TOTAL PRODUCTIVE MAINTENANCE AND PERFORMANCE OF THE KENYA SEED INDUSTRY

BY:

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A MANAGEMENT RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION, SCHOOL OF BUSINESS, UNIVERSITY OF NAIROBI

2015

DECLARATION

This project is my original work and has not been submitted for an award of any degree in any other university.

Signed………………………………………… Date………………………………….

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D61/72902/2012

This project has been submitted for the examination with my approval as the university supervisor.

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ACNOWLEDGEMENTS

I would like to thank the beloved Almighty God through whose love, grace, guidance and protection has enabled me to carry out this research.

Much gratitude also goes to the University of Nairobi fraternity who include the lecturers in the MBA programme, fellow students, staff of University of Nairobi, and the staff of the companies engaged who gave responses based on their best understanding of their business.

My special thanks goes to my supervisor Dr. X.N Iraki for his guidance and immeasurable support throughout the proposal and the entire project. His positive sentiments greatly enhanced and enriched this study. His uncompromising stance on quality and details greatly motivated me.

Finally, I am greatly indebted to my family more so, my sister and mother for their constant support and encouragement that I would make it in life despite the odd challenges of the earth.

God bless you all

DEDICATION

This project is dedicated to my mother Margaret Aboka Keny, my late father Tony Kitiabi, my sister Jean Marie Keny and the entire Keny family for being the source of encouragement and inspiration to me.

May the Lord, God Almighty be with you and bless you abundantly.

ABSTRACT

The purpose of this study was to investigate how Total Productive Maintenance (TPM) has affected the performance of the Kenya seed industry. Specifically, the study sought to fulfil the following objectives: To identify the TPM practices adopted by firms in the Kenya seed industry; To identify the critical success factors to be adhered to ensure TPM benefits the Kenya seed industry; To identify the extent that TPM has contributed to firm's performance in the Kenya seed industry. This study was justified by plant maintenance revolution that has been fuelled by competition and growth which has led industries to leverage on TPM to outpace the competition. This research problem was studied through the use of a descriptive survey design. The survey was cross sectional in nature since it covered a sample of 47 companies in various segments of the Kenya seed industry. The research employed stratified sampling technique in which the seed companies were stratified into four stratum according to their functions. The study used both primary and secondary data. Primary data was collected using structured questionnaires. The data and information obtained through the questionnaires was first checked for completeness and consistency and then analysed based on descriptive statistics. These were then presented using tables, pie charts and bar graphs for easier interpretation. Findings indicate that 52.6% of firms sampled have implemented TPM practices. The study also showed that planned maintenance and quality maintenance were the most implemented TPM pillars while development management and office TPM were the least implemented. Management leadership and commitment, employee empowerment and involvement, continous improvement, adoption of new technology and organizational culture change were found to be critical factors that will ensure the success of TPM in an organization. Finally the study showed that implementation of TPM practices in an organization not only improve the operating performance but also the profitability.

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ABBREVIATIONS AND ACRONYMS

TPM	Total Productive Maintenance
TQM	Total Quality Management
JIPM	Japanese Institute of Plant Maintenance
GDP	Gross Domestic Product
JIT	Just In Time
OEE	Overall Equipment Effectiveness
KPI	Key Performance Indicator
KEPHIS	Kenya Plant Health Inspectorate Service
KALRO	Kenya Agricultural & Livestock Research Organization
NGO	Nongovernmental Organizations

CHAPTER I: INTRODUCTION

1.1 Background of the Study

The business operations and management field has experienced an unprecedented degree of change in customer expectations, product and process technologies that has increased competition and ultimate growth of many industries. These changes have made industries to develop and adopt modern management systems that enable them to keep up with the changing environment and improve their quality, availability and productivity continuously (Nordin & Saman, 2012). The Kenya seed industry has not been left behind with companies implementing Total Productive Maintenance (TPM) as a management system that improves their competitive power.

Eti et al (2006) observes that with competition in manufacturing industries rising relentlessly, TPM has proved to be the maintenance improvement philosophy preventing the failure of an organization. As such a well conceived TPM implementation program not only improves the equipment efficiency and effectiveness but also brings appreciable improvements in other areas of the manufacturing enterprise (Melesse & Ajit, 2012).

TPM is a resource-based maintenance management system that aims at increasing capacity and ending the vicious cycle of breakdowns or reactive repairs through the use of autonomous and predictive maintenance, as well as equipment modifications to facilitate optimum machine availability, quality, and performance (Sessumes, 2012). It fosters an environment where improvement efforts in safety, quality, cost, delivery, and creativity are encouraged through the participation of all employees.

The participation of top management is vital to ensure the proper implementation of TPM. Bamber et al, (1999) notes that the major obstacle in implementing TPM in the United Kingdom was the lack of commitment by top management. Top management stimulates the contribution of operators to achieve zero breakdowns, zero stoppages and a safer working environment (Ahuja, 2007).

Bhadury (2000) defines TPM as an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns and promotes autonomous maintenance by operators through day-to-day activities involving the total workforce. The TPM approach changes the maintenance paradigm by emphasizing on involvement of all the employees in ensuring the proper running of machines and equipment and eliminating breakdowns and defects. As Venkatesh (2007) notes, TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process.

The TPM concept originated in Japan and was an equipment management strategy designed to support the Total Quality Management (TQM) strategy. The Japanese realized that companies cannot produce a consistent quality product with poorly-maintained equipment. TPM thus began in the 1950s and focused primarily on the preventive maintenance. As new equipment was installed, the focus was on implementing the preventive maintenance recommendations by the equipment manufacturer (Wireman, 2004).

TPM was them focused on productive maintenance in the 1960s as plant design was based on data collected from equipment and processes in the 1950s. This data was then used in the design, procurement and construction phase of equipment and machinery. In the 1970s, TPM evolved to a strategy focused on achieving productive maintenance efficiency through a comprehensive system based on respect for individuals and total employee participation. Wireman, (2004) notes that it was at this time that "Total" was added to productive maintenance. This concept was later introduced by Nippon Denso Company Limited of Japan, a supplier of M/s Toyota Motor Company in 1971.

TPM is a proven and successful procedure for introducing maintenance considerations into organizational activities. The essence of TPM is encompassed in three words; Total signifies every aspect and the involvement of everybody right from top to bottom; Productive means eliminating waste and losses in the processes thereby reducing costs. Maintenance means that the equipment is kept autonomously by production operators in good condition, who repair, clean, grease and spend necessary time on the equipment (Poduval & Raj, 2013). TPM initiatives are focused upon addressing major losses, and wastes associated with the production systems by affecting continuous and systematic evaluations of production systems, thereby affecting significant improvements in performance (Ravishankar, 1992).According to Noon & Jenkins (2000), the three ultimate goals of TPM are zero defects, zero accidents and zero breakdowns.

TPM supports other strategies most often associated with World Class Manufacturing: Just-in-Time manufacturing (JIT), Total Quality Management (TQM), Total

Employee Involvement (TEl) and Continuous Performance Improvement (CPI) among others (Schonberger, 1996; Ollila & Malmipuro, 1999, Cuaet al., 2001; Sharma et al., 2005). TPM is thus a highly influential technique that is in the core of “operations management” and deserves immediate attention by organizations across the globe (Voss, 2005).

To prosper in today’s economic climate, any organization must be dedicated to never ending improvement, and more efficient ways to obtain products or services that consistently meet customer’s needs. Globalization has forced the engineers and managers of organizations to produce high quality products at a lower cost. Cost reduction without compromising on quality’ has become the motto of every organization, to survive in the global market. In the manufacturing industry, product quality has become a key factor in determining a firm’s success or a failure in a global market place (Singh and Khanduja, 2010).

Overall equipment effectiveness (OEE) is used as a metric of measuring the performance of a productive system that has adopted TPM. The overall goal of total productive maintenance is to raise the overall equipment effectiveness (Huang et al., 2002; Juric et al., 2006). It aims at increasing overall equipment effectiveness of facilities by operating and maintaining machinery at an optimum level (Prickett, 1999), where overall equipment effectiveness is a function of availability, performance, and quality rate (Blanchard, 1997).

Availability is measured as a proportion of time the equipment or the machine is actually available out of time that should be available, performance represents and influenced by the number of produced items in a given period of time, and quality rate represents the percentage of good parts out of total produced (Robbins, 2008).

TPM initiatives, as suggested and promoted by Japan Institute of Plant Maintenance (JIPM), involve an eight pillar implementation plan that results in substantial increase in labor productivity through controlled maintenance, reduction in maintenance costs, and reduced production stoppages and downtimes. They include autonomous maintenance; focused improvement; planned maintenance; quality maintenance; education and training; office total productive maintenance; development management; and safety, health and environment (Ireland & Dale, 2001; Shamsuddin et al., 2005; Rodrigues & Hatakeyama, 2006).

1.1.1 Autonomous Maintenance

Autonomous maintenance is the process by which equipment operators accept and share responsibility (with maintenance) for the performance and health of their equipment (Robinson & Ginder, 1995). This pillar aims at developing operators who are able to take care of small maintenance tasks, thus freeing up the skilled maintenance personnel to spend time on repairs that require more expertise. Autonomous maintenance involves simple activities such as cleaning, lubrication, tightening of loose bolts and visual inspection (Wakjira & Singh, 2012) and aims at maintaining or restoring the new condition of the machines.

Leflar (2001) observes that the implementation of pilot team autonomous maintenance activity at Agilent Technology reduced equipment failures by 90%, increased equipment productivity by 50%, and reduced maintenance time within one year. Thus involving operators in routine care and maintenance of machines reduces maintenance labor cost and eliminates travel time due to proximity of operator to machine. As Mobley (2004) observes, the ultimate reason for autonomous maintenance is simply that it saves money and improves bottom-line profitability. Operators are typically under used and have the time to perform lower-skilled tasks. Transferring these tasks to operating teams improves the payback on the burdened, sunk cost of the production workforce and at the same time permits more effective use of the maintenance crafts (Mobley, 2004).

1.1.2 Focused Improvement

Focused improvement includes all activities that maximize the overall effectiveness of equipment, processes, and plants through uncompromising elimination of losses and improvement of performance (Suzuki, 1994). It is driven by the TPM goal of zero losses. Nakajima (1998) observes that maximizing equipment effectiveness requires the complete elimination of failures, defects, and other negative phenomena – in other words, the wastes and losses incurred in equipment operation. According to Pormoski (2004), focused improvement includes three basic improvement activities. First, the equipment is restored to its optimal condition. Then equipment productivity loss modes (causal factors) are determined and eliminated. The learning that takes place during restoration and loss elimination then provides the TPM program with a definition of optimal equipment condition that will be maintained (and improved) through the life of the equipment.

1.1.3 Planned Maintenance

The objective of planned maintenance is to establish and maintain optimal equipment and process conditions (Suzuki, 1994). Planned maintenance is comprised of four parts: breakdown maintenance which is based on the philosophy of let it fail and fix it and is applicable where failure does not impose any significant effect on production and any cost except the cost of repair. Preventive maintenance which comprises of actions like inspection, lubrication, cleaning, tightening to prevent machines from failures through periodic inspection and recognition of equipment condition. Corrective maintenance which is done to increase the reliability, productivity and improving maintainability. Maintenance prevention done by checking current equipments and gathering data about their weaknesses, failure records and safety while new equipments are re-designed and installed (JIPM, 2009). Implementing these activities efficiently reduces inputs to maintenance activities and as a result lower the maintenance cost while at the same time ensuring the productivity of the machines through realization of zero failures.

1.1.4 Quality maintenance

Quality maintenance is establishment of conditions that will preclude the occurrence of defects and control of such conditions to reduce defects to zero (JIPM, 1996). Quality maintenance is achieved by establishing conditions for ‘zero defects’, maintaining conditions within specified standards, inspecting and monitoring conditions to eliminate variation, and executing preventive actions in advance of defects or equipment/process failure (Pormoski, 2004).

Production of quality products not only meets and exceeds customer's expectations but also reduces the cost of reworks that has an impact on the production cost. Phil Crosby (1984) believes that every defect represents a cost, which is often hidden. These costs include inspection time, rework, wasted material and labor, lost revenue and the cost of customer dissatisfaction.

1.1.5 Education and Training

Education is given to operators to upgrade their skill. It is aimed at having multi-skilled revitalized employees whose morale is high and who are eager to come to work and perform all required functions effectively and independently (Wakjira & Singh, 2012). The employees should be trained to achieve the four phases of skill. These phases are one; do not know, phase two; know the theory but cannot do, phase three; can do but cannot teach, and phase four; can do and also teach.

The steps in educating and training activities are setting policies and priorities and checking present status of education and training, establish of training system for operation and maintenance skill upgrading, training the employees for upgrading the operation and maintenance skills, preparation of training calendar, kick-off of the system for training, and evaluation of activities and study of future approach (Wakjira & Singh, 2012).

1.1.6 Office TPM

It involves implementation of TPM activities to continuously improve the efficiency and effectiveness of logistic and administrative functions (Pormoski, 2004).

These logistic and support functions may have a significant impact on the performance of manufacturing production operations. Office TPM addresses twelve major losses, they are processing loss; cost loss including in areas such as procurement, accounts, marketing, sales leading to high inventories; communication loss; idle loss; set-up loss; accuracy loss; office equipment breakdown; communication channel breakdown, telephone and fax lines; time spent on retrieval of information; non availability of correct on line stock status; customer complaints due to logistics; and expenses on emergency dispatches/purchases (Wakjira & Singh, 2012).

The benefits of office TPM are involvement of all people in support functions for focusing on better plant performance, better utilized work area, reduce repetitive work, reduced administrative costs, reduced inventory carrying cost, reduction in number of files, productivity of people in support functions, reduction in breakdown of office equipment, reduction of customer complaints due to logistics, reduction in expenses due to emergency dispatches/purchases, reduced manpower, and clean and pleasant work environment (Wakjira & Singh, 2012).

1.1.7 Development management

This pillar gives the methodology on how to produce new products and new machines at a very short time and at lowest cost. The tools and techniques that are to be adopted at each step in the development of a new machine or the new product is clearly defined.

1.1.8 Safety Health and Environment

Shirose (1996) describes safety as the maintenance of peace of mind. No TPM program is meaningful without strict focus on safety and environmental concerns. Ensuring equipment reliability, preventing human error, and eliminating accidents and pollution are the key tenets of TPM (Suzuki, 1994). This pillar is meant to achieve goals of zero accidents, zero injuries and zero environmental impact. Unreliable and fault equipment is a threat to the operator and the environment (JIPM, 2009).

1.1.9 Operating performance

This is a measure of how well the company in terms of profitability, operating efficiency and productivity. According to Loth (2000), operating performance ratios look at how efficiently and effectively a company is using its resources to generate sales and increase shareholder value. Each of these ratios have different inputs and measure different segments of a company's overall operational performance.

The outstanding results of TPM implementation on the operating performance have led many firms facing competitive pressures to adopt TPM (McKone K.E, Roger G.S and Cua K.O (1999). Research shows that companies achieved 15-30 per cent reduction in maintenance cost, while others revealed a 90 per centre reduction in process defects and 40-50 per cent increase in labour productivity (Nakajima, 1988). Chowdhury (1995) also observes that organizations with TPM culture have experienced benefits to the extent of 80 percent reduction in defect rate, 90 percent reduction in routine breakdowns and 50 percent increase in production output.

Cartel (1999) started the implementation of TPM in the US Shipbuilding industry achieved higher levels of quality and timeliness and eliminated costly delays in its shipbuilding operations. In 1996, MRC Bearing implemented a TPM program, and ten months later their breakdown losses fell to less than 30 hours, a decrease of over 54 percent (Aerospace 1999).The popularity of trucks like the F – series meant that the Ford Windsor Engine plant needed to produce more engines. An increase of 100,000 engines, announced in April, brought the output for 2000 to 950,000 units (Vasilash, 1999).From this case studies and researches, it can be seen that TPM improves the performance of firms in terms of productivity, quality, cost, delivery and safety.

1.2.0 The Kenya Seed Industry

Seed is one of the most crucial inputs in agricultural production, in that it has the greatest potential of increasing on farm productivity and enhancing food security. The Kenya seed industry is thus a major segment of the agricultural sector that is the backbone of the national economy.

The seed industry in Kenya can be split into two sectors: formal and informal (Funk & Wamache, 2012). The formal sector is the sector which focuses on breeding, producing and selling seed that is certified by the Kenya Plant Health Inspectorate Service (KEPHIS), the government entity responsible for regulating seed production in Kenya, among its other activities. The participants in the informal sector are mostly restrained to farmers and Nongovernmental organizations (NGOs).

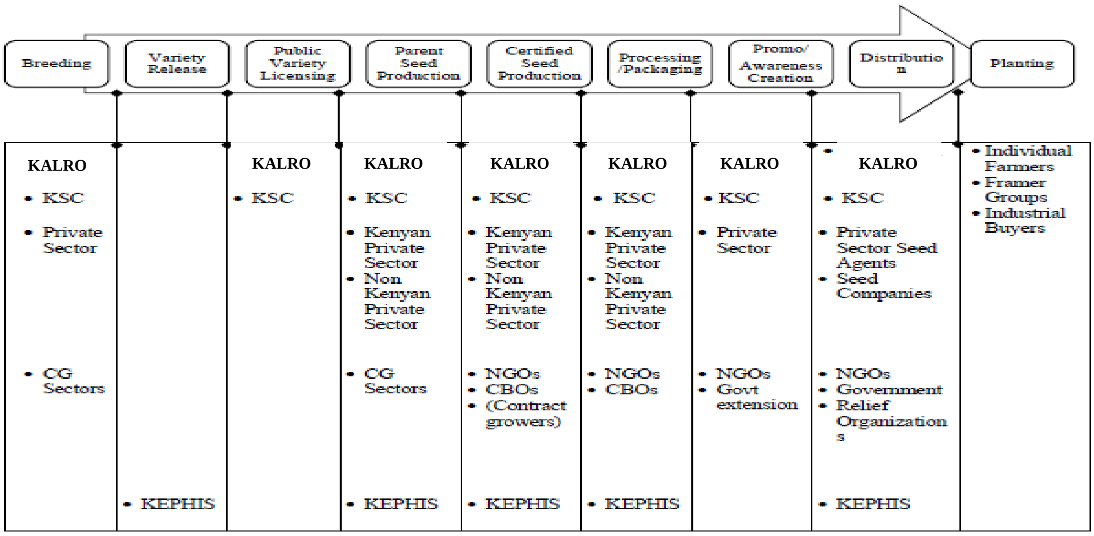


Figure 1.1 Seed Industry Activities and Participants, Formal Sector (Source Agri Experience, 2012).

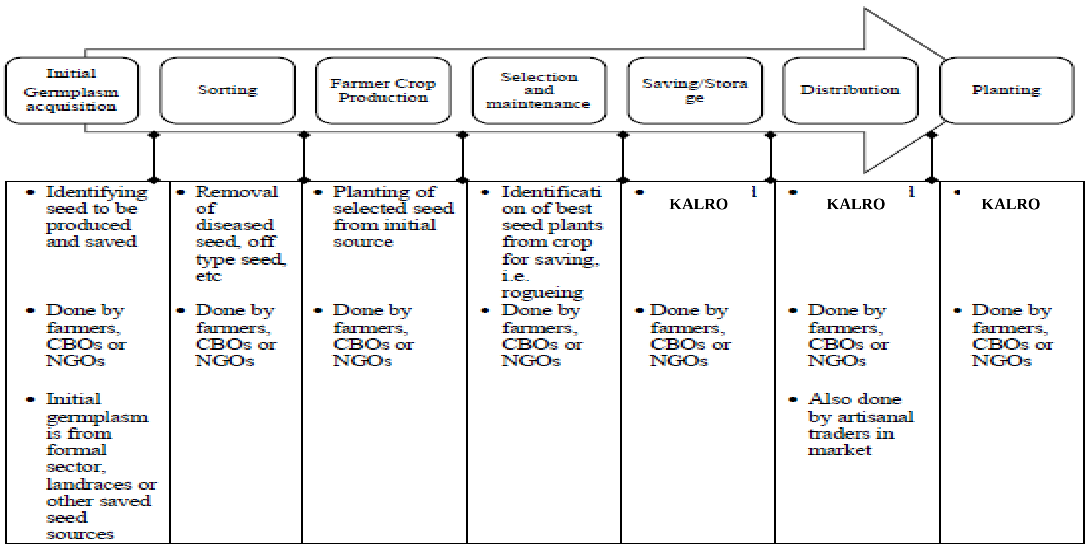


Figure 1.2 Seed Industry Activities and Participants, informal Sector (Source Agri Experience, 2012)

Even though 66% of all maize seed and 85% of all rice seed come from the formal sector, the informal sector dominates the seed supply at 78% of the total volume while the formal sector is responsible for the remaining 22% (Kenya Seed Industry Study, 2013).

The formal sector is dominated by Kenya Seed Company, a government-owned entity which holds an estimated 70% of the market share. Other key participants include several large multinationals and emerging mid- sized Kenyan companies that own the remaining 30%. The estimated Kenya seed industry market share is shown in the table below.

Table 1.1: Estimated Kenya Seed Industry Market Share

Company	**Market share**
Kenya Seed company	70%
Pannar	10%
Seedco	8%
Monsanto	5%
Pioneer	5%
Others	2%

Source: Kenya Seed Industry Study, 2013

A well functioning seed system is one that uses the appropriate combination of formal, informal, market and non-market channels to efficiently meet farmers' demands for quality seeds. Even though Kenya has one of the most developed seed system with ninety three registered seed companies who research, produce and process seed, the high cost of seed relative to other purchased inputs and inability to meet the demand by farmers have been cited as bottlenecks to the seed industry (Nyoro & Ariga, 2004).

The Kenyan seed industry is a part of the agricultural sector that contributes directly 29.5% of Gross Domestic Product (GDP) and 60% of export earnings. The sector contributes indirectly a further 27% through links with manufacturing, distribution and service related sectors in addition to providing employment to 75% of the Kenyan population (Kenya National Bureau of Statistics, 2014). The Kenya seed industry on the other hand has experienced tremendous challenges in ensuring seed products are delivered to customers on time. According to the Kenya seed industry study (2013), growth in the agricultural sector decelerated in 2013 to 2.9 percent from a revised growth of 4.2 percent in 2012 partly due to the high frequency of machine breakdowns of the major processing plants.

This led to late delivery of seed to the farmers way past the planting season that as a result led to low yields. Even though fake seeds have also contributed to the low productivity in the recent years, seed processing companies have adopted approaches and technologies that have ensured fake seed is detected by the farmers. For example, Kenya Seed Company, one of the major providers of seed has developed a Short Message Service (SMS) that enables farmers detect fake seeds before buying them. This has gone a long way to ensure high quality seeds are available in the market.

TPM is still a new concept in the Kenya Seed industry as most companies are still using the traditional approach that sees maintenance as a secondary process and a cost that needs to be reduced. According to Rich (1997), the traditional approach allows for a culture which is insular and detached from the commercial requirements of the business. This traditional approach must be changed to ensure the organizational wide approach to maintenance is adopted. Maintenance remains one of the very few areas through which significant increase in company profits can be achieved. McGuin

(2008) observes that robust Maintenance Capacity can be the difference between ongoing profits and impending downfall.

1.2 Research Problem

Maintenance is an indispensable function of a manufacturing plant and it is the major contributor to the performance and profitability of manufacturing systems (Kutucuglu et al., 2001). Its importance is increasing as there is an increasing trend towards automation and integration of manufacturing system i.e., installation of advanced manufacturing technology (Maggard and Rhyne, 1992). As such companies are adopting total productive maintenance as good maintenance and are overseeing 50 percent reduction in breakdown labour rates, 70 percent reduction in lost production, 50 –90 percent reduction in set up, and 60 per cent reduction in costs per maintenance unit (Koelsch, 1993). Total productive maintenance is thus an important aspect in the agricultural sector and specifically the seed sector of any economy as it ensures availability of high quality seed varieties to the farmer when needed at an affordable price through the reduction of costs associated with processing and production.

Plant maintenance in Kenya has been a major problem because of the traditional misconception of maintenance being viewed as an operational expense to be minimized and not as an investment aimed at increasing process reliability (Braglia, 2006). The cost of traditional maintenance consumes a significant part of the operating budget of an organization with heavy investments in plant, machinery and equipment (Cross, 1988; Dekker, 1996). The estimated cost of maintenance ranges between 15 and 40 per cent of production costs (Dunn, 1987) with an average of 28 percent (Mobley, 1990). This high cost of maintenance eventually reduces the profitability and performance of the organization.

Equipment maintenance is improved by incorporating the philosophy and principles of TPM in organizational practices. As Braglia (2006) notes, equipment and technology development capabilities have become major factors that demonstrate the strength of an organization and set it apart from others. Maintenance has now become a strategic tool to increase competitiveness rather than simply an overhead expense that must be controlled. Investment in TPM is one of the basic functions of a firm returns, improved quality, safety, dependability, flexibility, lead times (Teresko, 1992) and can be implemented as a complementary to other modern production management techniques like TQM or lean Just In Time (JIT) manufacturing.

There have been various studies done on total productive maintenance, performance and the Kenya seed industry. Lazim et al (2013) “Total Productive Maintenance and Manufacturing Performance: Does Technical Complexity in the Production Process Matter?” discusses the findings from a study of total productive maintenance practices in manufacturing organizations in Malaysia. Mfowabo (2006) in his research at Nelson Mandela Metropolitan University on “The impact of total productive maintenance on manufacturing performance at the Colt section of DaimlerChrysler in Eastern Cape” analyses the practice in Daimler Chrysler Eastern Cape .

Funk & Wamache (2012) in their research “Kenya Seed Industry Study (KSIS)” focus on describing, analyzing the functionality and recommending improvements in the Kenya seed industry. Sikinyi (2010) in his study “Baseline study/survey report on the seed sector in Kenya” describes the state of the industry. From the studies highlighted, there has not been any research on total productive maintenance and performance of the seed industry and in particular Kenya Seed Industry. This study filled this knowledge gap by answering the following questions.

1. What were the total productive maintenance practices adopted by firms in the Kenya Seed industry?
2. What were the critical success factors to be adhered to ensure total productive maintenance benefits the Kenya seed industry?
3. To what extent had total productive maintenance contributed to the firm performance in the Kenya seed industry?

1.3 Research Objectives

1. To identify the total productive maintenance practices adopted by firms in the Kenya seed industry.
2. To identify the critical success factors adhered to ensure total productive maintenance benefits the Kenya seed industry.
3. To identify the extent that total productive maintenance had contributed to firm's performance in the Kenya seed industry.

1.4 Value of the Study

The study findings will help the Government to identify any gaps on existing policies hence set new guidelines, regulations and procedures on total productive maintenance issues. The government will also realize their role in providing the necessary incentives to facilitate proper implementation of total productive maintenance in the Kenya Seed Industry.

To Kenya seed processing firms, the study will provide useful insights on how best to effectively use total productive maintenance as a tool to improve the performance of firms in the industry.

It will also seek to empower company directors and managers with knowledge on the various roles they need to play in order to ensure proper implementation and success of total productive maintenance practices.

Finally, the findings of the study will add into existing body of knowledge in the area of TPM that can be used by future researchers.

CHAPTER II: LITERATURE REVIEW

2.1 Introduction

This chapter presents literature on total productive maintenance (TPM), models and benefits. It also highlights the theoretical and conceptual framework of the study.

2.2 Total Productive maintenance

TPM is an original Japanese management protocol developed to alleviate production losses caused by machine breakdowns. A holistic evaluation of TPM global practice reveals that more companies now accept the concept of zero breakdowns as achievable. Indeed, with the solid foundation laid by TPM of striving for zero breakdowns, world-class plants are able to run for complete shifts without the need for intervention. In the recent days however, many world class companies have not only embraced TPM, but they have used it as a systematic catapult to evolve from the classic Total Productive Maintenance towards Total Productive Manufacturing and, hence, deliver a Totally Productive Operation capable of world-leading performance.

Wilmott & McCarthy (2001) argue that Company-wide TPM is about maximizing added value and eliminating waste across the supply chain in order to satisfy and exceed customers' expectations. They further argue that TPM should not only be viewed as containing the elements of Overall Equipment Effectiveness (OEE), autonomous maintenance, 5S, clean machines and so on, but should serve as effective roots and origins for applying company-wide TPM. In this context, TPM is not only a Maintenance Department-driven initiative, but actually brings production and maintenance together as equal partners under the umbrella of manufacturing.

2.3 Theoretical foundation

The theoretical foundation for this study hinges on three theories-, theory of constraints, cost of production theory of value and the systems performance theory. Goldratt (1984) defines the theory of constraints as a methodology for identifying the most important limiting factor (constraint) that stands in the way of achieving a goal and then systematically improving that constraint until it is no longer the limiting factor. Goldratt explains further that every complex system consists of multiple linked activities, one of which acts as a constraint upon the entire system. Focusing improvement efforts on the constraint is the fastest and most effective path to improved profitability. Pray & Ramaswami (1991) postulate that the major constraint hindering the development of the seed industry in developing countries is inefficient or weak seed industries. This is a direct reflection of the issue of plant maintenance as a limiting factor to the development of the seed industry that needs to be addressed to ensure the growth of the industry.

Adam smith sheds light on the cost of production theory of value by arguing that the price of a product is determined by the sum of the cost of the resources that went into making it. Even though modern day scholars criticize the theory for not taking into account factors such as demand and supply, costs such as maintenance play an important role in determining the final price of the product.

According to the systems performance theory, the overall performance of a production system is determined by both quantitative and qualitative properties of the system. These properties include operator performance, capacity performance, reliability performance, support performance and maintainability performance (Probert, Ogaji & Eti, 1998).

2.4 TPM critical success factors and limitations

According to the JIPM, the following five critical success factors are to be adhered to if full benefits are to be garnered from TPM; Management leadership and commitment; Organizational culture change; continuous improvement; actively involve all employees from top management to shop floor workers.

Management leadership and commitment in following, participating and monitoring actions and results is essential in ensuring the successful implementation of TPM. According to Dunbrack (2005), senior management commitment is required for any initiative to be successful. Top management commitment is accountable for setting goals that are specific, measurable, achievable, realistic and timely. Deming (1982) noted that commitment and strong leadership is essential for successful and durable strategies.

TPM is effective only if it includes a long-term culture change within the organization (Bacidore, 2012). This involves changing the misconception that maintenance is an operational expense to be minimized and not an investment aimed at increasing process reliability (Braglia, 2008). It will also involve developing respect for equipment and the products they produce by developing proper maintenance procedures and schedules for the machines and equipment that will ensure continuous improvement of their operation (Rubrich, 2013).

Employees play a critical role in supporting performance and productivity of the organization. Organizations that are competitive train their employees on how to use their abilities, skills and knowledge in ensuring continuous productivity (Wambugu, 2015). The TPM implementation process as proposed by Nakajima (1988) incorporates all employees leading to performance improvement. According to Li (2000), training employees and making them participate in decision making processes increases productivity and ensures free interaction between employees and the management.

Wilmott & McCarthy (2001) hypothesize conditions that limit the full gamut of benefits of company-wide TPM from being realized. To begin with, if full benefits of equipment OEE improves but the overall door-to-door time remains the same, the waste is not removed; secondly if equipment capability improves but quality standards remain the same, a potential area of competitive advantage is lost; thirdly if knowledge gained about the process does not produce higher rates of return on investment, the organization is not making the best use of its capabilities; and lastly if capability is increased but this is not met by generation of new business, an opportunity to reduce unit costs is lost.

2.5 Benefits of Implementing TPM

The full benefit of TPM is realized due to the fact that equipment downtime can bring lean manufacturing operation to a complete standstill. According to the productivity press edition on TPM collected practices and cases, the failure of equipment at one step of the process halts all the steps before it, so an operator can only pull work from a preceding step when he is able to perform that work. This brings out the full benefit of TPM, as it is an illustration that TPM is such a critical component of becoming lean. Indeed the study goes forward to postulate that strategies aimed at eliminating downtime are essential in any operation where the processes require the use of equipment. Almost all management decisions involve estimating the costs vis-à-vis the benefits of a particular decision before a stand is taken by management on whether or not to execute a particular course of action. In assessing the true costs and benefits of TPM, it would be beneficial to review best the number of breakdowns/involvement so as to fully grasp the extent of full benefits derived from TPM.

This is demonstrated in the table and graph below:

KPI Plant	*Book Covers*	*Clothing*	*Chemicals*	*Air Conditioners*	*Lighting Systems*
Breakdowns per month	18 5 3	707 2 ½ 15	200 4 10	250 6 5	387 4 33
Productivity	100 2 125	100 2 ½ 120	100 4 150	100 6 200	100 4 247
OEE (%)	55 3 75	71 3 120	100 4 160	65 6 88	71 4 88
Investment ($m)	1.9 5 3.4	1.0 per $ 2 ½ 10	1.0 per $ 4 3.0	1.0 per $ 6 4.5	0.7 5 4 3.5

Key: *Reference Point* *Time (yrs)* *Achievement*

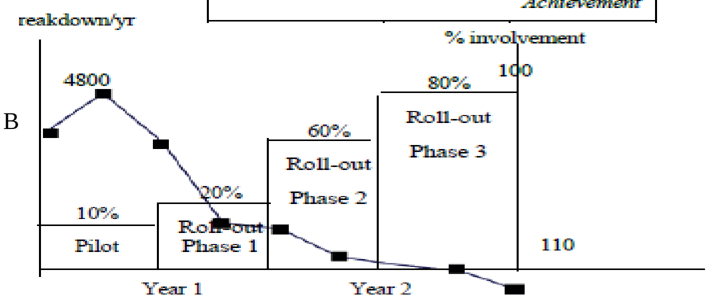


Figure 2.1 Number of breakdowns/involvement in world class TPM Plants. *TPM - A Route to World-Class Performance*. 2001.

2.6 TPM models

Different models have been developed to ensure proper implementation of TPM. The traditional TPM model was developed in the 1960's that consisted of 5S (sort, set in order, shine, standardize and sustain) as a foundation and the eight pillars as suggested and promoted by JIPM being supporting activities. Other models include the TPM loss model, chronic losses and sporadic losses model, Bottom up TRAC framework and the 5S/CAN DO philosophy.

2.6.1 The TPM loss model

Wilmott & McCarthy (2001) explain the TPM loss model as a tool that predicts how costs will behave as a result of continuous improvement. According to the duo, the model provides a feed forward mechanism, as opposed to 'feedback', to help management identify potential gains and direct priorities towards meeting and exceeding customer expectations. The model further provides that from experience, for every breakdown there are approximately 30 minor stops and 300 contributory factors which goes to prove that breakdowns are the result, not the cause or symptom. Examples given for the breakdown contributory factors include scattering of dust and dirt, poor equipment condition and human error. Progressively reducing and eliminating these provides the organizational learning necessary to achieve zero breakdowns.

2.6.2 Chronic Losses and Sporadic Losses Model

Shiros, Kimar & Kaned (2012) explain that equipment failures and defects appear either as sporadic or chronic losses. The trio further explains that sporadic losses indicate sudden, often large deviations from the norm i.e. current performance and quality levels whilst chronic losses on the other hand, indicate smaller, frequent deviations that gradually have been accepted as normal. This is illustrated in Figure II below:

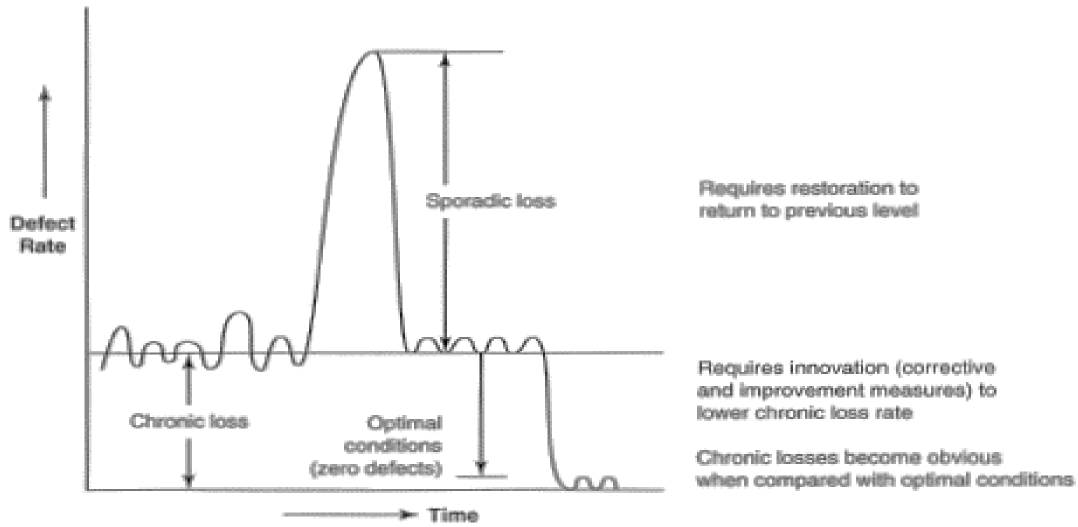


Figure 2.2 Sporadic Losses & Chronic Losses. *PM Analysis: An Advanced Step in TPM Implementation.*2012

2.6.3 Bottom-Up TRAC Framework

This model evolved from Lean TPM, which is a cross-functional team-based process improvement activity that may only take up a small percentage of attendance time but it is an essential element of engagement and ownership.

McCarthy & Rich (2015) further argue that this is the means by which front-line personnel can recognize a purpose to believe in and be provided with the backing and reinforcement to deliver their full potential. The TRAC framework incorporates the steps of autonomous maintenance interlinked with the corresponding planned maintenance, OEE improvement and education and training activities. It also incorporates the relevant lean manufacturing activities to support value stream flow, flexibility and focused improvement.

In a nutshell, according to the duo, the TRAC stepwise benchmarks guide the development of cross-functional alliance and high-performance operations teams. Indeed this is a steady and gradual model of improvement where progress through each step heightens everyone's sensitivity to abnormalities in the workplace and breaks down traditional barriers. This framework also discourages adopting a "cut and paste" approach by cautioning those who attempt to shortcut this process by cherry picking readymade practices from other organizations will achieve little in the way of engagement or bottom-line benefits.

2.6.4 5S/CAN DO philosophy

This philosophy serves as one of the first and crucial steps towards asset care which embodies five principles. These principles are seiri (organization), seiton (orderliness), seiso (cleaning -the act of), seiketsu (cleanliness-the state of) and lastly shitsuke (discipline -the practice of). The application of this philosophy requires getting rid of everything and anything unnecessary, putting what is wanted in its right place so that it is on hand, keeping clean and tidy at all times, recognizing that cleanliness is neatness (a clear mind/attitude), is spotting deterioration (through inspection), is putting things right before they become catastrophes, is pride in the workplace, giving self-esteem. Lastly the philosophy advocates passing on that discipline and order in the workplace colleagues so that we the team strives for a dust-free and dirt-free plant.

Wilmott & McCarthy (2001) give more insight to the CAN DO approach as encompassing review of the production facility and cleaning the workshop and its plant and machinery as it has never been cleaned before, whilst at the same time casting a ruthlessly critical eye at everything in the workplace. This discipline is categorical that nothing must be allowed to remain anywhere on the shop floor unless it is directly relevant to the current production process. This, they argue breeds good housekeeping which thereafter becomes everyone's responsibility and a way of life.

2.7 Industrial Performance

Industrial performance is divided into three dimensions. These are financial, operational and organizational effectiveness (Venkatraman & Ramanujam, 1986). Financial performance includes the profitability and sales growth. Operational performance includes product quality, market efficiency, market share and new product introduction. Organizational effectiveness is the extent to which organizations achieve their objectives effectively.

Industrial performance has two dimensions; judgmental and objective performance (Agarwal et al, 2003).Judgmental covers the employees and customers perceptions such as service quality, customer satisfaction and retention while the objective performance includes financial and market based assessments such as market share, profit and efficiency. In this study both the judgmental and objective performance measures were used to determine the effectiveness of TPM programs.

2.8 Conceptual Framework

Maintenance remains one of the very few areas through which significant increase in company profits can be achieved. McGuin (2008) observes that robust maintenance capacity can be the difference between ongoing profits and impending downfall. In this study, the independent variable was TPM while the dependent variable was performance. The critical success factors for TPM implementation was the intervening variable.

This study measured TPM by considering the eight pillars as promoted by Japan Institute of Plant Maintenance (JIPM).They include autonomous maintenance; focused improvement; planned maintenance; quality maintenance; education and training; office total productive maintenance; development management; and safety, health and environment.

There are many ways to measure performance. However, the most predominant approach is to use cost, quality, delivery, and flexibility as the four basic dimensions of performance. In some studies, these dimensions have been expanded to include several additional measures. (Hayes et al., 1988; Miller and Roth, 1994).This additional measures include equipment efficiency, overall productivity, customer complaints and inventory levels.

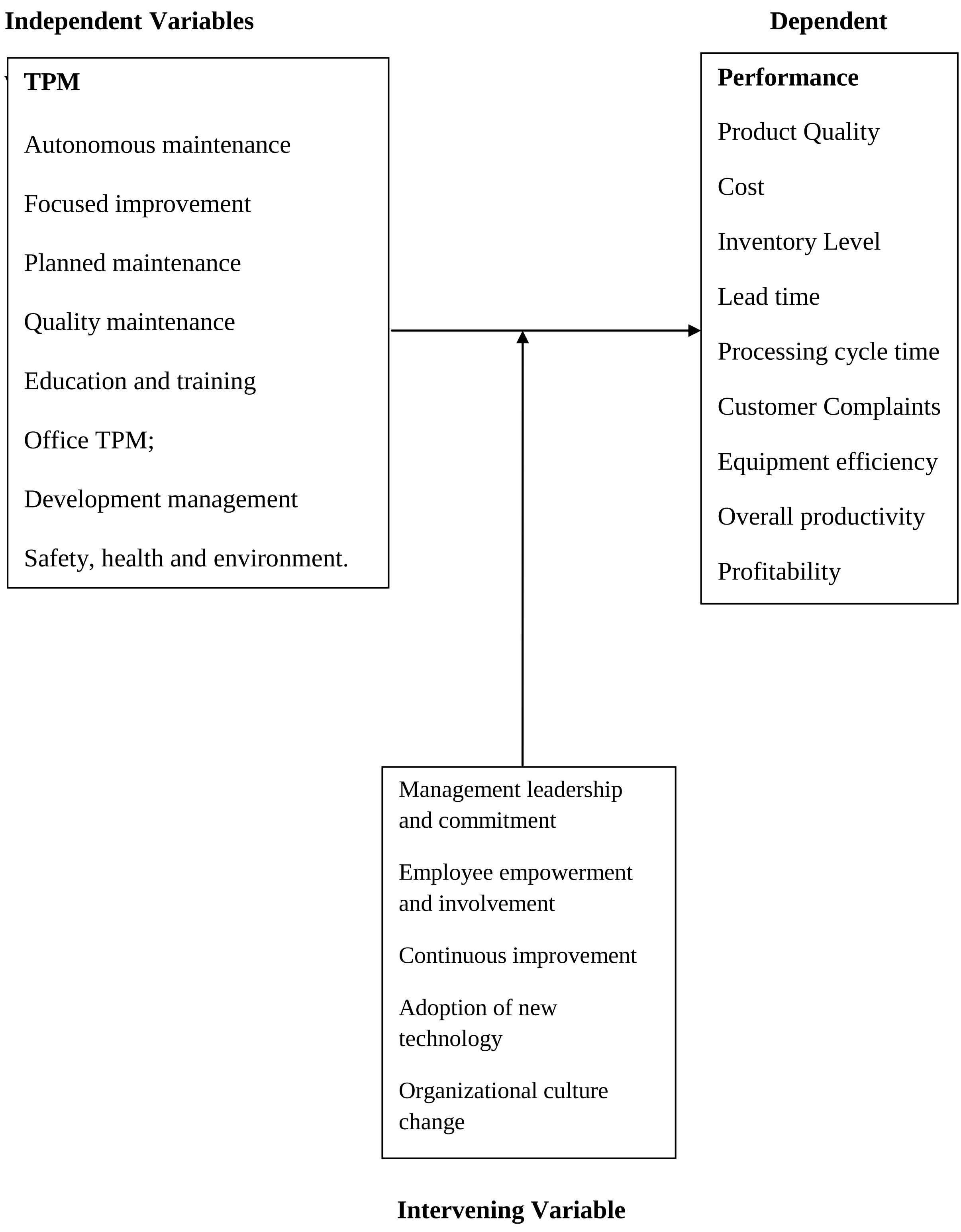


Fig 2.3 Conceptual framework

CHAPTER III: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes the research methodology and explains procedures that were followed during data collection and analysis. It includes research design, target population, sampling design and sample size, data collection methods and procedures and data analysis.

3.2 RESEARCH DESIGN

A descriptive research design was adopted for this study. According to Polit & Hungler (1999), descriptive research enables the researcher to obtain maximal information and provides an opportunity for considering many different aspects of the problem. It is also useful in identifying variables and hypothetical construct and it may be used to test a certain theory.

3.3 POPULATION OF THE STUDY

The target population for this study is the 93 registered seed companies involved in the research, production, processing or marketing companies as listed by the Kenya seed industry study, 2012. (Appendix II)

3.4 SAMPLE DESIGN

The study employed stratified sampling design. The seed companies were stratified into four stratum according to their functions. From each group a number was picked to have data representative sample. To determine the sample size for the study, Cochran's formula was used as shown:

$n=Z^2pq/e^2$

Where, n= desired sample size

Z= standard normal deviation, which is set at 1.96 (95% confidence level)

P= proportion of the targeted population that had the same functions focused in the study, is estimated at 93% (Agri experience, 2012).

q= Proportion of targeted population that didn't have the same functions focused in the study. i.e. 1-p

e= degree of accuracy, which is set at 5%. The degree of proportion of error that should be accepted in the study is 0.05, since the study has 95% confidence level.

Therefore, Desired Sample (n) **= {**1.96^2*(0.93*(1-0.93)}/0.05^2

n= 100

Since the total population is smaller than the desired sample size, the finite correction formulae (n_f) was used to adjust the desired sample size as shown below:

$n_{f\,=}$ n / {1 + (n-1)/N}

N = 93 n = 100

n_f = 100/ (1+99/93) = 47

A survey of 47 seed companies was carried out. Using the proportionate allocation method, the sample size from each stratum was determined. According to Stanley &

Gregory (2001), at least 10% sample of the population is considered generally acceptable method of selecting samples from each stratum. The stratified sampling method was used as it enabled sampling of even the smallest and most inaccessible subgroups in the population. The stratified sampling technique also has a higher statistical precision compared to simple random sampling. This is because the variability within the subgroups is lower compared to the variations when dealing with the entire population.

Table 3.1 Classification of firms in the seed industry and sample size

Function	**Number of companies**	**Sample**
Research	13	7
Production	30	15
Processing	20	10
Marketing	30	15
TOTAL	**93**	**47**

(Source: Agri Experience 2012)

3.5 DATA COLLECTION

The research relied on primary and secondary data. The data was obtained through administration of questionnaires to the respondents. The questionnaire was structured and had closed ended questions. The questionnaire comprised of section A that aimed at collecting information about the organization and its function, section B that collected data on TPM, section C which looked into TPM and processing performance, section D looked into the critical success factors for implementation of

TPM and finally section E looked at the performance of the company in 2014 in terms of profit and market share.

3.6 OPERATIONALIZING THE VARIABLES

The independent variable (TPM) was measured by considering the eight pillars as promoted by Japan Institute of Plant Maintenance (JIPM). The likert scale and ordinal measure were used to determine the extent to which each of the pillars has been implemented in the organization. The dependent variable (Performance) also used the ordinal measure to determine how the independent variables have affected product quality, cost, inventory level, lead time, processing cycle time, customer complaints, equipment efficiency and overall productivity. Performance in terms of profitability was determined using the interval and ratio measure.

The intervening variable was also measured using the ordinal scale to determine how factors such as continuous improvement, adoption of new technology, organizational culture change, management leadership, commitment, employee empowerment and involvement enable successful implementation of TPM.

3.7 DATA ANALYSIS

This included the aspect of editing, coding, and computer entry. The questionnaires were checked for consistency so as to avoid sampling errors. This entailed confirming whether the questionnaires were correctly filled. Descriptive statistics such as graphs and charts, measures of central tendency (mean, mode, median) and measures of variation were used to analyze objective one and two. A regression model was used to analyze objective three.

CHAPTER IV: DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This chapter considers the results and findings from the study. The findings of the study are presented according to the research objectives presented afore.

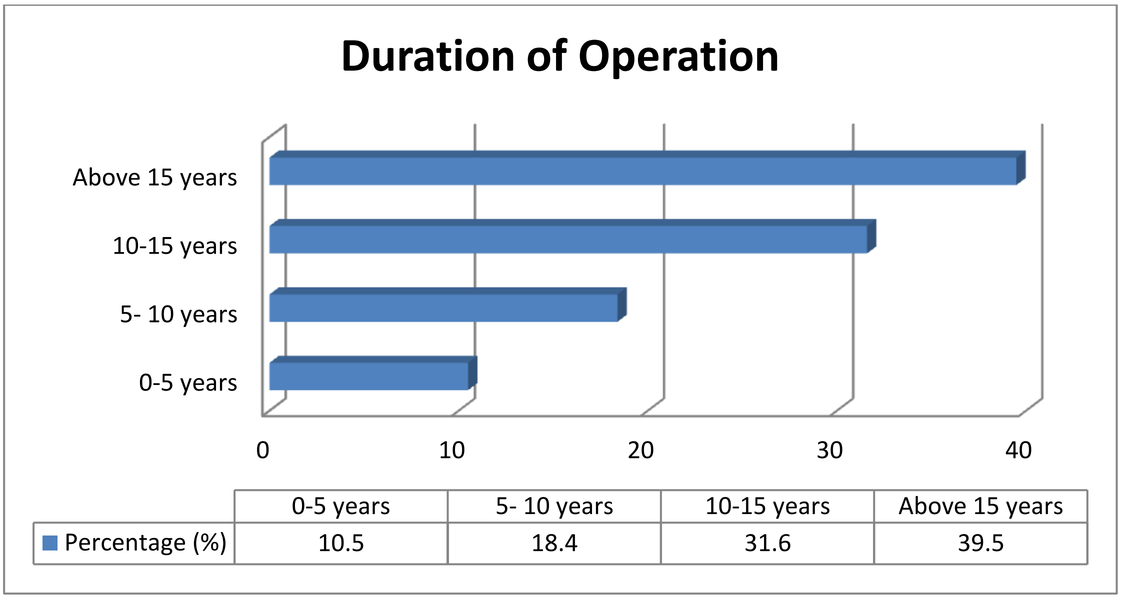
4.2 Response return rate

There were 47 questionnaires distributed to forty seven companies in the target population. Of the 47 questionnaires sent to the sampled subjects, 38 were filled by respondents and later collected. This translated to 80.9% response rate. According to Kiess & Bloomquist (1985), atleast 60% is considered a generally acceptable response return rate as it reduces the risk of non-response bias that will affect the accuracy of the data collected. This high response rate was achieved through persistent and constant interaction and liaison between the researcher and the respondents. All the returned questionnaires were found fit for analysis. For objective one and two, mean scores which were below 3.00 were interpreted to mean little extent while those above 3.00 were interpreted to mean great extent.

4.3 Preliminary data analysis

On a general basis, the study sought to establish how long organizations in the Kenya seed industry have been in operation, the total number of employees and their core functions. In terms of duration of operation, 71.1% of the organizations in the Kenya seed industry have been in operation for more than ten years as shown in the figure 4.1.

Figure 4.1: Duration of operation



In terms of employment, 76.3% of the companies in the Kenya seed industry have more than 100 employees as shown in figure 4.2. Literature review attests to the fact that the Kenya seed industry which is a part of the agricultural sectors provides employment to approximately 75 % of the Kenya population. The above findings support this view.

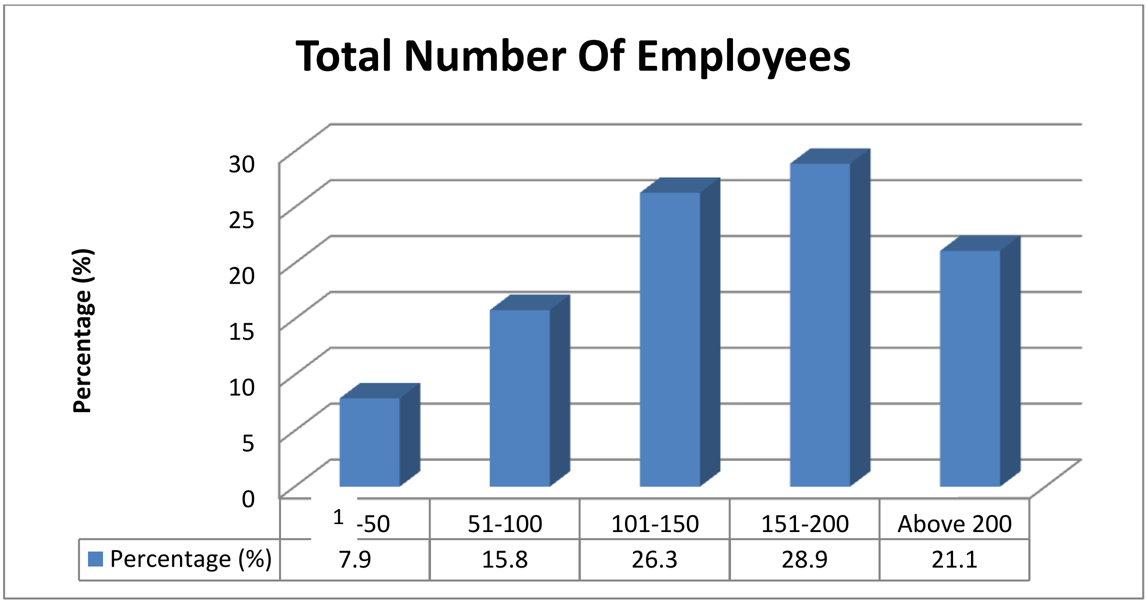


Figure 4.2: Total number of employees

In terms of the functional business, 7.8% of the respondents were in research, 31.6% in production, 18.4% in processing and the remaining 42.2 % in marketing as shown in table 4.1 below.

Table 4.1: Function of the organization

Function of the organization	Frequency	Percentage (%)	Cumulative percentage (%)
Research	3	7.8	7.8
Production	12	31.6	39.4
Processing	7	18.4	57.8
Marketing	16	42.2	100.0
Total	38	100.0	

Source: Results from Survey, August 2015

Companies in the research function had the lowest response rate at 7.8%.This low response was due to few experienced respondents in the functional area. According to the literature review, Scopus database (2015) noted that Kenya has only 6 researchers for every 10,000 working people while the United Kingdom and United States of America have 79 researchers for every 10,000 working people. These findings thus show a significant gap of experienced researchers that exists within the research sector in Kenya. The findings also show the governments' low expenditure on research and development as only 27% of the companies in the research function were governmental organizations and parastatals.

The marketing function had the highest response rate of 42.2 %.This is due to the enormous growth of the marketing function in Kenya. Githaiga (2008) notes that the gap between the rich & poor, plus the emergence of the middle class has made marketers to effectively configure marketing & communication mix that address the different segments and as a result has evolved the marketing function in Kenya. The presence of multinational has resulted in more professionals coming in the Kenyan market making it the most developed within the East African region.

4.3.1 Total productive maintenance practices

The study sought to determine the TPM practices adopted by firms in the Kenya seed industry. Inherent in this study was also an evaluation of the extent at which the TPM pillars have been implemented in the organizations. The percentage of companies that had adopted TPM stood at 52.6%.This finding is supported by the literature review which noted that the level of TPM implementation in Kenyan industries is low. This is because TPM is a new concept and companies are still using the traditional approach that sees maintenance as a secondary process and a cost that needs to be reduced (Nyoro & Ariga, 2004).

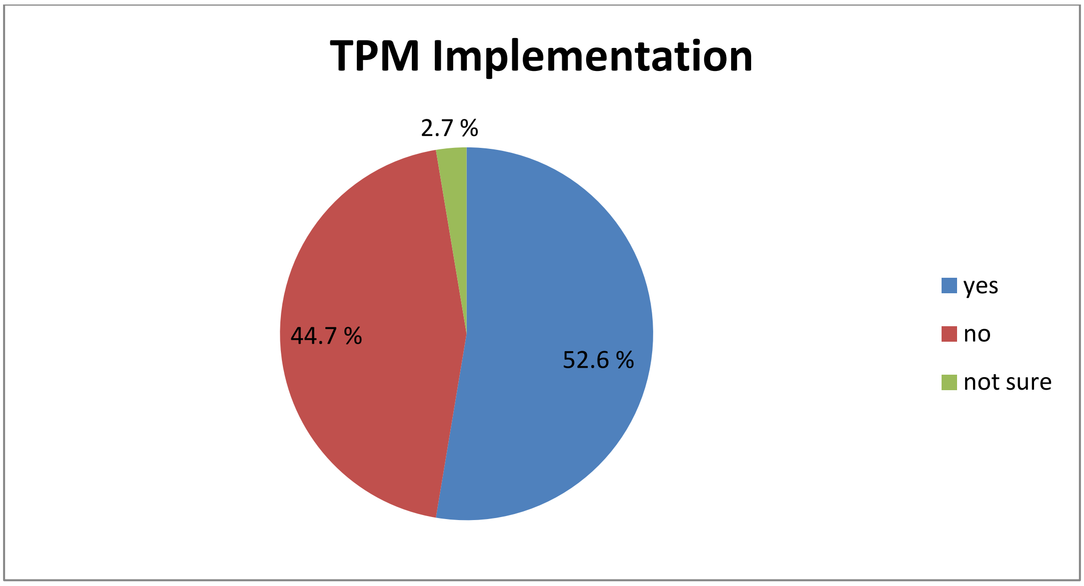


Figure 4.3 TPM adoption/implementation

Table 4.2: Extent of TPM implementation

Pillars	Mean	Std Dev	Rank
Autonomous Maintenance	3.1579	0.63783	**6**
Focused Improvement	3.4474	0.50390	**3**
Planned Maintenance	3.8421	0.67888	**1**
Quality Maintenance	3.6579	0.66886	**2**
Education and Training	3.2632	0.72351	**5**
Office TPM	2.6316	0.75053	**8**
Development Management	3.0263	0.63616	**7**
Safety, Health and Environment	3.4211	0.50036	**4**

Source: Results from Survey, August 2015

Planned maintenance was the most implemented TPM pillar with a mean of 3.8421 while development management and office TPM were the least implemented with a mean of 3.0263 and 2.6316 respectively. This demonstrates the fact that despite organizations striving to improve the efficiency and effectiveness of their machines, they still incur other losses such processing loss; cost loss in areas such as procurement, accounts, marketing, sales leading to high inventories; communication loss; idle loss; set-up loss; accuracy loss; office equipment breakdown; communication channel breakdown, telephone and fax lines; time spent on retrieval of information; non availability of correct on line stock status; customer complaints due to logistics; and expenses on emergency dispatches/purchases as a result of ignoring the logistics and administrative function of the organization (Wakjira & Singh, 2012).

4.3.2 Critical success factors for TPM implementation

As a precursor to identifying the influence of TPM on performance, the firms surveyed were tasked with highlighting the critical success factors for TPM implementation. All the factors had a mean above 3 indicating that the factors are necessary for proper implementation of TPM. The results of the study are shown in table 4.3 below.

Table 4.3: Critical success factors for TPM implementation

Factors for TPM implementation	**Mean**	**Std Dev**	**Rank**
Management leadership and commitment	4.9737	0.16222	**1**
Employee empowerment and involvement	4.7895	0.41315	**2**
Continuous Improvement	3.9737	0.36664	**4**
Adoption of new technology	3.4474	0.50390	**5**
Organizational culture change	4.4737	0.50601	**3**

Source: Results from Survey, August 2015

Management leadership and commitment was found to be the most critical success factor with a mean of 4.9737.As highlighted in the literature review, Dunbrack (2005) noted that senior management commitment is required for any initiative to be successful. Top management commitment is accountable for setting goals that are specific, measurable, achievable, realistic and timely and hence is the most important factor for proper TPM implementation. Senior management must show commitment to TPM by devoting time, allocating resources to create and sustain the required cultural change, and educate employees.

Employee empowerment and involvement is ranked as the second most important factor with a mean of 4.7895. Teamwork among all employees in various departments in companies can ensure better TPM implementation. Indeed, the complexity of getting commitment and involvement from employees is one of the implementation difficulties of TPM (Arca & Prado, 2008).The employee involvement is nonetheless essential, particularly on the part of the person who operates the equipment. Sufficient and effective training programs can help to detect abnormalities in the equipment condition as soon as possible. Moreover, it is very important to follow up on any training and education programmes in order to ensure that operator's commitment, skills and knowledge are at exceptional level. Furthermore, through total employee involvement, skepticism about maintenance being a support function, non-productive and not a core function that adds little value to the business (Bamberet al., 1999) can be avoided.

Organizational culture change, continuous improvement and adoption of new technology were also found to be critical factors for TPM implementation and ranked as third, fourth and fifth respectively. Literature from Boharis (1995) has emphasized upon affecting changes in the management structure focusing on continuous production system improvement, managing synergic cooperation of the production and maintenance, deployment of effective developed computerized maintenance system and gradual implementation of TPM on a handful of machines at a given time as key contributors towards successful TPM implementation. Hansson (2003) has also emphasized upon effectively managing organizational change for enhancing organization's performance for strategic survival in the competitive environment.

The literature review thus supports the findings of the study by showing that management leadership and commitment, employee empowerment and involvement, organizational culture change, continuous improvement and adoption of new technology are critical factors that ensure the proper implementation of TPM in an organization.

4.3.3 TPM and Operating performance

The study had the overarching objective of establishing the extent to which TPM affects the performance of companies in the Kenya seed industry. Equipment efficiency was ranked the highest with a mean of 4.4211. TPM is essentially a philosophy that seeks to ensures production equipment is able to produce at the highest capacity with zero loses in terms of running time and quality. This results in lower maintenance and production costs. Literature confirms that one of the benefits for TPM is zero downtime that ensures the equipment efficiency.

Literature also confirms that one of the key pillars of TPM is Quality Maintenance, which focuses on prevention of defects at source, in-line detection and segregation of defects (Mohamed, 2013). In this study, product quality was ranked second with a mean of 4.3158 .This is in line with TPM goal of zero defects.

One of the main aims of TPM is to increase productivity of plant and equipment in such a way as to achieve maximum productivity with only a modest investment in maintenance (Ahuja and Singh, 2012).This literature supports the findings of this study that ranked overall productivity third with a mean of 4.2105.

Cost had a mean of 4.1316. Induswe (2013) notes that TPM ensures equipment are optimized and operators are trained on basics maintenance skills to carry out minor tasks rather than waiting for the maintenance teams. The operators are trained to detect the likelihood of equipment breakdown before it happens. With failure being anticipated and corrective action taken before it occurs, organizations are able to reduce maintenance costs.TPM also influenced the lead time, processing cycle time and customer complaints to a great extent with a mean of 3.6053, 3.5263 and 3.2895 respectively.

Inventory level was ranked the last with a mean of 3.1253.This showed TPM implementation ensures efficient management of inventory. With improvement in equipment reliability as well as rates of production that results in minimum downtime, the organization's inventory levels are easily monitored.

The results of this study shown in table 4.5 below are in-line with Ahuja & Khamba (2008) statements that TPM implementations showed marked improvement in the equipment efficiency and also brought about appreciable improvement in other manufacturing functions in the organization.

Table 4.4: TPM and Performance

Performance measure	Mean	Std Dev	Rank
Product quality	4.3158	0.47107	**2**
Cost	4.1316	0.34257	**4**
Inventory level	3.1253	0.57101	**8**
Lead time	3.6053	0.49536	**5**
Processing cycle time	3.5263	0.50601	**6**

Customer complaints	3.2895	0.56511	**7**
Equipment efficiency	4.4211	0.50036	**1**
Overall productivity	4.2105	0.41315	**3**

Source: Results from Survey, August 2015

4.3.4 Multiple regression model for TPM in relation to financial performance

Multiple Regression analysis was conducted using data collected from the eight pillars of TPM as suggested and promoted by Japan Institute of Plant Maintenance (JIPM). They include autonomous maintenance; focused improvement; planned maintenance; quality maintenance; education and training; office TPM; development management; and safety, health and environment.

The adjusted R square value (0.707) in table 4.5 which is the proportion of variation accounted for by the regression model above and beyond the mean model indicates that TPM explains 70.7% of the variability of profit margins. Therefore, there is a positive relationship between TPM and financial performance in terms of profit. The results of ANOVA show that this relationship was significant.

Table 4.5 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.878[a]	.771	.707	.46609	.771	12.184	8	29	.000

a. Predictors: (Constant), Safety, health and environment, Office TPM, Planned Maintenance, Autonomous Maintenance, Development Management, Education and training, Focused Improvement, Quality Maintenance

b. Dependent variable: Profit (Millions)

4.3.4.1 Regression model test

The F-ratio in the ANOVA table 4.6 below tests whether the overall regression model was a good fit for the data. The table shows that the independent variables statistically significantly predict the dependent variable, $F(8, 29) = 12.184$, $p < 0.05$ (i.e., the regression model is a good fit of the data).

Table 4.6 ANOVA table for F-ration

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.174	8	2.647	12.184	.000[b]
	Residual	6.300	29	.217		
	Total	27.474	37			

a. Dependent Variable: Profit (Millions)

b. Predictors: (Constant), Safety, health and environment, Office TPM, Planned Maintenance, Autonomous Maintenance, Development Management, Education and training, Focused Improvement, Quality Maintenance

4.3.4.2 Test of Multicollinearity

It can be seen from table 4.7 below that the unstandardized coefficient for autonomous maintenance is the only value statistically significant showing that profit is dependent on autonomous maintenance. However the beta values for the other independent variables are not statistically significance despite the high adjusted R square value (0.707) as shown in table 4.5.This is due to multicollinearity where the model includes multiple independent variables that are correlated not just to the dependent variable, but also to each other. This view is supported by the values of the variance inflation factor (VIF) which assesses how much the variance of an estimated regression coefficient increases if the independent variables are correlated. If the VIF is equal to 1 there is no multicolinearity among the independent variables, but if the VIF is greater than 1, the predictors may be moderately correlated. The output above shows that the VIF for all the variables are above 1, which indicates some correlation.

Table 4:7 Test of multicollinearity

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	-1.399	.639		-2.190	.037		
Autonomous Maintenance	.423	.166	.313	2.541	.017	.521	1.919
Focused Improvement	.068	.244	.040	.280	.781	.390	2.565
Planned Maintenance	.300	.204	.236	1.471	.152	.306	3.269
Quality Maintenance	.290	.190	.225	1.526	.138	.364	2.747
Education and training	.143	.168	.120	.850	.402	.397	2.517
Office TPM	.115	.138	.100	.832	.412	.548	1.825
Development Management	.075	.180	.055	.416	.681	.447	2.236
Safety,health and environment	.043	.187	.025	.230	.820	.669	1.494

a. Dependent Variable: Profit (Millions)

4.3.4.3 Stepwise Multiple Regression

Multicolllinearity problem is solved by removing highly correlated predictors from the model through stepwise multiple regression. The adjusted R square value for model 3 is 0.738 which indicates that planned maintenance, autonomous maintenance and quality maintenance explain 73.8% of the variability of profit margins.

Table 4.8: Stepwise model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.747[a]	.557	.545	.58127
2	.836[b]	.700	.682	.48560
3	.859[c]	.738	.715	.45987

a. Predictors: (Constant), Planned Maintenance

b. Predictors: (Constant), Planned Maintenance, Autonomous Maintenance

c. Predictors: (Constant), Planned Maintenance, Autonomous Maintenance, Quality Maintenance

The unstandardized beta coefficients are statistically significantly and predict the dependent variable.

Table 4.9: Regression model coefficients

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound
1	(Constant)	-.114	.549		-.208	.836	-1.228	.999
	Planned Maintenance	.948	.141	.747	6.731	.000	.662	1.233
2	(Constant)	-.816	.490		-1.665	.105	-1.810	.179
	Planned Maintenance	.625	.142	.493	4.410	.000	.337	.913
	Autonomous Maintenance	.614	.151	.455	4.072	.000	.308	.921
3	(Constant)	-1.065	.477		-2.232	.032	-2.035	-.096
	Planned Maintenance	.414	.164	.326	2.520	.017	.080	.747
	Autonomous Maintenance	.513	.150	.380	3.421	.002	.208	.817
	Quality Maintenance	.378	.169	.294	2.242	.032	.035	.721

a. Dependent Variable: Profit (Millions)

The model 3 in table 4.9 above predicts that a 1% increase in planned maintenance will increase the profit by Ksh 414,000 holding all other pillar of TPM constant. Likewise, a 1% increase in autonomous maintenance will increase the profit by Ksh 513,000 while a 1% increase in quality maintenance will increase the profit by Ksh 378,000 in each case holding other independent variables constant.

CHAPTER V: SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

This chapter provides a summary, recommendations and conclusions drawn from the study. The chapter also covered the limitations of the study and made recommendations on areas that will require more research to enhance greater understanding of the subject area.

5.2 Summary

Three research objectives were identified in Chapter one and in this section, results for them are summarized, discussed and conclusions drawn. Conclusions and recommendations were made from the analysis and data collected in Chapter four in order to address the preset objectives. The respondents comprised of 47 registered seed companies as determined by the stratified sampling design. Indeed conclusions made in this study have the overarching imperative of bringing out how TPM could improve the performance of companies in the Kenya seed industry.

The prime objectives of the study were to identify the TPM practices adopted by firms in the Kenya seed industry, to identify the critical success factors to be adhered to ensure TPM benefits the Kenya seed industry and lastly to identify the extent that TPM has contributed to firm's performance in the Kenya seed industry.

On the first objective, it was established that 52.6% of companies surveyed have adopted TPM practices. Planned maintenance, quality maintenance and focused improvement were the most implemented TPM pillars while development management and office TPM ranked much lower in the adoption scale which goes to show that even though TPM has grown in terms of implementation, other TPM practices not associated with manufacturing function such as development management and office TPM are not being implemented as much. A lot of unexplored potential could be harnessed from these TPM practices that will eventually boost firm's productivity and ergo their competitiveness. This observation goes in line with Suzuki ,(1994) who notes that manufacturing is not a stand-alone activity, but is now fully integrated with, and dependent on, its support activities. These support departments increase the productivity by documenting administrative systems and reducing waste and loss.

On the second objective of identifying the critical success factors to be adhered to ensure TPM benefits the Kenya seed industry, it was established that management leadership and commitment, employee empowerment and involvement, continous improvement, adoption of new technology and organizational culture change are crucial in ensuring the proper implementation and success of TPM practices in an organization with all having a mean of above 3.0.Management leadership and commitment was rated the highest with a mean of 4.9737 while adoption of new technology was the least rated with a mean of 3.4474.

The third objective touched on how TPM affects the performance of companies in the Kenya seed industry. In terms of operating performance, respondents were of the view that implementing TPM affects the operating performance of companies in a great extent. Equipment efficiency was rated the highest with a mean of 4.4277 followed by product quality with a mean of 4.3158 while overall productivity finished off the top three with a mean of 4.2105.In terms of financial performance, there is a positive relationship between TPM and financial performance in terms of profit. The eight pillars of TPM were found to be correlated and hence planned maintenance, autonomous maintenance and quality maintenance were found to best explain the 73.8 % variability of profit based on the multiple regression model. These findings are supported by Bhadury, (2000) who notes that TPM promotes autonomous maintenance by operators through day to-day activities involving total workforce. Wireman (2004) also includes preventive maintenance, productive maintenance and quality maintenance in the definition of TPM by noting that they are important in ensuring the profitability of organizations implementing TPM.

5.3 Conclusion

TPM is a strategic change management approach that has considerable impact on the efficiency of global organizations. TPM has been widely known in manufacturing environment. This proactive maintenance strategy contributed to manufacturing performance improvements are highlighted by various researchers (Tsang and Chang, 2000; Eti et al., 2004; Ahmad et al., 2005; Ahuja and Khamba, 2008b).

TPM is a key competitive strategy for business organization in the global market place. This study concludes that implementation of TPM in organizations improves performance for operations and financially. TPM concepts and philosophy can be effectively employed to realize fundamental improvements in the manufacturing performance in the organization, thereby leading organizations successfully in the highly competitive environment (Induswe, 2013)

TPM can prove to be an effective global strategy for rendering firms consistent enhancement in performance in terms of achieving core competencies. Thus in the highly competitive scenario, TPM might prove to be amongst the best proactive strategic initiatives that can lead organizations to scale new levels of achievements and can make the difference between success and failure of organizations.

In addition, top management leadership and commitment, employee empowerment and involvement, continuous improvement, adoption of new technology and organizational culture are crucial in order to ensure the full benefits of TPM are enjoyed by organizations that are implementing the management system.

5.4 Recommendations

The study established that 52.6% of companies in the Kenya seed industry have implemented TPM.This level of implementation is still is still low and in order to improve it, directors of companies in the Kenya seed industry should ensure a very high level of awareness and commitment right from the top management to the shop-floor level. Top management in the Kenya seed industry should establish steering committee that will provide necessary planning, commitment direction and continuance of TPM activities, establish clear measures of performance including achievable milestones and objectives using project management techniques and financial support.

In addition to these, the departmental, line and team managers should ensure that the TPM practices support the company business strategy. The implementation should be in line with the corporate vision, mission, values and plans including communication and evaluation plans to build employee buy-in and communicate results. This will ensure that performance is measured to track actual performance against expectations, new initiatives, and budgets including resources needed for new initiatives.

Finally, the effectiveness of TPM practices also need to be evaluated. Effectiveness should be measured through performance measurements such as inventory, cycle time, product quality and delivery time. Review audits to address the elements of the entire TPM system should also provide a basis to improve performance. Rich (1999) notes that the ultimate goal of the audit process is to eliminate waste from the TPM support structure and provide meaningful management information, relating to the alignment of policies and practices of TPM.

5.5 Limitations of the Study

The researcher faced a number of limitations in the carrying out of this survey. First there was the limitation of similar studies done in the Kenya seed industry. This lack of precedence revealed a lacuna which the study attempted to bridge partially as there was no scientific basis (e.g. models for research design) that could be used to sanitize the study. Online resources were however employed to fill this gap whilst journals and books were used to identify the theoretical models which this study hinged on in the theoretical framework.

There was also the case of “artificial analysis” only limited amount of information was asked for and without explanation. The most immediate consequence of this is that of bias which would question the validity of the conclusions drawn from the study. There is also the challenge of establishing how truthful the respondents were since there is the possibility that inaccurate answers would be given in favour of the firm .Time constraint was another challenge, as respondents were busy most of the time, thereby constant pressure asking them for the filled out questionnaire resulted in some of the questionnaires not being returned regardless of the fact that the number of respondents was small. In data collection, there was a challenge of accessing the respondents especially those located away from the Nairobi. This was not only expensive but also led to little interaction with the respondents.

5.6 Suggestions for Further Research

This research paper has provided insight into the impact of TPM on the performance of the Kenya seed industry. However it has also created opportunities for further research. Studies need to be done that can align TPM and TQM and evaluate the impact on the productivity in the Kenya seed industry. Organizations in the industry may benefit by aligning the techniques and employees encouraged to initiate continous improvement projects as well as elimination of manufacturing wastes. A study could also be conducted to determine the impact of world class manufacturing techniques on the performance of the Kenya seed industry.

REFERENCES

Aerospace (1999). *Aerospace supplier blast off with TPM.* Industrial Maintenance & plant operation, Vol 60 No. 9, pp 44 – 6.

Ahuja, I.P.S. & Khamba, J.S. (2007). *Total productive maintenance: literature review and directions.* Journal of Quality in Maintenance Engineering Vol. 13 No. 4, 2007pp. 338-352.

Bamber, C.J., Sharp, J.M. and Hides, M. (1999).Factors *Affecting Successful Implementation of TPM: A UK manufacturing case study perspective*. Journal of Quality in Maintenance Engineering, Vol. 5 No. 3, pp.162-81.

Bhadury, B. (2000). *Management of productivity through TPM*. Productivity, 41(2), 240-51.

Cochran, W. G. (1963). *Sampling Techniques*. New York: John Wiley and Sons, Inc.

Chowdhury, C. (1995). *NITIE and HINDALCO: Give a New Dimension to TPM*. Udyog Pragati, Vol. 22 No. 1, pp. 5-11.

Cua, K.O., McKone, K.E. & Schroeder, R.G. (2001), "*Relationships between implementation of TQM, JIT, and TPM and manufacturing performance*", Journal of Operations Management, Vol. 19 No. 6, pp. 675-94.

Funk, O.A & Wamache, K. A (2013). *Kenya Seed Industry study*. Agri experience.

Gardner, L. (2004). *Continuous Improvement through 100% Workforce Engagement. 11th* Annual Total Productive Maintenance Conference and Exposition, Dallas, Productivity, Inc.

Ireland, F. & Dale, B.G. (2006).*Total productive maintenance: criteria for success.* International Journal of Productivity and Quality Management, Vol. 1, No. 3, pp. 207–223

JIPM solutions co. ltd. What is TPM (online). *Available at: http://www.tpm.jipms.jp/tpm/index.html (accessed 25 April 2013*).

Kenya Seed Policy (2010). *National seed policy*. Ministry of Agriculture, Government of Republic of Kenya.

Kenya national bureau of statistics (KNBS),*'the 2014 Economic Survey'*.

Koelsch, J.R. (1993). *A dose of TPM: downtime needn't be a bitter pill.* Manufacturing Engineering, Vol. 110 No. 4, pp. 63-6.

Kutucuoglu, K.Y., Hamali, J., Irani, Z. & Sharp, J.M. (2001).*A framework for managing maintenance using performance measurement systems.* International Journal of Operations & Production Management, Vol. 21 Nos 1/2, pp. 173-94.

Lazim et al (2013), *Total productive maintenance & manufacturing performance: Does complexity in the production process matter?* International journal of trade, vol 4, No 6.

Leflar, J. (2001), "Practical TPM," Portland, OR, Productivity Press.

McCarthy, D. & Rich, N. (2015). *Lean TPM: A blueprint for change.* New York, BH.

MacRobert, J.F. 2009. *Seed business management in Africa.* Harare,Zimbabwe, CIMMYT.

Maggard, B.N. (1992).*Total Productive Maintenance: A Timely Integration of Production and Maintenance.* Production and Inventory Management Journal, vol.33 No.4 pp 6-10.

Melesse .W & Singh,P.A(2012).*Total productive maintenance: A case study in manufacturing industry.* Global journal of researches in Engineering, vol 12.

McKone, K. E., R. G. Schroeder, et al. (1999). *Total Productive Maintenance: A contextual View*. Journal of Operations Management, Vol 17: pp 123-144.

Mohammed, M. (2013*). Adoption of total productive maintenance practices by food processing firms in Kilifi county, Kenya*," unpublished MBA Thesis, University of Nairobi.

Nakajima, S. (1988). *Introduction to Total Productive Maintenance (TPM)*. Productivity Press, Portland. OR.

Nakajima, S. (1989). *TPM development program: Implementing total productive maintenance.* Productivity Press, Portland, OR.

Nordin,M. & Saman,Z.M (2012).*Implementation of total productive maintenance concept in a fertilizer processing plant.*Junal mekanikal, No 34,pp 66-82
Pomorski, T. (2004). *Total productive maintenance, Concepts and Literature Review*. Cincinnati, OH, The Union Institute and University.

Rodrigues, M. & Hatakeyama, K. (2006), *Analysis of the fall of TPM in companies*. Journal of Materials Processing Technology, Vol. 179 No 1-3, pp. 276-9.

Robinson, C. J. and A. P. Ginder (1995).*Implementing TPM: The North American Experience.*Portland, OR, Productivity Press.

Sangameshwran, P. & Jagannathan, R. (2002). *HLL's manufacturing renaissance*. Indian Management, November, pp. 30-5.

Shirose, K., Ed. (1996). *TPM-Total Productive Maintenance: New Implementation Program in Fabrication and Assembly Industries*. Tokyo, Japan, Japan Institute of Plant Maintenance.

Shamsuddin, A., Hassan, M.H. & Taha, Z. (2005). *TPM can go beyond maintenance: excerpt from a case implementation*, Journal of Quality in Maintenance Engineering, Vol. 11 No. 1, pp. 19-42.

Singh, K. & Ahuja, I.S. (2012*). Justification of TQM–TPM implementations in manufacturing organizations using analytical hierarchy process: a decision making approach under uncertainty*, The International Journal of Productivity and Quality Management, Vol. 10, No. 1, pp. 69-84.

Suzuki, T., Ed. (1994). *TPM in Process Industries.* Portland, OR, Productivity Press.

Tajiri, M. and F. Gotoh (1992). *TPM Implementation - A Japanese Approach*. New York, McGraw Hill.

Venkatesh, J (2007). *Plant Maintenance Resource Centre. An Introduction to Total Productive Maintenance (TPM) (online).*available at: http://www.plant maintenance.com/articles/tpm. intro.pdf (accessed 20 April 2013).

Willmott, P. & McCarthy, D (2001).*TPM-A route to world class performance*. New York, BH.

Wireman, T. (2004*). Total Productive Maintenance - An American Approach*. New York, Industrial Press.

APPENDICES

Appendix I: Questionnaire

DECLARATION

This research intends to examine the extent to Total Productive Maintenance (TPM) affects manufacturing performance in Kenya's seed industry. It aims to identify the TPM practices adopted by firms in the industry and factors that influence the implementation of TPM .The information obtained from this survey shall be kept confidential, and shall be used strictly for academic purposes only. Your participation in this survey shall be highly appreciated.

Total productive maintenance (TPM) is a resource-based maintenance management system that aims at increasing capacity and ending the vicious cycle of breakdowns or reactive repairs through the use of autonomous and predictive maintenance, as well as equipment modifications to facilitate optimum machine availability and performance.

Section A: General Information

Name of firm/Organization ……………………………………………

Department/Function …………………………………………….

Position in the Firm/Organization …………………………………………….

1) How long has the firm been in operation? (select by ticking the check box)

☐ 0-5 yrs ☐ 6-10yrs ☐ 10-15yrs ☐ Over 15yrs

2) What is the total number of employees in your firm/organization?

☐ 1-50 ☐ 51-100 ☐ 101-150 ☐ 151-200 ☐ above 200

3) Which is the core function of the firm /organization?

a) Research ☐

b) Production ☐

c) Processing ☐

d) Marketing ☐

Section B: Total Productive Maintenance Practices

4) Has the organization adopted /implemented Total Productive Maintenance practices/pillars?

☐ Yes ☐ No ☐ Not sure

5) What is the extent of the Total Productive Maintenance pillars implemented in the firm/organization?

Scale ranging from (1) Very Low (2) Low (3) Average (4) High (5) Very High

No	Pillars	Scale				
		1	2	3	4	5
1	Autonomous Maintenance					
2	Focused Improvement					
3	Planned Maintenance					
4	Quality Maintenance					
5	Education and training					
6	Office TPM					
7	Development Management					
8	Safety, Health and Environment					
9	Others					

Section C: Total Productive Maintenance and Performance

6) To what extent has Total Productive Maintenance contributed to the firms/organization achieving the following performance measures?

Scale ranging from (1) Very Low (2) Low (3) Moderate (4) High (5) Very High

No	Performance Measure	Scale				
		1	2	3	4	5
1	Product Quality					
2	Cost					
3	Inventory Level					

4	Lead time					
5	Processing cycle time					
6	Customer complaints					
7	Equipment efficiency					
8	Overall productivity					

Section D: Critical success factors for TPM implementation

7) Rate the following factors for successful implementation of TPM in your firm/organization with a scale of 1-5(Where 1 is most critical and 5 least critical)

No	**Factors for TPM Implementation**	**Scale**				
		1	**2**	**3**	**4**	**5**
1	Management leadership and commitment					
2	Employee empowerment and involvement					
3	Continuous improvement					
4	Adoption of new technology					
5	Organizational culture change					

SECTION E: PERFORMANCE OF THE COMPANY

8) What is the performance of your company in the past year (2014) in terms of

a) Profit(Ksh-millions)

☐ Below 1M ☐ 1-50M ☐ 51-100M ☐ 101-150M ☐ above 150M

Thank you for taking your time to complete this questionnaire

Appendix II: List of Companies in the Kenya Seed Industry

No	Company	**Function**
1	ADC ltd	**Research**
2	KALRO seed unit	
3	KEFRI seed centre	
4	Egerton University Seed Unit	
5	Syngenta East Africa ltd	
6	Genetic technologies international	
7	Bayer EA ltd	
8	Green life Agroscience EA ltd	
9	Veterinary and Agronomic EA ltd	
10	Oil crop development ltd	
11	Vegpro Kenya LTD	
12	Murphy Chemicals ltd	
13	Agrifarm EA ltd	
14	Mount Elgon Orchards ltd	**Production**
15	Freshco International	
16	Pollen Ltd	
17	Lambwe Seed Growers(LASGA)	
18	Crop Africa ltd	
19	Sunripe (1976) ltd	
20	Kisima Farm	
21	Homegrown K ltd	
22	Greenland Agroproducers ltd	
23	Frigoken ltd	
24	Everest Enterprises	
25	East African Growers ltd	
26	Agrifresh Kenya ltd	
27	AAA growers ltd	
28	Migotiyo Plantations	
29	Wakala Africa ltd	
30	Kitui Ginneries ltd	
31	Lake basin development authority	
32	Mwea Rice growers multipurpose society	
33	Mwea Cotton Ginnery ltd	
34	Rehabilitation of arid environments	
35	Suera Flowers Ltd	
36	Alliance One tobacco Kenya ltd	
37	Agro Irrigation and pump services	
38	Dominion Farm ltd	
39	Green forest Social investment ltd	
40	Green Africa Foundation	
41	First Choice Seeds enterprises	
42	Hortitec Kenya ltd	
43	Benvar Estate Ltd	
44	Western seed & grain co	
45	Kenya Seed Company Limited	

46	Pioneer ltd	
47	Simlaw seed	
48	East African Seed Co	
49	Monsanto Kenya ltd	
50	Sacred seed company ltd	
51	Uniseed	
52	Adaptive Seed Co ltd	
53	Goldsmith Seeds Kenya ltd	
54	Safari seeds ltd	
55	Amapop seed ltd	**Processing**
56	Dryland seeds ltd	
57	Agri-seed co	
58	Kenya Highland Seed co	
59	Savanna seeds ltd	
60	Mavuno Seeds	
61	Pannar seed co ltd	
62	Royal seed ltd	
63	British American Tobacco Kenya	
64	Elgon Kenya ltd	
65	Leldet Ltd	
66	Orion East Africa Ltd	
67	Agrifarm EA ltd	
68	Redshank Ltd	
69	MIAD	
70	Wilham Kenya ltd	
71	Chemisian Far ltd	
72	Stokman Rozen Kenya ltd	
73	Rifcot Ltd	
74	Milwar Enterprises	
75	Midlands ltd	
76	Kenya Malting ltd	
77	Kenfap Services ltd	
78	Hamer K ltd	
79	Olerai ltd	
80	Equip Agencies ltd	**Marketing**
81	Color vision roses ltd	
82	Charles Gerald ltd	
83	Carzan Flowers ltd	
84	Syova Seed Ltd	
85	Africallalily Kenya ltd	
86	Lesiolo Drain handlers ltd	
87	Lagrotech	
88	Amira K ltd	
89	Alibhai sheriff & sons ltd	
90	Hygrotech EA ltd	
91	Gnass K ltd	
92	Adaptive seeds co ltd	

93	Agrichem and tools ltd	