TOTAL PRODUCTIVE MAINTENANCE BY CEMENT COMPANIES IN KENYA

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

MARCH 2015

DECLARATION

This research project is my original work and has not been submitted to any University for examination.

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

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ACKNOWLEDGEMENTS

I would like to acknowledge the Almighty God for His grace, guidance, strength, health, courage, knowledge and wisdom. Special gratitude goes to my husband for his immense support, inspiration, encouragement and understanding. To my children I say thank you for your patience when I was not there.

I appreciate my supervisor Mr. Tom Kong'ere for his guidance, support, timely feedback, constructive criticism and always being available to assist. Without his valued support, consideration and input, this study would not have been successfully accomplished. His uncompromising stance on quality and details greatly motivated me to do better. Thank you very much sir.

I also acknowledge the support received from my friends, classmates and colleagues.

Thank you and God bless you all.

DEDICATION

To my lovely husband and my wonderful sons

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ABSTRACT

Global competition and the demand to increase productivity of manufacturing and production lines have attracted many industrial organizations from a wide spectrum to implement Total Productive Maintenance (TPM) as a tool for improving productivity and system's output. TPM is a production-driven improvement methodology that is designed to optimize equipment reliability and ensure the efficient management of plant assets. It has been found to impact the bottom-line, drive down costs, improve capacity, improve quality and workplace safety and help organizations respond faster to customer requirements all enabling an organization to be competitive in the market. The objective of the study was to establish the extent to which the Nairobi Grinding Plant (NGP) had applied TPM practices, the challenges and success factors to effective TPM implementation and the benefits of TPM implementation at NGP. The research methodology used was a case study using NGP as a unit of study. The research findings revealed that NGP has began to implement TPM with 6 pillars already implemented. Office TPM and early management pillars have not been implemented. All TPM practices have been implemented except the practice of 5S. Health and safety systems to achieve zero accidents and downtime countermeasures have been fully implemented. The TPM recommended measurements of manufacturing performance are in use at NGP forming some of the key performance indicators for the plant. The measurements are the cost of production, overall equipment effectiveness, delivery performance, customer satisfaction and quality. Two main hurdles that NGP encountered during TPM implementation were employees considering TPM as additional work and lack of sufficient training and education. The key drivers of effective TPM implementation were found to be; training and employee involvement, thorough planning and preparation, managing synergic cooperation of production and maintenance, top management support and commitment and effective communication. The benefits of effective TPM implementation include; improved workplace safety, high levels of product quality, strong delivery performance, improved overall equipment effectiveness, increased customer satisfaction, higher equipment utilization, reduction in number of equipment breakdowns and reduced cost of production. The results confirm that TPM implementation does deliver benefits to organizations that effectively implement the program. The management at NGP should focus on the development and deployment of their highly dedicated employees to fully implement TPM through the success factors already in place and to overcome the challenges at hand in order to reap the full benefits of TPM implementation.

ABBREVIATIONS AND ACRONYMS

CMMS – Computerized Maintenance Management System

JIPM – Japan Institute of Plant Maintenance

LCC – Life Cycle Cost

MPM - Maintenance Performance Measurement

NGP – Nairobi Grinding Plant

OEE – Overall Equipment Effectiveness

RBV - Resource Based View

SHE – Safety, Health and Environment

SWOT – Strengths, Weaknesses, Opportunities and Strengths

TPF - Theory of Performance Frontiers

TPM – Total Productive Maintenance

UK – United Kingdom

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

In today's highly dynamic and rapidly changing environment, the global competition among organizations has led to higher demands on the manufacturing organizations (Miyake and Enkawa, 1999). The manufacturing industry has experienced an unprecedented degree of change in the last three decades, involving drastic changes in management approaches, product and process technologies, customer expectations, supplier attitudes as well as competitive behaviour (Ahuja, Khamba and Choudhary, 2006). To overcome these challenges organizations are proactively implementing strategies that will help them remain competitive. Recent competitive trends have prompted top management of manufacturing enterprises to look at the performance of each and every business function, including manufacturing and maintenance, to achieve competitive advantage (Ben-Daya and Duffuaa, 1995; Pintelon, Pinjala, and Vereecke, 2006).

Maintenance has now become a strategic tool to increase competitiveness rather than simply an overhead expense that must be controlled (Waeyenbergh and Pintelon, 2007). The Maintenance function is treated as an investment in increasing process reliability in many organizations (Patterson, Fredendall, Kennedy and McGee, 1996). Over the past decade there has been increased recognition that in world-class manufacturing, maintenance is not a separate, isolated function that makes repairs and performs assorted activities as needed. Rather, maintenance is a full partner, striving together with the other functions to achieve the firm's strategic goals (Etienne-Hamilton, 1994).

The inadequacies of the maintenance practices in the past, have adversely affected the organizational competitiveness by reducing throughput and reliability of production facilities. This has resulted in fast deterioration of production facilities, lowering equipment availability due to excessive system downtime, lowering production quality, increasing inventory, thereby leading to unreliable delivery performance (Ahuja and Khamba, 2008). Kenya experienced a cement shortage in July and August 2006 due to a surge in demand following factory closures for maintenance by the cement companies. As a result, the price of a 50-kg bag of cement went up by about Sh100 to Sh650 (www.cemnet.com, accessed 1st August 2015). This case demonstrates the impact maintenance can have on availability of product and company performance. Therefore it is critical to implement strategies that will deliver reliable delivery performance.

Total Productive Maintenance is the proven manufacturing strategy that has been successfully employed globally for the last three decades, for achieving the organizational objectives of core competence in the competitive environment (Ahuja, Singh, Sushil and Wadood, 2004). International competition and the demand to increase productivity of manufacturing and production lines have attracted the management of industrial organizations from a wide spectrum to implement Total Productive Maintenance as a tool for improving productivity and system's output (Graisa and Habaibeh, 2011).

1.1.1. Total Productive Maintenance

Total Productive Maintenance (TPM) is a maintenance program involving a defined concept for maintaining equipment and plant. The goal of TPM is to significantly increase production, employee morale and job satisfaction. The

definition of TPM includes five major elements (Nakajima, 1988): overall equipment effectiveness maximization; a thorough system of preventive maintenance for the equipment's whole life span; implementation by various departments (engineering, production, maintenance, etc.); total employee involvement from top management to the workers on the floor and management of motivation through small group activities and teamwork.

TPM is a production-driven improvement methodology that is designed to optimize equipment reliability and ensure the efficient management of plant assets (Robinson and Ginder, 1995). TPM provides a comprehensive, life-cycle approach to equipment management that minimizes equipment failures, production defects, and accidents. It is based on teamwork and provides a method for the achievement of world-class levels of overall equipment effectiveness through people and not through technology or systems alone (Willmott, 1994).

TPM programs have been found to impact the bottom-line, improve capacity and workplace safety and reduce maintenance costs hence reduction in overall operational costs. Successful TPM implementation leads to significant intangible benefits such as continuous improvement of workforce skills and knowledge, fostering employee motivation through adequate empowerment, clarification of roles and responsibilities for employees, a system for continuously maintaining and controlling equipment, enhanced quality of work life, reduced absenteeism and enhanced communication in the workplace (Carannante, 1995).

1.1.2. Cement Companies in Kenya

Cement is a versatile material used in most civil construction works including buildings, foundations, roads, bridges, airports, sea ports, irrigation, dams etc. Cement consumption is a key indicator of activity in the construction sector. The cement industry is important as it plays a forward and backward linkage with other economic sectors hence playing a critical role as an indicator to the general economic conditions. The cement industry is a key contributor of revenue to the government and supports other key sectors like energy (Njeru, 2007).

The cement industry in Kenya has witnessed a transformation in the past five years amid increased competition accentuated by new entrants and enhanced capacity by existing players stimulated by a growing cement and related products market. The margins of the cement companies have come under strain following aggressive price competition strategy adopted by the new entrants coupled with increased costs of production in the sector. The high costs of production have been exemplified by escalating fuel and electricity prices coupled with pressure of spiraling double digit inflation on administrative and raw material costs (Ndegwa, 2013).

The role of cement companies in the Kenyan economy has increased significantly in the recent past especially due to the growth of the construction industry in the country (Wanjira, 2010). There are six cement companies in Kenya namely; Bamburi Cement Limited, Athi River Mining Limited, East African Portland Cement Company Limited, National Cement Company Limited, Mombasa Cement Limited and Savannah Cement Company (Ministry of Industrialization and Enterprise Development, 2014). Bamburi Cement Limited is

the largest manufacturer of cement and has the largest market share. As a key player in the cement industry, Bamburi Cement Limited plays an important role in the Kenyan economy by paying taxes, offering employment opportunities and sustaining the construction industry (Mwanzia, 2009).

1.1.3. Nairobi Grinding Plant

Bamburi Cement Limited is a subsidiary of Lafarge, the world leader in building materials and top ranking player in the cement, aggregates and concrete industries. Bamburi Cement Limited is listed on the Nairobi Securities Exchange and has three subsidiaries namely Hima Cement Limited, Bamburi Special Products Limited and Lafarge Eco Systems Limited. Bamburi Cement Ltd opened Nairobi Grinding Plant in Athi River near Nairobi in 1998 (Bamburi Cement Annual Report, 2013).

Nairobi Grinding Pant (NGP) is a part of Bamburi Cement Limited. NGP has been in existence for sixteen years and has a grinding capacity of one million tons of cement annually (www.lafarge.co.ke, accessed 12 March 2015). NGP has helped Bamburi Cement Limited to improve its service to Nairobi and upcountry markets, through speedier and more efficient packing turnaround time. The rail sliding at NGP has also facilitated sales to Western Kenya and Uganda (www.lafarge.co.ke, accessed 12 March 2015).

1.2. Statement of the Problem

TPM has been widely accepted by the industrial organizations worldwide. It addresses entire production system over the entire life cycle and builds a concrete, shop floor-based mechanism to prevent various manufacturing losses and wastes. The objective is to continuously improve the production system

availability and prevent the degradation of equipment to achieve maximum effectiveness (Ravishankar, Burczak and Vore, 1992). Therefore, it helps organizations that adopt it to drive down costs, respond faster to customer requirements, improve quality and achieve safe workplaces all enabling an organization to be competitive in the market. TPM is a people-oriented concept that starts by fully exploiting and harnessing the human intellectual capabilities which are normally hidden and unexploited in most organizations.

The cement industry is a crucial industry in any economy. Cement companies play a crucial part in the social and economic development of the country. According to Tourki (2010) in his strengths, weaknesses, opportunities and threats (SWOT) analysis on the cement industry, there are a number of changing-forces which are the significant global increases of fuel and energy costs that have heavily impacted the cement industry, market pressure to keep prices lower than the competitors and the high market demands that have put the cement industry under pressure to simultaneously reduce cycle time and downtimes, and increase utilization and throughput of the equipment. High cost of production due to frequent fluctuations of fuel and electricity prices is one of the challenges facing Bamburi Cement Limited. The entry of new players into the cement sector is also eating into the profitability and market share of Bamburi Cement Limited (Mwanzia, 2009). In order for Bamburi Cement Limited to compete effectively, the company needs to reduce its cost of production to deliver low prices in the market as competition in the cement industry is on the basis of price. Therefore, it is important that they implement strategies such as TPM to drive down their production costs, improve their performance and deliver superior service to their customers. Nairobi Grinding Plant is a part of Bamburi Cement Limited and was

picked for this study because it is one of the biggest and oldest grinding plants in Kenya.

Ahuja and Kumar (2009) carried out a study on an Indian manufacturing facility on TPM implementation and revealed that TPM initiatives are far more influential in affecting manufacturing performance improvements as compared to traditional maintenance practices. Another study was carried out by Bartz, Siluk and Barth (2014) to evaluate the improvement in industrial performance of a company in Brazil based on indicators of industrial performance. According to the specifications of TPM, the scrap, rework and efficiency rates showed significant improvement and positive trends. They found out that the production line studied benefited from TPM, becoming more competitive in relation to those of competitors and providing better performance.

Several studies have been conducted in Asia (Ahuja and Khamba, 2008) and in Europe where Bamber, Sharp and Hides (1999) conducted a study to develop a critical understanding of factors affecting successful implementation of TPM in a UK small to medium size enterprise. In the cement industry a study has been conducted on the Libyan cement industry by Graisa and Al-Habaibeh (2011).

Locally, a research was conducted on implementation of TPM in large manufacturing firms in Kenya (Induswe, 2013) and another one on adoption of TPM in food processing firms in Kilifi County (Yusuf, 2013). Ateka (2013) undertook a study on adoption of total productive maintenance practices among large manufacturing firms in Mombasa County and Matuga (2013) researched on Contribution of total productive maintenance strategy to the competitive advantage of Unilever Kenya Limited. Their findings indicate that TPM is an ideal tool for performance improvement. No study has been conducted on TPM

implementation in a cement company in Kenya and more specifically at Nairobi Grinding Plant therefore this research was intended to contribute to existing knowledge on TPM by addressing this gap in knowledge.

The aim of the study was implementation of Total Productive Maintenance (TPM) by cement companies in Kenya using Nairobi Grinding Plant as a unit of study. The study sought to answer the following questions: To what extent has Nairobi Grinding Plant applied TPM practices? What are the challenges to successful implementation of TPM at Nairobi Grinding Plant? What are the success factors of TPM implementation by the Nairobi Grinding Plant? What are the benefits of implementing TPM at Nairobi Grinding Plant?

1.3. Research Objectives

The general objective of this study was to establish the effects of Total Productive Maintenance implementation on Cement Companies in Kenya using a case of Nairobi Grinding Plant. However the specific objectives were as listed below:

i. To determine the TPM practices adopted at the Nairobi Grinding Plant.

ii. To establish the challenges faced in TPM implementation at the Nairobi Grinding Plant.

iii. To determine the success factors in TPM implementation at the Nairobi Grinding Plant.

iv. To determine the benefits of TPM implementation at the Nairobi Grinding Plant

1.4. Value of the Study

The study will benefit the Nairobi Grinding Plant in achieving their ambitions of performance improvement and cost reduction by establishing what the challenges, success factors and benefits are should they implement TPM. This benefit can be replicated by Bamburi Cement Ltd by implementing TPM in its fully integrated Plant in Mombasa to consolidate the gains from a successful TPM implementation.

This study will assist managers of the other manufacturing companies to discover whether TPM will benefit their organizations. It will provide insights that would help them better prepare to face the challenges that are associated with the implementation of TPM.

Policy makers will get insights that will help in policy formulation on cement importation and taxation to encourage the local cement companies to produce cement cheaply to effectively compete with external companies importing cement into the country.

The study will contribute new knowledge to scholars as regards TPM implementation in the cement companies in Kenya. They can use the study as a source of secondary data on the subject of TPM implementation.

CHAPTER TWO: LITERATURE REVIEW

2.1. Theoretical Foundation of the Study

The theoretical foundation of this study hinges on four theories; theory of constraints, decision theory, theory of performance frontiers and resource based theory. Theory of constraints is a multi-faceted systems methodology that has been progressively developed to assist people and organizations to think about problems, develop breakthrough solutions and implement those solutions successfully (Mabin and Balderstone, 2003). Theory of constraints increases throughput by first identifying the most critical bottlenecks (constraints) in the sequence that will produce the biggest and quickest benefit. Bottlenecks are then systematically and sequentially optimized to maximize system throughput and productivity. Ideally, a system relieved of bottlenecks will increase throughput and lead the firm to seek new markets which increases demand. The increased demand placed on the system will ultimately locate new bottlenecks, provide new opportunity for system optimization, which leads to increased throughput and the process continues (Tersine and Hummingbird, 1995). Maintenance can be viewed as a constraint that needs to be addressed through total productive maintenance to improve cement industry performance.

Decision theory provides a logical framework for solving real-life problems. It is concerned with the identification of an action which is expected to provide maximum benefits to the decision maker. Maintenance decision making may take place in several contexts with different types of systems in terms of technology, repairability and availability requirements (De Almeida and Bohoris, 1995). The theory of performance frontiers (TPF) maintains that inefficiencies are influenced by managerial decisions, operating characteristics, and external forces. Therefore,

resolving these inefficiencies through rationalizing resource utilization will reduce the plant's distance from the performance frontier, i.e. best-in-class performance (Zhang, Joglekar and Verma, 2012).

Various researchers have noted the importance of TPM implementation in the manufacturing environment (Ahmed, Masjuki and Taha, 2005; Ahuja and Khamba, 2007). In addition, Barney (1991) argues that in the resource based view (RBV), the resources of the firm enable it to achieve competitive advantage, which can lead to superior long-term performance. Resource based view is an important inside out management concept that is useful in developing successful strategy. Moreover, the resource base of the firms has contributed to a theory of competitive advantage.

2.2. Total Productive Maintenance

Total Productive Maintenance (TPM) was developed by the Japan Institute of Plant Maintenance (JIPM) as a tool for equipment-intensive manufacturing sectors to increase machine availability (Suzuki, 1994). The credit for establishing JIPM goes to Seiichi Nakajima (McCarthy and Rich, 2004). According to Sharma, Kumar and Kumar (2006), TPM is defined as a team-based maintenance strategy designed to maximize equipment effectiveness by establishing a comprehensive maintenance production system covering the entire life of equipment, spanning all equipment related fields (planning, use and maintenance) and involving everyone in the organization.

2.3. Total Productive Maintenance Pillars

TPM is built on eight pillars (Sangameshwran and Jagannathan, 2002) as suggested and promoted by the Japan Institute of Plant Maintenance. They are; autonomous maintenance, focused maintenance, planned maintenance, quality

maintenance, education and training, office TPM, early management, and safety, health and the environment (Ireland and Dale, 2001; Shamsuddin, Hassan and Zahari, 2005).

2.3.1. 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). The objective of focused improvement is for equipment to perform very well each and every day. The better the machines run, the more productive the shop floor and the more successful the business becomes (Leflar, 2001). The driving concept behind focused improvement is zero losses. 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 (Nakajima, 1988).

2.3.2. 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 and Ginder, 1995). The driving concept of autonomous maintenance is the creation of ‘expert equipment operators’ for the purpose of ‘protecting their own equipment’ (Shirose, 1996) Autonomous maintenance is the cornerstone of TPM activities (Komatsu, 1999). Autonomous Maintenance aims to foster the development and knowledge of the equipment operators and to establish an orderly shop floor, where the operator may easily detect departure from optimal conditions (Tajiri and Gotoh, 1992). It is the most basic of the eight

pillars of TPM. If autonomous maintenance activities are insufficient, the expected results will not materialize even if the other pillars of TPM are upheld (Komatsu, 1999). Autonomous maintenance empowers (and requires) equipment operators to become knowledgeable managers of their production activities and able to: detect signs of productivity losses, discover indications of abnormalities and act on those discoveries.

2.3.3. Planned Maintenance

The objective of planned maintenance is to establish and maintain optimal equipment and process conditions (Suzuki 1994). Devising a planned maintenance system means raising output (no failures, no defects) and improving the quality of maintenance technicians by increasing machine availability. Implementing these activities efficiently can reduce input to maintenance activities and build a fluid integrated system, which includes: regular preventive maintenance to stop failures, corrective maintenance and daily maintenance prevention to lower the risk of failure, breakdown maintenance to restore machines to working order as soon as possible after failure and guidance and assistance in autonomous maintenance (Japan_Institute_of_Plant_Maintenance, 1996). Planned maintenance activities put a priority on the realization of zero failures (Shirose, 1996).

2.3.4. Training and Education

Training and education pillar ensures that employees are trained in the skills identified as essential both for their personal development and for the successful deployment of TPM in line with the organization’s goals and objectives (Marofi, 2014). Improved skills and performance of all employees throughout the

organization is vital for successful implementation of TPM. The aim of training and education pillar is to have multi-skilled revitalized employees whose morale is high and are eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skills. The goal is to create a factory full of experts. The employees should be trained to achieve the four phases of skills which are: Phase 1- Do not know, Phase 2 - Know the theory but cannot do, Phase 3 - Can do but cannot teach and Phase 4 - Can do and also teach (Venkatesh, 2007).

2.3.5. Early Management

Early Management is also known as Maintenance Prevention (Suzuki 1994). Maintenance Prevention refers to design activities carried out during the planning and construction of new equipment, that impart the equipment high degrees of reliability, maintainability, economy, operability, safety, and flexibility, while considering maintenance information and new technologies, and to thereby reduce maintenance expenses and deterioration losses (Shirose, 1996). The classic objective of early management is to minimize the Life Cycle Cost (LCC) of equipment. In TPM, the concept of early management design is expanded to include design that aims at achieving not only no breakdowns (reliability) and easy maintenance (maintainability) but also prevention of all possible losses that may hamper production system effectiveness and pursuit of ultimate system improvement. The early management design process improves equipment [and process] reliability by investigating weaknesses in existing equipment [and processes] and feeding the information back to the designers (Suzuki, 1994)

2.3.6. 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. 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. The key concept of quality maintenance is that it focuses on preventive action ‘before it happens’ rather than reactive measures ‘after it happens’ (Japan_Institute_of_Plant_Maintenance, 1996). Quality maintenance supports a key objective of TPM which is ensuring that equipment and processes are so reliable that they always function properly (Schonberger, 1986). Pre-conditions for successful quality maintenance implementation include abolishment of accelerated equipment deterioration, elimination of process problems, and the development of skilled and competent users. (Shirose 1996)

2.3.7. Office TPM

Office TPM is carried out in order to improve productivity, increase efficiency in administrative and technical functions, and to identify and eliminate losses. This includes analyzing processes and procedures with the aim of increasing office automation (Patra, Tripathy and Choudhary, 2005). These departments increase their productivity by documenting administrative systems and reducing waste and loss. They can help raise production-system effectiveness by improving every type of organized activity that supports production (Suzuki, 1994).

2.3.8. Safety, Health and Environment

Safety, Health and Environment (SHE) is the final TPM pillar and implements a methodology to drive towards the achievement of zero accidents. TPM program is only meaningful with strict focus on safety, health and environmental concerns. Ensuring equipment reliability, preventing human error, and eliminating accidents and pollution are the key tenets of TPM (Suzuki, 1994). Implementing the TPM safety, health and environmental pillar focuses on identifying and eliminating safety, health and environmental incidents. Environmental safety goes beyond simply eliminating accidents and includes reduction of energy consumption, elimination of toxic waste, and reduction of raw material consumption (Pomorski, 2004).

2.4. Total Productive Maintenance Implementation Process

Nakajima developed the classic twelve-step TPM implementation process (Nakajima 1988; Nakajima 1989) that has been the foundation for TPM implementation. Numerous TPM practitioners have suggested their own version of a TPM implementation process; however, most are a variation or simplification of the Nakajima model.

Table 2.1: TPM Implementation Process

TPM Implementation Phase	TPM Implementation Step
Preparation	1. Formally announce the decision to introduce TPM
	2. Conduct TPM introductory education and publicity campaign
	3. Create a TPM promotion organization
	4. Establish basic TPM policies and goals
	5. Draft a master plan for implementing TPM
Introduction	6. Kick off the TPM initiative
Implementation	7. Establish a system for improving production efficiency (Focused improvement, Autonomous maintenance, Planned maintenance and Education and training pillars
	8. Establish and deploy the maintenance prevention activities
	9. Establish quality maintenance systems
	10. Create systems for eliminating efficiency losses in administrative and logistics functions
	11. Create systems for managing safety, health and the environment.
Consolidation And Sustaining	12. Sustain full TPM implementation and continually improve the TPM process.

Source: http://www.tpmconsulting.org (Accessed 29 March 2015)

2.5. Measurement of Total Productive Maintenance Effectiveness

There are different ways of measuring manufacturing performance and the most common approach, as reported in published literature, is to use cost, overall equipment effectiveness, quality, delivery and customer satisfaction as the basic dimensions (Hon, 2005). McKone, Roger and Kristy (1999) have observed that TPM has a strong and positive association with low cost, high levels of quality and strong delivery performance. The TPM concept (Nakajima, 1988), provides a quantitative metric called overall equipment effectiveness (OEE) for measuring the productivity of manufacturing equipment.

2.5.1. Overall Equipment Effectiveness

Overall equipment effectiveness (OEE) is the core metric for measuring the success of TPM implementation programme (Jeong and Phillips, 2001). The metric has become widely accepted as a quantitative tool essential for measurement of productivity in manufacturing operations (Huang, John, Shi, and Qi, 2002). OEE provides a systematic method for establishing production targets and incorporates practical management tools and techniques to achieve a balanced view of process availability, performance efficiency and rate of quality (Bulent, Tugwell, and Greatbanks, 2000). OEE is the product of equipment availability, performance rate and quality rate. An OEE of 85% is considered as world class performance (Blanchard, 1997).

2.6. Benefits of Total Productive Maintenance Implementation

TPM can be a strong contributor to the strength of the organization and has the ability to improve manufacturing performance (Gosavi, 2006). It aims to increase the availability of existing equipment in a given situation hence reducing the need for

further capital investment. Instrumental to its success is the investment in human resources, which further results in better equipment utilization, higher product quality and reduced labour costs (Bohoris, Vamvalis, Trace, and Ignatiadou, 1995). TPM seeks to achieve higher productivity, better quality, less failures, cost reduction, dependable deliveries, inspiring working surroundings, improvements in confidence and safety of the employees (Waghmare, Raut, Mahajan and Bhamare, 2014).

Previously unknown and hidden manufacturing losses can be identified with the help of OEE. Scores of OEE can be traced which can help to improve manufacturing processes. The functions that are delivered by OEE are rich in nature and are truly important to find the appropriate time needed for production and also to identify the causes of loss in productivity. The importance can be understood by the very fact that even as minute as 1% improvement in OEE index can prove vital and improve profits and productivity drastically (Kumar, Varambally, and Rodrigues, 2012).

Research by Johansson and Nord (1996) indicated that TPM improves productivity, cost, quality, delivery time, safety and morale of employees. Sharma, Kumar and Kumar (2006) undertook a research on manufacturing excellence through TPM implementation and the findings indicate that TPM not only leads to increase in efficiency and effectiveness of manufacturing systems, measured in terms of OEE index, by reducing the wastages but also prepares the plant to meet the challenges put forward by globally competing economies to achieve world class manufacturing status. Aspinwall and Elgharib (2013) studied TPM implementation in large and medium size UK manufacturing companies and revealed that two benefits gained by the four companies studied were a significant improvement in the availability and performance of the equipment within the plant and improved communication between

employees. Additional benefits were financial improvement, reduced energy cost and increased employee morale and job satisfaction.

2.7. Success Factors of Total Productive Maintenance Implementation

Many companies are known to have successfully implemented TPM and have achieved desired outcome as a result. In order to realize the true potential of TPM and ensure its successful implementation, TPM goals and objectives need to be fully integrated into the strategic and business plans of the organization because TPM affects the entire organization and is not limited to production. For TPM to be successful, the improvement process must be recognized as benefiting both the organization and the worker (Robinson and Ginder, 1995). Lycke and Akersten (2000) proposed that careful, thorough planning and preparation are keys to successful company-wide implementation of TPM and so is senior management's understanding and belief in the concept.

Bohoris et al. (1995) have emphasized upon affecting changes in the management structure, focusing on continuous production system improvements, managing synergic cooperation of production and maintenance, deployment of effective developed computerized maintenance management system (CMMS) and gradual implementation of TPM on a handful of machines at a given time as key contributors towards successful TPM implementation. Hansson, Backlund and Lycke (2003) have emphasized upon effectively managing organizational change to enhance organization's performance for strategic survival in the competitive environment.

Groote (1995) proposes a maintenance performance evaluation approach based on a quality audit and quantifiable maintenance performance indicators. He suggests that

the maintenance function effectiveness must be defined through relative economic and technical ratios, to permit the maintenance manager to follow the evolution of maintenance performance and to make decisions necessary for improved maintenance management. Fredendall, Patterson, Kennedy and Griffin (1997) suggests that a TPM development program should typically emphasize among other things the leadership role of top management in launching and implementing TPM, establishment of TPM policies, goals, and master plan and communicating these to everyone in the organization, and building a system for training and employee involvement. The commitment of top management in preparing a suitable environment for TPM's introduction and in planning and coordinating for its implementation is considered crucial to TPM's success. Hutchins (1998) advocated for making considerable efforts to recognize teams and enable them to display their work for successful TPM implementation.

2.8. Challenges of Total Productive Maintenance Implementation

Implementing TPM is by no means an easy task as it is heavily burdened by organizational barriers which can only be surmounted with a strong backing from the top management (Cooke, 2000). Several factors could hinder successful implementation of TPM including lack of senior management support, lack of budget or investment, pressure of workload, conflict of management initiatives, inefficient use of maintenance staff and senior management's tolerance of poor performance (Ahuja and Khamba, 2008).

Some of the prominent problems in TPM implementation include partial implementation of TPM, overly optimistic expectations, lack of a well-defined routine for attaining the objectives of implementation (equipment effectiveness), cultural

resistance to change, lack of training and education, lack of organizational communication, and implementation of TPM to conform to societal norms rather than for its instrumentality to achieve world class manufacturing (Becker, 1993). An organization's inability to effectively manage resistance to change is also a key contributor to the failure of TPM implementation.

Ahmed, Hassan and Taha (2004) conducted a study on state of implementation of TPM in small and medium manufacturing industries in Malaysia. The findings indicated that equipment maintenance is still a low priority. Lack of understanding about the importance of equipment in organizational performance was one of the main obstacles.

Graisa and Al-Habaibeh (2011) conducted a study to investigate production challenges facing the Libyan cement industry and the need for innovative TPM and found that the four factories under investigation had low productivity and production levels when compared with the design values. There was no clear TPM strategy. It was also found that lack of training and personal development was a major cause of the problem. In addition, employees were found to lack motivation since there was no management strategy and reward structure.

2.9. Empirical Literature Review

Ireland and Dale (2001) conducted a study of TPM implementation in three large global companies exporting to international markets. Sharma, Kumar and Kumar (2006) undertook a research on manufacturing excellence through TPM implementation to examine the need to develop, practice and implement such maintenance practices, which not only reduce sudden sporadic failures in semi-automated cells but also reduce both operation and maintenance costs.

Aspinwall and Elgharib (2013) researched on TPM implementation in large and medium size UK manufacturing companies and highlighted the effectiveness and obstacles encountered in the process of TPM implementation. Kumar, Soni and Agnihotri (2014) studied impact of TPM implementation on Indian manufacturing industry and recommended that research be further extended to be sector specific. The proposed research is aimed at filling this gap in knowledge.

Yusuf (2013) researched on adoption of TPM practices by food processing firms in Kilifi County, Kenya. He recommended that further studies be carried out in different sectors such as mining and fishing. This research is a step towards establishing more knowledge in TPM implementation in the specific manufacturing sectors. Induswe (2013) conducted a study on implementation of TPM in large manufacturing firms in Kenya and recommended further research among firms in the same industry. This research seeks to fill this gap by studying implementation of TPM by cement companies in Kenya using Nairobi Grinding Plant as a unit of study.

2.10. Literature Review Summary and Knowledge Gap

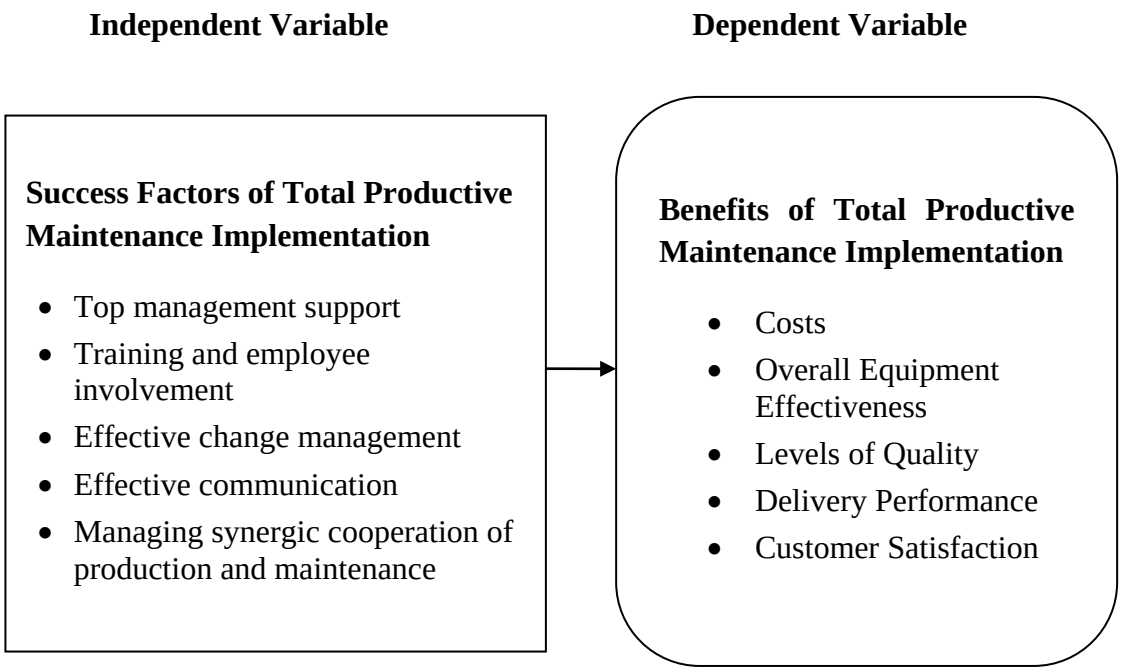
The literature review indicates that different authors have attempted to investigate the implementation of TPM with differing purposes and objectives.The proposed research is motivated by the fact that no study has been done on TPM implementation in a cement company in the Kenyan context and neither has there been a study conducted on TPM at the Nairobi Grinding Plant. From the above researchers it is recommended that more specific studies be conducted as far as TPM concept is concerned.

2.11. Conceptual Framework

This section outlines the conceptual framework for the study. It shows the conceptual model that will explain the relationship between the independent variable and

dependent variable. For the purpose of this study the independent variable will be the success factors of Total Productive Maintenance implementation while the dependent variable will be the benefits of Total Productive Maintenance implementation. The conceptual framework is shown on the figure below.

Figure 2.1: Conceptual Framework



The above figure illustrates the conceptual argument for this study showing the relationship between the success factors of TPM implementation with the benefits of Total Productive Maintenance implementation. Effective implementation of Total Productive Maintenance practices through appropriate success factors and effective actions to overcome challenges that arise during implementation will facilitate the reaping of the benefits of the Total Productive Maintenance program indicated by reduced costs, improved overall equipment effectiveness, high levels of quality, strong delivery performance and increased customer satisfaction. This will indicate successful implementation of Total Productive Maintenance.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Introduction

This chapter outlines the methodology of the study that was used in order to accomplish the research objectives. It consists of the research design, population of the study, sample design, data collection method, operationalization of the variables and data analysis technique which are discussed in detail.

3.2. Research Design

The research design applied in this research was the case study method. Case study research method was chosen because it is a valuable way of looking at the world around us (Rowley, 2002). It helped in gaining in-depth knowledge into the subject of Total Productive Maintenance implementation by the cement companies in Kenya using Nairobi Grinding Plant as a unit of study. Yin (2012) describes a case study as a research method that facilitates a deep investigation of a real-life contemporary phenomenon in its natural context. The case study approach has been widely used in the studies of organizations and has generated a huge amount of high quality information which has contributed significantly in deepening the understanding of organizational life in reality. Case studies provide an important means for checking the effectiveness of the TPM philosophy in different fields of application, especially in manufacturing industries (Aspinwall and Elgharib, 2013). This study helped document the TPM practices already applied at the Nairobi Grinding Plant and the challenges, success factors and benefits of implementing TPM.

3.3. Population of the Study

The target population was all the managers and supervisors at the Nairobi Grinding Plant. They were twenty two in number.

3.4. Sample Design

Census study was found to be the most appropriate because the population was small for the managers and supervisors. The managers and supervisors were the key informants in this study because they are mostly involved in the formulation and implementation of business strategies at the plant. Therefore, they had better appreciation of the success factors, challenges and the benefits accrued from these strategies.

3.5. Data Collection

Primary data and secondary data were used for this study. Secondary data was collected through observation of available company documents and published annual financial reports. Primary data was collected through structured questionnaire to ensure uniform responses to the questions. The questionnaire was designed on the basis of the research objectives. Responses were sought from all the six managers and 16 supervisors at the Nairobi Grinding Plant. The questionnaire was administered through face to face in-depth interviews with the respondents. However, in cases where the respondent was unavailable for an interview session, the questionnaire was dropped to them and collected in a week's time. The advantage of in-depth interviews is that they provide a more relaxed atmosphere in which to collect information as people may feel more comfortable having a conversation with the researcher about their program as opposed to filling out a survey (Boyce and Neale, 2006).

3.6. Operationalization of the Variables

This study had one independent variable which was the success factors of Total Productive Maintenance (TPM) implementation and a dependent variable which was the benefits of TPM implementation. The success factors were the measures put in place to ensure successful TPM role out and sustainable implementation to accrue benefits of the program. Benefits were the gains achieved through effective implementation of TPM after overcoming all the challenges and ensuring that all the success factors were successfully in place.

The research instrument for the two variables was a questionnaire. The benefits and success factors of TPM implementation were listed on a table. The respondents rated the benefits and success factors of TPM implementation on a likert scale of 1 to 5. The key success factors and benefits of TPM implementation were established by analyzing the data collected.

3.7. Data Analysis

Descriptive statistics such as measures of central tendency (mode and median), percentages and charts were used to analyze quantitative data collected for objectives one, two, three and four. Descriptive statistics is used to describe basic features of data collected in a study and provides simple summaries about the sample and the measures. This combined with simple graphic analysis, form the basis of virtually every quantitative analysis of data (Muganda, 2010).

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DISCUSSION

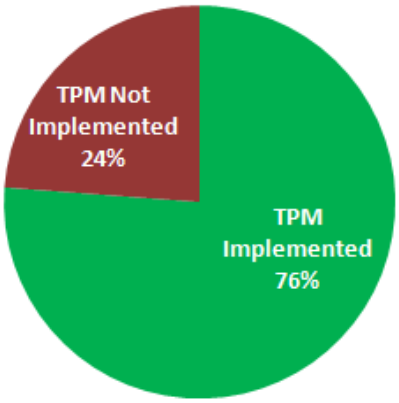
4.1. Introduction

The main objective of this research was to establish Total Productive Maintenance (TPM) practices adopted at the Nairobi Grinding Plant (NGP) and to determine the success factors, benefits and challenges to effective implementation of TPM. This chapter presents the analysis and interpretations of the data collected with regards to the objectives of the study. Sixteen questionnaires were administered through face to face in-depth interviews with the respondents. Six questionnaires were issued to those respondents who were not available for the interview sessions out of which five were returned. Therefore, the response rate was 95%.

4.2. Total Productive Maintenance Practices Adopted at Nairobi Grinding Plant

One of the objectives of this study was to establish the TPM practices already adopted at NGP. This was covered in the second section of the questionnaire where the first question was required to find out if NGP had begun to implement TPM. Sixteen respondents reported that TPM is already implemented while five of the respondents reported that TPM has not been implemented at NGP. The figure below shows that NGP has began to implement TPM given the majority of the respondents answered yes to the question.

Figure 4.1: Implementation of TPM at NGP



The second question sought to determine which TPM pillars had been implemented at NGP and the findings show that planned maintenance, safety, health and environment, education and training, and quality maintenance pillars have been majorly implemented while focused improvement, autonomous maintenance, office TPM and early management pillar have not been fully implemented given the low number of positive responses especially for office TPM and early management pillar. The findings are summarized on the table below.

Table 4.1: TPM Pillars Implemented at NGP

TPM Pillars implemented	Number of positive Responses	Percentage
Planned maintenance pillar	20	**95%**
Safety, health and the environment pillar	20	**95%**
Education and training pillar	16	**76%**
Quality maintenance pillar	15	**71%**
Focused improvement pillar	14	**67%**
Autonomous maintenance pillar	13	**62%**
Office TPM pillar	8	**38%**
Early management pillar	7	**33%**

The secondary data observed showed that six out of eight pillars have been implemented at NGP with structures and systems in place though some have been implemented to a greater extent than others. Office TPM and early management pillars have not been fully implemented based on the secondary data checked.

The third question was to help establish the TPM practices implemented at NGP. The findings as per the table below indicate that health and safety systems to achieve zero accidents and downtime countermeasures e.g. root cause failure analysis have been fully implemented given the confirmation by all the respondents with a score of 100%. Preventive and predictive maintenance programs, technical training of employees, maintenance cost analysis and teamwork approach to increase Operational Equipment Efficiency (OEE) are practices which are also in place given the confirmation by above 80% of the respondents. Involving machine operators in the preventive maintenance and continuous improvement activities (kaizen) are partially implemented while the practice of 5S is not in place at NGP given the low response rate of 33%.

Table 4.2: TPM Practices Implemented at NGP

TPM Practices in place at NGP	**Number of Responses**	**Percentage**
Health and safety systems to achieve zero accidents	21	**100%**
Downtime countermeasures e.g. root cause failure analysis	21	**100%**
Preventive and predictive maintenance programs	19	**90%**
Technical training of employees	19	**90%**
Maintenance cost analysis	19	**90%**

TPM Practices in place at NGP	Number of Responses	Percentage
Teamwork approach to increase Operational Equipment Efficiency	17	**81%**
Involving machine operators in the preventive maintenance	13	**62%**
Continuous improvement activities (kaizen)	11	**52%**
The practice of 5S (Sort, Set in order, Shine, Standardize and Sustain)	7	**33%**

The secondary data points out that most of the TPM practices are in place at NGP. Health and safety is highly upheld as confirmed by the high number of days (3,175 days) since the last lost time incident i.e. an accident in the workplace that cause someone not to work even for a day. Machine operators are involved in the preventive maintenance program by carrying out first level inspection on the equipment and alerting the maintenance department on the actions that need to be taken in a timely manner to prevent breakdowns and achieve high equipment reliability. The operators do not do minor repairs and replacement of parts. Continuous improvement activities (kaizen) are carried out as confirmed by the secondary data that demonstrated actions delivering consistent improvement on performance and reduction in number of breakdowns. The practice of 5S is not implemented as there was no information provided on it.

The data collected on the fourth question under the objective on TPM practices adopted at NGP indicate that cost of production, overall equipment effectiveness, delivery performance, quality and customer satisfaction are used to measure manufacturing performance. The findings are shown on the table below.

Table 4.3: Manufacturing Performance Measurement at NGP

Manufacturing Performance measurements at NGP	Number of Responses	Percentage
Cost of production	21	**100%**
Overall equipment effectiveness (OEE)	20	**95%**
Delivery performance	20	**95%**
Quality	20	**95%**
Customer satisfaction	16	**76%**

The percentage of positive responses ranged from 76% to 100% showing that these measurements are used at NGP. The secondary data observed also confirmed that these performance measurements are used to measure manufacturing performance and they are some of the key performance indicators for the plant. They are tracked daily, weekly and monthly. Actions are put in place on a continuous basis to correct any deviations that arise and consistently improve on the parameters to ensure sustained continuous performance improvement.

4.3. Challenges Faced in Implementing Total Productive Maintenance at Nairobi Grinding Plant

The second objective of this study was to establish the challenges of TPM implementation at NGP. Informants were required to rate the challenges on a scale of 1 (strongly disagree) to 5 (strongly agree). The mode and percentages were used to analyze the data. The mode is the most frequent number in a set of data. The summary of the results is shown on the table below.

Table 4.4: Challenges of Implementing TPM at NGP

Challenges Faced in TPM Implementation	Scale					Mode	Percentage of Highest Score
	5	4	3	2	1		
Employees considering TPM as additional work	1	8	4	7	1	**4**	**38%**
Lack of sufficient training and education	1	6	6	4	4	**4 & 3**	**29%**
Lack of a well-defined routine for attaining the objectives of implementation	3	5	4	6	3	**2**	**29%**
Lack of employee motivation	3	6	4	7	-	**2**	**33%**
No support and understanding from the top management	2	2	4	9	4	**2**	**43%**
Lack of understanding about the importance of equipment in organizational performance	-	2	5	9	5	**2**	**43%**
Lack of a suitable management organization	2	5	3	9	2	**2**	**43%**
Lack of TPM strategy and objectives	4	1	4	10	2	**2**	**48%**
Failure to allow sufficient time for change to take place before results can be realized	-	3	6	11	-	**2**	**52%**
Cultural resistance to change	-	4	6	11	-	**2**	**52%**
Lack of organizational communication	-	5	4	11	1	**2**	**52%**

The results of challenges faced in implementing TPM at NGP were as follows: employees considering TPM as additional work (38% agreed), lack of sufficient

training and education (29% agreed and 29% were neutral), lack of a well-defined routine for attaining the objectives of implementation (29% disagreed), lack of employee motivation (33% disagreed), no support and understanding from the top management (43% disagreed), lack of understanding about the importance of equipment in organizational performance (43% disagreed), lack of a suitable management organization (43% disagreed), lack of TPM strategy and objectives (48% disagreed), failure to allow sufficient time for change to take place before results can be realized (52% disagreed), cultural resistance to change (52% disagreed) and lack of organizational communication (52% disagreed).

The results indicate that NGP faced two major challenges during implementation of TPM which were; the employees considering TPM as additional work and lack of sufficient training and education. The other listed challenges did not significantly affect implementation of TPM at NGP and hence the informants disagreed that they were hurdles to be overcome.

4.4. Success Factors for Total Productive Maintenance Implementation at Nairobi Grinding Plant

The third objective of this study was to establish the success factors of TPM implementation at NGP. Informants were required to rate the success factors on a scale of 1 (strongly disagree) to 5 (strongly disagree). The findings are summarized on the table below.

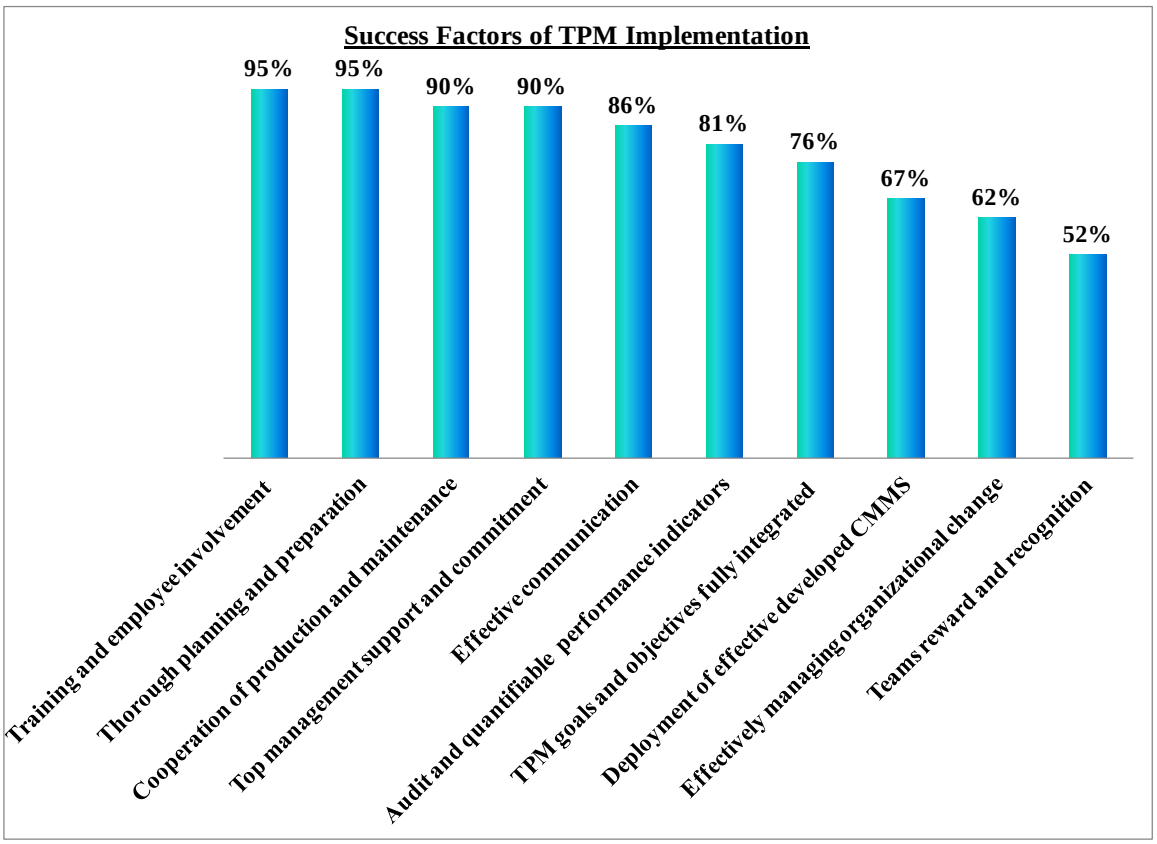
Table 4.5: Success Factors of Implementing TPM at NGP

Success Factors for TPM Implementation	Scale					Mode	Percentage of Highest Score
	5	4	3	2	1		
Training and employee involvement	5	15	1	-	-	**4**	**71%**
Effectively managing organizational change	1	12	7	-	-	**4**	**57%**
Managing synergic cooperation of production and maintenance	7	12	2	-	-	**4**	**57%**
Effective communication	7	11	3	-	-	**4**	**52%**
Top management support and commitment	9	10	2	-	-	**4**	**48%**
Thorough planning and preparation	10	10	-	1	-	**5 & 4**	**48%**
Deployment of effective developed computerized maintenance management system (CMMS)	4	10	4	2	1	**4**	**48%**
Quality audit and quantifiable maintenance performance indicators	7	10	2	1	-	**4**	**48%**
TPM goals and objectives fully integrated into the strategic and business plans of the organization	8	8	2	2	-	**5 & 4**	**38%**
Teams reward and recognition for successful TPM implementation	4	7	7	2	-	**4 & 3**	**33%**

The results reveal that training and employee involvement was the key success factor of TPM implementation at NGP as 71% of the respondents agreed. 57% of the informants agreed that effectively managing organizational change and managing synergic cooperation of production and maintenance were both key drivers of successful implementation of TPM. The following four success factors were agreed to

by 48% of the respondents for each factor. They include; top management support and commitment, thorough planning and preparation, deployment of effective developed computerized maintenance management system (CMMS), quality audit and quantifiable maintenance performance indicators. 38% of informants strongly agreed and 38% of the respondents agreed that TPM goals and objectives must be fully integrated into the strategic and business plans of the organization for successful implementation of TPM. Teams reward and recognition for successful TPM implementation was considered a moderate success factor with only 33% of the respondents agreeing while 33% were unsure as they responded neutral to the success factor. The chart below shows the results for combined agree and strongly agreed responses.

Figure 4.2: Success Factors of Implementing TPM at NGP



The chart shows that all the listed success factors contributed to successful implementation of TPM at NGP but the 5 most critical success factors at NGP were as follows; training and employee involvement, thorough planning and preparation, managing synergic cooperation of production and maintenance, top management support and commitment and effective communication.

4.5. Benefits of Total Productive Maintenance Implementation at the Nairobi Grinding Plant

The fourth objective of this study was to determine the benefits of TPM implementation at NGP. The respondents were required to rate the benefits of implementing TPM on a scale of 1 to 5 (Strongly agree {5} Agree {4} Neutral {3} Disagree {2} Strongly Disagree {1}). Majority of the respondents selected agree and strongly agree to all the benefits of TPM as the mode was either a 4 for agree or a 5 for strongly agree. The results are summarized on the table below.

Table 4.6: Benefits of Implementing TPM at NGP

Benefits of TPM Implementation	**5**	**4**	**3**	**2**	**1**	**Mode**	**Percentage of Highest Score**
Improved workplace safety	15	5	1	-	-	**5**	**71%**
High levels of product quality	15	5	-	-	-	**5**	**71%**
Strong delivery performance	5	13	2	-	-	**4**	**62%**
Improved Overall Equipment Effectiveness	9	12	-	-	-	**4**	**57%**
Increased Customer Satisfaction	4	12	4	-	-	**4**	**57%**
Higher equipment utilization	11	10	-	-	-	**5**	**52%**

Benefits of TPM Implementation	**5**	**4**	**3**	**2**	**1**	**Mode**	**Percentage of Highest Score**
Reduction in number of equipment breakdowns	11	8	1	-	-	**5**	**52%**
Reduced cost of production	10	11	-	-	-	**4**	**52%**
Reduced labour costs	7	10	3	1	-	**4**	**48%**
Improved employee morale and teamwork	2	9	8	1	-	**4**	**43%**

From the results, improved workplace safety and high levels of quality were considered the strongest benefits of TPM implementation at NGP given that 71% of the respondents strongly agreed for each of the two benefits. This was confirmed by the secondary data which showed very good safety records with no lost time injuries at the Plant in the last nine years and consistent high product quality maintained for all the products at NGP with data indicating 100% compliance to quality parameters over the years.

62% of the respondents agreed that strong delivery performance was a benefit that NGP had gained after implementing TPM. NGP has been able to improve delivery of products to its customers on time and in full ensuring product availability at the market place. 57% of the informants agreed that improved Overall Equipment Effectiveness (OEE) and increased customer satisfaction are both important benefits of TPM implementation at NGP. Improved OEE guarantees high quality and improved performance which then drives customer satisfaction from a point of view of quality, product delivery on time, faster response time and improved throughput which delivers a faster service rate hence faster turnaround time. The secondary data observed indicated a continuous improvement on OEE in the last 3 years.

52 % of the informants strongly agreed to the benefits of higher equipment utilization and reduction in number of equipment breakdowns. 52% of the informants agreed that reduced cost of production was a benefit of TPM implementation, making it a significant benefit achieved at NGP after TPM implementation. Reduction in number of breakdowns means that equipment reliability is high leading to higher equipment utilization and low maintenance costs. Breakdowns interfere with production leading to huge losses to the organization. This was confirmed from the secondary data which revealed that equipment reliability at NGP has consistently been above 98% for many years.

48% of the informants agreed that reduced labour cost was a benefit accrued from TPM implementation at NGP while 43% of the informants agreed that improved employee morale and teamwork was a moderate benefit of TPM implementation given the slightly lower percentage of the informants who agreed. To confirm this, 38% of the informants responded neutral to this benefit revealing that they were not so sure whether this was a benefit achieved at NGP.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

This chapter outlines the overall findings of the study on TPM practices implemented at NGP, the success factors, challenges and benefits of effective TPM implementation. The chapter also presents the conclusions and recommendations of the study. Limitations of the study and suggestions for further research are also discussed in this chapter.

5.2. Summary of Findings

The research findings indicate that NGP has begun to implement TPM since the TPM structures and systems are in place. However not all the TPM pillars and practices have been fully implemented and so the plant is not getting the full benefits of implementing TPM. From the study, six TPM pillars have been implemented while office TPM and early management pillars have not been implemented to the required level. Seven TPM practices have been implemented given the percentage scores ranging from 81% for teamwork approach to increase Operational Equipment Efficiency to 100% for health and safety systems to achieve zero accidents and downtime countermeasures. Involving machine operators in preventive maintenance was at 62% because the operators do not carry out minor maintenance though they undertake first level inspections on the equipment (equipment inspection on the run) as per the secondary data observed. Continuous improvement activities (kaizen) was at 52% indicating that most respondents were not clear about this practice and it could be that it’s done but not to an extent that would be known by all the supervisors and managers. The practice of 5S however is not implemented considering only a third of

the respondents positively responded to it and secondary data was missing to back the implementation of this practice. The TPM recommended measurements of manufacturing performance are used at NGP and form some of the key performance indicators for the Plant. The measurements are; cost of production, overall equipment effectiveness, delivery performance, customer satisfaction and quality. Secondary data viewed revealed that there was consistent improvement in these indicators over the years confirming that the pillars and practices implemented were delivering the desired benefits. It is expected that once there is full implementation of TPM further improvement can be expected.

The two main hurdles that NGP encountered during TPM implementation were; employees considering TPM as additional work and lack of sufficient training and education. Other challenges which had a considerable number of informants respond agree or strongly agree include; lack of employee motivation, lack of a well-defined routine for attaining the objectives of implementation and lack of a suitable management organization. However, the results indicate that good effort must have been put in place to timely address and overcome any hurdles encountered during the implementation of TPM.

The key drivers of effective TPM implementation were found to be; training and employee involvement, thorough planning and preparation, managing synergic cooperation of production and maintenance, top management support and commitment and effective communication. Other drivers of successful TPM implementation include; Quality audit and quantifiable maintenance performance indicators, TPM goals and objectives fully integrated into the strategic and business plans of the organization, deployment of effective developed computerized

maintenance management system (CMMS), effectively managing organizational change and teams reward and recognition for successful TPM implementation.

The benefits of effective TPM implementation include; improved workplace safety, high levels of product quality, strong delivery performance, improved Overall Equipment Effectiveness, increased customer satisfaction, higher equipment utilization, reduction in number of equipment breakdowns and reduced cost of production. The results confirm that TPM implementation does deliver benefits to organizations that effectively implement the program.

5.3. Conclusion

Nairobi Grinding Plant implemented TPM in order to improve its competitive advantage in the market place. This was to be achieved through reduction of production costs to deliver low prices in the market, health and safety excellence, performance improvement and superior customer service. Jain, Bhatti and Singh (2014) explained that the challenges of stiff competition and the drive for profits are forcing organizations to implement various productivity improvement efforts to meet challenges posed by ever-changing market demands. In the dynamic and highly challenging environment, reliable manufacturing equipment is regarded as the major contributor to the performance and profitability of manufacturing systems. The study reveals that TPM initiatives do positively affect the organizational manufacturing performance given the many benefits achieved at NGP in line with the plant's ambition. NGP has realized strategic manufacturing performance improvements for competing in the highly dynamic marketplace. Appropriate success factors were strongly put in place to drive effective TPM implementation with a sharp focus to overcome challenges that arose during implementation.

The challenges of TPM implementation cited by the informants on this study are consistent with the findings of Bakerjan (1994) whose study revealed that failure of an organization to successfully implement a TPM program is attributed to various obstacles including lack of sufficient training and failure to allow sufficient time for the evolution. Bamber, Sharp and Hides (1999) identified certain factors that are likely to be present in successful implementation of TPM including; the existing organization, measures of performance, alignment to company mission, the involvement of people, an implementation plan, knowledge and beliefs, time allocation for implementation, management commitment and motivation of management and workforce. These findings are consistent with the findings of this research as regards the success factors of TPM implementation.

The findings of this study on the benefits of TPM implementation are consistent with the research of other scholars. Singh and Ahuja (2014) discovered that TPM initiatives yielded considerable significant benefits to Indian manufacturing organizations where companies gained much higher ratings in terms of enhancing productivity, quality, equipment availability and reliability, ensuring participation of employees at all levels and aiming at long-term success through customer satisfaction. Ahuja and Khamba (2008) explained that successful TPM implementation boosts organization's productivity, improves maintenance performance, reduces costs, improves plant profitability, minimizes unnecessary downtime and ensures better utilization of resources thereby enhancing the competitiveness of an organization.

5.4. Recommendations

Complete implementation of the TPM program should be pursued in order to reap the full benefits of TPM. NGP should leverage on the benefits already accrued as a

result of partial implementation of TPM to persuade the entire organization to move a step forward in putting in place the pending pillars and practices. NGP management should remain committed and involve all its resources in fully exploiting and harnessing the human intellectual capabilities which are still hidden and unexploited.

The management at NGP should focus on the development and deployment of their highly dedicated employees to fully implement TPM through the success factors already in place and to overcome the challenges at hand. In the study, reward and recognition has not been used successfully to promote TPM implementation. Therefore, to progress further, teams reward and recognition for successful TPM implementation should be put in place as a strong success factor to motivate the employees to fully implement TPM knowing that their efforts will not be in vain.

The two main challenges identified in the study are within the control of NGP management because they can work towards changing the employees' attitude that TPM is additional work by making TPM a part and parcel of their day to day activities. They can also deploy resources to train and educate their workforce to ensure the employees acquire the right skills and competencies to implement TPM successfully. The training should be administered to all employees so that they fully understand the TPM concept and know what is in place and how to get to end goal with their full involvement. All the other challenges must also be addressed in a timely and effective manner. The management must be willing to promote an environment that supports change in the workplace and create support for the TPM program.

5.5. Limitations of the Study

The study was mainly constrained by limited time available. Respondents had very busy schedules and could only dedicate limited time to provide the information required therefore hindering an in-depth investigation of the study. Some respondents did not seem to fully understand the TPM concept thereby posing challenges in providing the required data and hence there were no responses to some questions.

5.6. Suggestions for Further Studies

TPM implementation is a beneficial strategy to manufacturing organizations as it helps in improving competitiveness in the global market place. Therefore, the benefits of TPM implementation should be examined in detail through further research to confirm their sustainability in the long term.

This study focused on TPM implementation by cement companies in Kenya using Nairobi Grinding Plant as a unit of study. A census study was used since the population was small. Further studies on TPM implementation are recommended across the other five cement companies in order to have a larger population.

This study also recommends further research on TPM implementation in other sectors of the economy and within the firms in the industry to compare the extent of differences in organizational performance between the firms that have implemented TPM and those that have not implemented it.

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APPENDICES

Appendix One: University's Letter of Introduction

UNIVERSITY OF NAIROBI
SCHOOL OF BUSINESS
MBA PROGRAMME

Telephone: 020-2059162
Telegrams: "Varsity", Nairobi
Telex: 22095 Varsity

P.O. Box 30197
Nairobi, Kenya

DATE 10-8-15

TO WHOM IT MAY CONCERN

The bearer of this letter ... SALOME CHELAGAT IRUNGU ..

Registration No. D61/68534/2013 .....

is a bona fide continuing student in the Master of Business Administration (MBA) degree program in this University.

He/she is required to submit as part of his/her coursework assessment a research project report on a management problem. We would like the students to do their projects on real problems affecting firms in Kenya. We would, therefore, appreciate your assistance to enable him/her collect data in your organization.

The results of the report will be used solely for academic purposes and a copy of the same will be availed to the interviewed organizations on request.

Thank you.

UNIVERSITY OF NAIROBI
SCHOOL OF BUSINESS
10 AUG 2015
P.O. Box 30197 – 00100, NAIROBI

PATRICK NYABUTO
MBA ADMINISTRATOR
SCHOOL OF BUSINESS

Appendix Two: List of Cement Companies in Kenya

No.	Cement Company
1	Bamburi Cement Limited
2	Athi River Mining Limited
3	East African Portland Cement Company Limited
4	National Cement Company Limited
5	Mombasa Cement Limited
6	Savannah Cement Company

Source: Ministry of Industrialization and Enterprise Development (2014)

Appendix Two: Questionnaire

The questionnaire is divided into five sections

Section 1: General Information

Please tick the box applicable to you

1. Level of education

   Secondary ☐

   Diploma ☐

   Graduate ☐

   Post graduate ☐

2. Functional area

   Maintenance ☐

   Production ☐

   Procurement and logistics ☐

   Finance and administration ☐

3. Organization level

   Supervisory ☐

   Management ☐

4. Duration working in current position

Less than two years ☐

Two to five years ☐

Five to ten years ☐

More than ten years. ☐

Section 2: Total Productive Maintenance Practices Adopted at the Nairobi Grinding Plant

1. Has your Plant begun to implement Total Productive Maintenance?

   Yes ☐ No ☐

2. Which Total Productive Maintenance pillars have been implemented at the Nairobi Grinding Plant?

   Please tick where appropriate:

   Autonomous maintenance pillar ☐

   Focused improvement pillar ☐

   Planned maintenance pillar ☐

   Quality maintenance pillar ☐

   Education and training pillar ☐

   Office TPM pillar ☐

   Early management pillar ☐

Safety, health and the environment pillar ☐

3. Which practices listed below are in place at the Nairobi Grinding Plant?

Please tick where appropriate:

The practice of 5S (Sort, Set in order, Shine, Standardize and Sustain) ☐

Involving machine operators in the preventive maintenance ☐

Preventive and predictive maintenance programs ☐

Technical training of employees ☐

Downtime countermeasures e.g. root cause failure analysis ☐

Continuous improvement activities (kaizen) ☐

Health and safety systems to achieve zero accidents ☐

Teamwork approach to increase Operational Equipment Efficiency ☐

Maintenance cost analysis ☐

4. How do you measure manufacturing performance?

Please tick where appropriate:

Cost of production ☐

Overall equipment effectiveness (OEE) ☐

Customer satisfaction ☐

Delivery performance ☐

Quality 

Section 3: Benefits of Total Productive Maintenance Implementation at Nairobi Grinding Plant

Please rate the following success factors for implementing Total Productive Maintenance at Nairobi Grinding Plant.

Strongly agree {5} Agree {4} Neutral {3} Disagree {2} Strongly Disagree {1}

	5	4	3	2	1
Reduced cost of production					
Improved Overall Equipment Effectiveness					
High levels of product quality					
Strong delivery performance					
Increased Customer Satisfaction					
Higher equipment utilization					
Reduction in number of equipment breakdowns					
Improved employee morale and teamwork					
Improved workplace safety					
Reduced labour costs					

Section 4: Success Factors for Total Productive Maintenance Implementation at Nairobi Grinding Plant

Please rate the following success factors for implementing Total Productive Maintenance at Nairobi Grinding Plant

Strongly agree {5} Agree {4} Neutral {3} Disagree {2} Strongly Disagree {1}

	5	4	3	2	1
Top management support and commitment					
Training and employee involvement					
Effectively managing organizational change					
Effective communication					
Managing synergic cooperation of production and maintenance					
Thorough planning and preparation					
Deployment of effective developed computerized maintenance management system (CMMS)					
Quality audit and quantifiable maintenance performance indicators					
TPM goals and objectives fully integrated into the strategic and business plans of the organization					
Teams reward and recognition for successful TPM implementation					

Section 5: Challenges Faced in Total Productive Maintenance Implementation at Nairobi Grinding Plant.

Please respond as appropriate by giving your opinion on the challenges faced when implementing Total Productive Maintenance at Nairobi Grinding Plant.

Strongly agree {5} Agree {4} Neutral {3} Disagree {2} Strongly Disagree {1}

	5	4	3	2	1
No support and understanding from the top management					
Lack of TPM strategy and objectives					
Lack of sufficient training and education					
Failure to allow sufficient time for change to take place before results can be realized					
Lack of a well-defined routine for attaining the objectives of implementation					
Cultural resistance to change					
Lack of organizational communication					
Lack of understanding about the importance of equipment in organizational performance					
Lack of employee motivation					
Employees considering TPM as additional work					
Lack of a suitable management organization					

THANK YOU FOR YOUR TIME