St. MARY'S UNIVERSITY

SCHOOL OF GRAGUATE STUDIES

INSTITUTE OF QUALITY AND PRODUCTIVITY MANAGEEMNT

PRODUCTIVITY IMPROVEMENT THROUGH OPTIMUM UTILIZATION OF RESOURCES: A CASE STUDY OF DERBA CEMENT

BY

FISAHA TEKLU

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A THESIS SUBMITED TO SAINT MARY'S UNIVERSITY, SCHOOL OF GRADUATE STUDIES, INSTITUTE OF QUALITY AND PRODUCTIVITY MANAGEMENT, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF SCIENCE IN QUALITY AND PRODUCTIVITY MANAGEMENT

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APPROVED BY BOARD OF EXAMAINNORS

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DECLARATION

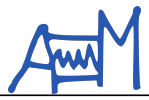
I hereby declare that the work which is being presented in this thesis entitled "**PRODUCTIVITY IMPROVEMENT THROUGH OPTIMUM UTILIZATION OF RESOURCES: A CASE STUDY OF DERBA CEMENT"** is original work of my own, has not been presented for a degree at any other university and all the resource of materials used for this thesis have been accordingly acknowledged.

_____ _____

Fisaha Teklu Date

ENDORSEMENT

This Thesis has been submitted to St. Mary's University School of Graduate Studies for examination with my approval as a university advisor.

Advisor: **Amare Matebu (PhD)** Signature  Date 23 May 2022

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Acronyms

APO: Asian Productivity Organization

CCR: Central Control Room

CDK: Cement Kiln Dust

CEM: Cement

CEMBRUE: Cement Business Research

DEA: Data Envelopment Analysis

DMC: Derba MIDROCK Cement

HACCP: Hazard Analysis Critical Control Point

HFO: Heavy Fuel Oil

HRIS: Human Resource Information System

HRM: Human Resource Management

MIDROC: Mahomed International Development Research and Organization Company

OEE: Overall Equipment Effectiveness

OM: Operational Management

OPC: Ordinary Portland Cement

PP: Partial Productivity

PPC: Pozollana Portland Cement

SCM: Supplementary Cementation Material

TFP: Total Factor Productivity

TPD: Ton per Day

U: Utilization rate

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Abstract

This study is conducted by aiming to sightsee a way higher productivity can be achieved through optimum resource utilization in cement manufacturing industries. To scrutinize the influence of optimum resource utilization in improving productivity Derba cement is taken as a case. Intended for computing partial productivity labor, machine, energy, materials and capital are selected. The result of partial productivity discloses a decline in labor, energy, and machine productivity in 2019, 2020 and 2021. Material productivity shows an increase while capital productivity lucks consistence increment in those years. In 2019 the total factor productivity in Derba cement used to be 3.87, 3.58, in 2020 and 3.39, in 2021. Between the year 2019 and 2020 productivity is declined by 7.5%. The rate amongst a year 2020 and 2021 confirms another decline in productivity by 5.3%. This study further looks into the current status of resource utilization in the company. For this reason a work sampling study of a 20 days was conducted starting from March 3, 2022 to March 23, 2022. The result of the work sampling study designates that Derba cement utilization rate is 43.5%. This result is a way below the utilization rate uttered by cement research business which is 60% to 70%. Loses during mechanical repair, electrical repair, lunch break or shift changes are the major contributors. The survey conducted to identify the factors that influence optimization of resource utilization discloses that. Luck of top management commitment, little awareness about optimization, inadequate maintenance, unsatisfactory teamwork, insignificant employee engagement, inattentive incentive scheme and poor exploitation of capital resources are the major factors that influences the utilization of resources for planned activities. Energy and material resources are identified as vital resources that contributes a larger stake in cement production cost. Improvement in energy resources can be allocated separately since it have little causal relation with other inputs. Material resources optimization could be achieved if and inly if the utilization of machine and labor resources are optimized. This study further recommends centering on the improvement of all influential factors identified. Meant for optimized utilization of resources for planned activities thus ultimately results higher productivity. An introduction of modern problem solving technique is also strongly recommended.

Key words; Productivity, Productivity Improvement, Resource Utilization, Optimization

CHAPTER ONE: INTRODUCTION

1.1 Background

Productivity is nothing but the reduction in wastage of resources such as labor, machines, materials, power, space, time, capital, etc. This definition of productivity stress more on a measurable aspects of the term. Productivity can also be defined as human endeavor (effort) to produce more and more with less and less inputs of resources so that the products can be purchased by a large number of people at affordable price. On the other hand the second definition emphasize on the way to achieve the ultimate productivity. Continual efforts of humans to minimize the amount of input used while increasing the output can surely result an increase in productivity. Measurement of productivity is a ratio between input and output. An increase in productivity means an increase in output that is proportionally greater than increase in input. Productivity may be measured either on an aggregate basis or individual basis. On aggregate basis, output is compared with all inputs taken together. This is called as total productivity. On individual basis, output is compared with any one of the input factor and this is called as partial productivity or factor productivity (Stevenson William J 2012). Productivity is a common measure on how well resources are being used. In the broadest sense, it can be defined as the following ratio:

$$\text{Productivity} = \frac{Output}{Input}$$

There are countless ways of productivity improvements including vast tools and initiatives well recognized and widely accepted. The most common classifications of productivity improvements is the one classifies productivity improvement factors into three broad categories. Those categories are productivity improvement by improving production process, productivity improvement by improving product itself, and productivity improvement by improving resource utilization. Each categories incorporate numerous improvement areas and techniques that specifically associated with them. The one this study emphasis on is productivity improvement through resource utilization. The main focus areas of resource utilization leis basically on the utilization of five well recognized organizational resources, those resources are known as factors of productivity. Major productivity factors such as Labor productivity, material productivity, machine productivity, capital productivity and energy productivities. This study will be conducted by using both partial and total productivity indices to measure the productivity in Cement manufacturing firm under investigation.

Optimal resource utilization will ensure waste reduction and higher factor productivity. Optimal Resource utilization which refers to the amount of time that a resource spends on performing planned activities can then, of course, only be measured when activities are being performed. Though, the utilization is not solely result of the direct relation between resource and activity (Richard Hedman, 2013). The utilization losses are influenced by factors of the surrounding environment which prevents the resource from performing planned activities, i.e. disturbances, system design factors, and need based factors. The work sampling technique can also be used to determine the utilization of equipment resources (Niebel et al. 2012). Same type of data could be extracted from a well-designed manufacturing executions system.

Hydraulic cements are the binding agents in concretes and most mortars and are thus common and critically important construction materials. Portland cement is a type of hydraulic cement with an artificial cement. Today, straight Portland cement is defined as a finely interground mixture of Portland cement clinker (an intermediate product in cement manufacture) and a small quantity (typically 3%–7% by weight) of calcium sulfate, usually in the form of gypsum (Hendrik G. van Oss, 2005).

The first Portland cement plant was set up at Wakefield, England by Aspdin. Today, there are very few countries that do not have at least one cement plant (Hendrik G. van Oss, 2005). The manufacturing of cement in Ethiopia started when Italian installed two cement manufacturing plants in Dire Dawa in 1936. Each plant has a capacity of 30,000 tons per year totally 60,000 ton of cement was manufactured by this two plant. Since then a lots of factory were installed and manufactures Portland cement in different parts of the country. Debra MIDROCK cement is one of the leading Portland cement manufacturer in the country at this time. DMC installed a kiln that can produce a 5600ton per day of clinker by mixing different raw materials.

A number of previously conducted studies shows that productivity improvement indexes and rate of resource utilizations in Ethiopians cement industry is at a very lower rate because of many reasons. The aim of this study is to analyze the actual rate of resource utilization in Ethiopian cement industry by taking Derba cement as a case. A lots of records and reports shows the utilization rate of Ethiopian cement industry is less than or equal to 50% (Dure Mulatu, et al 2018). A research done to address the way to improve overall equipment effectiveness in mugher cement enterprise shows the OEE of the factory is at 22% which is very lower than world class target (Ayantu Melkamu, 2019). This study focuses instantly on determining the current partial and total

productivity indices of cement industries, then examining the rate of resource utilization cement companies partake. At letter stage this study plans to foresee the productivity improvement cement factories can achieve. Through utilizing the resources they have for planned activities without any addition of the resources (input).

1.2 Problem Statement

Cement is one of the most consumed construction material. It is used almost in every construction. Cement industry can be considered as oligopoly market as all the industries follow same standards of the government. Thus, the cement offered by the companies remains almost similar with little or no product differentiation. The number of cement factories in Ethiopia has increased to 20 from which 16 are integrated plants and the rest are grinding plants. At the end of the 2019, Ethiopia's cement factories have a total capacity of around 16.5 million metric tons per year. The average per capital cement consumption of the country is 62kg; this is way below than the global average per capita consumption of 500kg. By the year 2025, per capita cement consumption is expected to increase to 179kg (Global Cement Magazine, December 2020).

The utilization rate of Ethiopian cement industry in 2018 is only 50% (Dure Mulatu, et al 2018). The slowdown of cement manufacturing and consumption comes at a time when cement producers are tackling with a long list of challenges: unfavorable supply-demand balance, higher cement prices, escalating production costs, low utilization rates, social unrest and lack of foreign currency (CemBR, 2019). The study made by Dure, Lulit, and Ji also indicates that the cost of cement production in Ethiopia is very high. Mostly because all factory uses an imported coal as an energy source. This and other similar studies suggests that the use of local coal by blending it with imported one can be considered as an option.

The above discussion shows the deficiency of productivity improvement of cement industries, similar patterns can be traced in Derba cement too. Derba MIDROC cement have an installed capacity to produce 5600 ton of clinker per day. This capacity makes it the largest among other factories in the country. However, records from chemical and construction input industry development institute (CCIDI) shows that in 2021 Derba cement is ranked third by only capturing 22% of the market share. The level of customer satisfaction in Derba cement at this time passes the point of only compliant. Now the customers are tired of complaining started suing the company for undelivered promises.

This tremendous decrease in output and loss of market share is happened while the company possess the almost the same amount of resources (input). This shows that the resource utilization of the company is very problematic. To further illustrate the resources (input) that company possess momentarily. Derba MIDROCK cement shortly known as Derba cement possess sufficient human resources that required to perform its activity at most maximum capacity. Even the company outsources some of its operation to a third party which specializes correspondingly. Derba cement is also equipped with the states of the art manufacturing equipment and machineries. Which also happens to be the most available pollution free cement manufacturing technology.

Derba cement owns a lots of assets in the plant facility and other raw material extraction sites. At plant site a number of buildings, workshops and other facilities required to perform its activities are installed. At mining sites the company leases a large area of land to extract mineral and other buildings, workshops. The company also owns a number of vehicles which is used to transport raw material and distribute product to the customers. Derba Cement is granted a license to extract mineral deposits to mine it in a large scale level. The required raw material for cement manufacturing are limestone, clay (basalt), sandstone, gypsum and pumice. The company owns its own mine sites for all the raw materials required.

Cement manufacturing is a very energy incentive because cement manufacturing requires a large amount of thermal and electrical energy. To satisfy this needs the company is directly supplied the required electricity from the national grid. Coal and Heavy fuel oil (HFO) are used as source of thermal energy. Half of the coal, HFO and fuel oil for the equipment's and vehicles are imported from foreign suppliers. The record shows that the company have a very good relationships with its local and foreign energy source suppliers. The major enquiry that this study is about to answer is the reason why output is decreasing from time to time while the same amount of inputs are possessed by the cement manufacturing firms in the country.

1.3 Research Question

By keeping in mind all the above mentioned resources (Inputs) are in line for the company to perform its activity of cement manufacturing. This study raises the following research questions.

1. What is the current partial and total productivity indices of Derba cement?
2. How much is the utilization rate of Derba cement?

3. What are the reasons that affects the rate of resources utilization?
4. How can optimizing a resource utilization can result productivity improvement in cement industry?

1.4 Objectives of the Study

1.4.1 General objective

The main objective of this study is to determine how productivity improvement can be achieved through optimum utilization of resources in a cement manufacturing firms.

1.4.2 Specific objective

- ✓ To determine the current partial and total productivity indices of Derba cement.
- ✓ To determine the rate of resource utilization at Derba cement.
- ✓ To determine all the reasons that affects the rate of resources of utilizations.
- ✓ To foresee the way to improve the productivity of cement manufacturing firms by utilizing the resources for the planned activities.

1.5 Significance of the Study

Cement as being one of the principal building and construction materials in the construction sector, is essential to meet society's needs for housing and basic infrastructures such as roads, hydro-dams, irrigation, water treatment facilities, government buildings, universities and hospitals. Ethiopia's cement sector registered the highest growth in the last decade when compared to all East African markets (12.8%) (CemBR, 2019). The Ethiopian cement industry has so far crossed through three main stages of development: the modest beginnings up to 1984 (less than 0.5 million tonnes in cement capacity), the construction boom of 2004, followed by the steep cement capacity expansion that ultimately led the industry in to its overcapacity that started around 2011/2012. From year 2012-2018 most cement manufacturers including Derba cement used to export cement to neighboring countries because the amount of cement produced used to exceed the local demand. This doesn't necessarily means that the cement industries productivity improvement used to be organized. There was a time that the country was in tight spot of cement supply. Because of this situations some analyst suggest an import of a cement from abroad. At list 30 million quintals of cement is planned to be imported during 2020/21 Ethiopian fiscal year, decides the ministry of

trade and industry. (September 8, 2020, Ethiopian Monitor newspaper). The country was about to turn its position from exporter to importer of cement. While each and every input and facility to produce surplus amount exists in the country. So the researcher believe that this study anticipates to provide a practical solutions for this pressing problem of the cement industry.

1.6 Scope and Limitation of the Study

This study will only focus on Derba MIDROC integrated cement plant. Derba MIDROC Cement PLC. Was founded on the February 13, 2006 and inaugurated on February 05, 2012. The Derba integrated Cement plant is located 70km far from Addis Ababa in northern direction. This study will be conducted through covering Quarrying (raw material preparation and supply) department, clinker production (intermediate product for cement) department, cement production department, Technical and utility department, Quality Assurance department, Maintenance and Repair department and Human Resource departments. This study will give a little emphasis to the finance and marketing segment of the company since the main concern of the study is productivity improvement it mainly focuses on production.

1.7 Organization of the Research Report

This research will be organized in five chapters, the first chapter gives brief introduction to the whole plan of the research conducted. This chapter contain background of the study, statement of the problem, basic research questions, objectives of the study, significance of the study, and delimitation/scope of the study. The second chapter will contain a relevant literature reviews on productivity improvements and resource utilization especially in cement manufacturing firms. The third chapter will describe the type and design of the research, the subjects/participant of the study, the sources of data planned to be used, the data collection tools/instruments employed, the procedures of data collection, and the methods of data analysis used. The fourth chapter will summarize the results/findings of the study in this chapter the detail resources utilization trends in cement production process along with the bottlenecks of productivity improvement. The fifth chapter provides the conclusions and recommendation along with a summary for future work.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In this chapter we are about to discuss the relevant literatures that are available in the study area. The main concern of this research is productivity improvement especially in cement industry. In order to address this discussion about basic concepts of productivity, then the way to measure and improve productivity is directed. More emphasis will be given to productivity improvement principles, techniques and assessment of previously conducted study will be presented. After analyzing the available literatures on the productivity improvement the missing link that this study is desires to address will be highlighted. Available findings in literature that shows a way of achieving productivity improvement through improving resource utilization will be analyzed. Later on a background and other information about our case will be presented. A history and development of cement industry globally and locally will be discussed briefly. The ongoing development trends of global cement industry will be briefed. After doing that the development trends and productivity improvement trials in the country will be discussed by referring findings from available literatures. All this assessment and analysis is to highlight the missing link that the proposed study can possible overcome in theoretical or practical sense.

2.2 Theoretical Framework

2.2.1 Productivity

As it is summarized by Vinay V. Panicker Productivity can be defined in many ways. Some of them are as follows: (Vinay V. Panicker, 2017)

- Productivity is nothing but the reduction in wastage of resources such as labor, machines, materials, power, space, time, capital, etc.
- Productivity can also be defined as human endeavor (effort) to produce more and more with less and less inputs of resources so that the products can be purchased by a large number of people at affordable price.
- Productivity implies development of an attitude of mind and a constant urge to find better, cheaper, easier, quicker, and safer means of doing a job, manufacturing a product and providing service.

- Productivity aims at the maximum utilization of resources for yielding as many goods and services as possible, of the kinds most wanted by consumers at lowest possible cost.
- Productivity processes more efficient works involving less fatigue to workers due to improvements in the layout of plant and work, better working conditions and simplification of work. In a wider sense productivity may be taken to constitute the ratio of all available goods and services to the potential resources of the group.

There are several ways of understanding productivity, but there are at least two essential definitions often used and espoused by the Asian productivity organization (APO). Productivity is the relationship between the quantity of output (goods and services produced) and the quantity of input (i.e., resources such as labor, materials, machinery, and energy) that are used in production. Productivity is concerned with how efficiently goods and services are produced and the value created by the production process. If a product is made at the lowest cost with high quality and can be sold competitively in the market at a price higher than its cost of production, then its productivity level is considered high (Antonio D. Kalaw, Jr, 2015,). The objective of productivity is to maximize output and minimize input. The other element of the productivity equation is effectiveness. This relates to the attainment of the desired goals or outcomes set by the producer of a product or service. If the customers are highly satisfied in using the product or service, this could mean higher revenues and repeat orders for the product or service.

Productivity = Efficiency + Effectiveness

2.2.2 Productivity Improvement

Productivity is the ratio between output and input. It is quantitative relationship between what we produce and what we have spent to produce. Productivity is nothing but reduction in wastage of resources like men, material, machine, time, space, capital etc. It can be expressed as human efforts to produce more and more with less and less inputs of resources so that there will be maximum distribution of benefits among maximum number of people. Productivity denotes relationship between output and one or all associated inputs.

A firm or department may undertake a number of key steps toward improving productivity. William J. Stevenson lists these steps to productivity improvement (Stevenson William J 2012):

- Develop productivity measures for all operations; measurement is the first step in managing and controlling an organization.
- Look at the system as a whole in deciding which operations are most critical; it is over-all productivity that is important.
- Develop methods for achieving productivity improvement, such as soliciting ideas from workers (perhaps organizing teams of workers, engineers, and managers), studying how other firms have increased productivity, and reexamining the way work is done.
- Establish reasonable goals for improvement.
- Make it clear that management supports and encourages productivity improvement. Consider incentives to reward workers for contributions.
- Measure improvements and publicize them.
- Don't confuse productivity with efficiency. Efficiency is a narrower concept that pertains to getting the most out of a given set of resources; productivity is a broader concept that pertains to use of overall resources.

Productivity Improvement is the result of managing and intervening in transformation or work processes. The major five ways of improving productivity are as follows:

- Decrease inputs but increase output.
- Maintain inputs but increase output
- Increase inputs but get a greater increase in output
- Decrease input but maintaining output
- Decrease inputs with a smaller decrease in output

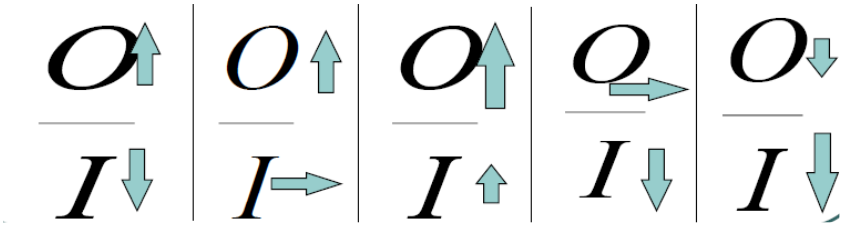

Figure 1 ways of productivity improvement

Productivity Improvement Initiatives

There are numerous ways of describing and classifying productivity improvement initiatives. From those the one which is considered to be the best approach in classifying and

discussing about productivity improvement initiatives is the one described by Asian productivity organization (APO). The productivity improving or enhancing initiatives, which can be in the form of a basic principle, tool, technique, method, practice, guideline, model, or approach that had been espoused by the APO, are presented in a simplified framework to allow users a quick grasp of how they are used and how they fit into the larger picture of an organization's productivity goals. They may be grouped into the following four Ps, which represent areas of concern in any organization that is aspiring to achieve productivity improvements - people, product, policy, and process (Antonio D. Kalaw, Jr, 2015,).

1. **People-focused:** When a productivity-enhancing initiative aims to directly raise the efficiency and effectiveness of a worker.
2. **Product-focused**: When a productivity-enhancing initiative aims to improve the quality and responsiveness of a product to consumer demand.
3. **Process-focused:** When a productivity-enhancing initiative aims to make the planning, design, production, and delivery of goods and services more efficient and effective.
4. **Policy-focused:** When a productivity-enhancing initiative aims to improve the overall environment for production and/or consumption of goods and services.

The second and most common classifications of productivity improvements is the one which classifies productivity improvement factors into three broad categories. Those categories are productivity improvement by improving production process, productivity improvement by improving product itself, and productivity improvement by improving resource utilization. Each categories incorporate numerous improvement areas and techniques that specifically associated.

Productivity Improvement						
Resource					Process	Product
Human	Material	Machine	Capital	Energy		
-Motivation -satisfaction - accidents -ergonomics -competence -absenteeism	-scrap -rework -quality -purchase -material utilized	-availability -breakdown -technology -setup time -schedule -less speed	-inventory -cash flow -account received	-oil -gas -coal -electricity -water	-lead time -bottlenecks -late delivery -inventory -layout	-product Varity -product quality -standardization

					-tact time -material flow	-design of assembly
Productivity Improvements						

Table 1: List of Productivity-enhancing approaches and their impact area

2.2.4 Resource Utilization

Resource utilization which refers to the amount of time that a resource spends on performing planned activities can then, of course, only be measured when activities are being performed. Though, the utilization is not solely result of the direct relation between resource and activity. The utilization losses are influenced by factors of the surrounding environment which prevents the resource from performing planned activities, i.e. disturbances, system design factors, and need based factors. The work sampling technique can also be used to determine the utilization of equipment resources (Niebel et al. 2003).

The real capacity of a manufacturing process, which as defined is the result of multiplying the Method, Performance and Utilization dimensions, is used to evaluate a production system's improvement potential against an ideal state. Visualization of this improvement potential is one of the main parts stated in the objective. The developed model visualizes the improvement potential in following ways (Richard Hedman, 2013). The improvement potential in resource utilization is shown in relation to the current standard (activity design) and the surrounding system (disturbances, production system design, and need based criteria).

Work sampling

Work sampling is a technique used to investigate the proportions of total time devoted to the various activities that constitute a job or work situation. The results of work sampling are effective for determining machine and personnel utilization, allowances applicable to the job, and production standards (Niebel, et al 2012). Although the same information can be obtained by time study procedures, work sampling frequently provides the same information faster and at considerably less cost. In conducting work sampling studies, analysts take a comparatively large number of observations at random intervals. The ratio of observations of a given activity to the

total observations approximates the percentage of time that the process is in that state of activity. Work sampling was first applied in the British textile industry. Later, under the name ratio-delay study, the technique was brought to the United States (Niebel, et al 2012). The accuracy of the data determined by work sampling depends on the number of observations and the period over which the random observations are taken. Unless the sample size is sufficiently high, and the sampling period represents typical conditions, inaccurate results may occur. The work sampling method has several advantages over the conventional time study procedure (Niebel, et al 2012):

1) It does not require continuous observation by an analyst over a long time.
2) Clerical time is diminished.
3) The total work-hours expended by the analyst are usually much fewer.
4) The operator is not subjected to long-period stopwatch observations.
5) Crew operations can be readily studied by a single analyst.

2.2.6 Cement Industry

Cement has played a key role as a construction material throughout the history of civilization. Cement manufacturing is a major mineral commodity industry. The cement industry contributes significantly to local and regional economies of a given country through the wide geographic spread of its plants which are mainly located in rural areas. Cement is a binder in the form of a powder which hardens when mixed with water. The four different basic processes (or "whole plant concepts") can be shortly characterized as follows (CEMBUREAU, 2009):

- **Dry process:** Dry raw meal is fed to a cyclone preheater or precalciner kiln or, in some cases, to a long dry kiln with internal chain preheater.
- **Semi-dry process:** Dry raw meal is pelletized with water and fed to a travelling grate preheater prior to the rotary kiln or in some cases, to a long kiln equipped with internal cross preheaters.
- **Semi-wet process:** Raw slurry is first dewatered in filter presses. The resulting filter cake is either extruded into pellets or fed to a travelling grate preheater or fed directly to a filter cake drier for (dry) raw meal production prior to a preheater/ precalciner kiln.
- **Wet process:** The raw slurry is fed either directly to a long rotary kiln equipped with an internal drying/preheating system (conventional wet process) or to a slurry drier prior to a preheater/precalciner kiln (modern wet process).

Common to all these processes are the following **sub-processes** (CEMBUREAU, 2009). **Quarrying:** Natural ("primary") raw materials such as limestone/chalk, marl, and clay/shale are extracted from quarries which, in most cases, are located close to the cement plant. After extraction, these raw materials are crushed at the quarry site and transported to the cement plant for intermediate storage, homogenization and further preparation. "Corrective" materials such as bauxite, iron ore or sand may be required to adapt the chemical composition of the raw mix to the requirements of the process and product specifications. The quantities of these corrective materials are usually low compared to the huge mass flow of the main raw materials.

Raw Materials Preparation: After intermediate storage and pre-homogenization, the raw materials are dried and ground together in defined and well-controlled proportions in a raw mill to produce a **raw meal** for the dry (and semi-dry) process. In the wet (and semi-wet) process, the raw materials are slurred and ground with addition of sufficient water to produce a **raw slurry**. As a rule of thumb, approximately 1.5 – 1.6 tons of (dry) raw materials are required to produce one ton of the burnt product clinker.

Fuels Preparation: Conventional (fossil) fuels used in cement industry are mainly coal (lignitic and hard coal), pet coke (a product from crude oil refining), and heavy fuel oil (HFO). Natural gas is rarely used due to its higher cost. **Alternative fuels** i.e. non-fossil fuels derived from industrial ("waste") sources are widely used today to substitute in part for the traditional fossil fuels. Fuels preparation i.e. crushing, drying, grinding, and homogenizing usually takes place on site. Specific installations are required such as coal mills, silos and storage halls for solid fuels, tanks for liquid fuels, and the corresponding transport and feeding systems to the kilns. The thermal fuel consumption is largely dependent on the basic process design applied in the burning of clinker.

Clinker Burning: The prepared raw material ("kiln feed") is fed to the kiln system where it is subjected to a thermal treatment process consisting of the consecutive steps of drying/preheating, calcination (e.g. release of CO2 from limestone), and sintering (or "clinkerisation", e.g. formation of clinker minerals at temperatures up to 1450° C). The burnt product "clinker" is cooled down with air to 100-200° C and is transported to intermediate storage. Exhaust heat from the kiln system is utilized to dry raw materials, solid fuels or mineral additions in the mills.

Cement Grinding: Portland cement is produced by intergrinding cement clinker with a few percent of natural or industrial gypsum (or anhydrite) in a cement mill. Blended cements (or "composite" cements) contain other constituents in addition such as granulated blast-furnace slag, natural or industrial pozzolana), or inert fillers such as limestone.. Grinding plants may be located remotely from the clinker production facility. The different cement types have to be stored separately in cement silos prior to bagging and dispatch.

Cement Dispatch: Cement may be shipped as bulk cement or usually to a lesser extent packed into bags and palletized for dispatch. Transport methods used (i.e. road, railway, waterways) depend on local conditions and requirements.

Ethiopian Cement industry

The Ethiopian cement industry has endured through three major milestones; the beginning of cement production and modernizations till 1984, construction boom in 2004 followed by acute shortage and aggressive expansion of the sector in 2012 onwards resulting in inflaming excess capacity. The first cement factory in Ethiopia was established in 1936 in the city of Dire-Dawa. In 1964 and 1965 cement factories in Addis Ababa and Massawa were established respectively with capacity of 60,000 tons each per year. Since then cement sector growth had remained sluggish for decades. In 1984 with establishment of Mugher cement, the industry had revived. Mugher cement's 1st, 2nd and 3rd line started operation in 1984, 1989/90 and 2011 respectively. As cement demand growth prospect appeared promising in 2001, Messebo cement becomes operational with initial 600,000-ton clinker capacity. In the subsequent years Messebo had expanded its capacity to its current level (Dr. Lemi Guta, etal2015).

Since 2004 sustained shortage of cement supply resulted in price hike. In 2007 the government responded to the price hike by allowing the private sector to import cement. Since 2012 Derba MIDROC Cement emerged as the major market player in Ethiopia cement industry. Later in May 2015 a giant cement manufacturer called Dangote joins the local market by installing an integrated cement plant. Currently there are 20 cement factories which are operational 16 of them are integrated cement plants and four of them are cement grinding plants.

Background of Derba Cement

Derba MIDROCK Cement PLC, Was founded on the February 13, 2006 and inaugurated on February 05, 2012. Since its inauguration the company is contributing its share in unleashing the potentials of Ethiopian cement industry by availing cement. **MIDROC** (Al-Muwakaba for Industrial Development and Overseas Commerce) is a large group company having many business interests in Ethiopia, Saudi Arabia and other countries. **MIDROC** intends to develop a cement business in Ethiopia and a separate company, **DERBAMIDROC CEMENT PLC. (DMC),** has been established for the purpose. **DMC** installed greenfield cement plant of clinker capacity 5,600 tons per day (tpd) equivalent to a cement capacity of 8,000 tpd based on Derba limestone deposit this will add up to 2,500,000 tons of cement per year. Ordinary Portland Cement (OPC) and Portland Pozzolana Cement (PPC) are the main type of cement manufactured at the plant. Both the cements shall meet the requirements of Ethiopian National Standard No. EN-197. OPC shall be produced as per CEM-I - 42.5 grades and shall contain 95% clinker and 5% gypsum. PPC shall be produced as per CEM-II - 32.5 grades and shall contain 67% clinker, 28% pumice and 5% gypsum. Rather than this two main cement product the company also produces a cement product called special OPC as per CEM-I-52.5N and special PPC as per CEM-II - 42.5N as a demand of the customer.

The cement plant is located about 8 km from village Derba in SulultaWereda in North Shoa Zone of Oromiya Regional State, Federal Democratic Republic of Ethiopia (FDRE). The mining area is located within the AndaWeizero Peasant Association in Sululta Wereda, North Shoa Zone of Oromiya Regional State and is about 7 km (crow fly distance) from the Plant site. The Derba Cement plant site can be reached from Addis Ababa, a distance of 70 km, via Chancho.

2.3 Empirical framework

2.3.1 Implementation of Productivity Improvement Initiatives

In discussing the ways of implementing productivity improvements we empirically assess the literatures available on the implementation practices. In doing so instantly we discuss the findings of previous studies that are conducted in three perspectives or impact areas. Those perspectives or productivity improvement initiatives impact areas are human resource (peoples) approach, process approach, and the whole resource utilization approaches. After describing the

findings of the previous research works, then we highlights the major gaps that this study is planning to solve.

The research conducted aiming to examine the association between human resource information systems (HRIS), employee productivity, and HR costs by focusing on the data of 40 Bangladeshi banks. Results indicate that the use of HRIS applications generated a higher efficiency in terms of employee productivity and the reduction of HR costs (where all things remain constant) (H. Begum et al, 2020). This study indicates that even if every other factors stays as it is only using a proper Information system in human resources managements can result an increase in labor productivity. The research paper made to explore how human resource management (HRM) can promote productivity and quality enhancement through HRM practices in organizations indicated that. Organizations must introduce and sustain productivity and quality promoting HRM systems, policies and practices through HRM with effective feedback mechanism (A. Anton Arulrajah, 2017). The finding of this intensive literature study indicated prioritization of feedback mechanism is very essential.

An interesting research was conducted on the way of productivity improvement through Incentive Scheme indicates a lots of important points. The study was conducted in a national ammonium company NALCO, Angul (Orissa, India). The finding are incentive scheme which is productivity linked group incentive scheme, has reduced the absenteeism of employees to much more extent and made the calculation of incentive amount easier and also increased the productivity. For any incentive mechanism to be effective, it must be fully integrated into the organization. Thus, incentive schemes must be adapted to the: Culture, Clientele, Products and Processes (Debesh Mishra1, A. Mohanty, 2017). This study indicated that, an incentive scheme is a proven method of labour productivity improvement but it requires a very careful designing and monitoring.

The other research conducted on the ways of enhancing productivity by reviewing an Operations Management (OM) and Human Resource Management (HRM) practices as well as joint applications of these practices. This study was conducted by assessing a multi- disciplinary reviews of different literatures on two topics. This study reveals that taking as a whole, the research findings reviewed literatures are equivocal. Some studies have found a positive relationship

between the adoption of management practices and productivity, some negative and some no association whatsoever (Peer-Olaf Siebers et al, 2008).

The second productivity improvement initiatives implementation impact area we are about to look in is the process approaches. The research conducted to asses' means to achieve improvement of productivity through process optimization at a manufacturing company indicated a lots of important points. The research revealed that there is an important link between the various manufacturing systems (organization of people and facilities) within a company and that these need to be integrated by a computerized manufacturing support system for efficient and effective operation (Lodrina Masiyazi, et al, 2014). The similar study conducted aiming to improve productivity by reengineering and simulation in a footwear industry highlighted the use of computer aided operations. After performing the simulation experiments, the results indicate that the production rate increases by approximately 29% with the new configuration, and up to 41% when the human resources are optimized through OptQuest software's (Rubén Calderón-Andrade, et al 2020). This two studies makes it clear that using integrated computerized manufacturing system plays a greater role in process improvement in particular and productivity improvement in general.

The research paper made by analyzing how productivity improvement can be achieved through optimum utilization of plant layout indicates significant points. The study was conducted in a milk processing company called XYZ milk plant. The research proposed layout new optimized plant layout by analyzing the defects in the existing one. Shows the total overall distances travelled is reduced from 108m to 57m. By the application of systematic layout planning for the design of an optimized plant layout it is possible to reduce the wastes due motion and transportation, therefore increasing the productivity of the plant (Akshay D. Wankhade, Dr. Achal S. Shahare, 2017). Plant layout and placement of equipment is very curtail in order to create simplification in manufacturing process as this particular research indicated.

A research paper prepared to discuss related issues of motion and time study implementation and its influence toward productivity improvement indicated several significant points. The success of implementing motion and time study had been contributed by several success factors such as top management commitment, interdepartmental cooperation, good planning and control system, company technique capability, effective training, experienced work

forces, steady fund inflow and clear product strategy. Unfortunately, the companies implementing motion and time study face many challenges such as cooperation from workers, followed by inexperienced project leader, unavailability of relevant consultant, staff training and lack of inter departmental cooperation (Mohd Razali Muhamad, 2005). Similar study conducted by aiming to improve the productivity by using work measurement method (method of doing work, movement distance with time), taking one of the shoe factory as a case study. This research proved case company can be increase its daily production from 734pairs/day to 764 pair/day of shoe with making good working conditions of the workers (Moti Melkamu Abera, 2020). Both researches that are discussed above emphasizes on the motion and time study avoiding unnecessary movement during production process play an important role in improving productivity.

The final productivity improvement initiatives impact area we are about to discuss is improvement of productivity through utilizing resources for planned activities. A research was made to examine a productivity and production increase by optimum utilization of machines and man power. The study was conducted in an energy of lead recycling plant. After successful implementation of the method and modifications in the process it is possible to increase the recycling percentage of lead up to 86-87% (previously it was in the range 80-83%). By this method it is also possible increase the purity of lead the purity of lead while pollution emitted to the atmosphere will be decreased. Overall capacity of the plant is also increased from 600 Kg/Day to 640 Kg/Day (Narendra K Verma, et al, 2019).

The research conducted aiming to indicate the way to improve productivity, workflow management, and resource utilization in precast construction highlighted several significant points. Findings show the effectiveness of process integration and cross-training resources over production zones in off-site construction. Transferring excess capacity from underutilized to over utilized resources in a direct pathway can address the issue of capacity imbalance within the network. An indirect capacity shifting to bottlenecks (skill chaining) will be optimal when networks are exposed to high levels of process variability (Mehrdad Arashpour, et al, 2017).

A research paper made to analyze the way to increase productivity by optimum utilization of the resources reveals some important points that requires further attention. The results prove 5 key productivity factors, including leadership, strategic quality planning, people, data and information, and process management, leading to a conceptual model. The rate of production when

machine is used far exceeds the rate of labor productivity. The result of the study also shows that increase in manpower can also give rise to increase in productivity, although it has been observed that increase in production may or may not affect increase in productivity ratio (B.Anil Kumar, Dr. R. Ramachandra, 2017).

As it is discussed earlier there are several ways of improving productivity by implementing. The missing link that this study is about to discourse is the productivity improvement through optimum utilization of resources. For doing so we use work sampling technique to measure the utilization of resources. There is no research that are conducted as such and the researcher believe the findings of this research will add significant points in the existing body of knowledge.

2.3.2 Optimum Utilization of Resources

As we discuss earlier there are numerous ways of achieving productivity improvement. The most effective is optimum utilization of available resources. Now we assess the previously conducted studies on the possible ways of improving resource utilization. The research work we are about to look on firsts is the study done aiming to examine resource utilization and performance implications over time in an environment undergoing fundamental institutional transformation. The study finds that the impact of resource utilization is contingent on the degree to which different resources are committed to factors of production, the impact is curvilinear and only valid within an "optimal" range, and the performance implications change over time. As firms enter later stages of the transitional process, efficiency becomes less important as they shift their strategic focus from exploitation to exploration, which requires more flexibility (Justin Tan & Yong Zeng, 2009).

The other research paper written to specifies why some firms might be better at utilizing resources than others. The result of the research indicates once skill sets are developed, over time the strategies for resource acquisition continuously change, leading to changes in the mix of resources that firms possess. Similarly, there are specific skill sets which enable firms to transform resources into outputs. Feedback as to the way resources are transformed inculcates learning and leads to changes in the strategies required for conversion (Sumit K. Majumdar, 1998).

The study made to introduce an innovative framework that integrates two newly developed models for resource utilization and multi-objective optimization that are designed to optimize these recovery efforts. The developed models and demonstrate their capabilities in identifying a wide

spectrum of optimal reconstruction plans, where each provides a unique and non-dominated trade-off between minimizing the recovery duration and cost. This allows decision makers in emergency management agencies to select and implement reconstruction plans that address various societal and economical needs in the aftermath of natural disasters (Wallied Orabi, et al, 2010). Similar research also done by aiming at conducting Taguchi method along with computer simulation to determine the optimum combination of resources. For a real world case study involving a concrete pouring operation in order to reduce cycle time and process costs. The result of the study shows that the optimum resource combination will be achieved when all of resources are located in the low level. This means that number of trucks, spreader crew, vibrator crew and finisher crew should be equal to 3, 1, 1, and 1 respectively to improve the total performance (Seyed Mojib Zahraee, 2014)

A research work was conducted aiming to discover the nature and degree of wastage, and to find out the various causes of wastage. To quantify the effects of wastage and to propose a technique for maximum utilization of resources. The result of this research identified that the causes of wastage can be categorized in two aspects: construction methods and construction management. Under these two categories these were the common issues like excess preparation of motor, use of dry cement, high silt content in sand not removed, improper cutting and utilization of steel, changes in design, specification and materials, poor workmanship (J. RamaJogi and SS. Asadi, 2017). In a related research work done deeply analyzing the situation of resource utilization management system of construction waste, limiting influence of the existing problems on the resource utilization of construction waste was pointed out. And then made a detailed summary of the management policies and analysis of the problems, and it improved the resource utilization management policies of construction waste (Li Yinga et al, 2011). As it is indicate in the above discussions there are numerous ways of improving resource utilization. The aim of this study is first to determine the rate of resource utilization mostly labor and machine utilization then try to identify the main factors contributing for the lower utilizations. Then recommend an improvement area that can help to realize a productivity improvement in cement manufacturing industry. All most all of the previously conducted research work fails to address this issues directly or indirectly. So the researcher believe the outcome of this research work can add value to the existing body of knowledge in cement industries improvement schemes.

2.3.3 Productivity Improvement in Cement Industry

Cement industry goes through different developments and improvement stages. Still there are numerous study that are ongoing to further improve the cement making process. From those researches and developments underway in a daily basis. We try to assess the global research and development practices to determine the direction of recent focus areas of improvement. Then the review of previously conducted studies in Ethiopian cement industry productivity improvement will be presented. After doing this we try to highlight the gaps that this research work plans to address.

The research paper prepared and documented within a patent document on method for producing nano-cement, and nano-cement indicated that. The world cement industry is developing in the following two directions: Reducing the fuel cost and CO2 emissions in the air, and Improving the construction and technical properties of portland cement (BICKBAU, Marsel Yanovich, 2016). The indicated finding summarizes the whole cement industry development directions in very recent years. Similar research work aims to evaluate the influence of nano raw materials (nano-silica, nano-alumina, nano-iron oxide and nano calcium carbonate) on the quantity of energy involved in the clinkerization process as well as on the quality of clinker (alite reactivity). The finding of this study indicated that alite reactivity was improved with additionally decrease of the clinkerization temperature from 1450 to 1250 ºC, in comparison with using micro raw materials (Susana G. Sanfélix, et al 2011).

Other research work that examines the theory of microeconomics firms used to find a model of optimal production productivity in cement industry. The result of this study shows the effect of preventive maintenance system in the model, energy consumption of equipment is considered as a function of failure rate of equipment and then added to the set of constraints. Using this model energy consumption is reduced up to 15% and total annual cost is reduced up to 12.7% (Naghiloo, A, et al, 2011). Cement industry worldwide, has now started realizing the importance of Process Control and Automation in achieving trouble free continuous operation leading to improved productivity and energy efficiency. Automation also takes care of optimal operation in mining and hence longer life of mines and consistent desired cement quality is assured. Higher level control systems thus help in various ways. They can bring about cost saving based on

improvement in process efficiency to the tune of 2.5 to 5%. Equipment health monitoring and predictive maintenance increase the life of key equipment and reduce maintenance cost (inventory control and spares management) by 10-15% (Suchismita Bhattacharya, 2015).

The research Paper that made an attempt to appraise retrospective of cement industry, to examine the cement industry production efficiency in terms of capacity utilization and also to suggest remedial measures to improve the capacity utilization. The findings of this study indicates for attaining the level of excellence in terms of optimum production, capacity utilization, earning profits, eco-friendly, cement plants would require to. Use optimum capacity vis-a-vis technology reduce energy consumption level, reduce emission level, upgrade the skills of manpower, and minimize production cost with product diversification (Dr. Y Kesava Reddy, 2020).

The study conducted to examine the effect of international acquisitions to increase labor productivity in cement industry. The result showed that in the short run, productivity growth was predominantly due to optimization of the number of employees, while in the long run productivity grew more slowly and was predominantly a consequence of increased production, i.e. introduction of new technologies, better organization and higher employee motivation (Slađana Savović, Dušan Marković, 2021).

The research paper which try to review the history, production, available resources, the technologies and energy use of the Ethiopian cement industry indicated the following points. The use of imported energy sources has a huge impact on the high production costs of the industry. In order to overcome this problem, the industry shall try to replace the use of imported energy sources with locally available and alternative energy sources. This research also recommend Ethiopian cement industry should encourage and promote the production of green cement (Dure Mulatu, 2018). A very similar study conducted aiming to identify critical barriers to Green Manufacturing practices of Ethiopian cement industries shows that. Low enforcement, low top management commitment, weak legislation, lack of awareness/information, and the like were critical barriers (Geleta Merera Bogale and Prof. K. Rama Mohana Rao, 2018). This clearly indicate why the cement production cost is very high because there is a little to no efforts are made to use alternative energy.

The research work aims to design and techno-economic analysis of power generating unit from waste heat (preheater and grate cooler) of cement factory line to avoid the problems that are

caused due to the burning of fossil fuels and to ensure the environmental sustainability. The outcome of this experimental study reveals that it is possible generate power from the system was much as 966 kW as well as cost saving of 543,371 USD/year. Producing electricity with own power using waste heat by using waste heat recovery from the process will reduce electrical consumption from national grid supply and fossil fuel consumption (Aweke Gugssa Iddo, et al, 2021). This will also have a greater impact in increasing the energy productivity. In another study aims to make use of process west such as calcite and volcanic soil as cement filling and additive materials in order to maximize cement productions in Ethiopia. Investigation shows that between 20-25% Calcite filled cements have superior properties to the current Portland cement and Portland Pozzolanic Cements such as high early strength, excellent volume stability, minimum cost of productions and easy manufacture process (Mulatu Tadesse, 2016). This findings are evident that there are a possibilities of increasing productivity by making use of a process wastes.

A study that aims to assess the challenges and current status of Enterprise Resource Planning (ERP) implementation in DERBA and Mugher cement industries, exhaustively the Mugher Cement Factory indicated important facts. The result of this study shows that successful implementation of ERP system was greatly affected by ignoring critical success factors in each ERP implementation stages. Disregarding organizational, people and strategy factors that encompass top management support, users training and education, effective project management, user involvement, suitability of software and hardware communication and data accuracy creates great challenge for the success of an ERP implementation (Kibebework Asrat, 2015). Similar study conducted to identify the impact of information technology facility, policy and culture that is available in cement factories. The result of the study showed that the limited functionality of ICT facility, the non-availability of knowledge management policy and limited capacity knowledge expert are problems that hinder organizational productivity in the factories (Yeshiareg Temtime, Worku Jimma, 2015). This two research work indicated that there is a limitation of adopting and utilizing information system in cement factories in the country. Now a days the use of information system in every manufacturing industry is mandatory in order to compete ever changing market.

A study conducted examine a way to enhance overall equipment effectiveness (OEE) through total productive maintenance in the case company Mugher Cement Factory indicates a lots of facts. The OEE was found in the range of 19 to 24% which shows that the OEE of the

company was much lower than the world class OEE. Lack of periodic maintenance, lack of autonomous maintenance in the company, like inspection, tightening, cleaning, and low quality of the spare part are the main reasons for the decrement of OEE (Ayantu Melkamu, et al, 2019). This study shows the OEE of one of the largest cement manufacturers in the country and the result is very worrisome.

A research literature shows their used to be a several attempts made in the same company to implement productivity improvement initiatives. A research work done to assess the success and failure of kaizen implementation in Mugher cement factory in respect of productivity shows that. Management commitment and practical support, absence of kaizen implementation plan at corporate level, lack of understanding of kaizen concept and considering it as specific group task, misconception as kaizen additional work and one time work, absence of incentive for good contribution of kaizen implementation, gap in setting up department dedicated to promote kaizen, irregularity of implementation between departments and within the department, gap in identifying and prioritizing work areas that can gain more benefit than others, lack of resource, absence of comprehensive evaluation system and continuous training are seen as the major challenges in kaizen system implementation (Fikadu Deme Minda, 2018). This is not the only improvement initiative that have been tried and failed to succeed in Mugher cement.

A research paper that investigate the success and failure of business process reengineering (BPR) implementation in Mugher Cement Factory (MCF) and map out the way forward indicated that. Organizational structure, BPR project planning and management commitment are the top three critical failure factors those led implementation of BPR in MCF to be failed. How-ever Information technology (IT) infrastructure, capacity building of the employees, and suitable office lay out are fruits of BPR project which had not been exhaustively used yet (Abayneh Kebede Woldie, 2018). The main constraints of these initiatives happens to be management's commitment and lower level of understanding about the benefits of those productivity improvement.

In a much unrelated research work that is conducted to examine the effect of covid-19 pandemic on cement industry economic performance. The case study was made in one of countries leading cement manufacturer called Dangote cement. The finding shows that during the pandemic, the sales of the company in terms of value shows 12.54% increment and 8.98% in quantity. The market share of the company increased to 28% in the same year the market share of Derba cement

decreased. The logistics and letter of credit extension cost 161.43% increment and employees benefit shows an 8% decrease from the previous year's (Tigist Aklilu, 2021). While conducting this research it is unfortunate to ignore such a crisis that affects the trends of local and international ways of doing business. So this research will be conducted by exempting that all the possible effects that the pandemic can Couse in productivity improvement by just only focusing in avoidable and technical aspects.

As a country as a whole and as a cement industry in particular there is a very limited interest of implementing any of improvement initiatives. Because mostly the market structure of the country is very rigged even if the productivity of a given organization is very low it manages to be profitable. These context are started changing in some areas because the competition is becoming very tight with a cheaper imported items. When it comes to cement, importing is banned for the time being. But the production cost of cement in the country is rising in tremendous rate. These and other several reason forces each factories to focus to increase their productivity to become competent in the market. All cement factories operate in the country possess a lots of resources and fail to manage such resource to improve their productivity and growth. There is no study which address this pressing issue. That is why the researcher believe the findings of this research work can add a significant value to the existing body of knowledge in productivity improvement in cement industry.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Research design

Research approach and design utilized in this study directly associated to what is settled as an objective. Which is to determine the way productivity improvement can be achieved in cement manufacturing firms by optimum utilization of resources. In order to achieve this objective, the research design selected is a case study research design. Case study research is an intensive analysis of an individual unit stressing development factors in relation to context. This type of design is selected because the problems of cement manufacturing firms happens to be more or less the same in pursuit of productivity improvement. An in-depth investigation of a given case means Derba cements resource utilization can address others too. This study chooses to follow is a descriptive and explanatory research type. The researcher plan to use descriptive design because it helps to answer the research question and assess, identify, and describe the problem at hand. In addition to that explanatory research is conducted involving in explaining why something happens and assessing causal relationship between variables. The reason why the combination of this two type of research are preferred is to take advantage of both research types. The study also adopted both qualitative and quantitative research approaches to obtain the desired results of the study. The quantitative research approach can help us to survey the current level of partial and total productivity indices in Derba cement. The current status of resource utilization rate of the company will also one of the quantitatively described phenomena. The qualitative research approach is used for explaining and understanding all the possible reasons that affects productivity and resource utilization.

3.2 Sample and Sampling Techniques

The target population that might provide information for this specific study includes respondents from each departments within Derba cement factory. Those departments are Quarrying (raw material preparation and supply), clinker production (intermediate product for cement) department, cement production department, Technical and utility department, Quality Assurance department, Maintenance and Repair department and Human Resource departments.

Rather than internal target populations to gather primary data this study will conducted its secondary data's from different sources.

The sampling techniques chosen for this study is stratified sampling, the entire population is divided into various mutually exclusive and collectively exhaustive strata (groups). In our case we consider each department as a given strata. The number of respondent are selected from each strata based on their percentage of staffs. Both primary and secondary data will be used. The primary data will be collected from a respondent selected from each strata's or departments. These primary data will be collected by using close ended questionnaire with selected respondent from each department. Interview will be conducted with a management teams of each department by using structured interview guides. Additionally, observation check sheet will be prepared to collect the rest of data that can be collected through observations. Apart from the primary data, the secondary data will be gathered from company records and periodic reports. Other sources of secondary data's are government bodies such as chemicals and construction inputs industry development institute (CCIIDI), ministry of industry, ministry of mines and petroleum, ministry of trade. The rest of secondary data will be collected from previously conducted researches from different journals, books, internets, newspapers, magazines etc.

3.3 Data Collection

In this study a triangulation of structured interview questions, close ended questionnaire and observations check sheet is being utilized to gather data. The purpose of the interview is to discuss the organizations productivity performance with middle and top management. This is conducted by aiming to acquire necessary data on the existence of plans, the execution of plan, control and monitoring trends. Further during interview the production plan and actual production will be discussed. The data gathered by structured interview will be used to compute and discuss on the productivity functions. The second data collection instrument used is questionnaire. A close ended questionnaire is prepared to help a respondent to reflect on the possible factors that might affect the optimum utilization of resources. The questionnaire will be prepared for the respondent to reflect their opinion on possible factors in lekhert scale. The scale is from strongly agree, agree, neutral, disagree to strongly disagree. The outcome of this response latter on used to do an analysis and identify the factors that the respondents indicate as most influential. Observation check sheet will be used to administer a work sampling study in selected sub process to compute the rate of

utilization. This observation check sheet will be prepared by discussing with the relevant personnel who work on related sub process. The purpose of this discussion is to identify the incidents that cause a utilization loses. The outcome of the observation check sheet will be utilized to compute the rate of utilization.

3.4 Methods of Data Analysis

In this research the proposed data analysis techniques are both qualitative and quantitative data analysis techniques. The responses planned to be collected from questionnaire, interview and observation which will be analyzed by both qualitative and quantitative approach. Tabulation of the results that shows, a number of responses to each question and percentage of respondents will be prepared. Statistical tools like bar cart and histogram will be used to show the distribution of the collected data. Scatter diagram and pareto diagram will be used to show the relation between variables (partial productivity indexes). The area that requires attention for productivity improvement initiatives. The rest of the qualitative data collected through questionnaire, interview, and observation will be narrated qualitatively.

3.5 Productivity Measurement

Productivity is an index that measures output (goods and services) relative to the input (labor, materials, energy, and other resources) used to produce it. It is usually expressed as the ratio of output to input. Productivity is a common measure on how well resources are being used. In the broadest sense, it can be defined as the following ratio: Productivity = $\frac{Output}{Input}$

Productivity growth is the increase in productivity from one period to the next relative to the productivity in the preceding period (Stevenson William J 2012). Thus,

$$\text{Productivity growth} = \frac{Current\ Productivity - Previous\ productivity}{Previous\ Productivity} \times 100$$

Productivity may be measured either on an aggregate basis or individual basis. On aggregate basis, output is compared with all inputs taken together. The word tangible here refers to measurable.

$$\text{Total productivity index} = \frac{Total\ \ Tangable\ output}{Total\ \ tangable\ Input} = \frac{Total\ production\ of\ goods\ and\ services}{Labour + Material + Capital + Machine + energy}$$

Multifactor productivity index = $\frac{Total\ output}{Labour + Capital + Energy}$, or = $\frac{Total\ Output}{Labour + Machine + Material}$

Partial productivity measurement is used when the firm is interested in the productivity of a selected input factor. It is the ratio of output values to one class of input. Depending upon the individual input partial productivity measures are expressed as. Factor productivity or partial productivity indices are of following types:

i. **Labor productivity:** The important function in any production set-up is that the budgeted quantity of work must be achieved over a period of time. The productivity of labor can be increased by increasing efficiency of labor and reducing labor time.

Labor Productivity = $\frac{Total\ Output}{Labour\ Input}$Labor productivity (in terms of money) = $\frac{Total\ cost\ (or\ sales\ value)\ of\ output\ produced}{Amount\ in\ terms\ of\ cash\ spent\ on\ workers}$

ii. **Material productivity:** Production system converts raw material into finished product with the help of mechanical or chemical processes. Material productivity depends upon percentage of rejection, creation of scrap, level of spoilage, obsolescence, work wastage etc. Material productivity is expressed as:

Material productivity = $\frac{Total\ Output}{Material\ Input}$, or Material productivity = $\frac{Number\ of\ units\ produced}{Total\ material\ cost}$

iii. **Machine Productivity:** Production system converts raw material into finished product through mechanical or chemical process with the help of machines and equipment's.

Machine Productivity = $\frac{Total\ output}{Machine\ Input}$, or Machine Productivity = $\frac{Output\ in\ standard\ hours}{Actual\ machine\ hours}$

iv. **Capital productivity:** For any production set-up, facilities of machines, tools, land etc. are required which are assets of organization. Indirect labor is also used for material movement, good housekeeping, cleaning etc. Indirect expenditure is incurred on indirect material like tools, oils, lubricant etc.

Capital Productivity = $\frac{Total\ Output}{Capital\ Input}$, or Capital Productivity = $\frac{Total\ Output}{Capital\ Employed}$

v. Energy Productivity: production system requires a different kinds of power energy in order to operate its equipment's and machineries. Energy productivity mostly depends on the

availability of energy, the availability of alternative energy, the effects of pollution, the efficiency of the equipment's, skills and experience of operators, and etc.

Energy productivity = $\frac{Total\ Output}{Input\ Energy}$, or Energy productivity = $\frac{Total\ output\ in\ ton}{Input\ energy\ in\ kilowatt}$

3.6 Measurement of Resource Utilization

Measurements of manufacturing resource utilization (U) can be done by work sampling studies when the resources perform activities. Measurements of resource utilization can be done on a Workstation level as well as on a Subsystem or Factory level. Rate of resource utilization will be defined as (Hedman, R, et al, 2013): **Need based utilization rate (UN):** the need based utilization rate depends on the need for relaxation and personal time. It is often regulated by agreements at the work place. It includes paid breaks and losses before and after a break. **System designed utilization rate (US):** The system designed utilization rate is defined as the balance losses designed into the system. It can be balance losses on an assembly line as well as losses in a semi-automated work station. **Disturbance affected utilization rate (UD):** Disturbance affected utilization rate corresponds to the losses caused by different random disturbances. It includes the lost time from discovery of the disturbance until the work is performed at full speed again.The utilization ratios UN, US, and UD symbolizes utilization losses. Consequently, U= 100% would imply that the resource is spending 100% of the planned time on performing the defined activity with zero losses. Utilization above 100% is not possible, and utilization equal to 100% in a real life setting is highly unlikely since there will always be losses. The above definition can be summarized as following: Rate of Utilization (U) = 100% - UN – US - UD

The work sampling technique can also be used to determine the utilization of man power and equipment resources (Niebel et al. 2012). The theory of work sampling is based on the fundamental law of probability: at a given instant, an event can be either present or absent. Statisticians have derived the following expression to show the probability of x occurrences of such an event in n observations: $P(x) = \frac{n!}{x!(n-x)!} P^x q^{n-x}$ Where p = probability of a single occurrence, q = 1 - p probability of an absence of occurrence, n = number of observation

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter deals with presenting, interpreting, summarizing and evaluating the results of the research conducted so far. This study is conducted aiming to portray the current productivity improvement trends in Ethiopian cement manufacturing firms. For this specific reason an intensive case study was conducted in one of the country's leading cement manufacturer. Derba MIDROCK cement is a leading cement manufacturer operating since 2012. When we look at the sequence of presentation, instantly the measurements of productivity in Derba cement is discussed. Based on the interview conducted, and collected information from the records and reports of company archive. The partial and total productivity indexes of the company in three consecutive years of 2019, 2020 and 2021 will be computed. The interpretation and analysis of this computed productivity indexes will be discussed. After completing dealing with productivity indexes the result of a work study will be presented, interpreted and analyzed. Work study is conducted to measure a rate of resources utilization in a given firm in our case Derba cements. Work study is conducted through designed observation check sheets. The outcomes of a 20 days observation in a selected segment of cement manufacturing sub- process will be discussed. Onwards a response to a questionnaire dispatched will be presented, interpreted and analyzed. The quantitative and qualitative results of the whole study well be discussed in a way to highlight major findings of the research.

4.2 Result and Discussion of Productivity Indexes

Productivity is an index that measures output (goods and services) relative to the input (labor, materials, energy, machine, capital and other resources) used to produce it. Measurement of productivity is a ratio between input and output. The productivity indexes that will be utilized in this study is partial and total productivity of a given firm. In our case Derba cements last three consecutive years productivity indexes will be manipulated. The duration of our inquiry is from January 2019 to December 2021. In order to compute those indexes the records and reports from the company archive will be exploited. In computing both partial and total productivity indexes we converts all the inputs and outputs in to monetary terms except machine input. For the sec of calculation and interpretation machine productivity is computed through machine working hours.

4.2.1 Result and Discussion of Partial Productivity Indexes

Partial productivity measurement is used when the firm is interested in the productivity of a selected input factor. It is the ratio of output values to one class of input. Depending upon the individual input partial productivity measures. In computing partial productivity indexes productivity of an individual inputs such as labor, machine, energy, material and capital will be treated. Starting from January 2019 each months output input ratio of every individual inputs will be premeditated. The annual partial productivity of every inputs and rate of productivity in consecutive years is computed. The correlation between each indexes is executed and analyzed. The calculation of partial productivity indexes in terms of monetary will be presented as follow.

Labor productivity

The important function in any production set-up is that the budgeted quantity of work must be achieved over a period of time. Labor productivity depends upon how labors are utilized.

$$\text{Labor productivity (in terms of money)} = \frac{Total\ cost\ (or\ sales\ value)\ of\ output\ produced}{Amount\ in\ terms\ of\ cash\ spent\ on\ workers}$$

$$\text{Productivity rate} = \frac{Current\ Productivity - Previous\ productivity}{Previous\ Productivity} \times 100$$

Based on above formula a labor productivity of Derba cement starting from January 2019 to December 2021 will be summarized in the following table including monthly and annual indexes.

$\frac{Total\ cost\ (or\ sales\ value)\ of\ cement\ produced}{Amount\ in\ terms\ of\ cash\ spent\ on\ workers}$		Labor productivity 2019	Labor productivity 2020	Labor productivity 2021
	Valid	12	12	12
Mean		49.17	34.7290	24.0844
Std. Deviation		15.295	5.50286	8.46565
Skewness		.034	-.544	-.207
Std. Error of Skewness		.637	.637	.637
Range		48	21.46	24.47
Minimum		25	22.45	11.33
Maximum		73	43.91	35.80
Annual Labour productivity		47.98	34.68	23.99
Productivity Rate		***	-27.6%	-31.44%

Table 2 Summary of Labor productivity

Table 2 shows the summaries of each month's labor productivity calculated, based on above stated formula the annual labor productivity and rate of productivity are also portrayed. As it is illustrated on the above table the mean labor productivity of 2019 is 49.17, with a standard deviation of 15.295. The distribution is positively skewed this tells us that most of the records are above the mean. When we look at the 2020 mean is 34.72 with a 5.5 standard deviation. The 2020 distribution is skewed to the left which expresses that most of the records are less than the mean. The mean value of labor productivity of each months in 2021 is 24.0844 with standard deviation of 8.46 the distribution in 2021 is also skewed to the left which tells us most of the values are less than the mean.

The annual labor productivity or ratios of total sell of cement produced to amount of cash spent on workers in three consecutive years indicated that. It used to be 47.98 in 2019, 34.68 in 2020 and 23.99 in 2021, what we can understand from this is that the labor productivity is decreasing from year to year. This can be resulted from un-proportional increase of cost of labor or tragically decrease of output. Rate of productivity in 2020 compared to 2019 shows a decline by 27.6% similarly the rate of productivity in 2021 compared to 2020 reduced by 31.44%. Looking at this in monthly basis it is possible to understand that in those consecutive months and years output is decreasing while the cost of labor is increasing. The following histogram will illustrate the frequency distribution of labor productivity in Derba cement in three consecutive years.

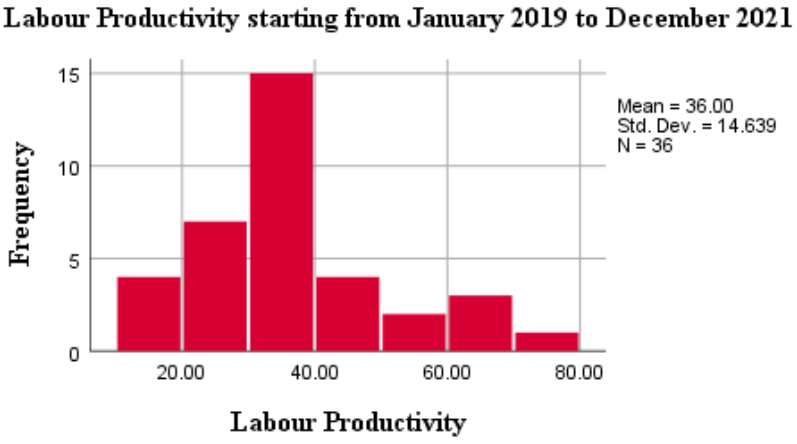

Figure 2 Labor productivity

As it is indicated earlier the labor productivity results of the three consecutive years is skewed to the right as further illustrated in the above histogram.

Machine productivity

Production system converts raw material into finished product through mechanical or chemical process with the help of machines and equipment's. Machine productivity is computed through machine working hours little bit different from the rest of the partial productivity indexes. Here there is no need to convert machine working hour in to cash. Because all the costs incurred to run the machine will be treated in other productivity indexes. Likewise the result of machine productivity is not going to be used in computation of total productivity. The summary of three years machine productivity in Debra cement is computed by considering the standard output of the firm which is 7000 tons of cement per day. The formula used to calculate machine productivity indicate the indexes is a ratio of a standard output in hour to the actual machine working hours. The ultimate machine productivity would be 438 by considering 16hr active machine working hours per day. Machine Productivity = $\frac{Output\ in\ standard\ hours}{Actual\ machine\ hours}$

$\frac{Output\ in\ standard\ hours}{Actual\ machine\ hours}$		Machine productivity 2019	Machine productivity 2020	Machine productivity 2021
	Valid	12	12	12
Mean		565.6726	651.7437	763.1846
Std. Deviation		286.13379	266.10315	149.63430
Skewness		-1.335	-1.081	1.340
Std. Error of Skewness		.637	.637	.637
Range		911.46	968.63	495.28
Minimum		.00	.00	615.84
Maximum		911.46	968.63	1111.11
Annual Machine Productivity		565.67	651.71	763.18
Productivity		***	13.3%	14.6%

Table 3 Summary of machine productivity

The results of actual machine productivity indexes at Derba cement is described in table 3. When we look at the mean of a year 2019 it is around 565.67 which is a lot higher than the ultimate rate of productivity. In the year succeeding the result is even getting to distant from the ultimate rate in 2020 mean is 651.74 and in 2021 the mean result is 763.18. Those result shows the machine downtime or stoppage is increasing from time to time.

Now let's look at the annual machine productivity of 2019, 2020, and 2021 as it is portrayed in the above table the indexes is very distant from the ultimate rate. The machine productivity indexes for this three consecutive years is 565.67 in 2019, 651.71 in 20220 and 763.18 in 2021. For instance the indexes in 2019 is higher than the ultimate rate by 127.67 which is very big gap. In the next year which is 2020 the result of the indexes is larger than the ultimate by 213.71 this also indicate tremendous decrease in machine productivity. In 2021 the number gate even worse the actual machine productivity index is higher than the decisive by 352.18 which almost tends to double. This indicates machine productivity is decreasing in very fastest rate in those consecutive years higher rate productivity indicates higher downtime.

The rate of machine productivity at Derba cement in those consecutive years shows that machine productivity is decreasing in monthly basis. When we look at the rate of productivity between year 2019 and 2020 the ratio between standard outputs to actual machine working hour increases by 13.3%. Which indicates an increase in machine stoppage and downtime by 13.3%. In another word machine productivity is decreasing by 13.3% which is very significant. Now let's look at the next year's rate of productivity between 2020 and 2021 the rate shows an increase by 14.6% this is very shocking. This means a machine stoppage and down time is increased by 14.6% also the machine productivity is decreasing tremendously.

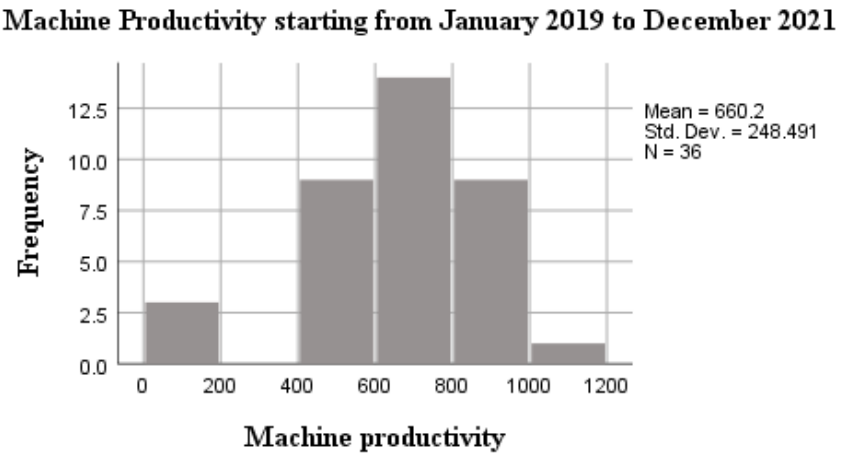

Figure 3 Machine productivity

The above histogram illustrates the machine productivity indexes in each months of the last three consecutive years. From the distribution portrayed we can observe the small isolated peak from the general type histogram that indicate the machine stoppage for a month or more than a month.

Energy productivity

Production system requires a different kinds of power energy in order to operate its equipment's and machineries. The required energy in any production system might be both thermal energy and electrical energy or just only electrical energy.

Energy productivity = $\frac{Total\ sell\ value\ of\ cement\ produced}{Total\ cost\ of\ Input\ energy}$

$\frac{Total\ sell\ value\ of\ cement\ produced}{Total\ cost\ of\ Input\ energy}$		Energy productivity 2019	Energy productivity 2020	Energy productivity 2021
	Valid	12	12	12
Mean		13.9223	14.5364	11.5067
Std. Deviation		21.29826	24.59424	19.69729
Skewness		3.335	3.356	3.438
Std. Error of Skewness		.637	.637	.637
Range		76.57	87.99	69.82
Minimum		4.25	3.94	4.10
Maximum		80.82	91.92	73.92
Annul energy productivity		7.1	6.71	5.8
Productivity rate		***	-5.5%	-13.5%

Table 4 Summary of energy productivity

Table 4 presents the energy productivity indexes of Derba Cement from January 2019 to December 2021. In 2019 the mean energy productivity is 13.92 the maximum energy productivity in this year is 80.82 this happen most probably at the season of Kiln stoppage for maintenance purpose for month or more. In year 2020 the Energy productivity increases to 14.53 which is a positive thing. Because it shows an increase in a ratio of outputs sales value to an input energy. Since energy is the most expensive or covers at least 40-60 % of overall production cost this increase means a lot for the company. In the preceding year which is 2021 the mean energy productivity decreased to 11.5. Which is even less than what it used to be in 2019 this shows the company's failure to sustain its achievement of year 2020.

The annual energy productivity of Derba cement in three consecutive years of 2019, 2020 and 2021 is also computed and illustrated in the above table. Energy productivity indexes in year 2019 is 7.1. Which indicate the cost incurred in energy is very high laterally speaking an energy cost constitute as much as 60% 0f overall production cost. In the succeeding year's energy

productivity indexes in 2020 the mean is 6.71 which is a drop from the previous year. A reduction of energy productivity even by smaller fraction results a lots of decline in overall productivity index. Since the cost incurred in energy for manufacturing cement is very substantial. In year 2021 the energy productivity is 5.8 also a huge decline from the previous years. More or less the energy productivity in those three consecutive years shows a decline from time to time.

The rate of energy productivity computed in the period specified is also illustrated in the above table. The rate of energy productivity between a year 2019 and 2020 indicated the indexes is decreasing by 5.5% from previous results. Which is very substantial considering the importance of energy productivity in cement manufacturing. The rate of productivity between the consecutive years of 2020 and 2021 reveals that productivity is declined by 13.5%. This is also a shocking result to look at. Generally the records and reports from the company archive shows there is an intense decline in energy productivity in three consecutive years.

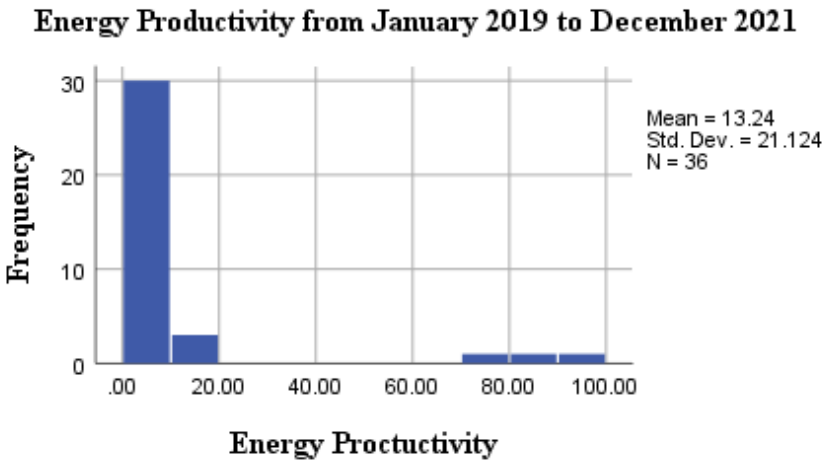

Figure 4 Energy productivity

Figure 4 shows a histogram that illustrates the energy productivity starting from a January 2019 to December 2021. The frequency distribution illustrates that almost 30 of the indexes are between zeros to ten. The rest of frequency that can be observed in the histogram as an isolated bar from the general graph shows the time that the kiln stopped. The kiln which produces an intermediate cement product called clinker stopes for planned maintenance, at least for 40 days per years. The energy consumption will decrease because there is no requirements for thermal energy at that times. The three isolated bars represent the time that the kiln stopped for maintenance purpose in those consecutive years.

Material Productivity

Production system converts raw material into finished product with the help of mechanical or chemical processes. Material productivity plays important role in cost of production.

Material productivity = $\frac{Total\ sale\ value\ of\ cement\ produced}{Total\ material\ cost}$

$\frac{Total\ sale\ value\ of\ cement\ produced}{Total\ material\ cost}$		Material productivity 2019	Material productivity 2020	Material productivity 2021
	Valid	12	12	12
Mean		12.6763	12.2204	18.8294
Std. Deviation		4.84041	3.86646	12.16728
Skewness		-.354	1.375	2.332
Std. Error of Skewness		.637	.637	.637
Range		16.08	12.52	44.83
Minimum		3.67	8.37	8.15
Maximum		19.75	20.88	52.98
Annual material productivity		11.17	11.40	14.7
Productivity rate		***	2.01%	22.44%

Table 5 Material productivity

Table 5 shows the material productivity in Derba cement in three consecutive years starting from 2019 to 2021. The material productivity indexes for those consecutive years is computed by dividing each months total output cement sales value to a total cost incurred in raw material. The mean value of this in year 2019 is 12.67. Which is very significant possibly it constitute as much as 25% of overall cement production costs. The mean material productivity indexes in the later year which is 2020 is 12.22, which shows a decline from the previous years. Material productivity or cost of acquiring a raw material is the second in line next to cost of energy in cement manufacturing process. So a decline in material productivity most definitely results a decline in total productivity indexes. In the last year under investigation as far as this study is concerned. The mean material productivity in year 2021 is 18.8 which is a very large escalations from the previous years. Hopefully this raise can affect the overall productivity indexes positively

The annual material productivity computed by dividing the total sales value of a year to total cost incurred to acquire the raw material as it is indicated in the formula shows that. In a year 2019 material productivity used to be 11.17 this constitute the second next to the energy

productivity. In the later year of 2020 the material productivity shows some raise and become 11.40. Which can be taken as a good improvement. An increase in a fraction of material productivity means that the company is on the right truck as far as material productivity is concerned. In 2021 a material productivity in Derba cement is 14.7 which is a very important raise. Most importantly the company manages to repeat its improvement in increasing material productivity.

The rate of material productivity in those consecutive years is also described in the above table. The productivity rate between a years 2019 to 2020 shows an increase of 2.01%. Which is very good considering the significance of material productivity in cement manufacturing. Literally speaking an increase in a ratio means that less many is incurred to acquire a raw material than the previous years. Which needs to be appreciated and celebrated by the company. In the following years the rate of material productivity is accounted an increase by 22.44%. This increase is also a very astonishing one because an increase in such rate will surely affect the overall productivity. Generally speaking the records and reports in Derba cement indicates that an increase in material productivity in three consecutive years under investigation. This means the cost of acquiring a raw material is decreasing form time to time which is a very positive improvements needs to be praised and celebrated by the company.

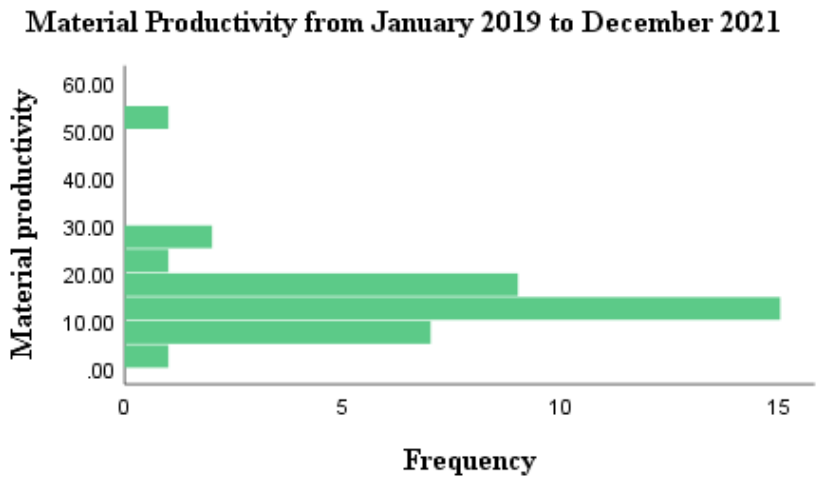

Figure 5 Material productivity

The above histogram illustrates the material productivity indexes from January 2019 to December 2021. The frequency distribution observed above indicates that there is an isolated peak from a general type histogram. That isolated peak represents a time that a kiln stopped for periodic

maintenance and the cement used to be produced from a stocked clinker. Clinker is an intermediate product which is produced by exerting a thermal energy to a raw material in the kiln.

Capital Productivity

For any production set-up, facilities of machines, tools, land etc. are required which are assets of organization. Capital is needed for such assets. As huge capital is locked in assets, their effective utilization is absolutely necessary.

$$\text{Capital Productivity} = \frac{Total\ sell\ value\ of\ cement\ Output}{Capital\ \ cost\ Employed}$$

$\frac{Total\ sell\ value\ of\ cement\ Output}{Capital\ \ cost\ Employed}$		Capital productivity 2019	Capital productivity 2020	Capital productivity 2021
	Valid	12	12	12
Mean		75.6818	69.9977	83.9004
Std. Deviation		4.02711	15.13839	18.41380
Skewness		-3.464	.083	.439
Std. Error of Skewness		.637	.637	.637
Range		13.95	36.13	49.64
Minimum		62.89	51.30	57.94
Maximum		76.84	87.43	107.58
Annual capital productivity		75.2	66.96	77.91
Productivity Rate		***	-12.3	14.05

Table 6 Capital productivity

The table 6 presents the computed capital productivity in Derba cement in three successive years of 2019, 2020, and 2021. In computing capital productivity we divide the total sales value of an output to capital cost incurred. Those costs that we consider as a capital costs were the machine and equipment depreciation cost, cost of maintenance, cost of spare parts, and other overhead operational costs. The capital productivity indexes in a year 2019 is 75.6 means the company spends a significant amount of many in capital costs as far as the records show. There are some capital costs that might be incurred which happens to be confidential to be accessed. In the later year of 2020 the capital productivity used to be 66.99 shows a decline from the preceding years. Although capital cost constitute is the least as far as the records are concerned. This doesn't necessary means that a decline in the indexes doesn't have any impact. Reduction in capital productivity will have its own influence in decreasing the overall productivity. The following years of 2021s mean capital productivity is 83.9 which is a greater raise from the preceding years. This

increase will also result a positive impact to overall productivity such an improvement needs to be appreciated and celebrated by the company.

The annual capital productivity indexes of a successive years of 2019, 2020 and 2021 is also computed and portrayed in the above table. The capital productivity indexes in 2019 is 75.2 this means the company incurs very significant amount of cost on capital items. In the later years of 2020 the annual capital productivity is declined to 66.96 which is very alarming. It means that the company spends more many in purchasing capital items than the preceding years. In the following year of 2021 the capital productivity used to be 77.91. Which is a raise from the preceding year by very significant number. This shows the company spends less cost in purchasing capital items that the previous years.

The rate of productivity in those successive years are also computed and demonstrated in the above table. The rate of capital productivity between a year 2019 and 2020 shows a decline in 12.3%. Which is very noteworthy because capital productivity have its own influence in computing overall productivity indexes. In the later year the rate of productivity between 2020 and 2021 shows an increase by 14.05% which is a positive improvement for the company needs to be celebrated. This raise means that a significant amount of cost in purchasing or acquiring capital items is decreased. Generally speaking the capital productivity indexes lucks consistency in way of improving it. When we compare to the rest of the partial productivity it might be considered somehow blameless.

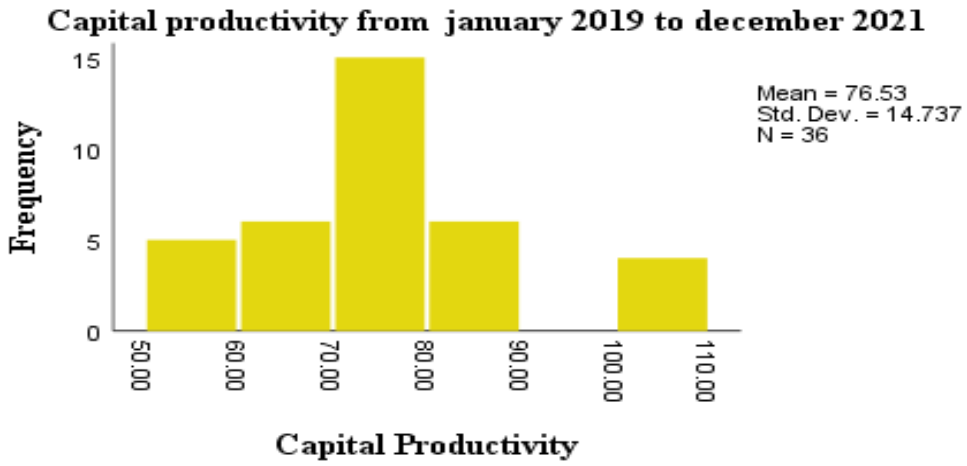

Figure 6 Capital productivity

The above histogram illustrates the capital productivity indexes of Derba cement starting from January 2019 to December 2021. The frequency distribution shows symmetric distribution the isolated plate from a general type histogram represents a time where a total sales value highly exceeds a cost incurred to acquire capital item. Literally speaking those points represent a duration that the company used to produce close to its capacity or maximum production as far as the duration covered by this study.

4.2.2 Summary of Partial Productivity Indexes

Labor productivity or ratios of total sell of cement produced to amount of cash spent on workers in three consecutive years. It used to be 47.98 in 2019, 34.68 in 2020 and 23.99 in 2021. This result indicate a decline of productivity by 27.6% in 2020 compared to 2019 similarly the rate of productivity in 2021 compared to 2020 reduced by 31.44%. Looking at this we can understand that in those consecutive years output is decreasing while the cost of labor is increasing. Machine productivity indexes for three consecutive years is 565.67 in 2019, 651.71 in 20220 and 763.18 in 2021. Between year 2019 and 2020 the ratio between standard outputs to actual machine working hour increases by 13.3%. Which indicates an increase in machine stoppage and downtime by 13.3%. In another word machine productivity is decreasing by 13.3% which is very significant. Rate of productivity between 2020 and 2021 shows an increase by 14.6% this is very shocking. This means a machine stoppage and down time is increased by 14.6% also the machine productivity is decreasing tremendously.

Energy productivity indexes in year 2019 used to be 7.1, 6.71 in 2020 and 5.8 in 2021. The rate of energy productivity between a year 2019 and 2020 indicated the indexes is decreasing by 5.5% from previous results. Which is very substantial considering the importance of energy productivity in cement manufacturing. The rate of productivity between the consecutive years of 2020 and 2021 reveals that productivity is declined by 13.5%. Generally the records and reports from the company archive shows there is an intense decline in energy productivity in three consecutive years. In a year 2019 material productivity used to be 11.17 in the later year of 2020 shows some raise and become 11.40this can be taken as a good improvement. In 2021 material productivity is 14.7 this is a very important raise. Between a years 2019 to 2020 it shows an increase of 2.01%. In the following years the rate of material productivity is accounted an increase

by 22.44%. This means the cost of acquiring a raw material is decreasing form time to time which is a positive improvements needs to be praised and celebrated by the company.

The capital productivity indexes in 2019 is 75.2, in a later years of 2020 capital productivity is declined to 66.96. In the following year of 2021 the capital productivity used to be 77.91 which is a raise from the preceding year by very significant amount. Between a year 2019 and 2020 shows a decline in 12.3%. Between 2020 and 2021 shows an increase by 14.05% this is a positive improvement for the company needs to be celebrated. Capital productivity indexes lucks consistency in way of improving. When it is compared to the rest of the partial productivity it might be considered somehow blameless.

4.2.3 Result and discussion of Total productivity Indexes

Productivity is a common measure on how well resources are being used. Total Productivity can be computed by utilizing the following formulas.

Total productivity index = $\frac{Total\ Tangable\ output}{Total\ tangable\ Input}$ = $\frac{Total\ production\ of\ goods\ and\ services}{Labour + Material + Capital + Machine + energy}$

Total tangible output = Value of finished goods produced + Value of partial units produced Dividends from securities + Interest+ Other income Total tangible input = Value of (human + material + capital + energy + other inputs) used. The word tangible here refers to measurable our measurement is in terms of monetary or local currency.

$\frac{Total\ Tangable\ output}{Total\ tangable\ Input}$		Total productivity index 2019	Total productivity index 2020	Total productivity index 2021
	Valid	12	12	12
Mean		3.9686	3.8124	3.6848
Std. Deviation		1.13042	.94336	1.31996
Skewness		1.688	.870	2.446
Std. Error of Skewness		.637	.637	.637
Range		4.24	3.47	4.90
Minimum		2.72	2.49	2.55
Maximum		6.96	5.96	7.45

Annual total productivity	3.87	3.58	3.39
Rete of productivity	***	-7.5	-5.3

Table 7 Total productivity indexes

The table 7 presents the computed total productivity indexes of Derba cement for the three successive years. The formula used to compute the productivity is also portrayed in the table. Total productivity index represents a ratio of total tangible output or a total sales value of cement produced to a total tangible inputs or a sum of all the costs incurred to produce those outputs. All the measurements used to compute total productivity indexes are in terms of monetary or local currency. The mean value of 2019 total productivity index computed by dividing all the tangible output to all the tangible input is 3.968 with a maximum value of 6.96 and minimum value of 2.72. Total productivity in year 2019 goes as good as 6.96 at a time and as low as 2.72. The frequency distribution is positively skewed that means most of the data are below the mean. That is not good because it might indicate the decline of the result.

In a later year of 2020 the mean result of computed total productivity index is 3.81, with the maximum value of 5.96 and minimum value of 2.49. The frequency distribution in this year reveals a positively skewed this also have a bad implication showing a decline in the results. When it is compared with the preceding year it shows a decline by very significant amount. In the following year of 2021 the mean result of computed total productivity index is 3.68 with a maximum value of 7.45 and minimum value of 2.55. This indicate there was a time that a total productivity accounted to be as good as 7.45 which is very high result and as low as 2.55. The frequency distribution also tells us that it was positively skewed this means most values are less than a mean. This might show that the results are decreasing from time to time.

Table 7 also presents the annual total productivity indexes of three successive years 2019, 2020 and 2021. This result is very important because it shows the company is current position and have a possibilities of indicating where the company is heading to. The computed result of total productivity index in 2019 is 3.87. This result is acquired by dividing a total sale value of produced cement or total tangible output to a total cost incurred to manufacture those output or total tangible input. In the later year of 2020 a computed total productivity index is 3.58 which is a decline from the previous year by very significant amount. In the following year of 2021 the computed total productivity index is 3.39 which also show a greater decline. Such a decline in these two

consecutive years happened because of two main reasons. One reason might be there is a decline in output while the input is almost the same or there is an increase in input while output is almost the same. There is also a possibility of a decrease in sales value of an output as the same time an increase in the cost incurred to acquire all the inputs required.

The rate of productivity in the above stated successive years is also computed and presented in the table. The rate of total productivity index between the year 2019 and 2020 shows a decline by 7.5%, which is very enormous when we convert this into monetary terms. This result point out very important thing that the company's overall productivity indexes are declining. In another word the profit of the company is declined in a year 2020 than its preceding years by a very significant amount. In the later year of 2021 the rate of productivity between 2021 and 2020 reveals a decline by 5.3%. This means the ratio between tangible output and tangible input is declining by 5.3% also the profit. Generally speaking from the total productivity indexes computed by referring records and reports from the companies archive. The firm productivity is declining from time to time as far as the duration this study is concerned. In a very similar terms the results computed above illustrate that the company under investigation and other similar companies are heading to the wrong direction. An increase in productivity means growth and a decrease in productivity leads to failure. Companies in such truck should have to look for their inabilities and work on it to result a better outcome and to survive in the business of this ever changing competitive markets.

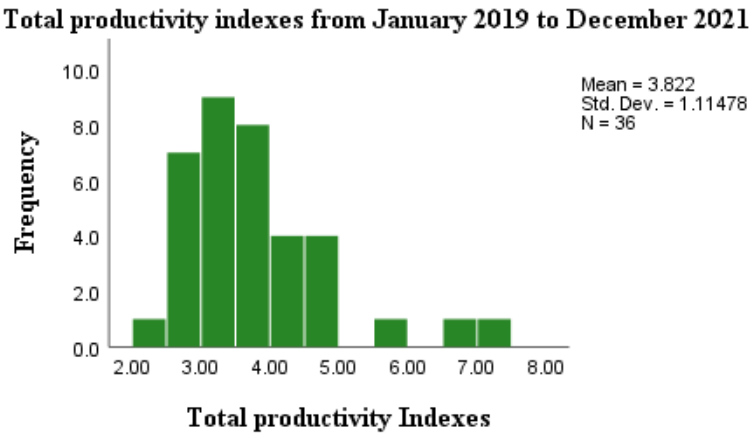

Figure 7 Total productivity indexes

Figure 7 shows a histogram demonstrates the total productivity indexes from January 2019 to December 2021 computed as a ratio of total tangible output to total tangible input. The isolate peak that is isolated from the general type histogram represents. A duration when an energy

productivity used to be very high. In another words those durations are the times that a kiln is being stopped for planned maintenance. In such time there is not required to purchase a sources of thermal energy. This histogram simply discloses the influence that an energy productivity alone can have in overall productivity indexes.

4.3 Result and discussion on Resource Utilization

Resource utilization which refers to the amount of time that a resource spends on performing planned activities can then, of course, only be measured when activities are being performed. Though, the utilization is not solely result of the direct relation between resource and activity. The utilization losses are influenced by factors of the surrounding environment which prevents the resource from performing planned activities, i.e. disturbances (UD), system design factors (US), and need based factors (UN). The work sampling technique can also be used to determine the utilization of equipment resources. After completing the computation of partial and total productivity we proceeds to conduct a work sampling study to identify a rate of resource utilization in Derba cement. The utilization ratios UN, US, and UD symbolizes utilization losses. Consequently, U= 100% would imply that the resource is spending 100% of the planned time on performing the defined activity with zero losses. Utilization above 100% is not possible, and utilization equal to 100% in a real life setting is highly unlikely since there will always be losses. Naturally, improvement initiatives should strive to minimize the identified losses. The above definition can be summarized as following

Rate of Utilization (U) = 100% - UN – US - UD

4.3.1 Result and discussion of Work Sampling Study

The work sampling technique can be used to determine the utilization of man power and equipment resources. The theory of work sampling is based on the fundamental law of probability: at a given instant, an event can be either present or absent. Statisticians have derived the following expression to show the probability of x occurrences of such an event in n observations:

$P(x) = \frac{n!}{x!(n-x)!} P^x q^{n-x}$ Where p = probability of a single occurrence, q = 1 - p probability of an absence of occurrence, n = number of observations

To determine the number of observations needed, the analyst must know the desired accuracy of the results. The more observations, the more valid the final answer. This theory can be used to estimate the total sample size needed to achieve a certain degree of accuracy. This specific work sampling study is conducted by administering a real time observation rather than random observation. This is chosen because it maximizes the accuracy rate and the availability of all the plant operations data's under one roof from central control room (CCR). Central control room or operation room is a central space where a large physical facility or physically dispersed service can be monitored and controlled. With a central control room it is possible to monitor control all equipment used in multiple mines, mills and power plants. With the help of CCR this study plans to administer an observation in utilization of resources by focusing to a sub processes that are directly related to inputs.

The sub process that this study identified for having a direct relation to the utilization of resources are Quarrying, Raw Materials Preparation and Fuels Preparation. The equipment that performs different operation in the above sub process are a part of the observation. In quarrying the equipment that performs different operation and included in this study are (limestone, ballast, and additive crushers) and (limestone, basalt, and additive handling conveyor belts), and (limestone, basalt and additive bins). The equipment's that performs different tasks in raw material preparation and be a part of the observations are (Limestone, basalt and additive domes), (limestone, basalt, and additive homogenization equipment's), (limestone, basalt and additive handling conveyor belts) raw material proportion bins, raw grinding mills and raw material silos. The equipment's that performs different operation in fuel preparation sub process and be a part of the observations are coal crusher, coal handling belt conveyor, coal dome, coal homogenization equipment, heavy fuel oil tanker and spraying device.

The duration of this work sampling study covers 20 days starting from March 3, 2022 to March 23, 2022 an observation of 15 days is enough to conduct a work sampling study. To make our study more reliably and since the accessibility of the data are considerably worthy. With the help of CCR this study runs a 20 day observation. By discussing with different operators and supervisors at CCR major factors that influence the utilization loses are identified. Those utilization loses are further grouped into three criteria's. Thus prevents the resource from performing planned activities, i.e. utilization disturbances (UD), system design factors utilization

(US), and need based factors utilization (UN). The following table summarizes the categorization of factors that influence the resources from performing a planned activities.

Categories	Loses	Abbreviations	Description
Need base Utilization (UN)	Tea break	UNTB	The time operators waste on breakfast and tea
	Launch break	UNLB	The time operators waste on eating launch
	After break	UNAB	The time required to return to a CCR after break
Syetem Baseb Utilization (US)	Preventive Maintenance	USPM	A stoppage to do a preventive maintenance
	Quality alert	USQA	A stoppage due to material quality problems
	Sensor alert	USSA	A stoppage due to alerts of different sensors
	Power cutout	USPC	A stoppage due to power cutout
	Waiting time	USWT	A stoppage for waiting a system to be adjusted
Utilization Disturbance (UD)	Material shortage	UDMSH	A stoppage due to shortage of material feed
	Detecting a problem	UDDP	A stoppage to detect a problem after sensor alert
	Mechanical repair	UDMR	A stoppage to fix a mechanical problem
	Electrical repair	UDEL	A stoppage to fix a electrical repair
	Restarting	UDRST	A time required till the system restarts running
	Idle	UDIDLE	A time that the system runs on idle

Table 8 Work sampling study

Based on above description a check sheet is prepared and every day during the period of the study the daily reports was collected from the CCR. The required data are already available in an information system which keeps a records of such kind on a daily basis. All the equipment's included in this study runs for 16 hours per day. This means all the sub process indicated are working two shifts. This is companies work schedule there are equipment's in other sub process which works nonstop and equipment's which operates 20 hour per day. This specific study choses relevant process which mostly related to inputs and all the sub process work two shift per day. The duration of this study is 20 days. The total time of 100% utilization would be 320 hours if all the process work without interruption. The result of a work sampling study conducted in Derba cements selected sub process such as quarrying, raw material preparation and fuel preparation are discussed below.

Result of work sampling study			
	Need based (UN)	System design Based (US	Disturbance based (UD)
Valid	20	20	20
Mean	02:00	02:15	04:42
Std. Error of Skewness	.512	.512	.512
Range	00:00	08:40	09:05
Minimum	02:00	00:40	01:30
Maximum	02:00	09:20	10:35
Sum	40:00	45:00	94:00
Skewness		2.488	.844
Percentage loss	22.34%	25.14%	52.52%
Percentage	12.5%	14.06%	29.935%
Total loss in hours	179		

Table 9 Results of work sampling study

Need based utilization Rate (UN)

The need based utilization rate depends on the need for relaxation and personal time. It is often regulated by agreements at the work place. It includes paid breaks and losses before and after a break. After conducting a brief discussion with operators and supervisors which works on those sub process under investigation. We identified three factors that influences the resource to perform its planned activity. Those are utilization loses during a tea break which includes a time lost eating a breakfast itself. The second one is launch break this includes the time spent by the operators to eat launch and shift changes because each shift changes at launch time. The third one is the time lost after taking brake returning to operation.

The result as it is portrayed in above table shows that every day two hours are lost by factors related to need based of the personnel who works on the process. The total time last to this categories in the duration of this study is 40 hours this contributes 22.34% of the total loses recorded. During the time this study is administered 12.5% of total operating time is spent on need

based issue. This rate is very significant that requires urgent adjustment. The company can simply look in to its work schedule and gate reed or minimize this loses.

System designed utilization Rate (US)

The system designed utilization rate is defined as the balance losses designed into the system. It can be balance losses on an assembly line as well as losses in a semi-automated work station. After conducting a brief discussion with operators and supervisors which works on those sub process under investigation. The factors that are identified as an influence for the resource to perform its planned activity that are also categorized under system designed loses are. The time lost in performing a planned and preventive maintenance. The time lost when a system is interrupted because of materials quality problem. This is automatically identified by detectors and the time required to adjust the quality problems. The time lost by interruption of alerts due to different reasons. The time or operation hours lost because of power shortage. The last one is the time spent on waiting the system to re-run on its full capacity.

As it is illustrated on the table that shows the result of a work study. During a 20 day that the work study is administered in selected sub process of quarrying, raw material preparation and fuel preparation. On average 2:15 hours from total operating hours will be lost as a reason of system design factors. During 20 days of observation a total of 45 hours is lost on system design factors. This contributes 25.14% of the total loses that are recorded during our 20 days of observation. From total operating hours in 20 days from March, 3, 2022 to March 23, 2022, 14.06% is lost by the reason associated system design factors. From the table we can identify the maximum hours spent on the factors associated with system design 9:20 this happens at a time when the power cutout occurred. Generally speaking there are areas that required attention and to be adjusted in minimizing the utilization loses as a reason of system design factors.

Disturbance affected utilization Rate (UD)

Disturbance affected utilization rate corresponds to the losses caused by different random disturbances. It includes the lost time from discovery of the disturbance until the work is performed at full speed again. The rest of operational disturbance identified by the discussion with CCR operators and supervisors are categorized as disturbance affected factors. Those include the operating time lost because of stoppage by the reason of material shortage. The operating time lost

in identifying the problem occurred after it is being alerted by the sensor. The operating time lost for making a mechanical and also electrical repair after problem is identified as such. The operating time spent on restarting the system and the time required for the system to become fully operational. Finally the operating time that an equipment run on idle for different reasons.

The work sampling study performed in selected sub process in Derba cement for 20 days staring from March 3, 2022 to March 23, 2022 shows the following result. During the time under investigation on average 4:42 hours per day is lost by the factors associated to different disturbance. From total operating hours of 20 days under investigation 94 hours is lost as a reasons of different factors associated with disturbance. As it is indicated on the above table a maximum of 10:35 hours spent on a given day from a daily operating hours. At this specific day a major repair of electrical and mechanical was performed. The operating time loss associated with different disturbance contributes 52.52% of the total loses during 20 days. From total operating hours under investigation 39.935% is lost by the reasons associated to different factors related to disturbance.

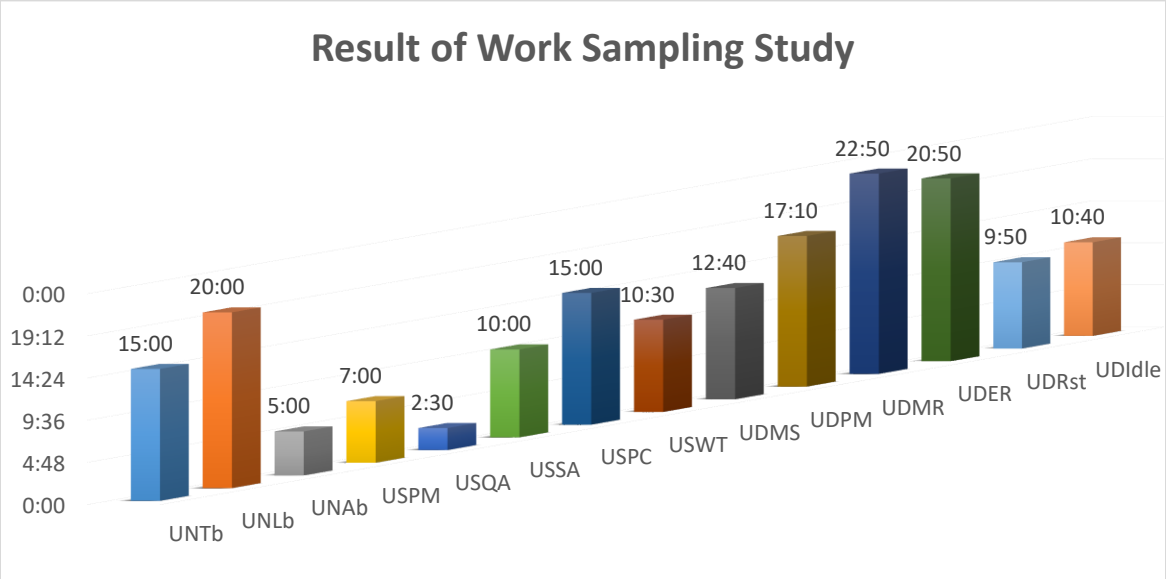

Figure 8 Utilization Loses

From the work study result we can learn that the major categories of factor that causes a most loses are related to disturbance factors. This indicates that the company should pay more attention to remedies that can possibly minimize those factors. The above chart drawn from the results of work sampling study shows that from all the factors identified. The maximum time is

spent on mechanical repair, electrical repair and launch break. The time lost as a reason of quality alert and after breaks are the least.

As we discussed earlier when we are computing for rate of resource utilization we subtract the identified losses from 100%. Form our work sampling study we conducted at selected sub process which are relevant to our study, because of their relation to the resource utilization. Quarrying, raw material preparation and fuel preparation and the equipment's that performs different tasks under those sub process are investigated. The result of the study shows that 12.5% of the total operating hours is lost by need based factors (UN), 14.06% of the total operating hours are lost by factors associated to system design factors (US), and a 29.935% of total operating hours are lost by different factors associated with disturbance (UD).

(U) = 100% - UN – US - UD

= 100%-12.5%-14.06%-29.935%

= 43.5%

The rate of resource utilization at Derba cement is 43.5% as the result of our work study indicated, this means a given resource performs its planned activities only 43.5% of a time. This result is way below than the range of utilization rate identified by global cement and cement business research which is between 60%-70% (CemBR, 2019). The company requires to make an extensive research and identify a factors that influences a resource to perform its planned activity. An improvement in the utilization of a resource directly results an improvement in rate of productivity. So the firm specified have to identify the areas that requires improvements and develop a remedies that can help to survive in this highly competitive markets.

4.4 Results and Discussion on Factors of Optimum Utilization

Optimal resource utilization will ensure waste reduction and higher factor productivity. Optimal Resource utilization which refers to the amount of time that a resource spends on performing planned activities can then, of course, only be measured when activities are being performed. Though, the utilization is not solely result of the direct relation between resource and activity. The productivity of a certain set of resources is therefore the amount of goods or services

which is produced by them. Land and building materials, machines, labour, energy, technology etc. are the resources at the disposal of a manufacturing company. In order to identify the factors that solely affects the optimum utilization of a resources a questionnaire arranged. The questionnaire was carefully organized to address each resource categories utilization trends. This questionnaire are dispatched to personnel's in different departments within Derba cement to gate their responses on the issue.

To highlight the way the questionnaire is organized part one of the questionnaire deals with demographic information of the respondents. Those include gender, age group, educational background, the area that the respondents works on, the position that the respondent held at the company and finally respondents work experience in the company. In part two several questions prepared for the respondent to express their opinions. The company's leanings regarding to optimum utilization of labor, machine energy material and capital resources. From the 75 questionnaires dispatched 72 of them have been returned and our analysis will be based on those responses. The return rate of the questionnaire is 96% the researchers would like to give his appreciation for the well-founded response provided by the respondents.

4.4.1 Demographic Data

1. Respondents gender

Gender		Frequency		Percent	Cumulative Percent
	Male	46		63.9	63.9
	Female	26		36.1	100.0
	Total	72		100.0	

Table 10 Gender of the respondent

Table 10 presents the gender of a respondent as it is indicated 63.9% of the respondents are male and 36.1 of them are female. There is no respondent who doesn't want to replay on this questions.

2. Age group of the respondents

Age group		Frequency	Percent	Cumulative Percent
	18-25	5	6.9	6.9
	25-35	49	68.1	75.0
	35-45	15	20.8	95.8
	45-55	1	1.4	97.2

	>55	2	2.8	100.0
	Total	72	100.0	

Table 11 Age group of the respondent

Table 11 shows the age group the respondent belongs to, as it is illustrated on the table 68.1% of the respondent belongs to youngest age group which is from 25-35. The respondent's age group that comes second in line is late youngster which is from 35-45 by accounting 20.8% of the respondent. The early youngster respondents are only 6.9% of them. 1 respondent is in the age group of 45-55 and the rest two respondents are above the age 55. There is no respondent who doesn't want to replay this questions.

3. Educational background of the respondent

Educational background		Frequency	Percent	Cumulative Percent
	<12	20	27.8	27.8
	Diploma	20	27.8	55.6
	First degree	22	30.6	86.1
	Second degree	10	13.9	100.0
	>Second degree	0	0	
	Total	72	100.0	

Table 12 Educational background of the respondent

Table 12 presents an educational background of the respondents as it is portrayed in the table 30.6 % of the respondents holds their bachelor degree. The respondents who hold diploma and tenth grade leaving certificate are 27.8% each, all of the respondent who holds tenth grade certificates are machine operators and drivers. 13.9% of the respondents are holders of a master's degree, no respondent who participated in this survey have an educational background above second degree. There is no respondent who refuses to answer this particular question.

4. Respondents work area

Work area		Frequency	Percent	Cumulative Percent
	Core process	39	54.2	54.2
	Support process	33	45.8	100.0
	Total	72	100.0	

Table 13 Respondents work area

Table 13 shows the work area that the respondents are engaging in, as it is illustrated on the above table out of a total 72 respondent 39 of them or 54.2% works in core process area. The process that are considered to be core area are all the cement manufacturing sub process those are quarrying, raw material preparation, fuel preparation, clinker burning, cement grinding and cement dispatching. The rest of the respondent 33 of them or 45.8% belongs to support process. The work area that are considered as support area are human resources, equipment maintenance and repair, finance, and all the operation that are outsourced to a third party.

5. The position that the respondent held in the organization

Position of the respondent		Frequency	Percent	Cumulative Percent
	Top management	1	1.4	1.4
	Middle management	10	13.9	15.3
	Supervisor	9	12.5	27.8
	Employee	52	72.2	100.0
	Total	72	100.0	

Table 14 Position of the respondent in the organization

Table 14 presents the position that the respondent is held in the organizational structures. As it is illustrated on the table out 72 total respondents 72.2% of them are employees who engage in front line operation and activities. 13.9% of the respondent held a middle management position within the organization. 12.5 of the respondents are supervisors who engage in supervising and guiding front line operation and activities. One respondent held a top management position within the organization. There is no respondent who refuses to replay to this particular question.

6. Respondents work experience in the company

Work experience		Frequency	Percent	Cumulative Percent
	<1 years	1	1.4	1.4
	1-3 years	1	1.4	2.8
	3-5 years	17	23.6	26.4
	5-9 tears	30	41.7	68.1
	>9 years	23	31.9	100.0
	Total	72	100.0	

Table 15 Respondents work experience within the company

Table 15 shows the experience or the stay of the respondents within the company, as it is portrayed on the table out of 72 respondents 41.7% works in the company from 5 to 9 years. 31.9% of the respondents have been with the company for more than 9 years. The respondent that have been working in the company for the last 3 to 5 years are 23.6%. One respondent works for the company for 1 to 3 years and another one respondent is working in the company for less than one year.

4.4.2 Factors that affect resource utilization

In second part of the close ended questionnaire was prepared for the respondents to reflect their opinion on the possible factors that might affect the optimum utilization of resources. Those questions are first categorized to five resource categories in order to address each factors productivities. Those categories are questions related to labor resource utilization, machine resource utilization, material resource utilization, energy resource utilization and capital resource utilization. The number of questioned allocated to each resource categories out of 53 questions 23 of them are concerned with labor resource utilization. 8 questions are about machine, 6 of them deals about material, and again 6 of the deals about material and finally 7 of the questions concerned about capital resource utilization. The responses of the above stated question which are prepared in a likert scale having five scale. Later on for the sec of analysis those questions which address a much related factors collected together in a group.

Responses of the dispatched question are grouped according to their association to the factors such as job design and recruitment, employee engagement and reward, team work, health, safety and legal requirement, maintenance, energy and material utilization, capital utilization and top management commitment. With the help of statistical package for social sciences (SPSS) software and using one of the methods for commuting a likert scale analysis. The result of the responses was concise. The method used to group each respondent's response of a closely associated questions was by calculating the median of those responses. This is done by assigning a numerical value to the responses 1 for strongly agree and 5 to strongly disagree. The median response of those diligently related question is treated as a representative of a given respondents response on the specific factor. For further interpretation and analysis the mode of the grouped question which are grouped according to their relation will be computed. The following 8 tables presents the frequency, percentage, and cumulative percentage of responses to each categories based on collected survey.

Factors that affect utilization of labor associated with job design and recruitment					
Q. No	**Does your organization have an attempt to utilizes it Labor resources by aligning**	Measurement	Frequency	Percentage	Cumulative Percentage
2.1	Appropriate job Design and Analysis to improve the Critical Psychological states of job/work	Strongly agree	0	0	0
2.2	Create job clarity and reduce role conflicts lead to improve productivity	Agree	10	13.9	13.9
2.3	Effective recruitment to develop a reliable and committed work force, loyal to the organization's goals of productivity	2.5	2	2.8	16.7
2.22	Equal Employment Opportunity and Affirmative Action, hiring women and minorities to mirror the increasingly diverse markets.	Neutral	27	37.5	54.2
2.25	Employment to candidates who have family difficulties or made redundant,	3.5	7	9.7	63.9
2.26	Employment local candidates in order to contribute to the sustainability of local economies and societies	Disagree	25	34.7	98.6
		Strongly disagree	1	1.4	100
			Total	72	100

Table 16 Lickert Scale job design and recruitment

Table 16 presents the opinions of the respondents on the issues that could possible affect the utilization of labor resources specifically related to employee recruitment and job design. From the respondent who replays to those questions 37.5% of them describes their opinion on this matter as being neutral. Out of 72 respondents 34.7% of them disagreed that the organization or Derba Cement lucks a definite procedure in providing a firm employee recruitment and job design for its labor forces. 13.9% the respondent agreed to those question that enquires if the organization have a well-established employee recruitment policy and job design. 2.8% of the respondent's leans their opinion might be between agreeing and being neutral on other part 9.7% also leans in between neutral and disagreeing. 1.4% of the respondent strongly disagree to the question that related to job description and employment. As it is indicated above a significant number of the respondent disagree to those enquires that are associated to a proper prearrangement of employment and job description in Derba cement. Having a very well-established human resource management police is very crucial in achieving quality and productivity as it is argued by Anton. Strengthening HRM

by adapting appropriate HRM systems, policies and practices any organization can ensure the quality and quantity of HRs and develop quality and productive culture in the organization. (A. Anton Arulrajah, 2017).

Factors that affect utilization of labor associated with employee engagement and reward					
Q. No	**Does your organization have an attempt to utilizes it Labor resources by aligning**	Measurement	Frequency	Percent	Cumulative Percent
2.4	Extensive training on job related tasks, training in small group problem solving, communication, and statistical process control	Strongly Agree	0	0	0
2.5	Engage employees at all levels in the thinking processes of an organization	Agree	1	1.4	1.4
2.6	A participative process that uses the input of employees	2.5	3	4.2	5.6
2.7	High Pay/Reward based on productivity improvements efforts	Neutral	19	26.4	31.9
2.8	Pay for performance and Feedback on performance	3.5	3	4.2	36.1
2.18	Participative leadership and delegation practices	Disagree	37	51.4	87.5
		4.5	4	5.6	93.1
		Strongly disagree	5	6.9	100
		Total	72	100	

Table 17 Lickert Scale employee engagement and reward

Table 17 shows the responses to the questions related to the factor that affects the utilization of labor mostly associated to employee's engagement and rewards based on performance. Out of 72 respondent who participated in this survey 51.4% of them disagreed that the organization attempt in aligning mechanism to engage employee and give rewards based on performance. 26.4% from the total respondent want to reflect their opinion on this issues as being neutral, while 4.2% of them lean in between being neutral and agreeing, the other 4.2% also leans in between neutral and being disagree. When 6.9% of the respondent strongly disagree the existence of any work environment that appreciate employees engagement and rewarding based on performance. 1.4% of the respondent agrees to the question that enquires the organizations prearrangement to engage employee and pay the reward based on performance. By looking at the summary of the responses portrayed above it is possible to identify that the organization lucks a prearrangement to engage and reward its employees. This is very alarming because a literature suggested that

incentive scheme which is productivity linked group incentive scheme, has reduced the absenteeism of employees to much more extent and made the calculation of incentive amount easier and also increased the productivity (Debesh Mishra1, A. Mohanty, 2017).

Factors that affect utilization of labor associated with team work					
Q. No	**Does your organization have an attempt to utilizes it Labor resources by aligning**	Measurement	Frequency	Percent	Cumulative Percent
2.9	Team based problem solving approach	Strongly Agree	0	0	0
2.10	Autonomous teams and decentralized decision making	Agree	1	1.4	1.4
2.11	Extensive sharing of financial and performance information throughout the organization.	Neutral	23	31.9	33.3
2.12	Suggestions scheme, Information and Idea Sharing	disagree	41	56.9	90.3
2.13	Good management-to-employee partnerships. Partnering means working together for mutual benefit	Strongly disagree	7	9.7	100
2.14	Effective team-to-team partnerships	Total	72	100	
2.15	Smooth employee-to-employee partnerships				

Table 18 Lickert Scale of team work

Table 18 presents a summary of the responses to the questions related to factors which affects the utilization of labor resources mostly those associated to teamwork. The summary portrayed in the above table indicates that out of 72 respondents 56.9% disagreed that the organizations effort to align its labor force to work in a team. While 31.9% of the total respondent replays to those enquires as being neutral. 9.7% strangle disagree in the existence of work environment that appreciate teamwork. Only 1.4% of the respondent agrees that the organizations effort to establish the conducive environment to work in team is very recognizable. The above illustration indicates that the organizational effort to create a work environment that appreciate team work is very low. Team work is a very important thing that any organization that aspires improvement in resource should really pay attention on. Unluckily the result of the survey show opposite. Creating a work environment which appreciate a team work is what the company needs to concentrate on in the future endeavor.

Factors that affect utilization of labor associated health, safety and legal requirement					
Q. No	**Does your organization have an attempt to utilizes it Labor resources by aligning**	Measurement	Frequency	Percent	Cumulative Percent
2.16	Flexible work schedule/working hours	Strongly agree	0	0	0

2.17	Alternative work arrangement and teleworking set up	Agree	15	20.8	20.8
2.23	Compliance with labor laws regarding health and safety, minimum wage, working hours,	Neutral	25	34.7	55.6
2.24	Employees personal and family needs that are above and beyond legal minima,	Disagree	30	41.7	97.2
2.19	Made an effort to maintain sound physical wellbeing of employee	Strongly Disagree	2	2.8	100
2.20	Made an effort to maintain sound Mental wellbeing to make correct decision and to ensure good expected behavior	Total	72	100	
2.21	Develop good values among the workforces ethical behavior (fairness, dependability, integrity, honesty and truthfulness)				

Table 19 Lickert Scale health, safety and legal requirement

Table 19 presents a summary of the responses to the questions related to factors affecting the utilization of labor resource. Mostly those factors which are associated in making certain that health, safety and legal requirements of the employees attained. Out of 72 respondent 41.7% of them disagree to the fact that the organization make a very maximum attempt to make certain that the occupational health and safety of the employees are attained. When 34.7 of the respondent replays as having a neutral stand on such matters. 25% of the total agrees to the organization attempt to meets the legal requirement in attaining its employees' health and safety. 2.8 of the respondent strongly disagree to the fact that. The organization effort to uphold its employee's occupational health and safety is behind legal minima. The summary above shows that the organizations effort in making certain that all the prearrangement to improve the occupational health and safety is on the wrong truck. Serious improvement on such issues is very important in order to result an improvement in utilization of labor resources.

Factors that affects machine utilization associated with maintenance					
Q. No.	**Does your organization made and effort to properly utilizes its machinery resources by stressing on**	Measurement	Frequency	Percent	Cumulative Percent
2.29	Maintenance aims to reduce even minor defects of equipment	Strongly Agree	0	0	0
2.30	The organization prepares schedule in advance for various types of maintenance activity	Agree	3	4.2	4.2
2.31	There is monitoring and analysis of machine failure and taking action to prevent reoccurrence	Neutral	32	44.4	48.6
2.32	Maintenance program includes training of maintenance personnel in the appropriate field	Disagree	34	47.2	95.8

2.33	Reduction in setup times and unplanned downtime	Strongly disagree	3	4.2	100
2.34	Production operators are trained to perform routine preventive maintenance task	Total	72	100	

Table 20 Lickert Scale maintenance

Table 20 shows a summary of the responses provided to the questions related to the factors that influences the utilization of machinery. The factor which is grouped here is those which are directly related to maintenance activities. Out of 72 respondents 47.2 of them disagreed that the equipment and machinery maintenance in Derba cement is believed to be efficient and acceptable. When 44.4% of the respondent want to reflect their opinion on this matters as neutral. Most of them who choses being neutral believe that it is beyond their expertise to judge the maintenance process. From total respondent 4.2 strongly disagree that the maintenance procedure available at the company delivers the maximum outcomes. Only 4.2 agrees that the existing maintenance procedure is in the right truck. The result of this survey indicates the overall maintenance and repair process at Derba cement is very questionable. Since it is a manufacturing industry all its activity of manufacturing is associated with machine in one or another way. Being ineffective in maintenance results inadequate utilization of machine resources.

Factors that affect energy and raw material resource utilization					
Q. No.	**Does your organization made any known effort to appropriately utilize its energy and raw material resources by endeavoring to**	Measurement	Frequency	Percent	Cumulative Percent
2.37	Reduction in energy consumption electricity, fuel oil and water	Strongly Agree	0	0	0
2.38	Any effort to use alternative energy rather than Coal and HFO	Agree	3	4.2	4.2
2.39	Monitor and control proper utilization electricity and fuel oil consumption	Neutral	30	41.7	45.8
2.40	Reduction in additional investment in purchasing new machine/parts	Disagree	32	44.4	90.3
2.44	Appropriate trained and sufficiently organized mining team	Strongly disagree	7	9.7	100
2.45	Environmentally friendly mineral extraction practices	Total	72	100	
2.46	Harmless extraction practice that sufficiently supply required material				

Table 21 Lickert Scale energy and raw material resource utilization

Table 21 portrays the summary of the responses on the questions regarding the factors that affects the utilization of energy and material resources. A particular result of this category the most

important than the rest. Because most cost in cement manufacturing process is incurred in acquiring energy and raw material resources. As it is indicated on the above table from 72 respondents who participated in this survey 44.1% them disagreed. That the company's effort to utilize the energy and raw material available are appropriate. While 41. 7% of the respondent want to reflect their opinion on this matter as neutral. 9.7% strongly disagree on the appropriateness of energy and material utilization by the company. Only 4.2% of the respondent confidently aggress to the companies effort in utilization of energy and material resources is suitable.

The outcome of this result is very alarming because more than 80% of the respondent questions the company's utilization of energy and raw material. Since energy and raw material constitutes major cut of the cement production cost it is very essential to make an improvement in this matters. Spatially making certain that the very scarce energy resource are utilized properly and wisely is so important. An increase in productivity of this to two can ultimately result an increase it over all productivity. Because the world cement industry is developing in the following two directions: Reducing the fuel cost and CO2 emissions in the air, and Improving the construction and technical properties of portland cement (BICKBAU, Marsel Yanovich, 2016).

Factors that affect utilization capital resources					
Q. No.	**What is your organization attempt to put is available assets in better use to make sure the capital resources are utilized by concentrating on**	Measurement	Frequency	Percent	Cumulative Percent
2.49	Making maximum effort to make sure all the vehicles are used for planned activities	Strongly Agree	0	0	0
2.50	Making certain that all the buildings and workshops are used for planned activities	Agree	6	8.3	8.3
2.51	Unquestionable use of housing and other recreational facility	Neutral	14	19.4	27.8
2.52	Undisputable procedure to utilizes the available land	Disagree	44	61.1	88.9
2.53	Definite utilization of all purchased consumables	Strongly disagree	8	11.1	100
		Total	72	100	

Table 22 Lickert Scale utilization capital resources

Table 22 displays a summary of the responses that participant of this survey reflects on the factors that affect the utilization of a capital resources. As it is illustrated on the table out of 72 respondents 61.1% of them disagreed to the fact that capital assets owned by the company is in

proper use. 19.4% of the respondent reflects their opinion on this matter as neutral. While 11.1% of them strongly disagreed that the organizations effort on making better use of the available asset is proper. Only 8.3% if the respondent agrees to the fact that the organization is attempting its maximum effort to make better usage of the available capital resources. The result of this survey highlights that. The company is not in the right truck in making sure that all its available assets are adequately utilized. This poor utilization of capital resources have its own effect on overall utilization of the resources.

Factors that effect of resource utilization associated with management commitment					
Q. No	**Does top management in your organization made and effort to properly utilizes its resources by stressing on**	Measurement	Frequency	Percent	Cumulative Percent
2.27	Proper plan procedure to use every vehicle	Strongly Agree	0	0	0
2.28	Proper plan and procedure to use heavy trucks and machineries	Agree	6	8.3	8.3
2.35	Top management is committed to evaluate employees skill to improve it from time to time	Neutral	29	40.3	48.6
2.36	Top management takes part in making their employees multi skilling	Disagree	34	47.2	95.8
2.41	Proper exploration and deposit identification in mine sites	Strongly disagree	3	4.2	100
2.42	Well organized mine plan to efficiently utilize all the available mineral resources	Total	72	100	
2.43	Monitoring and controlling of mining plan execution				
2.47	Top management's commitment to prepare suitable plan on how to use the available assets				
2.48	Organizing appropriate structure to make better use of the assets				

Table 23 Lickert Scale management commitment

Table 23 displays a very curtail outcomes of the conducted survey from the factors which affects optimum utilization of resources management's commitment is the decisive one. The above table shows the responses of the participant on the questions related to the commitment of a top management. From 72 participant which participated in this survey 47.2% disagree that top management effort to show their commitment on better utilization of resource is proper. While 40.3% of the respondent chooses to reflect their opinion on this very decisive matter as neutral. 4.2% of them strongly disagree to the management's commitment to make batter utilization of the resources. Only 8.3% from the total of 72 respondent agrees that management's demonstration to

show commitment to improve the utilization of resources is proper. Management commitment happens to be the most critical factor that determines the success and failure of any organization. This survey highlights that more than 80% of the respondent questions the commitment of the management. After all the rate of productivity and rate of utilization that is discussed in this study surely traced back to the commitment that the management have to improve it. The success of implementing any improvement depends on several success factors the most critical is management commitment, steady fund inflow and clear product strategy (Mohd Razali Muhamad, 2005).

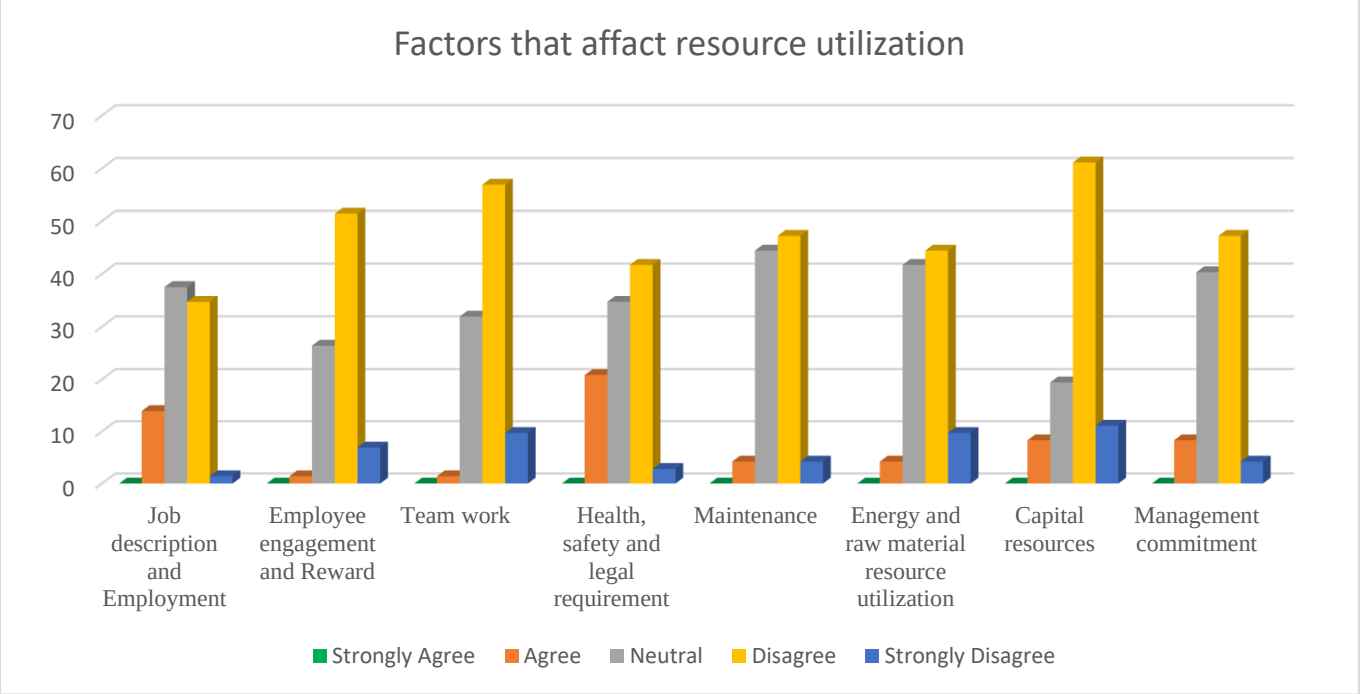

Figure 9 Factors affecting resource utilization

The chart displayed in figure 9 demonstrated the summary of the responses to the questions that are supposed to identify the factors that affects the utilization of resources. As it is illustrated in the chart a large percentage of the respondent disagrees in the company's effort to create a conducive work environment for team work. The luck of employee's engagement and rewards is also the critical things that are identified in having an influence of resource utilization. Luck of proper recruitment and job design policy and failing to uphold occupational safety and health requirements are identified as contributing factors. A very enormous percentage of the respondent have a critical questions in the adequacy of maintenance procedure and utilization of energy and raw material. More than 70% of the respondent accept that the company is making very minimum

effort to utilize its capital resources. The most critical factor that plays an important role in any organizations improvement effort is the commitment of management. More than 80% of the respondent have a question on this matter because the top management fails to demonstrate its commitment on batter utilization of resources.

4.5 Optimization of Resource Utilization

Throughout this study the partial and total productivity of a case company was computed and the result demonstrate that productivity is declining in very alarming rate. The computed partial productivity indicated that there are vital inputs that have a greater influence in determining the overall productivity. Energy and material inputs are the vital resources that have higher influence in determining the overall productivity rate. The result of a work sampling study conducted for 20 days in selected sub process that are very relevant to this study. Reveals that only 43.5% of the organizational resource is performing its planned activities. In order to identify the factors that affects the utilization of resources a survey was conducted. The result of this survey indicated that the organizations lucks a committed management, efficient utilization of energy and raw material resources, the maintenance process in the company is also indicated as a factor. A work environment that doesn't appreciate teamwork, failing to engage employee also not rewarding for their performance is a critical factors identified. An appropriate usage of the capital resources is also indicated as one factors that influences the utilization of available resources for planned activities.

Based on the information gathered throughout this study it is possible to foresee the potential improvement opportunities that can help the organization to overcome its problem. In order to do this, instantly this study runs a pareto chart of inputs resources in order to identify the inputs that influence overall productivity and utilization of the resources. Then a relations among those resources will be analyzed in order to foresee the areas of potential improvement.

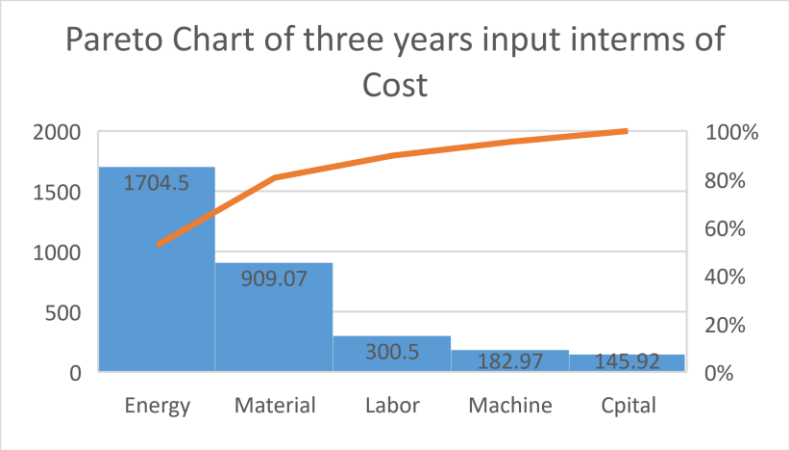

Figure 10 Pareto chart of inputs

The above chart is drawn by computing the total cost incurred to acquire each inputs staring from January 2019 to December 2021. As it is highlighted in the chart in Derba cement more than 80% of overall cost of production is the cost incurred in acquiring energy and raw material. This suggest that any improvement in utilization of those two resources have a possibility of improving overall productivity. Before we discuss the possible ways to optimize the utilization of energy and material resources it is important to look at the correlation those resources can have. For this reason we run a peasron correlation test of a 36 months under investigation starting from January 2019 to December 2021. If the result of a correlations is significant the scatter diagram will be drawn for further analysis. After investigating the causal relationships between the productivity of those resources it is possible to foresee the areas that requires improvement to optimize the utilization.

		Labor	Machine	Energy	Material	Capital
Labor	Pearson Correlation	1	-.362*	-0.276	-0.238	-0.259
	Sig. (1-tailed)		0.015	0.052	0.081	0.064
	N	36	36	36	36	36
Machine	Pearson Correlation	-.362*	1	0.214	.452**	0.221
	Sig. (1-tailed)	0.015		0.105	0.003	0.097
	N	36	36	36	36	36
Energy	Pearson Correlation	-0.276	0.214	1	0.196	0.067
	Sig. (1-tailed)	0.052	0.105		0.126	0.349
	N	36	36	36	36	36
Material	Pearson Correlation	-0.238	.452**	0.196	1	0.256
	Sig. (1-tailed)	0.081	0.003	0.126		0.066
	N	36	36	36	36	36
Capital	Pearson Correlation	-0.259	0.221	0.067	0.256	1
	Sig. (1-tailed)	0.064	0.097	0.349	0.066	
	N	36	36	36	36	36
*. Correlation is significant at the 0.05 level (1-tailed).						
**. Correlation is significant at the 0.01 level (1-tailed).						

Table 24 Causal correlation between partial productivity

Table 24 presents the causal correlation between results partial productivity computed for the duration under investigation in Derba cement. From the pareto chart constructed earlier we identified energy and material as vital factors. Which influences the overall productivity by constituting more than 80% of production cost of cement. When we look at the Pearson correlation that those vital inputs have to each other. Input energy doesn't have any significant relation to other inputs as it is indicated in the table. This means the optimization of input energy can be dealt with separately.

The work study conducted identifies that the factor that affects the resource utilization. Which directly related to energy resource is the power cut out and availability of material specifically coal. This two factors are mostly determined by external effects which this study is not going to address for the time being. The survey conducted to identify the factor that affects resource utilization identifies that low commitment of management to optimize the energy resource is the most important factor. The rest of the factor that have a potential to improve energy productivities are using alternative energy sources, and upgrading the skills of employees on the conservation of scarce energy inputs. World cement industry is developing in the following two directions: Reducing the fuel cost and CO2 emissions in the air (BICKBAU, Marsel Yanovich, 2016). Cement manufacturing firms around the world are struggling to improve their rate of energy productivity the case in Derba cement is no different. There are areas of improvement which potentially result an improved utilization of energy resources. As it is identified from the survey top management commitment. Considering the use of alternative energy source rather than conventional one. Using local coal and updating the employee's knowledge to create a multi skilled labor who can understand the importance of optimizing energy resources. Derba cement or any other cement manufacturing firm will ultimately improve its productivity by highly consecrating on the above mentioned areas of improvement.

Table 24 indicated that the second vital factor which is material productivity have a causal correlation with machine productivity. The Pearson correlation identified positive correlation between machine and material productivity. Machine productivity by itself have a negative correlation with labor productivity. The scatter diagram portrayed below demonstrates those causal relations between those factors.

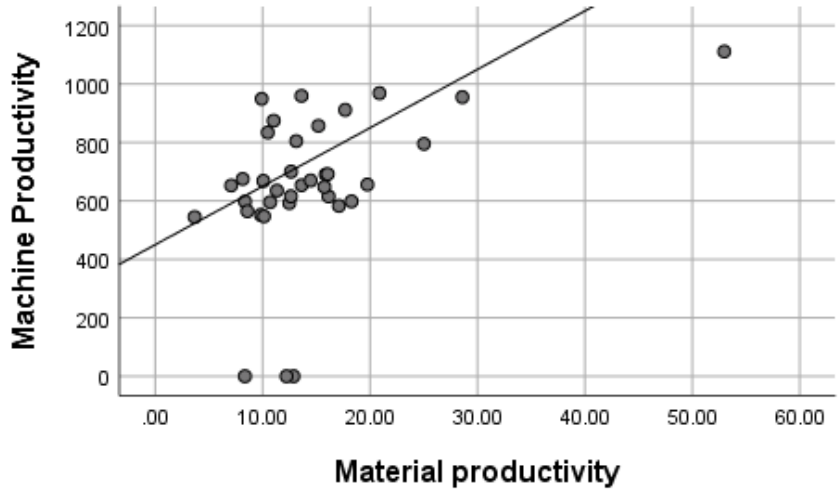

Figure 11 Scatter diagram between material and machine productivity

The above scatter diagram illustrates that there is a positive relation between rate of machine productivity and material productivity which is expected. The thing that requires a reminder is the way those rates are computed. As it is discussed earlier machine productivity is a ratio between a standard outputs to actual machine operating time. Which means an increase in the rate of machine productivity indicates a decline in machine operating time. As result of this an increase in a rate of machine productivity demonstrates a decline in productivity. The above diagram also illustrates the fact that an increase in machine productivity. Which indicate an increase in machine down time also positively related to the ratio of output to material input. Literally speaking the more dawn time occurred the cost incurred on acquiring raw material decreases. This decrease in material production causes a decline in cost incurred in acquiring material. Which by itself causes an increase in rate of material productivity. The other correlation identified is the causal relation between machine and labor productivity which is negative correlation. The scatter diagram below demonstrates the relation between those two factors.

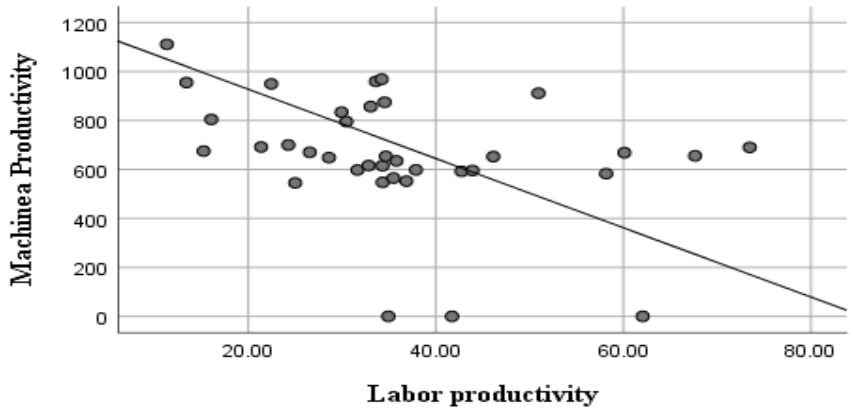

Figure 12 Scatter diagram between Labor and machine productivity

The scatter diagram portrayed above illustrate the negative relation between labor and material productivity. Which means an increase in machine productivity causes a decline in labor productivity. This kind of relation is also normal and expected. What can this result suggest is in order to increase labor productivity the rate of machine productivity have to be declined? Decreasing the rate of machine productivity means decreasing machine dawn time which potentially resulted by increasing the utilization of labor resources.

The above two scatter diagram portrays the intertwined connection between this three input resources. In order to improve the material productivity which is identified as vital factor in the Pareto analysis. It requires to improve both labor and machine productivity. From the work sampling study conducted it is identified that utilization loses during mechanical repair, electrical repair, lunch break, detecting the problem and tea break are the critical one. Other hand the result of a survey indicated that luck of top management commitment, questionable maintenance procedure. Very limited awareness on efficient utilization of material resources. Minimum teamwork effort, a low tendency of engaging the employee and failing to reward the employee based on performance. Those factors are identified as the most influential that affects optimum utilization of labor, machine and material. For Derba cement and any other cement manufacturing firm exists in the country or elsewhere. Paying a maximum attention to the above specified factors can result an optimum utilization of the resources. When a resource utilization is optimized ultimately the rate of productivity will be improved.

4.6 Summary of Results and Findings

This study was conducted by aiming to explore a way higher productivity can be achieved in cement manufacturing industries in Ethiopia. From numerous ways that can potentially result improved productivity optimization of resource utilization is the one which received an emphasis. In order to investigate the influence that optimization of resource utilization can have in improving productivity this study take Derba cement. The leading cement manufacturer in the country as a case. For the same purpose of examining the effect of optimization of resource utilization on an organization. This study gathered several production records and reports from the companies archive and compute the existing rate of productivity in the company. A duration of three years was chosen starting from January 2019 to December 2021 and partial and total productivity of those years was computed.

Intended for computing partial productivity labor, machine, energy, materials and capital are selected. Their rate of productivity on each moths during the time under investigation was exhibited. The outcome of partial productivity discloses labor, machine, and energy productivity is declining during three consecutive years. On the other hand material productivity is increasing and capital productivity also shows promising increment in those consecutive years. The results of total factor productivity and rate of productivity in the duration this study examines. In 2019 the total factor productivity in Derba cement used to be 3.87, in the successive year of 2020 productivity used to be 3.58. The result of productivity on the last year under investigation 2021 is 3.39. The rate of productivity between the year 2019 and 2020 shows productivity is declined by 7.5%. On the other hand the rate of productivity between the year 2020 and 2021 confirms another decline in productivity by 5.3%. From this computation it is possible to learn that the rate of productivity in Derba cement is declining in those consecutive years at frightening rate.

After identifying the decline of productivity this study further looks into the current status of resource utilization in the company. For this reason a work sampling study was conducted to compute that rate of utilization and also identifies the factors that affects in resource utilization. A 20 days observation was conducted starting from March 3, 2022 to March 23, 2022 in selected sub process of cement manufacturing. The selected sub process are those believed to have a direct relation with resource mobilization and consumption. Namely the selected sub process are quarrying, raw material preparation and fuel preparation. The observation was conducted by

referring to a central control room daily report summaries. The result of the work sampling study indicates that Derba cement utilization rate is 43.5%. This result is a way below the utilization rate that is suggested for cement manufacturing by cement research business. The recommended rate of utilization by cement research business is in between 60% to 70%. The factors that are identified by work sampling study as major contributors for loses of utilization are the following listed according to their contributions.

- ✓ Loses during mechanical repair
- ✓ Loses during electrical repair
- ✓ Loses occurred by stoppage during lunch time and shift change
- ✓ Loses occurred during detecting the problem once it is alerted
- ✓ Loses as a reason of power cutout and during breakfast or tea break

The survey was also conducted while the observation for work study is underway. Around 75 questioners were dispatched to the respondents who shows a willingness to participate in this survey based on the sampling design prepared earlier. Out of 75 questioners 72 of the respondent firmly answers the question asked. From the responses the major factors that affects the utilization was identified and illustrated by analyzing using relevant statistical functions. The factors that are identified for having a major influence on utilization of resources based on the responses are the following.

- ✓ Luck of management commitment
- ✓ Limited awareness on the importance of optimizing energy and material resources
- ✓ Unsatisfactory maintenance procedures
- ✓ Work environment that doesn't promote teamwork
- ✓ Failing to engage employee and rewarding based on performance
- ✓ Deficiency in meeting some of occupational health and safety requirements
- ✓ Poor exploitation of capital resources
- ✓ Luck of definite job design and recruitment policy

In order to foresee the potential improvement areas in optimizing the utilization of resources. A pareto diagram was drawn and the vital inputs which contributes a larger stake than the rest was identified. Those are energy and raw material inputs this two inputs constitute more than 85% of the total production costs. Improvement on this two vital factors can ultimately result an

optimization of resource utilization which can also result a higher productivity. The possible correlation that might exist between all the inputs are also investigated. The result of a Pearson correlation indicates energy doesn't have any causal relation with the rests of the input. The potential improvement areas in energy can be dealt with separately from the rest of the inputs. As it is identified in the work sampling study and from the survey conducted. An improvement in commitment from top management. A consideration of using alternative energy sources and usage of local coal. Updating the employee to make them multi skilled and understand the importance of optimizing energy resources can potentially result an improvement in energy utilization.

The result of a Pearson correlation indicates the relationship between machines productivity and material productivity as a positive correlation which is expected. The same correlation also portrays a negative correlation between machine and labor productivities. Most importantly it requires an improvement in machine productivity in order to achieve batter utilization of material resources. On the same pattern machine productivity is also highly influenced by labor productivity. Improvement in labor can surely result better machine productivity. The factors that are identified as factors that affects the utilization of labor, machine and material. In the work sampling study and conducted survey are also the potential areas of improvement. Advanced top management commitment, progressive maintenance procedure, updated awareness on efficient utilization of material resources. Creating the work environment that appreciates teamwork, high tendency of engaging employee and rewarding the employee based on performance. Improvement on the above mentioned areas can potentially result an optimization of material resources. In addition to this an introduction of a modern problem solving technique would help the company to overcome its problems scientifically.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

Conclusion

This study was conducted with an objective of determining how productivity can be improved though optimum utilization of resources in cement manufacturing firm. Intended to compute the rate of productivity a Derba cement a leading cement manufacturer was taken as a case. The total factor productivity in year 2019, 2020 and 2021 used to be 3.87, 3.58 and 3.39. The outcome of partial productivity discloses labor, machine, and energy productivity is declining during three consecutive years. On the other hand material productivity is increasing and capital productivity also shows promising increment in those consecutive years. The rate of productivity shows a decline in 7.5% between 2019 and 2020 and a drop in 5.3% between a year 2020 and 2021. The rate of utilization in Derba cement computed by using work sampling study confirms 43.5%. Loses during mechanical repair, electrical repair, lunch break or shift changes and during detecting the problems are the major contributors. The survey conducted to identify the factors that influence optimization of resource utilization discloses that. Luck of top management commitment, little awareness about optimization, unsatisfactory maintenance procedure, inadequate teamwork, failing to engage employee, unable to arrange an incentive scheme and poor exploitation of capital resources. These are major factors that influences the utilization of resources for planned activities. Energy and material resources are identified as vital inputs that contributes a larger stake in cement production cost. Improvement in the utilization of this two can ultimately result optimization of resource utilization. Improvement in energy resources can be dealt with separately since it have little causal relation with other inputs. When it comes to material resources optimization could be achieved. If and inly if the utilization of machine and labor resources are optimized.

Recommendation

Based on the findings it is recommended if the company or any other cement manufacturing company should focus on the following. Since management commitment indicated as very influential factors that affects resource utilization management is required to demonstrate their

advanced commitment. Operational factors such as maintenance is also very decisive in cement manufacturing process. A cement firm who aspires growth in productivity should concentrate in realizing progressive maintenance procedure. Updating awareness of every stake holders on the importance of optimizing energy and material resources. A consideration of using alternative energy sources. Since energy constitute major stake in cement production cost coming up with cheaper energy source such as increasing the usage of local coal is vital. Nurturing and creating the work environment that appreciates teamwork. Showing high a greater tendency of engaging employee by crafting different platforms.

Arranging an incentive schemes to appreciate and rewarding the employee based on performance. Upholding the all occupational health and safety of employees sometimes exceeding the minimum requirements will help. Better exploitation and management of capital resources. Delineating definite job design and recruitment policy. Throughout this study none of the modern problem solving techniques were encountered. This by itself can have possibility of becoming a problem. Hence it is strongly recommended to adopting modern problem solving techniques. Considering the difficulty that can be faced during an introduction of such problem solving techniques. The researcher believes an introduction of basic statistical process control tool as such as control chart and fishbone diagram is very likely to succeed.

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Appendix I

Questionnaire

SAINT MARY'S UNIVERSITY
SCHOOL OF GRADUATE STUDIES
INSTITUTE OF QUALITY AND PRODUCTIVITY MANAGEMENT

Dear Respondent,

My name is Fisaha Teklu. I am graduate of St. Mary‟s University, at Institute of Quality and Productivity Management studies and currently working a research on title **"Productivity improvement through optimum utilization resources; a case study of Derba Cement".** The main purpose of this questionnaire is to obtain relevant information on utilization of resource in Derba Cement. This research work also aspires to identify the factors affecting optimum utilization of labour, material, energy, machine and capital resources in Derba cement.

Any information you give will be kept confidential as the data are needed for academic purpose only.

Contact Address: Cellphone- 0912349135

Email- fiseha467@gmail.com

Your kind cooperation is very much appreciated.

Part One: Demographical Information: - Please mark 'X' in the space provided

1.1 Gender:-

Male	Female

1.2 Age Group:-

18-25	25-35	35-45	45-55	>55

1.3 Your Educational Status: Other please specify

≤12	Diploma	1st Degree	2nd Degree	>2nd Degree

1.4 Your work area:-

Core process	Support process

1.5 Which level are you belonging in your organization?

Top Mgt	Middle Mgt	Supervisor	Employee

1.6 Work experience in this company?

<1 year	1-3 year	3-5 years	5-9years	>9yeras

Part two: **Please mark 'X' in the space provided**

	Q. No 1. Does your organization have an attempt to utilizes it Labour resources by aligning	Strongly agree	Agree	Neither	Disa gree	Strongly disagree
2.1	Appropriate job Design and Analysis to improve the Critical Psychological states of job/work					
2.2	Create job clarity and reduce role conflicts lead to improve productivity					
2.3	Effective recruitment to develop a reliable and committed work force, loyal to the organization's goals of productivity					
2.4	Extensive training on job related tasks, training in small group problem solving, communication, and statistical process control					
2.5	Engage employees at all levels in the thinking processes of an organization					
2.6	A participative process that uses the input of employees					
2.7	High Pay/Reward based on productivity improvements efforts					
2.8	Pay for performance and Feedback on performance					
2.9	Team based problem solving approach					
2.10	Autonomous teams and decentralized decision making					
2.11	Extensive sharing of financial and performance information throughout the organization.					
2.12	Suggestions scheme, Information and Idea Sharing					
2.13	Good management-to-employee partnerships. Partnering means working together for mutual benefit					
2.14	Effective team-to-team partnerships					
2.15	Smooth employee-to-employee partnerships					
2.16	Flexible work schedule/working hours					
2.17	Alternative work arrangement and teleworking set up					
2.18	Participative leadership and delegation practices					
2.19	Made an effort to maintain sound physical wellbeing of employee					
2.20	Made an effort to maintain sound Mental wellbeing to make correct decision and to ensure good expected behavior					
2.21	Develop good values among the workforces ethical behavior (fairness, dependability, integrity, honesty and truthfulness)					

2.22	Equal Employment Opportunity and Affirmative Action, hiring women and minorities to mirror the increasingly diverse markets.					
2.23	Compliance with labour laws regarding health and safety, minimum wage, working hours,					
2.24	Employees personal and family needs that are above and beyond legal minima,					
2.25	Employment to candidates who have family difficulties or made redundant,					
2.26	Employment local candidates in order to contribute to the sustainability of local economies and societies					
	Q. No.2. Does your organization made and effort to properly utilizes its machinery resources by stressing on					
2.27	Proper plan procedure to use every vehicle					
2.28	Proper plan and procedure to use heavy trucks and machineries					
2.29	Maintenance aims to reduce even minor defects of equipment					
2.30	The organization prepares schedule in advance for various types of maintenance activity					
2.31	There is monitoring and analysis of machine failure and taking action to prevent reoccurrence					
2.32	Maintenance program includes training of maintenance personnel in the appropriate field					
2.33	Reduction in setup times and unplanned downtime					
2.34	Production operators are trained to perform routine preventive maintenance task					
	Q. No.3. Does your organization made any known effort to appropriately utilize its energy resources by endeavoring to					
2.35	Top management is committed to evaluate employees skill to improve it from time to time					
2.36	Top management takes part in making their employees multi skilling					
2.37	Reduction in energy consumption electricity, fuel oil and water					
2.38	Any effort to use alternative energy rather than Coal and HFO					
2.39	Monitor and control proper utilization electricity and fuel oil consumption					
2.40	Reduction in additional investment in purchasing new machine/parts					

	Q. No. 4. Does your organization made its best exertion to utilize its raw material resources by aligning					
2.41	Proper exploration and deposit identification in mine sites					
2.42	Well organized mine plan to efficiently utilize all the available mineral resources					
2.43	Monitoring and controlling of mining plan execution					
2.44	Appropriate trained and sufficiently organized mining team					
2.45	Environmentally friendly mineral extraction practices					
2.46	Harmless extraction practice that sufficiently supply required material					
	Q. No. 5. What is your organization attempt to put is available assets in better use to make sure the capital resources are utilized by concentrating on					
2.47	Top management's commitment to prepare suitable plan on how to use the available assets					
2.48	Organizing appropriate structure to make better use of the assets					
2.49	Making maximum effort to make sure all the vehicles are used for planned activities					
2.50	Making certain that all the buildings and workshops are used for planned activities					
2.51	Unquestionable use of housing and other recreational facility					
2.52	Undisputable procedure to utilizes the available land					
2.53	Definite utilization of all purchased consumables					

Thank you for your cooperation!!!

Appendix II

SAINT MARY'S UNIVERSITY
SCHOOL OF GRADUATE STUDIES
INSTITUTE OF QUALITY AND PRODUCTIVITY MANAGEMENT
Interview questions

This questionnaire is designed for partial fulfillment of MSc program, Saint Marry University, School of Graduate Studies in Quality and Productivity Management, for academic year 2021/2022. The information gathered and the finding of the research paper is dedicated only for academic purpose and will not pass to the third party without the clear permission of the company. Your cooperation is highly appreciated for answering the questionnaire dedicating your valuable time and sharing your knowledge to us.

Contact Address; Fisaha Teklu, **Tell;** 0912349135, **Email;** fiseha467@gmail.com

1. Does your organization have a proper plan manage its human resources? How do you evaluate the execution? What happens to be the bottle necks of implementing the plan?
2. Does your organization have timely and appropriate plan to make sure better handling and utilization of machinery? How do you evaluate the execution? Does top management committed to implement this plan? What is the thing that considered constraints to implement the plan?
3. Cement industry is considered as one of power incentive manufacturing industry to what extent that your organization engage in the following issues:
    a. Electrical energy reduction in cement mills by grinding media optimization?
    b. Optimization of compressors and cooler fans Intel modification?
    c. Best practices of maintenance?
    d. Identifying and attempting to use alternative sources of energy?
4. Did your company have good raw material exploration and extraction plan so that it can guarantee the sustainability of the plan?
    a. How come the top managements are committed to excite the plan?
    b. How much does the organization engage in executing its corporate social responsibility?
    c. What happens to be the major restriction that affects the implementation of the plan?
    d. Is there any difficulties reported that affects the raw material extraction process?
    e. Is there any security and mineral availability traits that might put the future of the plant under uncertainty?
5. What is your organizations effort to prepare and timely update the asset management and utilization plan? What is the top management's commitment on implementation and preparation of the plan? How do to evaluate the implementation of the plan? What are the limitations of those controlling and monitoring mechanisms?
6. Does your organization ever tried any of problem solving and productivity improvement initiatives?

Appendix III

Observation check list for work sampling study

Quarrying, Raw material preparation, and Fuel preparation

Number of working study_____ date_____
Remarks_____
_____

Obs Day	Opti me	Need based utilization losses			System design utilization losses					Disturbance affected utilization losses						Total observation	% productive	% non-productive
		Tea break	Lunch break	After break	PM	Quality alert	Sensor alert	Power cut out	Waiting time	Material shortage	Discovering problem	Mechanical repair	Electrical repair	Restarting time	Idle			
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2																		
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