shoe Co. (K) Ltd	C & P Shoe Industries Ltd	East Africa Tanners (K) Ltd
New Market Leather Factory Ltd		

Source: Kenya Association of Manufacturers (KAM) Directory. June, 2011

APPENDIX III: COVER LETTER