

Detailed Study of Cement Manufacturing Industry



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Nepal is a resource rich country having huge amount of water, forest, limestone and among others natural resources. The rational use of such resources is essential for the sustainable growth of the nation. Cement industry is one of the industries established in Nepal that aims to use domestic limestone as the prime raw material. The use of cement in Nepal can be marked from early 1950's. The domestic production started in 1975 with the establishment of Himal Cement Company Limited. Now, there are 124 cement industries legally registered in Nepal. Among them, 65 industries are already established that produces per year around 10 million metric ton cement.

This study was commissioned to identify the present status of cement manufacturing industries along with the forecast of cement demand for upcoming years. MaDRA takes an opportunity to express its' gratitude to those Experts/stakeholders who contributed their valuable time and added precious value in this study. Particularly it extends sincere appreciation to Mr. Binod Prakash Singh, Director General; Mr. Krishna Kharel, Director; Mr. Pushpa Shiwakoti, Statistical Officer and among others staff of the Department of Industry for their kind inputs and guidance to bring this report to the final stage.

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We hope this study will be useful to prepare further policy and directives related to cement manufacturing industry in federal context of Nepal.

MaDRA

EXECUTIVE SUMMARY

The use of cement in Nepal can be traced back to as early as 1950's. In the olden days, Nepal relied heavily on India for the supply of cement as there were no cement manufacturing industry in the country. Nepal's first state owned cement manufacturing plant, Himal Cement Company Limited was established in 1975. During the 1980s, the government gave priority to industries such as lumber, plywood, paper, cement, bricks and tiles, which made use of domestic raw materials and reduced the need for import. The growing pace of infrastructure development and urbanization led to an increase in the use of cement. With respect to the development of modern cement manufacturing industries, on the basis of development cycle of the use of cement, the time frame can be divided in to six periods of interval. In the pre-democracy era, only basic materials like mud and wood were used during the Malla and Lichhabi era, then during the Rana regime Bajra plaster was introduced. After democracy (1950-1971) it is considered as a *perceive period*, where with the upscale of infrastructure work, the demand of cement started to well up. The need and utility of cement rapidly increased with the establishment of several manufacturing industries from private sector investors to increase of development activities. This era is known as *commencement period* of the development and use of cement in the country. During the same period (1972-1984) two major foundation stones of cement factories were laid – Himal Cement Industry Ltd with 120,000 MT annual capacity and Hetauda Cement Industry later on the Udayapur Cement Industry established by the government. The Government of Nepal's move to engage the private sector in the cement manufacturing industry was a step taken to the privatisation of the sector. The period (1985-2003) was known as *traction period* where the government moved towards another height by shifting economy from control to gradual privatization process. During this period, 21 cement industries registered with the Department of Industry (DOI). The other stage of development of cement industry was known as *Transition Period* (2004-2010), during this period the government developed preparedness to regulate cement industries in Nepal with formulation and enactment of guidelines, the licenced industries during traction period started to produce cement from their plants. Domestic production of cement increased at an exponential rate, in the same period the government signed the WTO agreement, it further opened up FDI and encouraged investors as a result in the transition period as a result of which 35 new cement industries acquired licence from DOI. Growth or take off period of cement industry was from 2011 to 2019, in this period 18 years old Industrial Policy was replaced by the new Industrial Policy 2010 to encourage balanced national economic growth by ensuring supply of cement as a main ingredient of the development multiplier. At this stage a total of 58 new industries were registered with the DOI.

A total of 65 industries were registered with National Standard (NS) license and started with the production. However, this is the time to consider whether or not the government should issue more licence to produce more cement in the country. Therefore, to know the exact status of the cement industry in Nepal, the DOI has considered to conduct the study covering the following issues:

- Capacity utilization
- Energy consumption

- Demand forecast
- Trend and status of clinker import for cement production
- Availability of raw materials domestically for cement manufacturing industries for the future
- Technology upgradation
- Alternatives and substitution for cement
- Challenges faced by the cement Industries
- Financial position and area for improvement (policy level, association level and industries level)

There is a total of 124 cement industries; 114 registered with the DOI and 10 not found in DOI registration but registered and acquired NS licence from NBSM in Nepal. Out of those registered with the government agencies 65 industries have received NS License from NBSM. Cement industries are categorized in two groups: 1. fully integrated producing cement and clinker and 2. Clinker based milling industries.

The Department of Mines and Geology (DMG) issued 171 licenses for lime stone mines until 2075/76 FY.

Most of the factories are registered as Private Limited Company and few are with public limited structure. Only one company has gone public through stock market.

During 2074/75, total consumption of cement was 3.2 million and at the end of 2075/2076 it was 6.9 Million tons and the production will reach at more than 10 million tons during the 2076/77 FY estimated at a total of 13.4 million. It is estimated that if the firms and industry upgrade and install the plants according to the plans submitted to the DOI, the total installation capacity will reach about 20 million tons by 2022.

Growth of cement in Nepal since the last 20 years is not linear, cement production increased significantly from 2010 as a result cement import in the year 2075/76 decreased tremendously. It seems that the domestic installed capacity and production of cement can substitute import of cement completely by the end of 2076/2077.

Demand of cement is directly related to the GDP growth of the any country, therefore, multiplier factor to the cement demand in Nepal stands at 4.79, i.e. with one percent increase in GDP leads to 4.79 percent growth in demand of cement in Nepal.

Big Chinese industries entering the Nepali market with more than 3000 TPD, will put pressure on existing companies in Nepal in terms of price and technology in the cement manufacturing process.

The cement manufacturers' capacity utilization is improving with regular power supply and improvement of road network to the mine and plant. An average of 74.6 percentage of the total installed capacity was utilized in FY 2074/75. It is considered the capacity utilization rate would go up to 80 percent. The factory's average annual operating day is 300 per year.

Price and supply of cement in Nepal are not intercepting, small and medium sized cement producing companies are crowded, their cost of production is relatively high, economic scales are hard to improve, therefore to bring the supply, demand and price in equilibrium, few large industries should be established in Nepal. For the purpose, FDI could be a vehicle to meet the national and local demand, not only will this ease the supply situation but it will also bring down the price of cement.

Lime stone, silicon oxide, iron ore, magnesium oxide and aluminium oxide, chine clay, gypsum and clinker are the major ingredients of cement. Major raw materials for cement is limestone deposit of which, in Nepal, is estimated to be 1.39 billion tons reserve according to DMG 2004, 540 million tons are certified, 110 million tons are semi certified and 420 million tons are possibly deposit in various part of the country.

Clinker demand is increasing at 12 percent annually. A total of 8.5 million tons of clinker will be required to fulfil the annual demand for the FY 2076/77. The Department of Custom's import data shows that 2.93 million tons of clinker was imported mainly from India in FY 2074/75, the amount will be less in the current fiscal year 2075/76 than the previous. It is estimated that the import of clinker could be around 2.5 million tons till the end of FY 2075/76. The remaining demand will be fulfilled through domestic production.

Domestic production of clinker is increasing at the same pace as cement production in Nepal because of the establishment of new large integrated plants.

Landing price of the imported clinker at the factory was NPR 8.5 per kg in 2071/73 base price. Whereas the price was slightly increased in 2075/76 to NPR 9.41 per kg., according to the import data kept by TEPC and industry data.

Clinker's average price at factory on board in some of the companies in Vietnam is \$41 per ton, i.e. per kg price at source could be around 5 Rupees. Average clinker price at source in Indian clinker manufacturing plant is about INR 3500 ie. NPR 5.6 per kg. Whereas comparing the price of clinker produced in Nepal is about NPR 8.5 to 9 Rupees. Therefore, there is no significant difference of price of clinkers importing from overseas and buying from the domestic market for the manufacturers.

Energy Consumption has not been efficient as compared to global outlook, it is around 156.08 KWh/T cement which is more than standard consumption of 105 KWh/T. Similarly, thermal consumption is 5.411 MJ/Kg for clinker which is also more than standard consumption of 3.138 MJ/Kg.

Coal is mainly imported from India as demand for coal is increasing with the establishment and operation of new large cement and steel industries in Nepal. The total import of coal for the year 20175/75 was 1.3 million tons which is 31 percent more than the same operating year. 230 kg coal is required to produce one tone clinker. The consumption of coal has increased rapidly, a total of 64 racks of coal per month is required to fulfil the current demand in the entire cement industry in Nepal.

There are mainly the two types of the milling technology utilized by the cement industry in Nepal. The Rotary system of milling is more advanced than the VSK technology. In the factory, energy efficiency and environmental mitigation technologies are absent.

Cement as one of the construction ingredient would hardly be substituted in modern construction industry. New technologies with fabricated materials can reduce the use of cement but not completely replace cement. Some of the light substances being used and developed to replace the use of cement in the construction industry are: AshCrete, Timbercrete, HempCrete, Recycled Plastic (PVC), wood, Mycelium, Ferrock, Silica Fume, Bamboo and new technology introduced in construction industry.

Total capital investment in the Cement Industry is estimated around 20 billion Nepalese Rupee. Total investment in the sector is only estimated by Nepal Rastra Bank and it does not have actual investment data from the commercial banks in Nepal

Small cement plants of less than 500 TPD will be under threat in the future if they are unable to reengineer their business with the movement of market and demand, this will be the major challenge to small and medium scale industries.

Access to information on human resources and revenue of cement industry in Nepal are limited. Contribution of cement factory obviously is high in the national economy but it is not easy to calculate exactly the degree and magnitude the sector has contributed to the GDP growth, employment, import substitution and asset generation in the economy.

Regulation issues under the federal structure; role of province and local units on natural resource issues has complicated the regulation and licensing process. Creation of hassles due to ambiguous role of province and local unit.

Shortage of technical manpower in the manufacturing unit, industries are focused on minimum training and self-development programmes.

Industries are facing difficulties in coal import and quality issues as there is no dedicated department to oversee the coal production and to address the problems related to coal issue.

The Department of Industry (DOI) and other regulating institutions should review the exiting cement production and market before granting licenses in the future.

Over two billion rupees is invested in the sector, the industries borrowed from the Nepalese bank and financial institutions, therefore, the concerned institutions including banks should be cautious in the future before financing in the sector unless the external market is available.

It is necessary to have a separate cement unit under the DOI, rather than mixing other industries and SMEs in the same administration process.

Maintaining information of cement producers in Nepal is now becoming urgent; there are more than 124 registered cement companies and 65 already in operation, detailed status of the cement plants are still unknown, however each cement company should upgrade their plants and manufacturing status to the DOI and also should get registration and NS number from NBSM.

Data from the DOI shows that there are 65 registered with them. The DMG issues mining license to the cement companies. Three departments are working independently for the same purpose hence, it will be more practical, efficient and better coordination if all three departments shared their data and operated from a central data based system incorporating all information through a single protocol.

An information desk with full physical infrastructure including information management software system, well trained human resources and required facilities at the DOI would improve the information dissemination and management system of cement in Nepal. Online report upload facilities to the industries and firms would make all stakeholders comfortable and all relevant information will be available in time.

Clinker and cement production are two different procedures, while registering the cement company in the DOI they should clearly mention the clinker production and cement production category with respective quantity. The classification of the factories not only the capacity of cement but also their clinker production and combined capacity should be mentioned in their documents and DOI database as well.

An authorized coordinating body under the DOI engages representatives from cement manufacturing companies to review, discuss and settle issues at various levels of taxation, power supply and tariff, road network to the quarry, raw material, quality issues and other relevant areas related to the industry ensuring the creation of a harmonious atmosphere in the industry and government sector.

Cement producers are branding their products, it was difficult to find their brand registration in NS and DOI, the brand used should be registered with DOI and NS.

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ABBREVIATION

% - Percent

CBS - Central Bureau of Statistics

CME - Census of Manufacturing Establishments

CO₂ - Carbon Dioxide

DOI- Department of Industry

DMG- Department of Mines and Geology

EE – Energy Efficiency

EEC - Energy Efficiency Centre

EIA – Environmental Impact Assessment

ESPS - Environment Sector Programme Support

FDG- Focus Group Discussions

FDI- Foreign Direct Investment

FITTA – Foreign Investment and Technology Transfer

FNCCI - Federation of Nepalese Chambers of Commerce and Industry

FY – Fiscal Year

GDP - Gross Domestic Production

HDI – Human Development Index

HDPE – High Density Polythene

IEE – Initial Environmental Examination

ISO – International Organization for Standardization

kWh - Kilo watt hour

MECS – Manufacturing Energy Consumption Survey

MT/T- Metric Tonnes

MJ – Mega joule

MOI - Ministry of Industry, Commerce and Supply

MPA – Mega Pascal

MWh - Mega Watt Hour

NBSM – Nepal Bureau of Standards and Methodology

NEA - Nepal Electricity Authority

NEEP - Nepal Energy Efficiency Programme

NESHAP – National Emissions Standard for Hazardous Air Pollutants

NS – National Standards

SAARC - South Asian Association for Regional Cooperation

SEZ - Special Economic Zone

S. N. / S. No. - Serial Number

TEPC - Trade and Export Promotion Center

TPD- Tons per Day / Metric Tons per day

TOR - Terms of Reference

VSK - Vertical Shaft Kiln

CHAPTER I: INTRODUCTION

1.1 Background

The symbolic modernization path of Nepal can be traced back to 2007 B.S. The socio-economic development agendas were initiated only after first 5-year plan of economic development was drawn in 2014. Over the past 60 years, due to various politico-economic character Nepal is still in steady phase of development. However, in the last decade after the end of civic conflict Nepalese economy has achieved remarkable results. Central Bureau of Statistics (CBS), shows the country's Gross Domestic Product (GDP) growing at 6.9 percent at basic prices in 2073-74, the highest since fiscal year 2049/50. The GDP index is influenced by various sectors and their improvement can be recognized in recent period. The agricultural sector contributes largely towards the GDP while other sectors are showing improvements in recent years.

Infrastructure and industrial sectors are the other important pillars for economic growth of the country. Infrastructure including road transport, education, health and hydropower are seen as vital sectors contributing towards the development of the nation. According to CBS data of 2073-74, contribution of the construction sector towards the GDP increased by 12.43 percent. This indicates government has been making efforts to provide increased access to education, transportation, communication, health services, electricity and other infrastructure services. This creates opportunities for other sectors as well to help significantly contribute towards the socio-economic development of the nation. The other pillar of the country's economy is the manufacturing sector that is also on the upward trend and is a growing segment of the economic activity. The National Census of Manufacturing Establishment in 2068-69 released by the CBS shows that industrial/establishments have increased to 204,360 from 177,550 in 2063-64. The preliminary data of CBS indicates an annual growth of 8.04 percent in the manufacturing sector in 2074-75.

Nepal is rich in natural resources besides agriculture, forest and water, Nepal also has an abundance of and barely developed resources like iron ore, magnesite, copper, cobalt, pyrite, limestone, and mica which represents the wealth of the country. The sustainable growth of a nation is only possible by the proper use of the available resources found in the country. Due to the availability of such resources there is a chance for manufacturing industry like cement industry that will flourish in Nepal.

The use of cement in Nepal can be traced back to as early as 2007 B.S. In the earlier days, Nepal relied on India for the supply of cement as there were no cement manufacturing industry in the country. Nepal's first state owned cement manufacturing plant, Himal Cement Company Limited was established in 2032 B.S. During the 2035-40 B.S, the government gave priority to industries such as lumber, plywood, paper, cement, bricks and tiles, which made use of domestic raw materials and reduced the need for imports. The growing pace of infrastructure development and urbanization led to an increase in the use of cement. According to the report of the Ministry of Urban Development, in 2068 the country's total population was 26.5 million and only 17.1 percent of the total population lived in 58 municipalities, however according to the report in 2073 more than one-third of the country's population now live in a total of 217 municipalities. The increased

demand for cement within the country shot up leading to the establishment of many small to large scale cement manufacturing facility in the country.

The government aims to accelerate growth and aims to graduate to middle-income-country status by 2030 A.D. This aim requires large investment in infrastructure sequentially with industrial progression. The pace of urbanization is likely to remain the same with the implementation of new local level systems. The infrastructure development projects in the country such as hydropower projects, road network, reconstruction work after post-earthquake and construction of houses and apartments in urban areas have accelerated with increased demand of cement in recent years. Currently, domestic production fulfills 70 percent of the market demand while the remaining 30 percent is fulfilled through imports. With proper utilization of raw material (limestone) available, Nepal can be self-reliant in cement. Cement can be one of the export material if suitable business atmosphere is shaped. The government has prioritized the cement manufacturing industry because of its potential in the economic growth of nation. It is therefore essential to analyze the present situation of the gap between supply and demand and trends of cement industries.

1.2 History of Cement

The cement we use today comes with varied qualities and characteristics. The advancement in technology development has changed the whole dimension of cement manufacturing process and have produced cement of higher quality. In order to achieve this stage, analysis and study of cement manufacturing process and their use in the past history played huge role to make cement such a vital material in construction process and development of human civilization.

1.2.1 Evolution of cement

Natural cement is assumed to have existed on earth as a result of the earth having undergone intense geological change for at least 12 million years. In olden days natural cement was used for construction and over time and with the evolution and advancement of technology, man discovered how to make cement using various materials.

The use of cementing material in ancient world can be traced back to the Egyptians, Greek and Roman era, in each of these era, cementing material have played key role and were used widely. The Egyptians used calcined gypsum as cement whereas the Greeks and Romans made lime by heating limestone and then added sand to make mortar and for making concrete used coarser stones. The Romans have played a major role in initiating and contributing to the development of the cement technology. They used cement in the construction of harbors that hardened under water, it was made by adding crushed volcanic ash to lime which was called "pozzolanic" cement, named after the village of Pozzuoli near Vesuvius. Therefore, credit goes to the Romans for being the first to systematically use the properties of cementitious materials for particular applications and circumstances. Marcus Vitruvius Pollio, a Roman architect and engineer in the 1st century BC wrote his "Ten books of Architecture" - a revealing historical insight into ancient technology. Writing about Pozzolana, "There is also a kind of powder from which nature produces astonishing results. This substance, when mixed with lime and rubble, not only lends strength to buildings of other kinds, but even when piers are constructed of it in the sea, they set hard under water." The cement used for construction in Europe was of lower grade that took a long time to

harden all due to the loss of the improved formulation of the higher quality cement after the downfall of the Roman era until around 1300AD pozzolana cement was rediscovered.

During the industrial revolution in the eighteenth century in order to minimize loss of ships at sea, construction of lighthouses were increased, this drove cement technology forwards with increased demand for cement to build lighthouses that had a mix of lime, clay and crushed slag from iron-making produced a mortar which hardened under water. Joseph Aspdin in 1824 produce "Portland Cement," as a material by firing finely-ground clay and limestone until the limestone was calcined. This cement was not produced at a high-enough temperature to be the real forerunner of modern Portland cement but, it was surely a major innovation and subsequent progression in the development of cement.

Isaac Johnson in 1845, made the first modern Portland cement by firing a mixture of chalk and clay at much higher temperatures, similar to those used today. From late 19th century, the three major developments to manufacture modern Portland cement were; development of rotary kilns, addition of gypsum to control setting and use of ball mills to grind clinker and raw materials.

Branding of Cement

Cement has unique characteristics of strength and binding materials, the cementing material got upper hand over the other building material because of these characteristics. The Romans utilized cement in the majority of their construction by adding some attributes in cementing material. They signify cement as building material which can be used for specific use and/or conditions/situation. The great medieval cathedrals in England and France were built after thousands of years after the Roman downfall but the use of the properties of cementitious materials in the way developed by the Romans cannot be found in these cathedrals. However, at the end of 18th century most of the lighthouse construction in Britain were made from a mix of lime, clay and crushed slag from iron-making mortar that hardened under water. From the Great Pyramids at Giza to the light houses at different parts of England, cement has evolved through the years at different development phases. The industrial revolution of 18th century changed the whole purpose and course of cement utility. After Joseph Aspdin invented Portland cement in 1824 AD, in the 19th century concrete was used mainly for industrial buildings. Between 1850 and 1880, the Portland cement was widely used for real estate construction in Britain and France. In the colonization period, Britain and France the modern cement was branded and promoted the world over. The superior features of cement namely the setting time, durability and strength in no time made cement as a specialized and inevitable binding material in the construction industry. Today, cement comes in second as the world's most-consumed resource which undoubtedly portrays the wide use and importance of cement.

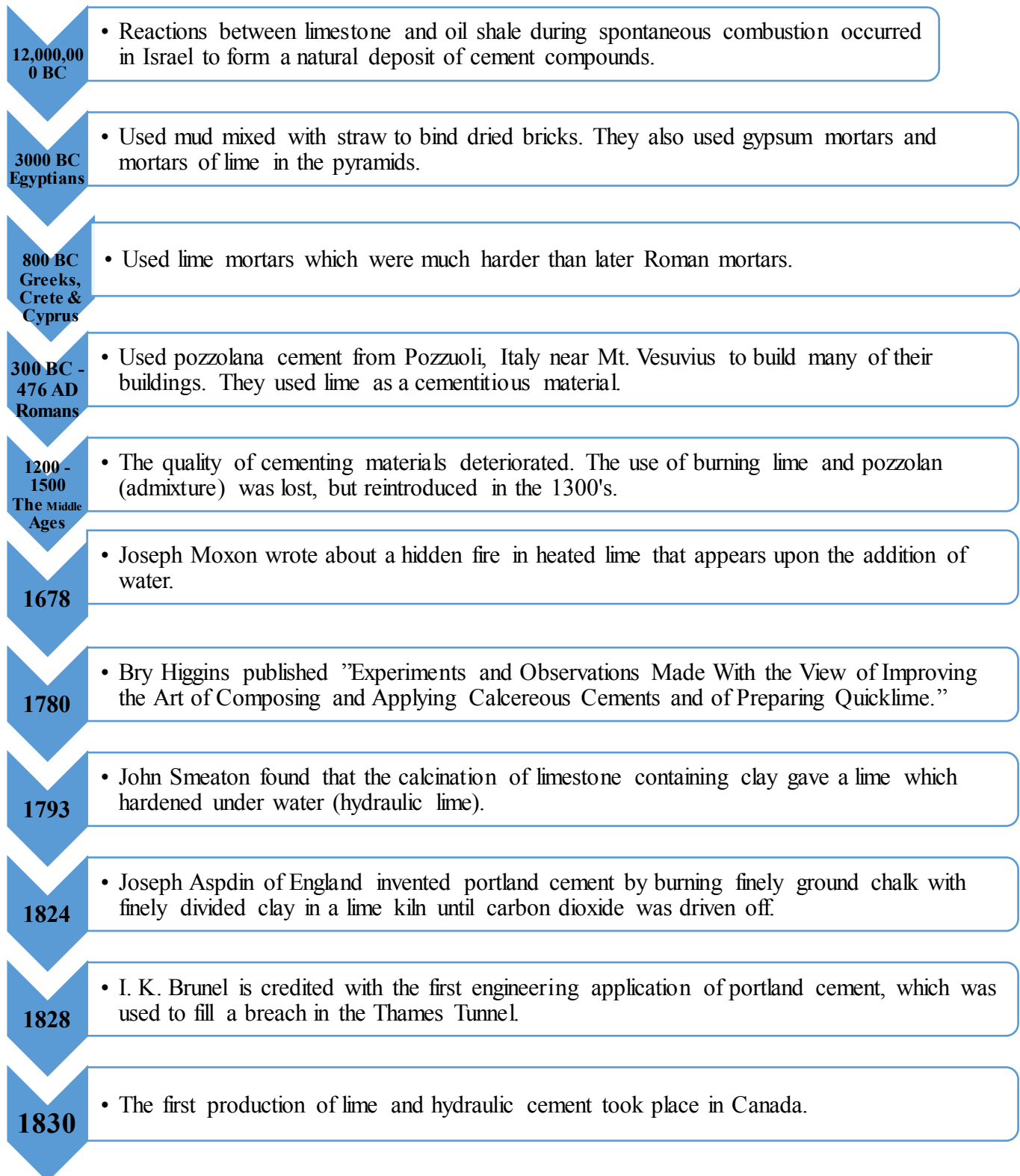
1.3 Civilization and Use of Cement

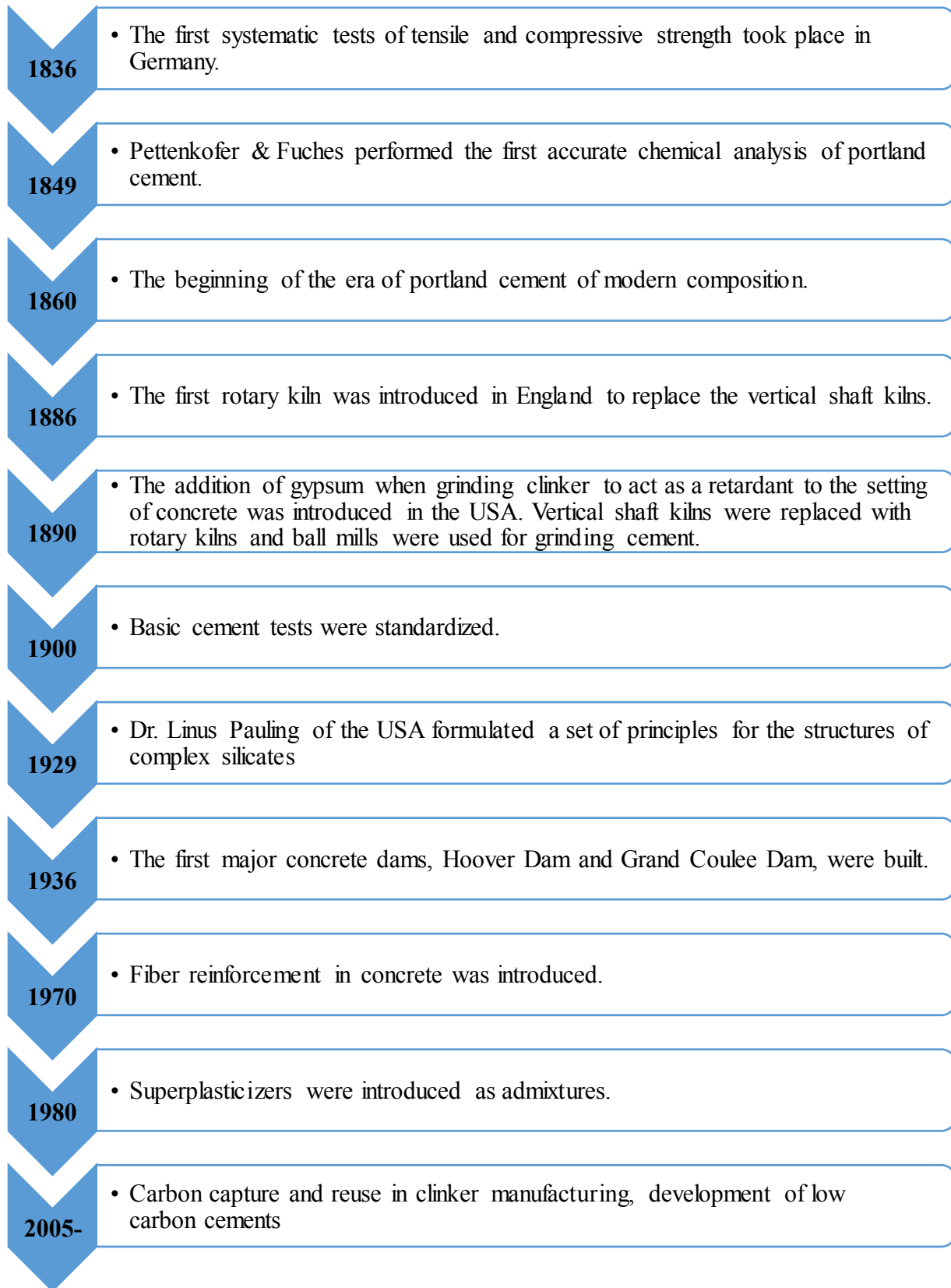
From ancient to modern civilization, cement has greatly contributed to mark every civilization to date. Civilization and the infrastructure development that exists today across the world would have been unthinkable without cement. Although, ancient Egyptian cement was very different from the cement in use today, the Egyptian Pyramids have proudly stood the test of time over centuries. The Egyptians used natural cement made by combining limestone and gypsum for construction. Ancient Greece used lime as cementing material to cover sun-dried brick walls and

most of the Mediterranean region used lime widely as binding material. Romans broadened the use of cement, almost all of the building construction in Roman civilization used an advanced form of cement than the Egyptians. They made remarkable buildings that many of their buildings, bridges and roads still exist today from the cementing material combination of slaked lime with Pozzolana, a volcanic ash from Mount Vesuvius.

The industrial revolution and colonization in the 18th and 19th century changed the whole dynamics of building and construction processes. In late 18th century many of the lighthouses in England were built with cement after John Smeaton discovered a more advanced technique for manufacturing hydraulic lime for cement in 1793. The use of cement increased more after Joseph Aspdin invented Portland cement in 1824. Thereafter, there was no looking back and with continuous innovation and improvement, more refined and advance quality cement is produced according to the need and situation of each construction. Cement is the prime substance that has given importance and an essential element as part of building material.

Timeline of development of cement





1.4 History of Cement Industry and Use in Nepal

The development of nation depends upon the various sectors which bolsters the overall economic growth. The contribution of sectors such as agriculture, service and manufacturing industry plays crucial role in accelerating economic prosperity. The development of manufacturing industry therefore is important for the nation to achieve prosperity, increase national income growth, create employment, stimulate trade and lessen poverty. The manufacturing industry sector in Nepal was only distinguished fittingly after the 1950's political revolution. The few government-owned industries were initiated at that time with aid from the Soviet Union and China. The development of manufacturing industry can be closely tied-up with change in different political scenarios within the nation. The government policies, initiatives and regulatory measures over time has shifted the course of industrial expansion.

With regard to the development of the cement manufacturing industry, one of the most flourishing manufacturing industry in the present time, observations following different timeframe were:

- **Pre-democracy Era**

The social structure and ways of living have changed over time in Nepal. The building culture reflects the socio-cultural and religious demands. The locally accessible building materials and the site geology primarily impact the development of building technology and methods. The two basic materials for construction are mud and wood that are used in traditional architecture of Nepal. Mud used as mortar, bricks, tiles and wood as rafters, struts, posts and joists. The traditional buildings were mostly built by using fired clay bricks, wood, stone and mud as mortar as per their availability.

Construction technologies embraced during the Rana period, saw the practice of different materials other than the traditional ones, in particular the widespread usage of lime plasters, which were and still are used to produce architectural essentials usually found in neoclassical designs. During the Rana reign most of buildings constructed used Bajra plaster (one part each of lime, sand, and surkhi: brick powder). Among them Singha Durbar and Bagh Durbar are the most notable structures that has stood the test of time.

- **Perceive Period (1950-1971)**

After the end of 104 years of the Rana regime, the government then formed, took initiation for the development of the industrial sector as it was identified as an essential factor for the country's socio-economic development. The first five-year plan of 1956 set a milestone in the process of industrialization in Nepal. The few public enterprises were opened at early 1950s with assistance from different foreign countries. With the challenges of inadequate modern infrastructure and knowledge, uprising of industries at desired rate was stalled, hence, the government plans covering the period 1950-1970 mostly concentrated on infrastructure development. The political turmoil in 1961 affected the development process for a few years. In the very same year industrial enterprise act 1961 was formulated on the basis of the first five year plan and the second plan (1962/63-1964-65) emphasis on industrial development with use of internal resources was prepared. Despite change in the political system, the industrial development shed some light with progress in the production along with infrastructural development.

With the upscale of infrastructure work, the demand for cement within the country started to swell. The government formed a feasibility committee for the probable cement manufacturing industry within the country with the realization of the importance of the cement industry. The committee recommended to establish the Himal Cement Industry within the Kathmandu valley. The three plans formulated covering the period 1956 to 1970, engagement of the private as well as the public sector to take part in the industrialization process was encouraged. These plans created the platform for industrialization process in Nepal. Even though importance of the cement manufacturing industry was realized and recommend to establish, no initiation was taken for the establishment of cement manufacturing industry in the country in this period.

- **Commencement Period (1972-1984)**

The government took bold move in early 1970s with the objective of establishing several manufacturing industries to attract private investors. The government prioritized and took initiatives to establish paper, cement, textile and fertilizer industry. In spirit of stated objective, the country got its first cement manufacturing industry in 1972, Himal Cement Industry Ltd. with the capacity of 120,000 MT. annual production in partnership with West Germany and Nepal Industrial Development Corporation established in Chobar, Kathmandu. This set a new trend in the journey of the cement manufacturing industry.

The industrial policy formulated in 1974-75 steered the fifth five year plan (1975-76 to 1979-80) to give a new dimension in the industrialization process. In 1976, Hetuada Cement Industry Ltd. in Makwanpur district was established as a major public enterprise. The government in collaboration with Japan international co-operation Agency (JICA) conducted a feasibility study in 1978 and recommended for the establishment of a cement industry in the Udayapur district of Nepal. Abundant availability of limestone, a major raw-material of cement was found in various parts of Nepal in this period.

The new industrial policy 1981, an amendment of the industrial policy 1974, exaggerated industrialization during the 1980s, industries working on lumber, plywood, paper, cement, bricks and tiles, used domestic raw materials and reduced the need for importation. Therefore, the government allocated budget to establish large scale cement and limestone industries in various regions of the country. For this purpose, budget was allocated to start limestone industry at Lamosanghu in Dolakha district and cement industries in Udayapur district and Parewadin in Dhankuta district.

Table 1-1: Establishment of Cement Industries in the period 1972 to 1984

S.No.	Name of Industries	Established Year	Address
1	Himal Cement Industry Ltd.	1972	Kathmandu
2	Hetuada Cement Industry Ltd.	1976	Makwanpur

- **Traction Period (1985-2003)**

Since the mid-1980s the government also significantly reviewed the industrial licensing regime and foreign investment procedures. The government took various policy measures to strengthen the manufacturing progression. In 1987, Udayapur Cement Industry Ltd. was established at Jaljale in Udayapur district.

Privatization Policy

The nation witnessed a major political revolution in 1990 establishing a democratic system in Nepal. The policies of the government was prepared to balance religion and development, the reformation of socio-economic development and accelerating pace of national development was the major agenda for the government. The government formulated the Industrial Policy 1992 to increase efficiency of industries. With the enactment of Industrial Enterprises Act 1992 along with the Foreign Investment and Technology Transfer Act of 1992 (FITTA), amended in January 1996, manufacturing investment with 100% foreign ownership was permitted in industries. The private sectors were attracted in the manufacturing industry due to the soft government policy.

Butwal Cement Mills Pvt. Ltd., National Cement Pvt. Ltd and other 2 industries were granted permission for the establishment during eighth five-year plan (1992-93 to 1996-97). Although, the Maoist insurgency in 1996 slowed down industrialization process the ninth five-year plan (1997-98 to 2001-2002) motivated the private sector to invest in hydropower development and manufacturing industries.

After the establishment of the Butwal Cement Mills Pvt. Ltd. and National Cement Pvt. Ltd many private entrepreneurs applied for establishing cement industries in the country during this period.

Table 1-2: Permission Granted Cement Industries in the period 1985 to 2003

S.No.	Name Of Industry	Address	Permission Year
1	Butwal Cement	Nawalparasi	5/29/1996
2	Lumbini Cement Pvt.Ltd	Rupandehi	7/1/1996
3	National Cement Pvt.Ltd	Morang	9/25/1996
4	Surya Cement Pvt.Ltd	Sunsari	9/25/1996
5	Balaji Cement Udyog	Dhading	6/4/1997
6	Kanak Cement Pvt. Ltd.	Makwanpur	4/18/1999
7	Mittal Cement Industry. Pvt. Ltd.	Jhapa	5/21/1999
8	Cosmos Cement Industries Pvt. Ltd.	Danusha	1/28/2000
9	Buddha Cement Pvt. Ltd.	Kapilbastu	5/9/2000

10	Pashupati Cement Pvt. Ltd.	Kapilbastu	6/26/2000
11	Laxmi Cement Ind. Pvt. Ltd.	Banke	11/28/2000
12	Vijaya Cement Pvt. Ltd.	Kapilbastu	1/16/2001
13	Chitwan Cement Udhog Pvt. Ltd.	Nawalparasi	5/4/2001
14	Jagadamba Cement Ind. Pvt. Ltd.	Rupandehi	5/11/2001
15	Narayani Cement Udhog Pvt. Ltd.	Bara	6/19/2001
16	Manakamana Cement Pvt. Ltd.	Siraha	7/10/2001
17	Buddha Cement Industries	Rupandehi	10/16/2001
18	Krishna Cement Co. Pvt. Ltd.	Bara	2/13/2002
19	Brija Cement Ind. Pvt. Ltd.	Rupandehi	2/18/2002
20	Bishwokarma Cement Pvt. Ltd.	Bara	4/3/2002
21	Suprim Cement Pvt. Ltd.	Rupandehi	4/7/2003

Source: (DOI, 2018)

Table 1-3: Establishment of Cement Industries in the period 1984 to 2003

S.No.	Name of Industries	Address
1	Udayapur Cement Industry Ltd.	Udayapur
2	Butawal Cement Mills Pvt. Ltd.	Nawalparasi
3	National Cement Pvt. Ltd	Morang

- **Transition Period (2004-2010)**

The socio-economic development pace of the nation took off to the next level after a major political change. The socio-economic development was the major agenda for the government and political parties, the policy of the government was therefore formulated accordingly. Nepal ascended to the World Trade Organization (WTO) in 2004, this integrated Nepal on to the global economy in a significant way. WTO provides opportunities for governments to negotiate trade agreements and to settle trade arguments. The open economic policy attracted many private and foreign investors.

The Department of Mines and Geology (DMG) had already laid foundation by exploring the limestone mines at various parts of the country and also started providing licenses for these mines resources. The proper business environment and development work going up, there were good signs and conditions for the cement industry to bloom in the country. These factors attracted many investors in the cement manufacturing industry during this period.

Table 1-4: Permission Granted Cement Industries in the period 2004 to 2010

S.No.	Name Of Industry	Address	Permission Year
1	Gorakhkali Cement Udyog Pvt.Ltd.	Jhapa	1/13/2004

2	Siddhartha Cement Udyog	Rupandehi	2/13/2004
3	Nepal Ambuja Cement Udyog	Rupandehi	3/15/2004
4	Reliance Cement Pvt.Ltd	Rupandehi	4/22/2004
5	Ambe Cement Pvt.Ltd	Parsa	7/30/2004
6	Shivam Cement Pvt.Ltd	Makawanpur	8/25/2004
7	Shree Cement Industry Pvt. Ltd.	Parsa	12/20/2004
8	Kailash Cement Pvt. Ltd.	Rupandehi	1/21/2005
9	Dang Cement Industries Pvt. Ltd	Salyan	3/28/2005
10	Shree Krishna Cements Pvt. Ltd.	Jhapa	4/5/2005
11	Om Cement Pvt. Ltd.	Chitwan	8/14/2005
12	Koshi Cement Udhog Pvt. Ltd.	Sunsari	8/30/2005
13	Maruti Cements Ltd.	Siraha	12/25/2005
14	Kepy Cement Industries Pvt. Ltd.	Dhading	2/1/2006
15	Jay Bageshwori Cement Industry	Banke	12/4/2006
16	Jayakali Cement Udyog Pvt.Ltd	Rupandehi	5/24/2007
17	Sagarmatha Cements Pvt.Ltd	Makwanpur	5/31/2007
18	Shuva Shree Jagadamba Cement Mills	Parsa	10/11/2007
19	United Cements Pvt.Ltd	Dhading	11/20/2007
20	Nigale Cements Pvt.Ltd	Dankuta	2/12/2008
21	Sourya Cements Limited	Udaypur	2/27/2008
22	Lotse Cement Pvt.Tld	Udaypur	6/4/2008
23	Sangrila Cement	Kailali	8/19/2008
24	Ghorahi Cement Industries	Dang	8/21/2008
25	Rolpa Cement	Rolpa	9/29/2008
26	Sonapur Cements Pvt.Ltd	Dang	1/19/2009
27	Delta Cement Pvt.Ltd	Nawalparasi	3/31/2009
28	Laxmi Cement Pvt.Ltd Shakhaudyog 1	Lalitpur	6/30/2009
29	Maiher Cement Pvt.Ltd	Rupandehi	9/23/2009
30	Manasha Cement Industries Pvt.Ltd	Jhapa	11/4/2009
31	Unitake Cement Pvt.Ltd	Bara	11/19/2009
32	Rmc Cement Pvt.Ltd	Bara	2/17/2010
33	Morang Cement Industries Pvt.Ltd	Morang	3/19/2010

34	Bishal Cement Industry Pvt.Ltd	Rupandehi	7/4/2010
35	Ganesh Cement Udyog	Rupandehi	7/4/2010

Source: (DOI, 2018)

- **Growth Period (2011-2019)**

The 18 year old Industrial Policy 1992 was replaced by a new Industrial Policy in 2010. The newly introduced policy focused on economic growth of the national economy backed up by ensuring balanced industrial growth, backward linkages, protection and state-support to the industries. The new Policy 2010 concentrated on accelerating manufacturing growth guided by timely rules, regulations and laws. The many new provisions helped to create friendly relations between the government and private sector.

The demand for cement skyrocketed in the period after 2010 with increased infrastructure works and mega projects. The private investor saw good opportunities in the cement industry and with the new policy many investors were attracted in the cement manufacturing industry. As a result of it 58 industries have already been granted permission to operate the industry and most of them are already on operation. In the present scenario, the country's overall cement demand is almost covered by manufacturing industry within the country and on the verge of self-reliance. The industries can be a pillar to the nation's economic development and prosperity with being self-reliant along with the export of cement in the next few years.

Table 1-5: Permission Granted Cement Industries in the period 2011 to 2018

S.No.	Name Of Industry	Address	Permission Year
1	Ganapati Cement Ind. Pvt. Ltd	Kapilbastu	1/4/2011
2	Baba Cement Pvt. Ltd	Parsa	1/10/2011
3	International Cement Pvt. Ltd	Parsa	2/24/2011
4	Routa Udayapur Cement Udyog Pvt. Ltd	Udaypur	4/7/2011
5	Eastern Cosmos Cement Pvt. Ltd	Morang	5/10/2011
6	Chatan Cement Industry Pvt. Ltd	Bara	5/13/2011
7	C.G. Cement Industry Pvt. Ltd	Nawalparasi	5/19/2011
8	Kanchanjanga Cement Udyog Pvt. Ltd	Jhapa	8/4/2011
9	C.G.Cement Industry Palpa Pvt. Ltd	Palpa	8/15/2011
10	Kapilbastu Cement Udyog Pvt. Ltd	Kapilbastu	10/13/2011
11	Sarbottam Cement Pvt. Ltd	Rupandehi	12/14/2011
12	Palpa Cement Industries Pvt. Ltd	Nawalparasi	12/15/2011
13	Maruti Cements Ltd Unit 1	Siraha	8/30/2012

14	Shreeram Cement Pvt. Ltd.	Rupandehi	8/30/2012
15	Jaya Bageshwori Cement Pvt. Ltd.	Banke	11/5/2012
16	Muktishree Cement Industries Pvt. Ltd.	Surkhet	3/20/2013
17	Mahashakti Cement Pvt. Ltd.	Kapilbastu	8/27/2013
18	Reliance Supertech Cement Pvt. Ltd.	Bara	3/12/2014
19	Aadharsheela Cement Pvt. Ltd.	Dang	3/28/2014
20	Samrat Cement Company Pvt. Ltd.	Dang	5/6/2014
21	Shuvashree Agni Cement Uddyog Pvt. Ltd.	Arghakhachi	7/15/2014
22	Shubha Shree Jagdamba Cement Mills Branch Unit – 1	Parsa	7/16/2014
23	Mega Cement Industries Pvt. Ltd.	Jhapa	2/23/2015
24	Riddhi Sidhhi Cement Pvt. Ltd.	Makwanpur	3/4/2015
25	Gurans Cement Pvt. Ltd.	Makwanpur	8/4/2015
26	Araniko Anbukhaireni Cement Industries Pvt. Ltd.	Dhading	10/18/2015
27	Shuva Laxmi Cement Udhog Pvt. Ltd.	Kapilbastu	10/18/2015
28	Nepal Ultra Tech Cements Pvt. Ltd.	Morang	11/24/2015
29	Hongshi Shivam Cement Pvt. Ltd.	Nawalparasi	12/14/2015
30	Arghakhachi Cement Pvt. Ltd. Unit -2	Kapilbastu	12/31/2015
31	Sunrise Cement Pvt. Ltd.	Jhapa	2/26/2016
32	Mangala Cement Udhog Pvt. Ltd.	Dhading	8/17/2016
33	Balaji Cement Industries Pvt. Ltd.	Kapilbastu	1/26/2017
34	Shikhar Cement Udhog Pvt. Ltd.	Kapilbastu	3/7/2017
35	Annapurna Cement Company Pvt. Ltd.	Morang	4/12/2017
36	Atal Cement Pvt. Ltd.	Kapilbastu	4/16/2017
37	Bajra Cement Pvt. Ltd.	Chitwan	4/24/2017
38	Bhugarbha Cement Udhog Pvt. Ltd.	Kapilvastu	4/25/2017
39	Morang Cement Industry Pvt. Ltd.	Morang	6/14/2017
40	Adhunik Cement Pvt. Ltd.	Morang	8/17/2017
41	Ghorahi Cement Industries Pvt. Ltd. Branch 1	Dang	8/25/2017
42	Kapilvastu Cement Udyog Pvt. Ltd.	Kapilbastu	9/13/2017
43	Tianyi Cement Industries	Nawalparasi	11/12/2017

44	Nepal Jagadamba Cement Industries Pvt. Ltd	Nawalparasi	11/28/2017
45	Huaxin Cement Narayani Pvt. Ltd.	Dhading	12/15/2017
46	Janaki Cement Industries Pvt. Ltd.	Sunsari	2/2/2018
47	Siddhi Laxmi Cement Pvt. Ltd.	Nawalparasi	2/21/2018
48	Arun Cement Industries Pvt. Ltd.	Dang	2/25/2018
49	I.M.S. Cement Pvt. Ltd.	Kapilbastu	3/12/2018
50	Krishna Raj Cement Industries Pvt. Ltd.	Kapilbastu	4/24/2018
51	Dhanusha Cement Industries Pvt. Ltd.	Dhanusha	6/25/2018
52	A Plus Cement Pvt. Ltd.	Jhapa	8/5/2018
53	Atharva Cement Pvt. Ltd.	Syangja	9/13/2018
54	B.S. Cement Industries Pvt. Ltd.	Palpa	9/18/2018
55	Synergy Cement Pvt. Ltd.	Kapilbastu	11/26/2018
56	Maruti Cements Limited Branch Unit 1	Siraha	12/9/2018
57	Kabeli Cement Industries Pvt. Ltd.	Jhapa	12/17/2018
58	Garud Cement Industries Pvt. Ltd.	Kathmandu	2/3/2019

Source: (DOI, 2018)

CHAPTER II: GLOBAL CEMENT PRODUCTION AND CEMENT MANUFACTURING INDUSTRY IN NEPAL

2.1 Overall Cement Production in the World

The construction industry, infrastructure development and urbanization with fast growing real estate development business are the major sectors that use cement. Countries in gradual transition such as China and Vietnam are aggressively producing cement in transition economies which undergoes the structural changes of the institution shifting from scale of state control to the market-based private sector. The state-owned resources have been transferred to the private sector, collectively run enterprises are remodelled according to the need of the free market for macroeconomic stabilization. Early nineties of the twentieth century was the take off period of the cement production and infrastructure development of the countries in transition, Centre and Middle East Asia. Particularly construction industries contributed a significant role in the GDP of those countries.

With respect to the growing business in the construction industry the demand for cement rose at exponential rate. China produced 2.4 billion tons of cement in 2018 while it used to produce .5 billion tons in 1996. In the two decades of production time of cement rose about five times in China alone and it retains almost 58 percent share of total cement production in the world.

Vietnam gradually opened the door to private sector and allowed them to enter from planned economy to a market economy. This policy allowed free market and establishment of enterprises with investment of private capital. The cement manufacturing industries emerged in the period with the opportunity made available by the government in process of liberalization of national economy. Vietnam had produced 5.7 million tons of cement annually in 1996 during the beginning of the economic liberalization that production reached 15 times from 1996 to about 86 million tons per annum in 2018.

India ranked in second after China in cement production with 290 million tons annual production. Compared to Vietnam and China, India's growth is slower however it rose from 80 million tons in 1996 to 290 million tons in 2018. The growth recorded for couple of decades was three times from 1996 production. ``

While reviewing the status of the cement production in United States, it reached over 100 million tons production in 2007, which is considered the highest quantity produced in US from 1996 to 1918 period. The trend of cement production in developed and industrialized countries mainly from Europe and North America is linear and the factories are regulated. In 2010 United States introduced National Emissions Standard for Hazardous Air Pollutants (NESHAP)¹ protocol for cement plants. All cement factory required to upgrade their production process of individual or multi kiln plants according to the guidelines provided by NESHAP. Those unable to upgrade were

¹ US Geological Survey, Mineral Commodities Summaries, 2018

forced to exit from the industry i.e. some factories merged to comply to protocol, those unable to merge such kind of industries shut down their plants.

Table 2-1: Production Capacity of Some Selected Countries of the world

Countries	Cement Production(MT) ('000)		Growth (%)	Per capita Consumption (kg/person)	
	2017	2018		2017	2018
USA	86600	88500	2.194	266	271
Brazil	53000	52000	-1.887	253	246
China	232000	2370000	2.155	1671	1669
Egypt	53000	55000	3.774	551	553
India	280000	290000	3.571	209	215
Indonesia	65000	67000	3.077	244	252
Iran	54000	53000	-1.852	669	644
Japan	55200	55500	0.543	434	437
Korean ROP	56500	56000	-0.885	1109	1095
Russia	54700	55000	0.548	375	382
Saudi Arabia	47100	45000	-4.459	1430	1343
Turkey	80600	84000	4.218	998	1021
Vietnam	78800	86000	9.137	825	889
Nepal	3215	6800	111.509	110	230
Other Countries	756000	759000	0.397		
Total Global	4050000	4100000	1.234568	540	545

Source: (US Geological Survey, 2018)

Table 2-2: Status of Per capita Consumption of in Nepal for last seven years

FY	Population	Production(MT)	Import (MT)	Total Consumption(MT)	Per Capita Consumption
2068/69	27649925	278515.6	500206.59	778722.19	28
2069/70	27985310	930961	476701.63	1407662.63	50
2070/71	28323241	1201607	388217.30	1589824.30	56
2071/72	28656282	1136027	295267.41	1431294.41	50
2072/73	28982771	1305322	212632.06	1517954.06	52
2073/74	29304998	2336320	106624.46	2442944.46	83
2074/75	29624035	3130525	84513.73	3215038.73	109

Source: (CBS, 2018; NRB, 2018)

2.2 Growth of Cement Production

Table 2-3: Growth of Cement Production

Year	China		India		Nepal		Global	
	Production(MT) (‘000)	Change	Production (MT)	Change	Production (MT)	Change	Production (MT)	Change
1996	490000		80000		343		1230000	
1997	493000	1	80000	0	360	5	1512000	23
1998	514000	4	85000	6	330	-8	1506000	0
1999	573000	11	90000	6	290	-12	1593000	6
2000	583000	2	95000	6	300	3	1643000	3
2001	661000	13	100000	5	285	-5	1720000	5
2002	705000	7	100000	0	290	2	1784000	4
2003	862000	22	100000	0	295	2	1969000	10
3004	970000	13	125000	25	300	2	2156000	9
2005	1070000	10	130000	4	290	-3	2309000	7
2006	1240000	16	155000	19	295	2	2524000	9
2007	1350000	9	170000	10	300	2	2791000	11
2008	1390000	3	180000	6	295	-2	2831000	1
2009	1630000	17	180000	0	295	0	2998000	6
2010	1880000	15	180000	0	295	0	3363000	12
2011	2100000	12	220000	22	930	215	3644000	8
2012	2210000	5	270000	23	1202	29	3849000	6
2013	2420000	10	270000	0	1136	-5	4080000	6
2014	2470000	2	270000	0	1305	15	4180000	2
2015	2350000	-5	275000	2	2336	79	4100000	-2
2016	2350000	0	275000	0	3130	34	4100000	0
2017	2320000	-1	280000	2	6900	120	4050000	-1
2018	2370000	2	290000	4	10000	45	4100000	1

Source: (American Geological Survey, 2018)

The establishment of the cement industries in Nepal was affected by the insurgency and political instability for the last twenty years between 1996 and 2007. The cement production remained limited for at least twenty years from 290 to 300 metric tons. The total demand for cement was huge which was supplied through importation mainly from India. In the same period growth of

cement was almost in double digits compared to the GDP of China during the same period the demand stood at .96 percentage on the one unit of growth of GDP. India has steady growth in cement production, however the production still under the demand of the requirement of the economy. India exports cement aiming to retain the global market even the demand is remained high domestically. China had the highest per capita consumption 1669 kg in 2018 cement where Nepal's record eight times less than china and slightly higher than India 215 for the same period. Nepal's cement production and consumption magnitude and growth both were recorded high during the last five years 2014 to 2019. It is assumed that Nepal will be self-sufficient in cement production domestically and it is expected that in the near future the cement industry will be pressured to export the production if the installed capacity is fully utilized. Growth rate of cement production and per capita consumption has reached its limit in developed countries. Even in China the data shows that the growth of cement production remained steady in the last five years, production dropped in 2.37 trillion tons in 2017 from 2.47 trillion tons in 2014. Total installed capacity of cement factory in India is accounted at 465 million metric tons, about 70 percent of the capacity is utilized (Hindustan Times, India). The growth of cement production in recent years has increased at an average of 4 percent however the Hindustan Times' source and study states that the average demand grows by 7 percent because of reduced construction of mega projects and government's priority on rural development. Out of the total production, 66 percent of its demand is from the housing and real estate sectors with rapid urbanization of Indian towns and cities and followed by 18 consumption in infrastructure sectors particularly in the northern states of the country and the rest 16 percent is consumed by the commercial sectors.

2.3 Analysis of Economic Growth and Demand of Cement

Growth in Gross Domestic Product (GDP) per capita, a measurement of the average national standard of living, can be a contributing factor to cement demand. Increased industrialization caused by economic expansion has a tendency to drive corresponding increases in cement consumption. This relationship is well known and has been widely used in the past to both judge the relative economic growth between nations and forecast likely cement consumption. (Defining the trend: Cement consumption vs GDP; 29 May 2014; Global Cement .com)

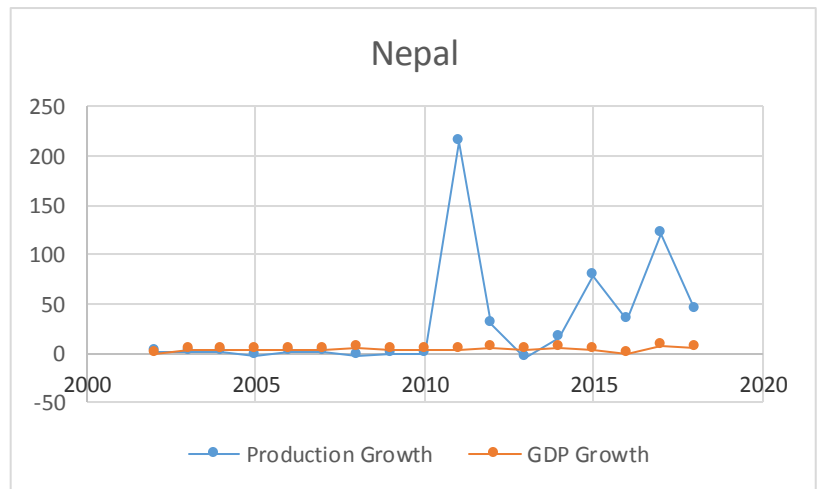


Figure 2-1: Production and GDP Growth of Nepal

Source: (US Geological Survey, 2018)

The demand of cement is based on the GDP growth of the country. It also establishes relationship with the per capita GDP as well. It is considered that the ideal quantity of demand of cement in developed countries where the per capita income is above \$25,000 are around 1000 kg per person.

Nepal's cement production era started from 2010, the medium and large-scale plants were established and quantity of production increased exponentially for a couple of years and replaced the import of the cement since then. This study tried to establish the relationship between GDP growth and the growth of cement in Nepal. The results showed that if the GDP increases by one percent the consumption or demand of the cement will increase by 4.79 percent.

Growth of cement production is directly related to the GDP growth in China. In 2003 economic growth of China was recorded just above 10 percent for the same period the cement production was recorded high 22.26 percent: similarly, with relation to the GDP growth 12 percent, the production of the cement was increased by 15.8 percent in 2006.

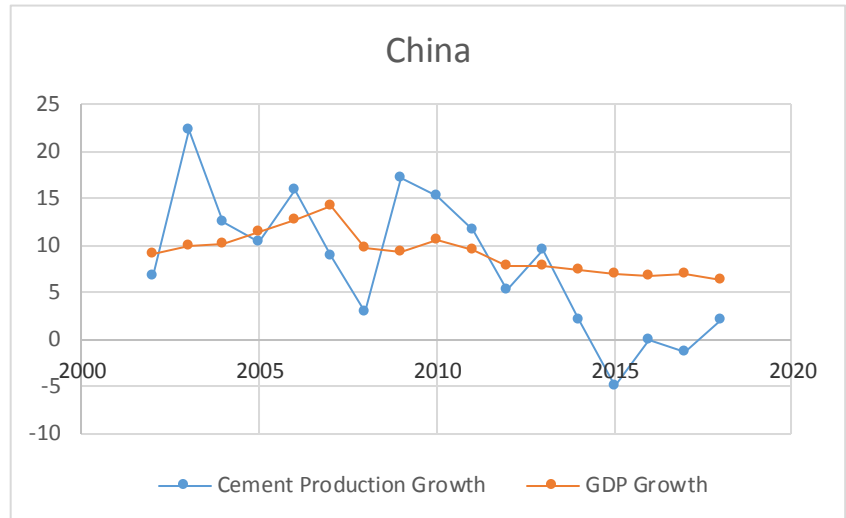
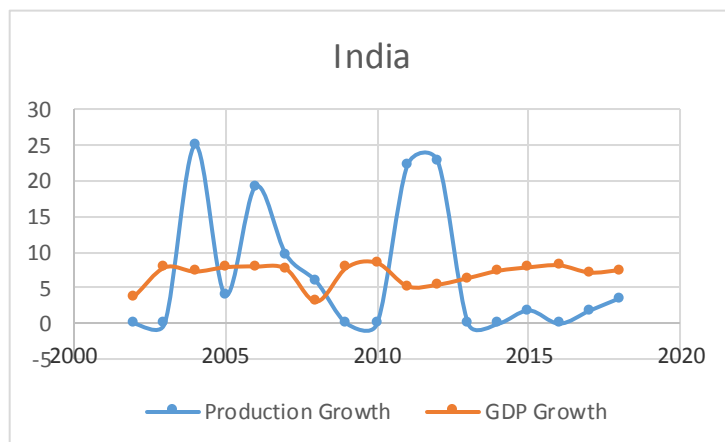


Figure 2-2: Cement Production and GDP Growth of China

Source: (US Geological Survey, 2018)

With growing and heated economy, the consumption level of cement shot up in 2006 and 2010; whereas, the economic growth had slowed down in 2016 and 2017 as it remained at around 6 percent, the corresponding growth of production of cement dropped by 1 percent. China alone retains one third of the production of cement in the world with over two and half billion tons per annum. The graph above shows the economy and production of cement moving alongside each other. The statistical co-relationship shows that if one percent of the economic growth takes place the production of cement will be increased by over 2 percent in China.

Figure 2-3: Production and GDP Growth of India

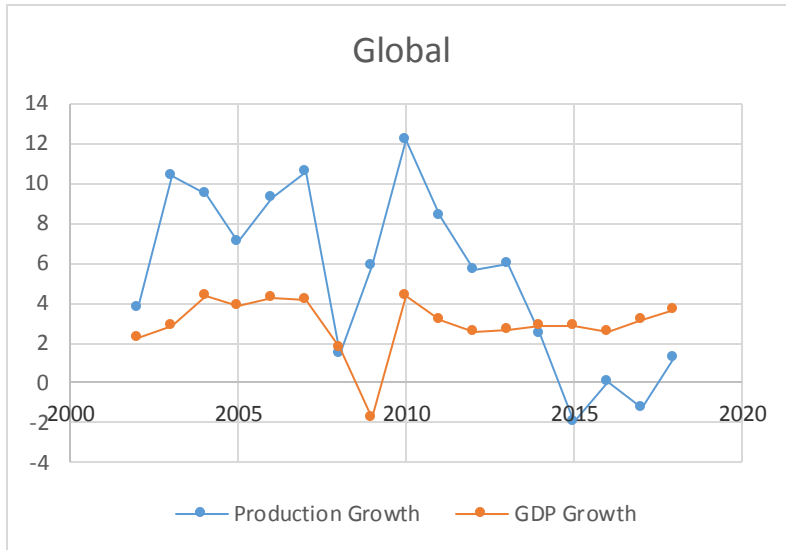


Cement production in India is also in increasing trend however the relation with the economic growth is volatile. Statistically it is not validated the relationship of the GDP and cement production of India. However, the cement production is increasing with respect to the increased GDP over the years.

Source: (US Geological Survey, 2018)

During the first decade of the millennium many companies established plants with large scale milling capacity. Total installed capacity reached at above 450 million tons in India, the plants were mainly based in the middle of the Indian territories. GDP growth was recorded above 7 percent in last five years, during the same period the average cement production was increased by 4 percent.

Figure 2-4: Production and GDP Growth of Global



Cement demand in third world and courtiers in economic transformation is increasing rapidly in the world. Infrastructure development in Middle East, East Asian Countries and China Peninsula and Indian subcontinent are growing rapidly, similarly north and South African countries investing huge amounts of resources in infrastructure development and urbanization. Demand of cement in those areas is tremendous, global GDP is

Source: (US Geological Survey, 2018)

(World Bank) for last three years. Demand of cement also increased by over one percent last year and is expected to maintain the same pace for the year 2019. Comparing the growth of cement with global GDP, there is positive relation in between. If one percent global GDP increases .96 percent of demand of cement will be increased.

also steadily increasing at 3 percent

2.4 Cement Manufacturing Industry in Nepal

2.4.1 Registration Process

Company registration in Nepal compacts with several lawful entities that make the objective of earning probable through business. According to the law of Nepal, the establishment in Nepal can be a private company, public company, sole proprietor company, and non-profit making company. All these companies should meet the standards of company registration necessities in Nepal.

The process of company registration in Nepal demands various documents to be presented to the respective offices. There are specific processes for company registration in Nepal that an applicant should follow in order to register a company and that varies according to the type of organization. The manufacturing industry like cement industry should first take permission to open an industry in a specific location from the Department of Industry. The industry should then conduct Environmental Impact Assessment (EIA) or Initial Environment Examination (IEE) based on the scalability (production capacity). Based on EIA and IEA report, the industry is granted permission to establish a production plant. The industry must submit a Memorandum of Association, copy of citizenship of the applicants, article of association should be presented to the Office of Company

Registrar as per requirement. The company is approved for registration only if considered viable under the Companies Act 2006 (2063B.S.).

2.4.2 Cement Factory Registration and Control Authority

- **Department of Industry (DOI)**

The Department of Industry is one of the major agencies at the Ministry of Industry which is responsible for the implementation of policy, act, rules and regulations related to the industrial development, through which the Government of Nepal plans to strengthen Nepalese economy. The department, as per the revised Industry Enterprise Act (IEA), 2016, administers and facilitates the Middle and large-scale industries which have fixed assets of more than 100 million Nepalese rupees. Furthermore, its scope of function also includes foreign investment and technology transfer in the industry as well as protection of industrial property

The cement industry at first must get their industry registered in DoI and should acquire permission to conduct basic feasibility study before establishment of an industry also DoI provides license to the industry to operate. The medium and large-scale cement industry must register industry which has fixed assets of more than 100 million Nepalese rupees in DoI prior to the operation. DoI provides permission for foreign investment, technological transfer and foreign loan also register foreign investment based industries. The department also has authority to overview Initial Environment Examination (IEE) report of the industry and approve it. The department also have monitoring role as and when required, to check the quality of plant and environmental compliance of the industry.

- **Office of Company Registrar**

The Office of Company Registrar (OCR) is the statutory authority for registering new companies in the Nepal. The Office also registers business names. A business name is a trading name which differs from the names of the persons or the company who own the business. OCR is the enforcement of the Companies Act in relation to the filing obligations of companies. The OCR can take a number of measures to deal with companies who fail to file their annual returns, including prosecution of the company or directors, or striking the company off the register. Companies who fail to file annual returns may be struck off the register of companies.

- **Nepal Bureau of Standards and Metrology**

Nepal Bureau of Standards and Metrology (NBSM) is the National Standard (NS) authority under the Government of Nepal, the Ministry of Industry. NBSM looks after the activities concerning standardization and quality control for qualitative improvement in the industrial production and to enhance productivity. Currently 369 domestic goods produced by 250 firms across the country have so far acquired NS certification from NBSM till ongoing fiscal year. The 65 cement factories operating within the nation are granted with licenses to use NS mark on their products. But, NBSM time and again routinely monitor and reassures the quality of the product to meet the standardization. The NS Certification scheme based on Type 5 model as per ISO/IEC 17067 for different product are set by the NBSM are as of follows:

- OPC: NS 49: 1984
- PPC: NS 385:1997
- PSC : NS 384:1997

2.4.3 Total Number of Cement Industry Registered in DOI

There are 124 industries currently operating in Nepal (114 listed in DOI 10 not found in record) Annex 1.

The DOI started the registration process from 2053 B.S. and also oversee the FDI in cement industries.

Table 2-4: Number of Industries Registered in DOI

Year Period (B.S.)	No. of industries registered
2041-2060	21
2061-2067	35
2068-2075	58

Source: (DOI, 2018)

2.4.4 Total Number of Cement Industry Registered in Nepal Bureau of Standards and Metrology

The National Standard (NS) is the standardization and quality control for qualitative improvement in the industrial production and to enhance productivity provided by the Nepal Bureau of Standards and Metrology (NBSM), authority under the Government of Nepal, Ministry of Industry. Each and every industry must get NS before the sale of their product into the market.

It is mandatory for every cement industry to get the NS for the product of their and only 65 industries out of 124 have given NS.

Table 2-5: Industries Registered in NBSM till 2019 May

S. No.	Name Of Industry	District	Install Capacity (TPD)	NS Product
1	Butwal Cement	Nawalparasi	700	OPC,PPC,PSC
2	National Cement Pvt.Ltd	Morang	200	PPC
3	Mittal Cement Industry. Pvt. Ltd.	Jhapa	100	OPC,PPC
4	Cosmos Cement Industries Pvt. Ltd.	Danusha	700	OPC,PPC
5	Pashupati Cement Pvt. Ltd.	Kapilbastu	440	OPC,PPC
6	Vijaya Cement Pvt. Ltd.	Kapilbastu	300	OPC,PPC
7	Chitwan Cement Udhyog Pvt. Ltd.	Nawalparasi	100	PPC

8	Jagadamba Cement Ind. Pvt. Ltd.	Rupandehi	900	OPC,PPC
9	Narayani Cement Udhog Pvt. Ltd.	Bara	1200	OPC,PPC
10	Krishna Cement Co. Pvt. Ltd.	Bara	170	PSC
11	Brija Cement Ind. Pvt. Ltd.	Rupandehi	200	OPC,PPC,PSC
12	Bishwokarma Cement Pvt. Ltd.	Bara	440	OPC,PPC
13	Suprim Cement Pvt. Ltd.	Rupandehi	1000	OPC,PPC
14	Gorakhkali Cement Udyog Pvt.Ltd.	Jhapa	250	OPC,PPC
15	Siddhartha Cement Udyog	Rupandehi	1150	OPC,PPC
16	Nepal Ambuja Cement Udyog	Rupandehi	200	OPC,PPC
17	Reliance Cement Pvt.Ltd	Rupandehi	500	OPC,PPC
18	Ambe Cement Pvt.Ltd	Parsa	300	OPC,PPC,PSC
19	Shivam Cement Pvt.Ltd	Makawanpur	3000	OPC
20	Shree Cement Industry Pvt. Ltd.	Parsa	200	OPC,PPC
21	Om Cement Pvt. Ltd.	Chitwan	135	OPC,PPC
22	Maruti Cements Ltd.	Siraha	1600	OPC
23	Kp Cement Industries Pvt. Ltd.	Dhading	125	OPC,PPC
24	Shuva Shree Jagadamba Cement Mills	Parsa	1600	OPC,PPC,PSC
25	United Cements Pvt.Ltd	Dhading	1200	OPC
26	Nigale Cements Pvt.Ltd	Dankuta	500	OPC,PPC
27	Ghorahi Cement Industries	Dang	2400	OPC,PPC
28	Rolpa Cement	Rolpa	500	OPC,PPC
29	Sonapur Cements Pvt.Ltd	Dang	1200	OPC,PPC
30	Manasha Cement Industries Pvt.Ltd	Jhapa	100	OPC,PPC
31	Rmc Cement Pvt.Ltd	Bara	500	OPC,PPC,PSC
32	Bishal Cement Industry Pvt.Ltd	Rupandehi	100	OPC,PPC
33	Ganapati Cement Ind Pvt.Ltd	Kapilbastu	100	PPC
34	International Cement Pvt.Ltd	Parsa	100	OPC,PPC
35	Routa Udayapur Cement Udyog Pvt.Ltd	Udaypur	800	OPC
36	Eastern Cosmos Cement Pvt.Ltd	Morang	300	PPC
37	C.G.Cement Industry Pvt.Ltd	Nawalparasi	250	OPC,PPC
38	Kanchanjanga Cement Udyog Pvt.Ltd	Jhapa	75	OPC,PPC

39	Sarbottom Cement Pvt.Ltd	Rupandehi	1200	OPC,PSC
40	Jaya Bageshwori Cement Pvt. Ltd.	Banke	800	PPC
41	Mahashakti Cement Pvt. Ltd.	Kapilbastu	100	OPC,PPC
42	Reliance Supertech Cement Pvt. Ltd.	Bara	500	OPC,PSC
43	Samrat Cement Company Pvt. Ltd.	Dang	1300	OPC,PPC
44	Mega Cement Industries Pvt. Ltd.	Jhapa	300	OPC,PPC
45	Araniko Anbukhaireni Cement Industries Pvt. Ltd.	Dhading	800	OPC
46	Arghakhachi Cement Pvt. Ltd. Unit -2	Kapilbastu	2375	OPC,PPC,PSC
47	Annapurna Cement Company Pvt. Ltd.	Morang	300	OPC,PPC
48	Bhugarbha Cement Udhyog Pvt. Ltd.	Kapilvastu	300	OPC,PPC
49	Hongshi Shivam Cement Pvt. Ltd.	Nawalparasi	6000	OPC,PPC
50	Sunrise Cement Pvt. Ltd.	Jhapa	500	OPC,PPC
51	Mangala Cement Udhyog Pvt. Ltd.	Dhading	550	OPC,PPC
52	Shuva Laxmi Cement Udhyog Pvt. Ltd.	Kapilbastu	1000	OPC,PPC
53	Nepal Ultra Tech Cements Pvt. Ltd.	Morang	1200	PPC
54	Riddhi Sidhhi Cement Pvt. Ltd.	Makwanpur	2200	OPC,PPC
55	Janaki Cement Industries Pvt. Ltd.	Sunsari	600	OPC,PPC
56	Agni Cementp Ltd	Rupandehi	300	OPC, PPC
57	Araniko Cement Pvt Ltd	Bara	400	OPC, PPC
58	Goenka Cement Pvt Ltd	Rupandehi	700	OPC,PPC,PSC
59	Hetauda Cement Udhyog Ltd	Makawanpur	750	OPC
60	Himalayas Cement	Jhapa	600	PPC, PSC
61	Jaya Mangalam Cements P Ltd	Banke	450	PPC
62	Mjaypee Cement	Kapilbastu	-	OPC, PPC
63	Nepal Shalimar Cement P Ltd	Bara	350	OPC,PPC,PSC
64	Pathak Cement P Ltd	Rupandehi	-	PPC, PSC
65	Star Cement	Bara	-	OPC,PPC,PSC

Source: (NBSM, 2018)

2.4.5 Registered with Department of Mines and Geology

Nepal has favorable geography for various minerals, limestone being among them. Limestone is the raw material which is processed to manufacture clinker a major ingredient of cement. The Department of Mines and Geology (DMG) is responsible for issuing the license for the limestone mines. Nepal has set a target of making the country self-reliant in production of cement and to achieve such high volume of extraction of raw-material is must. There are 51 companies/individual who have taken license from the department to extract the limestone for clinker manufacturing. The 177 individual and companies have taken prospecting limestone mine. The list of such are tabulated in annex II and III.

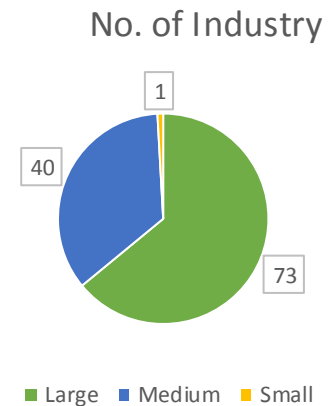
2.5 Nature of Cement Industry

The cement manufacturing industry operating in Nepal are distinguished through various parameters. They can be mainly characterized on the basis of size and production process.

- **On the Basis of Size**

DOI has classified the industry into 3 category on the basis of the investment. According to the DOI registration data of cement industry the 3 types of industry are:

- Small : Up to Rs. 10,00,00,000
- Medium : Rs. 10,00,00,000 to Rs. 25,00,00,000
- Large : Above Rs. 25,00,00,000



- **On the Basis of Production Process**

The cement industries in Nepal on the basis of production are particularly of two types:

- Integrated Industry
- Clinker Industry

The mine based industries produce the clinker themselves and also sold to the other clinker based industry to manufacture cement. There are 27 mine based industry in Nepal and other are clinker based.

CHAPTER III: PRODUCTION PROCESS AND TECHNOLOGY

3.1 Cement Manufacturing Process

Cement is the basic ingredient and mostly used construction material as it has the ability of enhancing adhesiveness of concrete which in return provides a concrete mix having better locking of sand and gravels property. Cement is basically manufactured through a closely controlled chemical combination of calcium, silicon, aluminium, iron and various other ingredients. Different minerals such as limestone, shale, gypsum, clay are mined in order to make cement. When these ingredients are heated at a high temperature to form a rock like substance, which is when grounded into the fine powder cement is formed.

There are mainly two types of cement manufacturing processes:

1. Dry Cement Process

Dry cement process is the most common and modern way of manufacturing cement. In this process, calcareous and argillaceous raw materials are fed into the burning kilns which are in entirely dry state. This method is used when the available raw materials are quite hard and are dried and reduced in size in the grinding mill. It is reduced to a fine powder and that dry powder is known as the raw meal. The dry cement process includes:

i. Treatment of raw materials:

The raw materials containing calcium, silicon, iron and aluminum are used to produce cement. Raw materials are limestone, clay and sand fulfill such needs of calcium, silicon and aluminum. The raw materials are firstly crushed, dried, ground and blended before they are fed into the kilns for burning process. In the crushing process, raw materials are crushed into small size (6-14mm) with the help of crushers. Drying of crushed materials is achieved by heating these materials separately at high temperature that is enough to drive out uncombined water. Drying kiln is used for heating purposes which is generally of rotary type. Firstly, preliminary grinding is done in which the materials are compacted to a fineness of 50 mesh. For preliminary grinding, ball mills are used. Secondly, the fine grinding is done in which the size of the materials are compacted to 200 mesh. For fine grinding, Tube Mills is used.

ii. Proportioning and Blending:

The raw materials are then mixed together thoroughly either through mechanical or pneumatic method, before they are fed into the kiln. The compressed rock is combined with other ingredients such as iron ore or fly ash and ground, mixed and fed to a cement kiln. In the pneumatic method, dry proportioned materials are inflated under passive blending where from they are drawn in the mixed state. The blended materials are then ready for feeding in the burning kilns. After completion of this process, there is no major difference between the dry and wet process, except the design of the rotary kiln.

iii. Burning of the Dry Mix

The finely powdered mixture is charged into long steel cylindrical tubes known as the rotary kiln. The kiln is attuned in an inclined position, making an angle of 15 degrees in a horizontal position, it moves around its longer axis. The raw mix of dry process of corrected slurry of wet process is inserted into the kiln from the upper end. The kiln is heated with the support of powdered coal or oil or hot gas from the lower end of the kiln so that the long hot flames is formed. The raw mixture is burnt in the kiln unless proper burning is acquired. This is shown by a greenish black color and vitreous (shining like glass) luster. The burnt material in the cement is the composition known as clinker. The clinker that is obtained from the burning zone is very hot. Air is admitted in counter current direction at the bottom of the rotary kiln to bring down the temperature of clinkers.

iv. Grinding of the clinker

A determined batch of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) is further added to the cooled clinker and both (clinker and gypsum) are sent for pulverizing. The cooled clinkers are sent into the mills after being received from the cooling pans. The mixture is then reduced to extremely fine powder, ball mill or tube mill is used to finely grind the clinker into the powder form. Around 2-3 percent of powdered gypsum is added as retarding agent during the final grinding. The rough portion of cement is fed back to the mill for further grinding.

v. Packaging and storing

Cement requires very careful packing and storage arrangement. After the manufacture of cement, it is commonly stored in the specially designed concrete storage tanks known as silos. Cloth, jute and high-density polythene (HDPE) bags are commonly used for cement packing. The cement comes to customers in bags having a measured quantity.

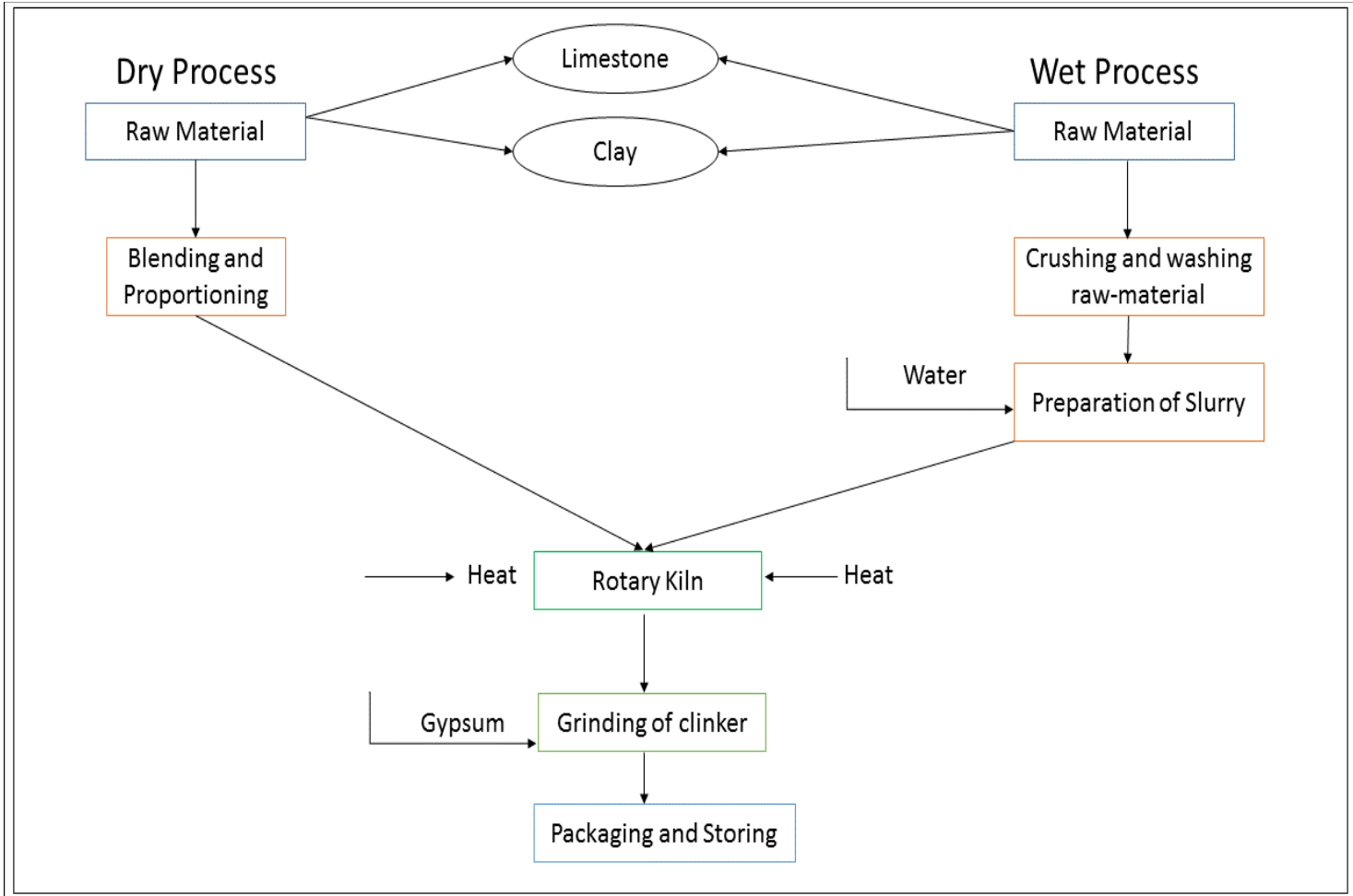


Figure 3-1: Cement Manufacturing Process

2. Wet Cement Process

The raw materials are ground with water before being fed into the kiln. Wet process is considered as a convenient process for the manufacture of cement when limestone of soft variety is available in abundance. Water is used while processing the cement. Clay is firstly crushed and washed into washing mills in the wet cement process. The raw material treatment and blending, proportioning is different from the dry process otherwise there is no major difference between dry cement and wet cement process.

This process can be further discussed into three headings:

I. Preparation of slurry

In this process an intimate mixture of raw materials with a lot of water in it is supplied to the kiln which is known as slurry. The raw materials are firstly crushed separately using crushers for limestone and grinding mills (wet) for clays then only, the standard composition of slurry is obtained. Separate tanks or silos are used to store these crushed materials. They are drained from the silos in fixed proportions into the wet grinding mills where, in the existence of a lot of water, these get ground to a fine, thin paste. A third silo is used to store this slurry. The composition is

tested once again and changed by adding together limestone slurry or clay slurry in required extent. Such changed slurry is then fed into the Rotary Kiln.

II. **Burning or calcination**

A similar type of rotary kiln as used in the dry process is used for burning of the slurry. However, the drying zone is bigger as the material is fed into the kiln with abundant water. All the moisture is drained from the slurry as it moves through the drying zone. In the following zones, it undergoes the same alteration as mentioned under dry process. At this stage, there is almost no variation in the wet and dry process.

III. **Treatment of clinker**

As the lump-shaped clinker comes out from the kiln, it is extremely hot. For that reason, it is passed through air-cooling rotary cylinders. It is then mixed with 3-4 percent of gypsum and ground to fine powder as discussed in the dry process of cement manufacturing.

3.2 Raw Material Extracting and Technology to Transfer to the Factory

The raw material extraction and transportation to plant needs to be done cautiously and in an economical way. The different geological features of the country has been a boon but it also has created difficulties as regards transportation. Most of the cement industries are located in the low lands of the country i.e. terai region whereas limestone is found in the hilly region. Due to the unavailability of sufficient and favorable land in hilly region to operate manufacturing industry, the plant is setup at low land hence has added to the cost of cement production sizably. On the availability of land, industries could be set up closer to the mines. The various technology and equipment used to transfer limestone to the factory depends on the distance to the factory. The process of raw material extracting and transferring to factory involves various steps:

- Mining
- Drilling and Blasting
- Loading
- Haulage
- Crushing

- **Mining / Quarrying**

Mining is a process of excavating and exploiting the limestone in the quarries with compressed air drilling and afterwards blasting with explosives. The method of removals and machinery usages are dependent on the material nature, mine site and scale of mine. Limestone can be broken by blasting or ripping, machineries such as back acting/dragline excavator, bulldozers can also be used.

- **Drilling and Blasting**

Drilling and Blasting are the favored combination for breaking out the raw material. Blast holes are drilled using drilling machines according to the desired length, diameter, spacing, and geometric features.

- **Loading**

Loading machines in the present technology is concentrated towards hydraulic excavators and wheel loaders. The machines used for loading in open-pit quarrying for solid rock such as excavators, hydraulic excavators, wheel loaders and others depending on the nature of the quarry.

- **Haulage**

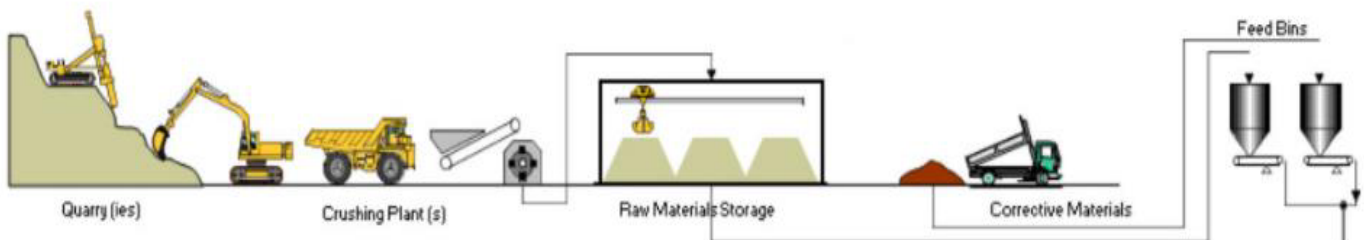
Haulage comprises of the transportation of fragmented rock pile material from the loading point to the crushing plant. The choice of haulage system may be:

- **By rail mounted vehicles**
- **By rubber-tired vehicles and other means such as belt conveyors, wheel loaders etc.**

- **Crossing**

Crusher is a device that is designed to reduce large solid chunks of raw material into smaller chunks, it is erected near to the limestone quarry. The limestone and sandstone is transported from respective quarry through the help of dump trucks to the crusher, which directly passes the crushed raw material to the ropeway so that the size is reduced to 25 mm. The crushed limestone is then stored in the stockpile through stacker.

Figure 3-2: Raw Material Extracting and Technology to Transfer to the Factory



3.3 Types of machinery and equipment used in the production process

There are various types of machinery and equipment used in cement processing from the crushing circuit to the bagging operation. The use of technology depends upon the industry's scale and production process. Some of them are as follows:

- Rotary kilns
- Cement finish mills
- Wet grind mills
- Jaw crushers
- Wobbler feeders
- Clinker coolers
- Apron feeders
- Dust collectors
- Vertical Shaft kilns
- Raw circuit mills
- Hammer mills
- Raymond bowl mills
- Impact crushers
- Separators
- Bag fillers

Among them rotary kilns and vertical shaft kilns (VSK) are two different types of kilns used to produce cement. These two technologies have been key in the evolution of the cement manufacturing industry. The use of kilns is associated with cost and efficiency, the choice depends on a combination of various factors involving social, technical and economic considerations. The details of these two kilns is discussed below:

3.3.1 Vertical Shaft Kiln

The Vertical Shaft Kiln (VSK) is probably the first type of kiln that was used and it can be traced back to the 5th century A.C. in Greece, when they were used for limestone calcining (Reiter, AC, 11/1997, p. 23). This is outdated by rotary kiln in late 1900s. However, in several countries such as China and India, many of these kilns are still operating (4000 units in China in 2005) and some companies still offer this technology.

Vertical shaft kiln technology is adopted by industry of smaller capacity for its low-cost implementation. It is modern day answer for cost effective production and advantageous for the developing countries like Nepal. It is suitable when production level need of the country is lower. Many industries of Nepal are still using VSK technology but as demand for cement soaring, most of them are replacing with rotary kiln.

3.3.2 Rotary Kiln

Rotary kilns use an inclined cylinder as the combustion chamber that rotates slowly to accomplish mixing of the materials and to attempt to expose all surfaces and substances to oxygen within the

chamber. Because this new type of kiln had much greater capacity and burned more thoroughly and uniformly, it rapidly displaced the older kilns. They were developed in the 1890s and became extensive in early 20th century and were a boundless enhancement on the earlier shaft kilns, giving continuous production and a more consistent product at higher capacities. The report from Kåre Helge Karstensen for the United Nations Industrial Development Organization “UNIDO” is summarized to differentiate these two kilns:

Figure 3-3: Pros and Cons of VSK

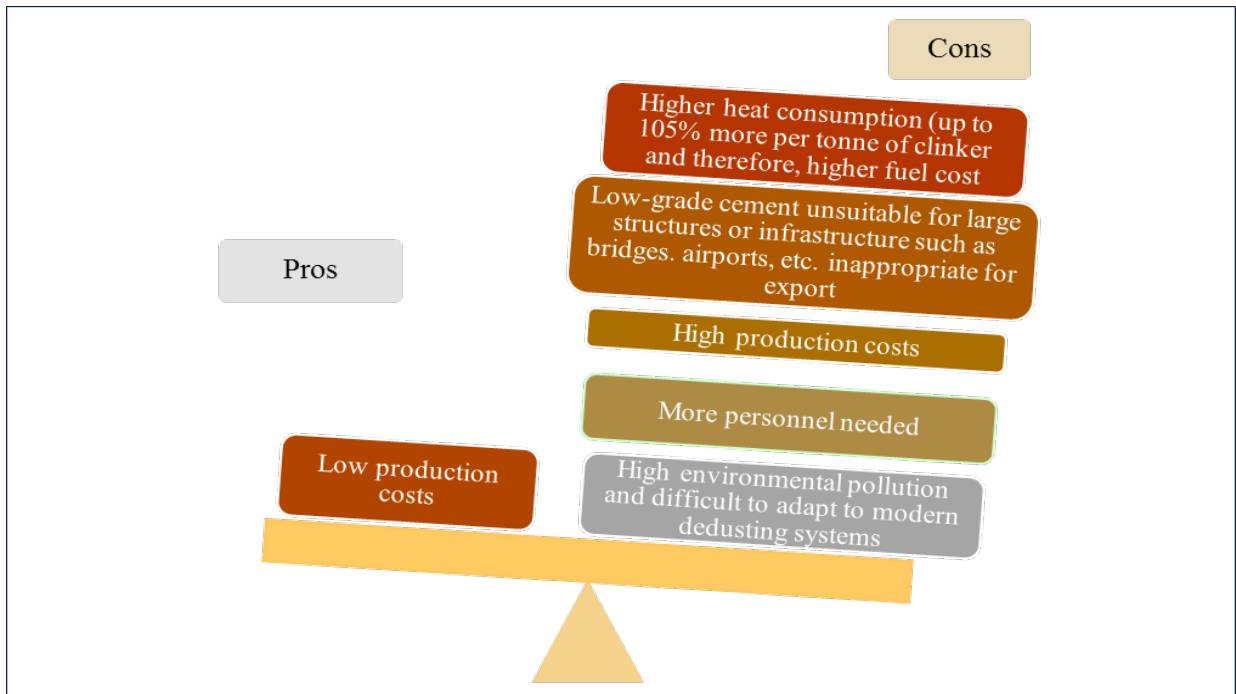
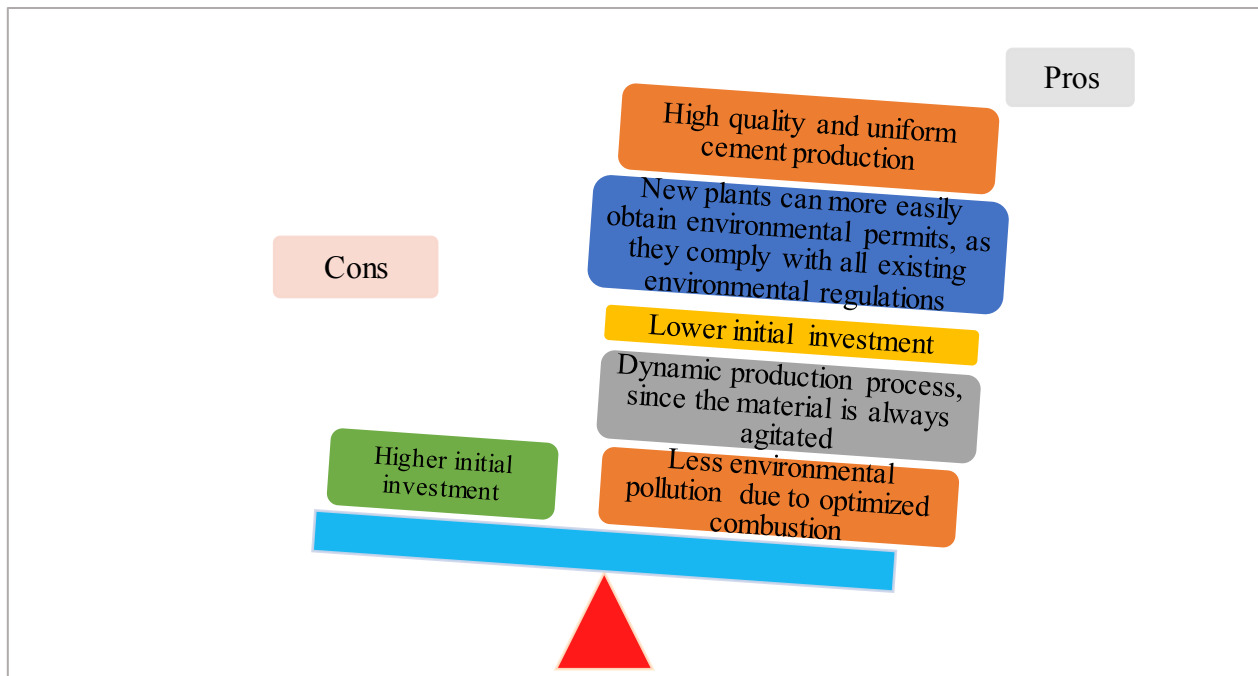


Figure 3-4: Pros and Cons of Rotary Kiln



It is fair to say that kilns have evolved from the so-called field or pot kilns that were crudely constructed of stone and often on the side of hills, to vertical shaft and rotary kilns with each evolution step carried out with the improvement of labor intensiveness, productivity, mixing, heat transfer and product quality in mind. The advancement of technology has been a blessing as it has reduced cost and increased efficiency of the industry.

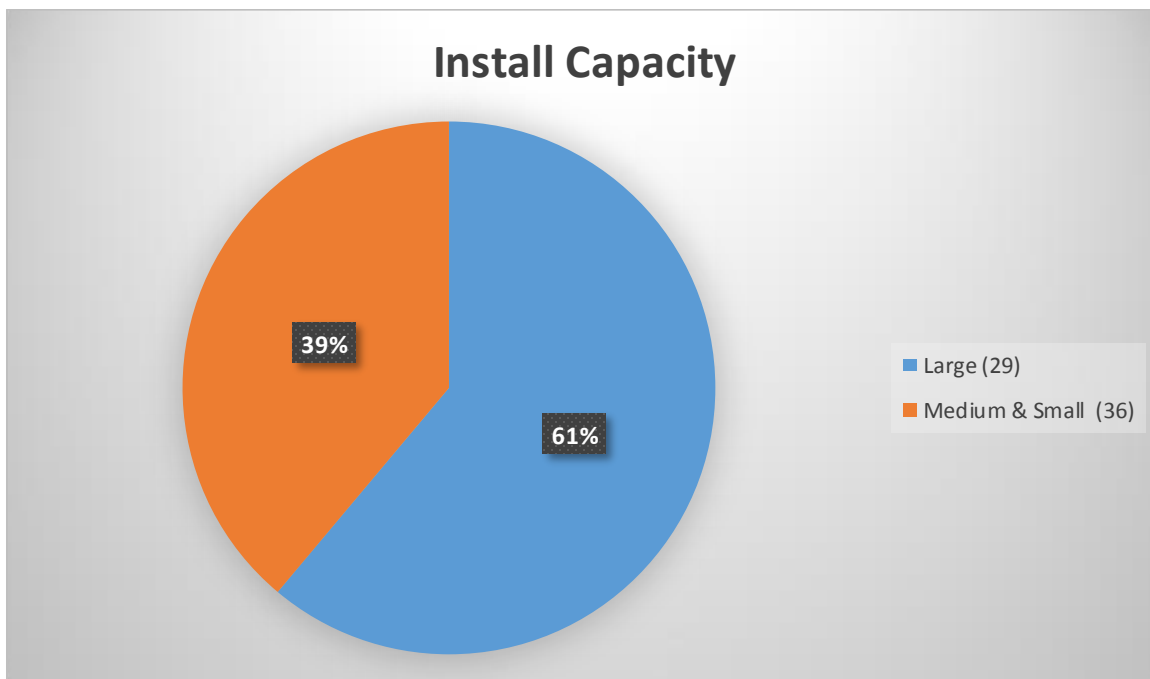
CHAPTER IV: CAPACITY UTILIZATION, DEMAND AND SUPPLY

The growth of cement manufacturing plant in Nepal has increased immensely in recent days with a lot of potential for development in the infrastructure and construction sector. The production of cement increase by 34 percent in fiscal year 2074/075. This opportunity has attracted huge investments, both from Nepal as well as foreign investors and it is certain that this growth will increase the production capacity more in coming days with new establishment.

4.1 Installed Capacity

The total installed capacity of the cement industry in Nepal is around 9 million tons in 2074/75 according to DOI. A total of 114 registered in DOI but only 65 are in operation which can be seen from the report of NBSM. Among these 65 industries, 29 large cement plants categorized by DOI together account for 8 million tons of installed capacity in the country, while 36 medium cement plants make up the rest.

Figure 4-1: Chart depicting Install Capacity According to Scale of Industry



Source: (DOI, 2018; NBSM, 2018)

The 114 registered industry has liscenced install capacity of around 23 million but, assuming the NBSM report 65 industry are in operation as they have obtained NS and their install capacity is about 14 million (Table 2. 5).

4.2 Capacity Utilization

Capacity utilization is a degree of the extent to which the productive capacity of a business is being utilized at any given time. The operating efficiency of the industries and cost structure can be accessed with help of capacity utilization rate. The effective utilization of the capacities for any manufacturing industry in today's competitive market is tough. The industries are struggling to achieve the comprehensive capacity utilization as this strongly propels their organization position in the market. The manufacturing industry have volatile capacity utilization.

In the prospect of cement manufacturing, various processes and agencies are involved in the course of manufacturing. The involvement of various stakeholders and being part of an open market, the analysis of decisive factors is very important to surge the capacity utilization rate in cement manufacturing industry. The capacity utilization eventually relates to the cost of production. The cement industry requires huge investment to operate and with higher capacity utilization, cost of production decreases resulting in more profits. Therefore, it is essential for the cement manufacturing industries to have capacity planning and management to excel capacity utilization.

The Trading Economics data shows that capacity utilization in Germany averaged 83.82 percent from 1992 until 2019 and in Denmark averaged 81.10 percent from 1987 until 2019. Similarly, our two neighbour nations; in India capacity utilization averaged 74.89 percent from 2008 until 2018 and in China it averaged 74.99 percent from 2013 until 2017 according to Trading Economics. The major factors that influence the overall utilization and must be accounted cautiously for are as follows:

- Utilization of machineries in a cement industry.
- Utilization of work-force in a cement industry.
- Collective utilization of machineries as well as work-force in a cement industry.
- Calculation of the overall capacity index of the cement industries.

The full capacity utilization is the ideal condition because inefficiencies in resource allocation always exists in an economy. However, to gain an upper-hand over its competitors the company must target for higher capacity utilization as it lowers the cost of production.

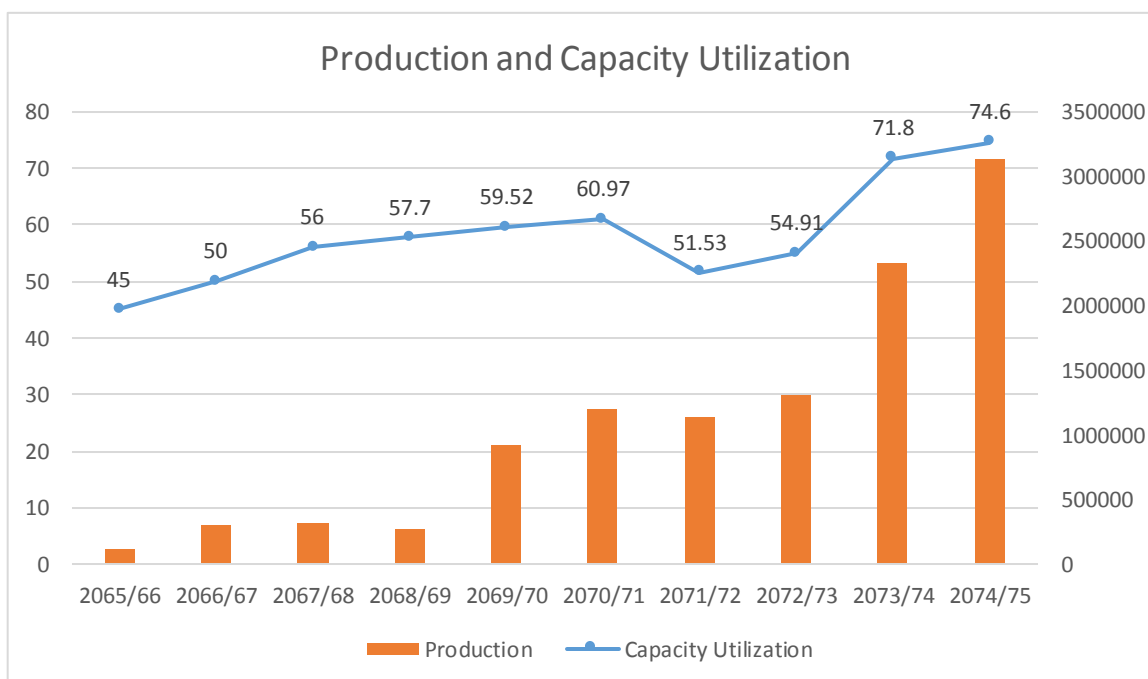
Although, there was growth of 34 percent in fiscal year 2074/075 the industry is still battling with under-utilization of the installed capacity. The capacity utilization of cement manufacturing industry of Nepal has been below par due to various determining factors. Under capacity utilization for over the last decade mainly was due to the shortage of power supply and limited availability of the transmission lines up to the plant. Though the industries were able to operate their plants over 50 percent during the period, which was considered above the mark of the profitability. When power supply was eased in recent years the cement industries' capacity utilization went up by 75 percent which is close to industrial rate of the world (Table 4.1). Total average number of days of operation of the plant in the industry is 300 days per annum.

Table 4-1: Capacity Utilization of Overall Cement Manufacturing Industries of Nepal

FY	Capacity Utilization (%)
2065/66	45
2066/67	50
2067/68	56
2068/69	57.7
2069/70	59.52
2070/71	60.97
2071/72	51.53
2072/73	54.91
2073/74	71.8
2074/75	74.6

Source: (NRB, 2018)

Figure 4-2: Production Capacity Utilization



Source: (NRB, 2018)

4.3 Demand and Supply Delineation

Demand is an economic standard where the condition of the capacity of customer to purchase or pay some product in the state of particular facility of it. Demand forecasting is the way to predict the data in the future based on historical data determinant of demand to reach some locations of extrapolative in the future (1). Cement being a key raw material for construction and infrastructure development it plays important role in building a better nation with strong economies.

The pace of development with increasing urbanization, the demand for cement in Nepal is expected to grow in coming days. The demand for cement is expected to increase with the increase in infrastructure developments in different sectors. The abundance availability of raw-material and advanced manufacturing technology has increased production of different types of cement in recent period. In the last decade, the number of manufacturing plant has increased enormously with increase in demand for cement.

Table 4-2: Historical Data of Consumption of Cement and Population of Nepal

FY	Population	Production(MT)	Import (MT)	Total Consumption(MT)
2068/69	27649925	278515.6	500206.59	778722.19
2069/70	27985310	930961	476701.63	1407662.63
2070/71	28323241	1201607	388217.30	1589824.30
2071/72	28656282	1136027	295267.41	1431294.41
2072/73	28982771	1305322	212632.06	1517954.06
2073/74	29304998	2336320	106624.46	2442944.46
2074/75	29624035	3130525	84513.73	3215038.73

Source: (CBS, 2018; NRB, 2018; Ministry of Finance, 2018)

Demand of cement is growing at an exponential rate every year, those demand were met by importing cement from overseas, particularly from India. Realizing the high demand of cement, domestic plants were established from 1996 by the private sector, the installed capacity for the period 2074/75 fiscal year (FY) was about 4.12 million tons. During FY 2068/69 total consumption of the cement was .8 million tons, of which 64 percent was supplied through importation and the remaining was supplied through domestic production which was accounted for at .28 million utilizing 57.7 percent of 488,622 tons total installed capacity. In six years period the scenario of cement consumption has changed. The total consumption of cement was over 3 million tons whereas in the same period 97 percent of the supply was from domestic production during the 2014/75 FY. Only about 3 percent ie. 84513.73 MT (Table: 4.2) was imported. The figure shows that domestic production is about to fulfill the national demand and heading to substitute importation fully in the following years.

4.3.1 Demand generating sectors

Cement consumption can be broadly classified into demand from three sectors:

Figure 4-3: Demand generating sectors



The demand from the these sector are generally:

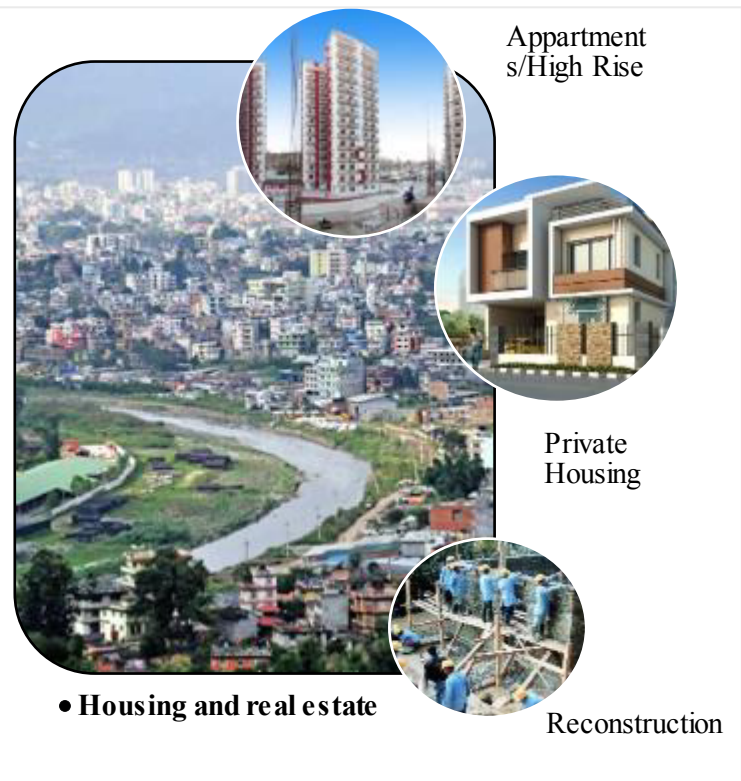
- Infrastructure: 30 %
- Housing and Real Estate: 62%
- Commercial and Industrial Development: 8%



Nepali cement market is growing every year over the last decade. Nepal is also moving towards importation of substitution in cement production as import has been decreasing year after year.

The Human Development Indicator (HDI) of Nepal is pushing forward with infrastructure development and sustainable socio- economic development. The slinking economy from earthquake of 2015 is bouncing back with rapid reconstruction work.

The infrastructure projects such as the hydropower projects, road networks and increased construction of houses, commercial buildings, post-earthquake reconstruction work and apartments in urban areas has considerably increased the demand for cement.



4.4 Status of Cement Production in Nepal

There were 114 cement industries registered at DOI till 2018. Among them only 65 industries have taken National Standards (NS). The industries listed in NS are in operation and few are under the process of operation. The past historical data of demand shows that demand of cement is increasing

steadily with mounting demand on generating sectors. The 58 industries were registered in period of 2068-2075 alone which is more than 50 percent of the total industries registered.

This clearly shows that the cement industry in Nepal is in a growing trend and there is abundant opportunities for the cement industry today to grab the pace of

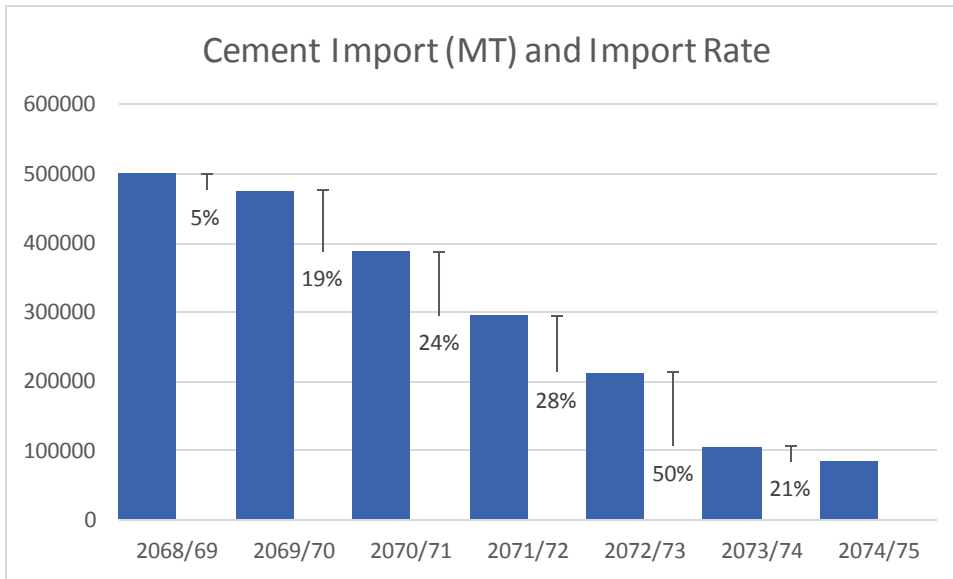
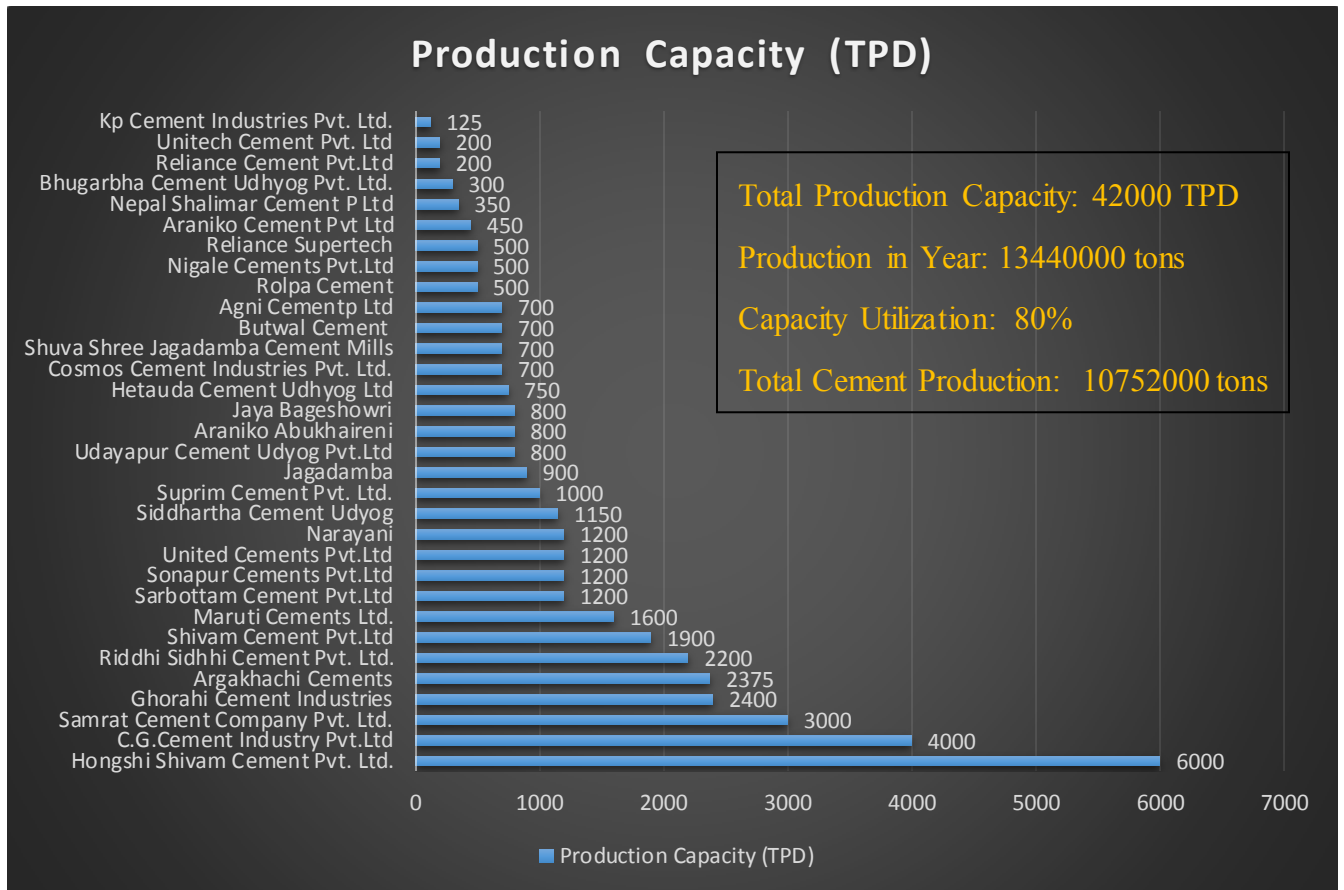


Figure 4-4: Status of Cement Import

the nation's development. The production of cement manufacturing industry within the country is still not sufficient to meet the total demand.

The country is still reliant on India to fulfill its present demand, however, due to increase of the number of production plants and capacity utilization increment, import has been reduced significantly. The import of cement last FY 2017/18 was accounted for 85514 MT and in the FY 2016/17 was 10662 MT which is 21 percent reduction in cement importation. With proper policy and sufficient utilization of the current plants, the country can achieve the target of self-reliance on cement in the days ahead. The current production capacity of the cement industries are depicted in fig.4.5.

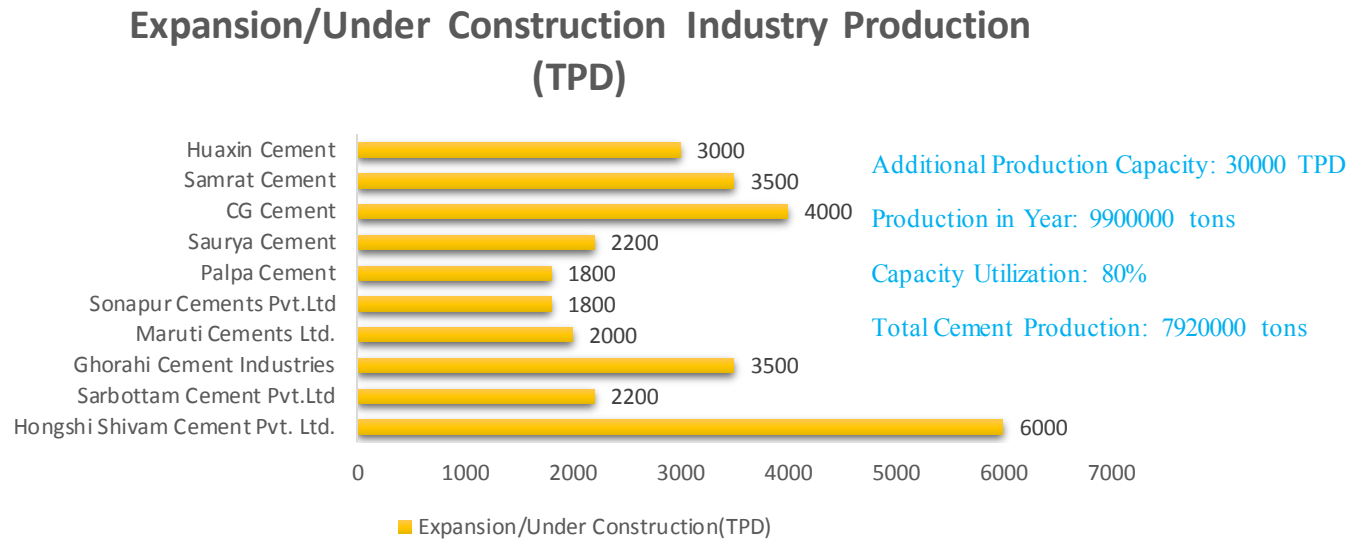
Figure 4-5: Production Capacity of Existing Cement Industry



Source: Field Survey,2019

The development process of the country is at pace with various national projects in operation and many other infrastructure work scaling up, thus the demand for cement continues to increase coupled with increased private housing and industrialization growth. In such circumstance, of 114 registered industries many prevailing medium and small-scale manufacturing industries are in expansion phase and numerous new large-scale entrants are entering to clasp the opportunity that exist in the market. The total registered capacity of 114 cement companies with DOI is 23,254,286 tons (table 8.1).

Figure 4-6: Production Capacity of Under Construction and Expansion Industries



Source: Field Study,2019

If all 114 registered industries are fully operated on their full capacity then the production will rise by three-fold as opposed to the present production. The demand in 2022 is expected to be 20 million tons which can be fulfilled by the nation's own production. Therefore, with industries coming up actively, analysis and preparations for over production in future years must be carried out in detail to address excess production without proper market analysis.

4.5 Estimation of the cement demand for the Next 10 years

Table 4-3: Estimation of the cement demand for the Next 10 years

Year	Annual Demand (MT)	% on Production growth	RGDP	GDP Growth
2067	320025		587534	
2068	778722.192	59%	614637	4.4%
2069	1407662.632	45%	637771	3.6%
2070	1589824.296	11%	674227	5.4%
2071	1431294.406	-11%	694269	2.9%
2072	1517954.059	6%	695688	0.2%
2073	2442944.456	38%	747107	6.9%
2074	3215038.726	24%	791144	5.6%

4.5.1 Regression Summary

Regression analysis has been conducted here to identify the multiplier factor to the cement demand in Nepal. Here in this regression, it is identified that the co-efficiency of growth on GDP has 4.79,

which indicates that one percentage point increase in GDP growth leads to increase in demand of cement by 4.79 times. In this study, percentage growth in demand of cement and percentage change in GDP are considered for the analysis.

Table 4-4: Regression Output

SUMMARY OUTPUT								
Regression Statistics								
Multiple R				0.429461				
R Square				0.184436				
Adjusted R Square				0.021324				
Standard Error				0.240923				
Observations				7				
ANOVA								
	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1	0.065632	0.065632	1.13073	0.336256			
Residual	5	0.29022	0.058044					
Total	6	0.355852						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.046586	0.20769	0.224307	0.831396	-0.4873	0.580471	-0.4873	0.580471
GDP Growth	4.793879	4.508247	1.063358	0.336256	-6.79494	16.3827	-6.79494	16.3827

4.5.2 Estimation Equation

It is deemed that with percentage change in real GDP causes to increase in cement demand. It is also presumed that there is a positive relationship between them. In functional form it can be written as:

$$\% \text{ on Production Growth} = f(\% \text{ on Real GDP Growth})$$

Based on this functional representation, after the regression, the estimated equation would be as

$$\% \text{ on Production Growth} = 0.047 + 4.79 * \text{GDP Growth} \dots \dots \dots (1)$$

Equation (1) states that one-unit increase in GDP growth, leads to increase in demand by 4.79. This factor has been supposed to proxy the cement demand. Based on this growth multiplier factors, different expected economic growth has been considered and the expected production growth factor has been determined.

4.5.3 Expected Demand

Demand is calculated on the basis of historical data, demand growth factors and the GDP growth of the country. The demand of cement is directly related with the GDP and the capital expenditure

of the government. Percentage of growth of cement primarily based on GDP and investment in infrastructure mainly in the construction industries. The growth sensitivity analysis has been done to estimate the demand of cement for next ten years. If the GDP as estimated by the annual budget 2076/77 achieved the demand, consumption level will reach at over eight and half million tons.

Table 4-5: Expected Demand

	Expected GDP Growth				
	5%	6%	7%	8%	9%
Expected Production Growth →	24.015981%	28.80986%	33.603739%	38.397618%	43.191497%
Year					
2074 (Base Year)	3215038.726	3215038.726	3215038.726	3215038.726	3215038.726
2075	3987161.816	4141286.882	4295411.948	4449537.015	4603662.081
2076	4944717.84	5334385.835	5738830.968	6158053.24	6592052.65
2077	6132240.337	6871214.926	7667292.749	8522599	9439258.873
2078	7604958.011	8850802.326	10243789.79	11795074.01	13516216.09
2079	9431363.282	11400706.09	13686086.18	16324101.47	19354072.15
2080	11696397.7	14685233.55	18285122.86	22592167.59	27713385.64
2081	14505402.34	18916028.77	24429607.82	31267021.8	39683211.77
2082	17989017.01	24365710.18	32638869.47	43272813.39	56822985
2083	22309255.92	31385437.17	43606749.97	59888542.97	81365682.86
2084	27667042.59	40427537.68	58260248.42	82884316.93	116508739.3
2085	34311554.28	52074654.69	77837870.24	114709920.3	166830608

The 5 percent economic growth is considered conservative based on the calculation of demand of cement if the growth rate constantly retained for next ten years, in this position the demand of cement only will be doubled in 2083 fiscal year. Similarly, as the growth increases to 6, 7, 8 and 9 percent, then the period to doubling the existing demand comes earlier. There is a direct correlation between the GDP growth and cement demand multiplier, higher the GDP growth bigger the volume of cement required in the country.

CHAPTER V: ENVIRONMENTAL AND LEGAL ISSUE

All the cement factories are required to obtain license before establishment and operation. Provision of compulsory licensing has given room for Nepal to facilitate and regulate the cement factories. Several laws and policies have different provisions for overall management, operation and smooth functioning of cement factories in Nepal. The following paragraphs and subsequent sections will describe such policies and laws in brief.

The first policy determined the categorization and establishment of the industry is the Industrial Policy 1974, which has defined the industry in the form of undertaking as sole proprietorship, partnership, cooperative, private and public limited company of cooperation duly registered to carry one industry like manufacturing, tourism, service assembling or transit and recreation.

The Ninth Five-year Plan (1997-2002) had unlocked the approach for the private sector to finance in hydropower development and manufacturing industries seeing that the growing demand for energy and products could not be contented by the government sector alone. This plan proposed deterring itself away from avoidable administrative and other forms of burden to emphasis on engaging the private sector in development activities. As a result, a number of industries, including Butwal Cement Mills Pvt. Ltd. and National Cement Pvt. Ltd were established. A number of private entrepreneurs applied for the establishment of the cement industries in this plan period and the Government duly approved for operation during the same period.

The Industrial Policy, 2010 was formulated with the objective of bringing positive changes in the overall economic and social sectors of the country by means of rapid industrial development. The policy has been formulated in order to accelerate the pace of industrialization in response to the diversity in the service industry and opportunities arising out of them. The policy has reinforced large-scale industries like cement industry to operate in the country and also has listed cement industry in the prioritized industrial group.

The Government of Nepal has typically prioritized the cement industries by introducing few incentive mechanisms. One such incentive was to provide road and electricity facilities to the cement industries to be established in designated districts. This policy has attracted many industries in those districts and now the Nepalese cement production can almost fulfill annual domestic demand.

5.1 Environmental Legal Provision

The cement sector is the third largest industrial source of pollution, emitting more than 500,000 tons per year of sulfur dioxide, nitrogen oxide and carbon monoxide. The business survives and grows in the environment. In today's business world, environment issue has been a hot topic and center concern for every business sector. In this prospect, the Government of Nepal has articulated various rules and acts to address the environmental issues related to all kinds of industry. The environmental governance includes organization, policy instrument, rules, procedures, norms that regulate the process of environmental protection. There exist various laws that are enforced by government to secure and maintain the environment in well state prioritizing sustainability of environment and industry.

The aim is to reach environmental goals along with communication and sustainable development with effective strategies and initiatives to address the issues.

Cement production results in the release of a significant amount of solid waste materials and gaseous emissions. The cement manufacturing industry is under close observation these days because of the bulks of CO₂ emitted. In actual fact, this industrial sector is thought to represent 5–7 percent of the total CO₂ emission. The chief environmental issues related with cement production are consumption of raw materials and energy use as well as emissions to the air. The legal act and regulations imposed by government that an industry must follow to operate their industry are:

- Environment Protection Act (1997)
- Environment Planning Guidelines (1998)
- Land Acquisition Act 1977
- Forest Act (1993)
- Forest Rules (1995)
- National Environmental Impact Assessment Guidelines (1993).

There are various legal provisions that are made to address environmental issues under these rules and regulations that must be followed by cement manufacturing industries prior and during the operation. Some of them are as follows:

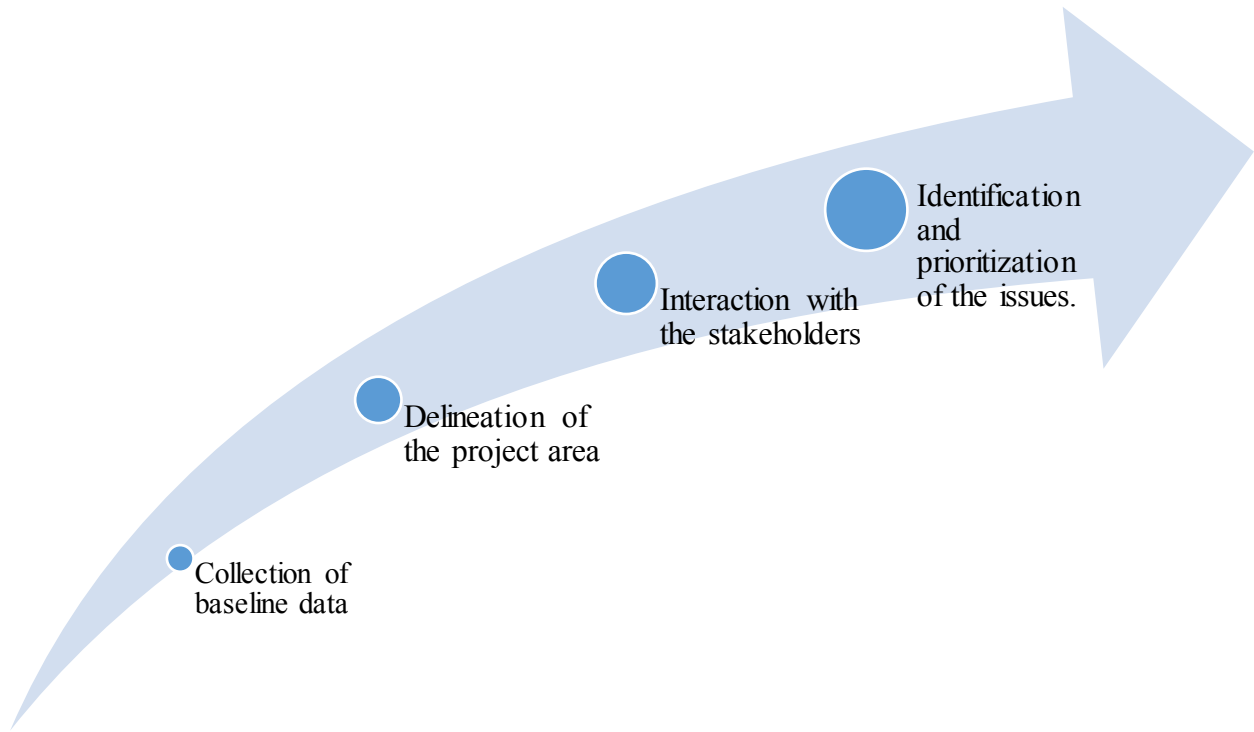
- Forest Act, 1993 calls for carrying out EIA of the development proposals if they are to be implemented in the forest areas and/or passes through the forest area. Section (68) of the Act empowers government to give consent to use any part or any category of forest areas, in case of the absence of alternative, for the implementation of the national priority proposal with the assurance that it does not pose any significant adverse effect in the environment. The National Parks and Wildlife Conservation Act, 1973 contains a number of environment-friendly provisions and prohibit activities that will have adverse impact on the environment. The Forest Rules, National Parks and Conservation Area Management Rules also contain a number of regulatory measures to minimize environmental impact within the forests, national parks, wildlife reserves and conservation areas;
- Mines and Minerals Rules, 2000 obligates the proponent to adopt environmental protection measures and ensure environmental conservation (Rule 19). Furthermore, the rules 32 and 33 elaborate provisions to minimize significant environmental impacts. This Rule provides an opportunity to identify potential environmental impacts and implement mitigation measures, which is a part of the EIA process.

5.1.1 Environment Impact Assessment

EIA started in the 1960's with the formulation of National Environment Protection Act, 1969 in USA. Later amended and made more prevalent in Environment Protection Act (EPA), 1997. In

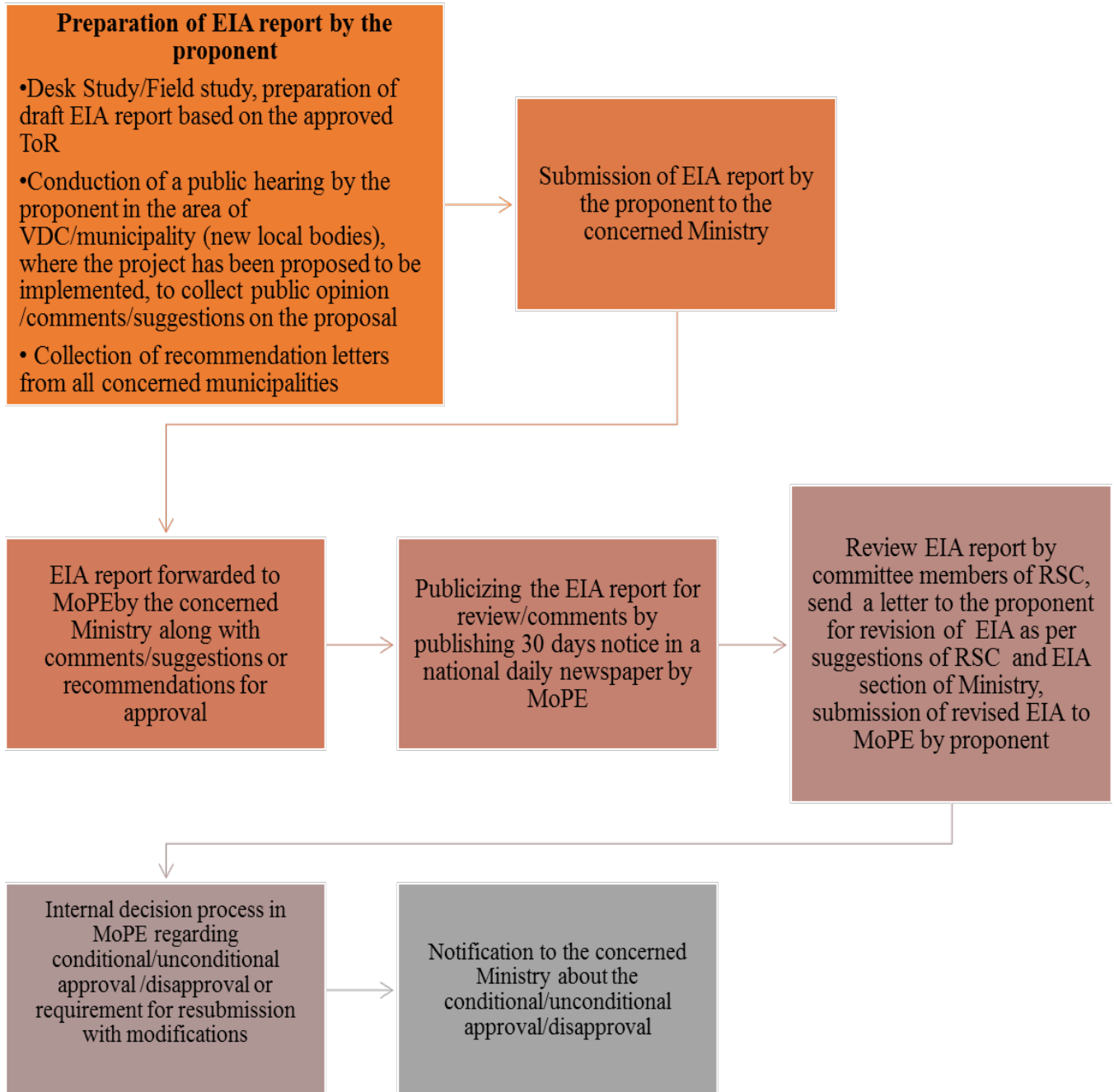
case of EIA, the Ministry of Population and Environment is the authority for report approval and the concerned ministry is responsible for monitoring.

Figure 5-1: Function of EIA



The industry must conduct EIA on the basis of daily production (3000 MT/day) and should study above mentioned prospects/factors of environment impact of the location where the industry will be installed and operated.

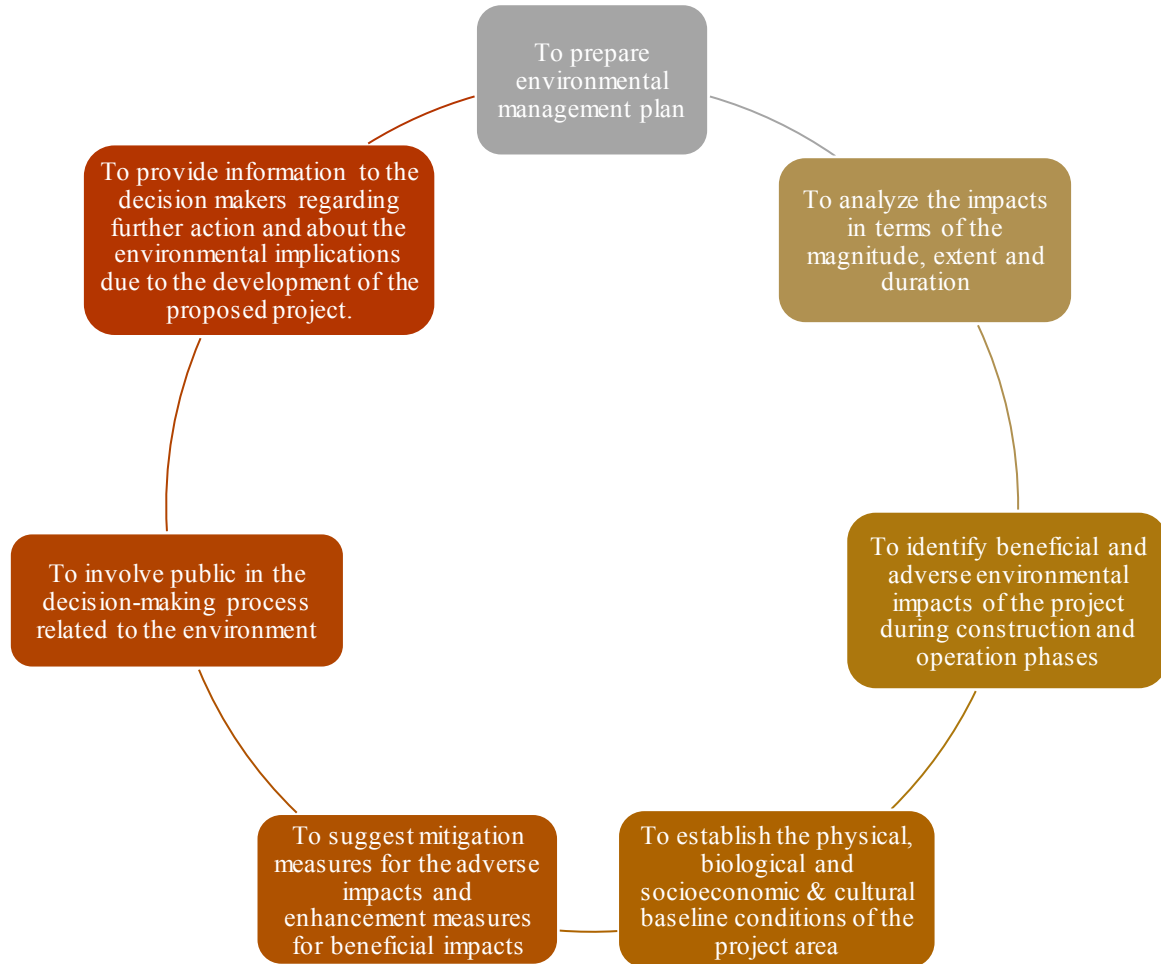
Figure 5-2: EIA Report Review & Approval Process



5.1.2 Initial Environmental Examination

Schedule -1 of Environment Protection Rules (EPR), 1997 lists proposal requiring an Initial Environmental Examination (IEE). As per the EPR, 1997 and the latest amendment, an IEE is required for every company which produces less than 3000 MT per day before its implementation. The general objective of the study is to prepare an IEE report in order to implement the proposed industry in an environmentally sound manner. The specific objectives of the study are depicted in Fig 8.3

Figure 5-3: Objectives of IEE



5.1.3 National ambient air quality standard

The Government of Nepal introduced National Ambient Air Quality Standard in 2012 to maintain limitation to the subsequent parameter.

Table 5-1: National ambient air quality standard For Cement Industry

Parameters	Averaging time	Maximum conc (mg/m ³)
TSP	24-h	230
PM ₁₀	24-h	120
SO ₂	Annual 24-h	50 70
NO ₂	Annual 24-h	40 80
CO	8-h	10,000
Lead	Annual	0.5
Benzene	Annual	5
PM _{2.5}	24-h	40
O ₃	8-h	157

5.1.4 Emission Standard

The Government of Nepal has introduced emission standard, 2069 for cement and crusher industry.

Table 5-2: Emission standard for cement and crusher industry

A. For cement industry	
Parameters	Maximum conc (mg/m ³)
TSP matter	Less than 500
Sample collection method	Testing method
The point of sample collection should be 300 to 500 meter far	Gravimetric
B. For crusher industry	
Parameters	Maximum conc (mg/m ³)
TSP matter	Less than 600
Sample collection method-	Testing method
The point of sample collection should be 10 to 40 meters	Gravimetric

5.2 Relevant Laws

Cement industries are by and large attracted by several laws. The major provisions of such laws are as follows:

- **Constitution of Nepal, 2015**

The Constitution of Nepal, through National Policies, has outlined various policies for industrial development in Nepal. Clause (d) of Article 51 has the following provisions in this regard:

- (1) Strengthening national economy through the participation and free development of public sector, cooperative sector and private sector;
- (2) Achieving economic prosperity with maximum utilization of available resources and means by stressing on the roles of private sector in the economy;
- (3) Providing for regulation to maintain fairness, accountability and competitive atmosphere in all activities of economic sector to promote and mobilize them for the overall national development;
- (4) Diversifying and expanding markets for production and services through the development and expansion of industries and promotion of exports by identifying the areas of comparative advantages;
- (5) Protecting consumer rights by maintaining ethical, disciplined and business fairness by controlling anomalies and malpractices such as black marketing, monopoly, artificial scarcity and unhealthy competition and making national economy competitive;
- (6) Prioritizing domestic investment based on Nepalese labor, skill and raw material for the development of the economy of the country through the protection and promotion of national industries, resources and means;
- (7) Accordingly prioritize domestic investment in service sector to promote it as a competitive industry for development of national economy;
- (8) Encouraging and mobilizing foreign capital and technology investment for infrastructure development in the area of export promotion and import to suit national interest.

With these clause, the Constitution has emphasized the need for national industries to develop the national economy as well as maintaining quality by protecting consumers' rights.

- **Company Act, 2006**

This Act is the governing law for the establishment and operation of any company in Nepal. It has described the procedures to establish the company, composition of Board, managerial aspect of any company and exit policies. Furthermore, this Act has the provision of ownership categorization, obligations of the companies and relation to the Government of Nepal.

- **Industrial Enterprise Act, 2016**

This Act has given continuity to the general classification of industries on the basis of (a) size of fixed asset investment and (b) nature/sector of business. However, on the basis of size of fixed assets investment, the Act has newly added "micro industries" within the classification. Furthermore, "Industries based on Information, Transmission and Communication Technology" has been added as a new classification on the basis of the sector of the business. The Act lists the industries falling within each classification and grants authority to the Industry and Investment Promotion Board to recommend to the Government of Nepal to alter the classification of industries.

The primary purpose of such classification appears to be the provision of fiscal and non-fiscal incentives on the basis of classification. However, such an approach is likely to create problems especially when a business in question does not fall under the category of "industries". For example, previously the Government of Nepal classified "investment business" as one of the categories of the industries and this category permitted foreign investment in Nepal. However, as the Act does not include such category on the list, the DOI might disapprove foreign investment under 'investment business' unless the same is notified by the Government of Nepal through Nepal Gazette.

- **Investment Board Act, 2019**

Primarily, this Act was enacted to facilitate large investors in potential areas such as hydropower, industries and large projects. This Act has established the Investment Board of Nepal with the jurisdiction of any industry costing a minimum of ten billion rupees.

The Investment Board Act is to mobilize the investment of public private partnership, co-operatives and national as well as foreign private sector for the economic development to accelerate the process of industrialization in a systematic manner to develop strong dynamic and competitive economy by constructing infrastructure and to make meaningful contribution towards poverty reduction by creating opportunity for employment.

The Investment Board Act Article 9 clause (k) and (l) defines the investment to be made in any infrastructure of service industry having fixed capital of ten billion rupees or having more than ten billion rupees project cost, for the purpose of this clause, infrastructure or service industry mean construction industry, mine industry, tourism industry or air industry.

- **Private Firm Registration Act, 1957**

This Act describes every step/procedure to be taken to establish a private firm. As a rule, a fee is required to register the company. The registration fee differs for a private company and Public Company. There is certain distinction between Private and Public company. The companies that generate money through public participation are public companies and those companies which are run by owner without the permission to have public participation in purchase of shares are private companies. Private companies are not allowed to have stock flow for the public.

Registration within 3 months after registration of company, the company receives the certificate of registration. A registered company in Nepal needs to be in Nepal Under the rule of the company Act. The registration number of the company, address of the company and other details of the company should be outlined and set where the company is established. These details must be provided to the Company Register Office within three months after the registration of the company.

- **Labor Act, 2017**

This Act is enacted and implemented to establish good industrial relations. Similarly, this Act establishes the rights and responsibilities of the labor working in any formal sector. The Labor Act is applicable to all entity, which has been defined to include company, private firm, partnership firm, cooperatives, association or other organization ("entity") in operation or established, incorporated, registered or formed under prevailing laws to undertake industry or business or provide service with or without profit motive.

The Labor Act is applicable to all entities regardless of the number of laborers (worker/employees), this also includes domestic workers. The Act has made certain provisions relating to domestic workers e.g. the Labor Act indicates the minimum remuneration of such workers, public and weekly holidays. The employer can deduct the expenses incurred in providing food and lodging from the remuneration if such is provided. Domestic workers should be allowed to celebrate festivals as per their culture, religion, tradition.

- **Mines and Minerals Act, 1985 and Mines and Minerals Rule, 2000**

These laws are particularly very important for the cement industries. They clearly define the mines and minerals to be extracted, the procedure to extract, the licensing procedures, definition of lease area and quarry areas as well as measures to be taken for minimizing the negative impacts. This law also has the provision of royalties to be paid by the extractors.

Mines and Minerals Rules 2000 helps to adopt environmental protection measures and ensure environmental conservation (Rule 19). Furthermore, the rule 32 and 33 elaborate provisions to minimize significant environmental impacts. This rule provides an opportunity to identify potential environmental impacts and implement justification measures which is a part of EIA process.

Similarly, Minerals Survey (Allowance and Privilege) Rules, 2024 (1967) talks about the privileges and allowances to be provided to the surveyor of the mines. This does not only apply to the national survey of minerals but also applies to the private sectors' survey. This rule is primarily designed to incentivize the surveyors to conduct their works in difficult atmosphere.

- **Consumer Protection Act, 2054**

This Act primarily ensures the rights of the consumers of any product in the country. Consumers are the customers who consume goods and services for personal purpose. So, the goods and services are consumed not only by the consumer but they can be manufacturer and service providers, suppliers and sellers as well. Any person can be a producer and distributor for one

product and can be a consumer for another product or services. Hence a consumer is any individual, institution, company etc.

- **Environment Protection Rule, 2054 (1997)**

This Act is applied for all the industries and activities in Nepal. A company shall have to carry out IEE and EIA of the proposals as prescribed. A company interested in implementing any proposal shall have to submit such a proposal accompanied by the report on IEE or EIA of the proposal to the concerned agency for the approval of such a proposal.

On receipt of any proposal pursuant to Section 5 and while examining the IEE or EIA report submitted with a proposal, if such a proposal does not appear to have significant adverse impacts on the environment, the concerned agency shall itself grant approval of the proposal with IEE and shall forward the proposal along with its opinion thereon to the Ministry with EIA report.

Notwithstanding anything contained in Sub-section (1), in case of, while examining the IEE report of the proposal, it is found necessary also to carry out EIA of such a proposal, the concerned agency may issue order to carry out EIA. In case any proponent, after having assessed environmental impacts pursuant to the order so issued by the concerned agency, submits an EIA report for approval, the concerned agency shall carry out necessary examination of such a proposal and forward the proposal along with its opinion to the Ministry concerned (Ministry of Forests and Environment for this purpose).

- **Foreign Investment & Technology Act, 1957**

This Act is in the process of amendment, rather a new Act is being drafted. The major objective of this Act is to attract foreign investment in the country. The Act also identifies the sectors for foreign investment, procedures to bring investment, repatriation provisions as well as incentives to foreign investors. This Act also ensures the One Stop Service for foreign investors.

The Act identifies technology also as investment. The Act has the provision of technology transfer and incentive mechanisms for such transfers.

- **Customs Act, 2056 (2007)**

As in all countries, the Customs Act is meant for ease international trade. The Customs Act of Nepal has several provisions on facilitating exports of domestic production. As the Government of Nepal has identified Cement as one of the main exportable items, several clauses of this Act are relevant for the cement industries in the country.

The Customs Act not only talks about the exports of domestic production but also facilitates for import substitutions by applying tariffs for some goods given it does not violate the provisions of WTO. This Act also has a negative list of tradable goods.

- **Nepal Standards (Certification Mark) Act, 2037 (1980)**

This Act has been enacted in order to standardize the domestic goods and services. Every good, be it imported or domestically produced, has to get certification according to this Act. This Act

was established to separate Nepal Standards and Measurement Department, which is dedicated for accreditation of the products.

- **Land Acquisition Act, 2034 (1977)**

Unlike in many other countries, Nepal has a unique landholding system. The property rights lie with the individual and it is transferred to the family members. The land required for any establishment requires acquisition by providing suitable compensation to the land owner. This is required for both public and private establishments.

This law has the mechanisms for land acquisition and compensation to it. Being an old Act (almost 42 years old), many provisions of this Act does not support the present condition. Nevertheless, this Act provides the basis for land acquisition for any investor in the country.

- **Forest Act, 1992**

The Forest Act is applicable to any industry that either touches or passes through the forests. The Act is a bit rigid for the industrial development. The provisions of replacement, compensation and time taken for the approval from competent authority are not only time taking but also put extra burden on the investors. Several provisions of this Act also relate to the Environment Protection Act, which might confuse the investors to comply all the provisions.

5.3 Procedure to Acquire Mines

The production of cement involves the consumption of large quantities of raw materials, energy, and heat. Limestone is the major raw-material in the production of cement amounting 60-70 percent in composition. Therefore, a huge mine of limestone is required for the industry to operate. Along with this the industry must also be established with proper analysis and calculations of quantity and quality of deposit minerals. DMG is the responsible authority who grants the permission for the extraction of limestone by issuing license to those who have fulfilled the listed standards. The standards are guided by the Mines and Minerals Rules, 2053.

The rules have defined the categories and scale of limestone as follows:

Table 5-3: Limestone Category and Scale of Excavation

Category				
On the basis of the nature		Non-Metallic		
On the basis of the importance		Precious and Valuable		
Scale				
Particular	Very Small	Small	Medium	Large
Land Excavation	Upto 10 Tons	Upto 100 Tons	Upto 500 Tons	Above than 500 Tons

Surface Excavation	Upto 20 Tons	Upto 200 Tons	Upto 1000 Tons	Above than 1000 Tons
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The department has explored the limestone mines all over the country that has 171 prospective limestone mines and among them 51 are in operation and few are ready for operation. The procedures of obtaining the mines licensing for the operation are:

- The person/company interested in the prospect of exploring minerals quality and quantity of which have not been yet determined, shall have to apply for document about prospecting operation to the Department;
- The Department grant the license if it deems fit to issue a license to the applicant after making necessary inquiry, issue a license with charging the fees;
- If a person/ company desires to carry out excavation of minerals quality and quantity of which have already been determined, he/she should apply document about prospecting operation to the Department with proposed scheme of excavation;
- If a person holding a license of prospecting operations and desires to perform the excavation, he/she shall have to apply to the Department to obtain a license for mining opening operation along with a detailed prospecting report and proposed scheme of excavation before expiry of the period of prospecting operations;
- A licensee has to complete the excavation of very small scale, small scale & medium scale and large scale, minerals within a period of Fifteen years, Twenty years and Thirty years respectively.

5.4 Mitigation Plan

The cement and crosser industries should maintain their industrial premises as follows:

- The dust containment and dust suppression system should be installed;
- Wind breaking walls should be constructed;
- Metallic road should be constructed inside the industrial complex;
- The industrial area should be cleaned regularly and wash the floor of the complex;
- Green belt should be constructed in the surrounding of industrial area.

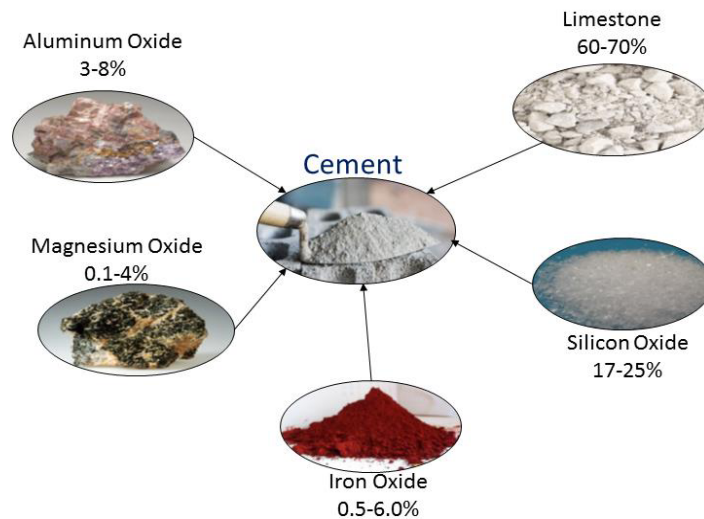
CHAPTER VI: INPUT ANALYSIS

The raw materials used for manufacturing cement are mostly natural that is used in the making of cement. The major raw ingredients required for cement manufacturing are lime, silica, alumina and iron oxide. Generally, limestone and clay are two main components and Nepal is rich in these two elements.

6.1 List of raw materials

The raw material required for cement manufacturing depends on the nature of the industry. The mine based industry extract limestone from quarry and processed it further to make clinker and adds gypsum to it at the final stage to produce cement. In contrast, clinker based industry grinds the brought clinker and gypsum is mixed with it to a small proportion. Here, clinker is the major component in the cement manufacturing which is constitute of 60-95 percent according to the types of Portland cement. The essential component required for clinker formation are described as follows:

Figure 6-1: List of Raw Material for Cement Manufacturing



6.2 Lime Stone

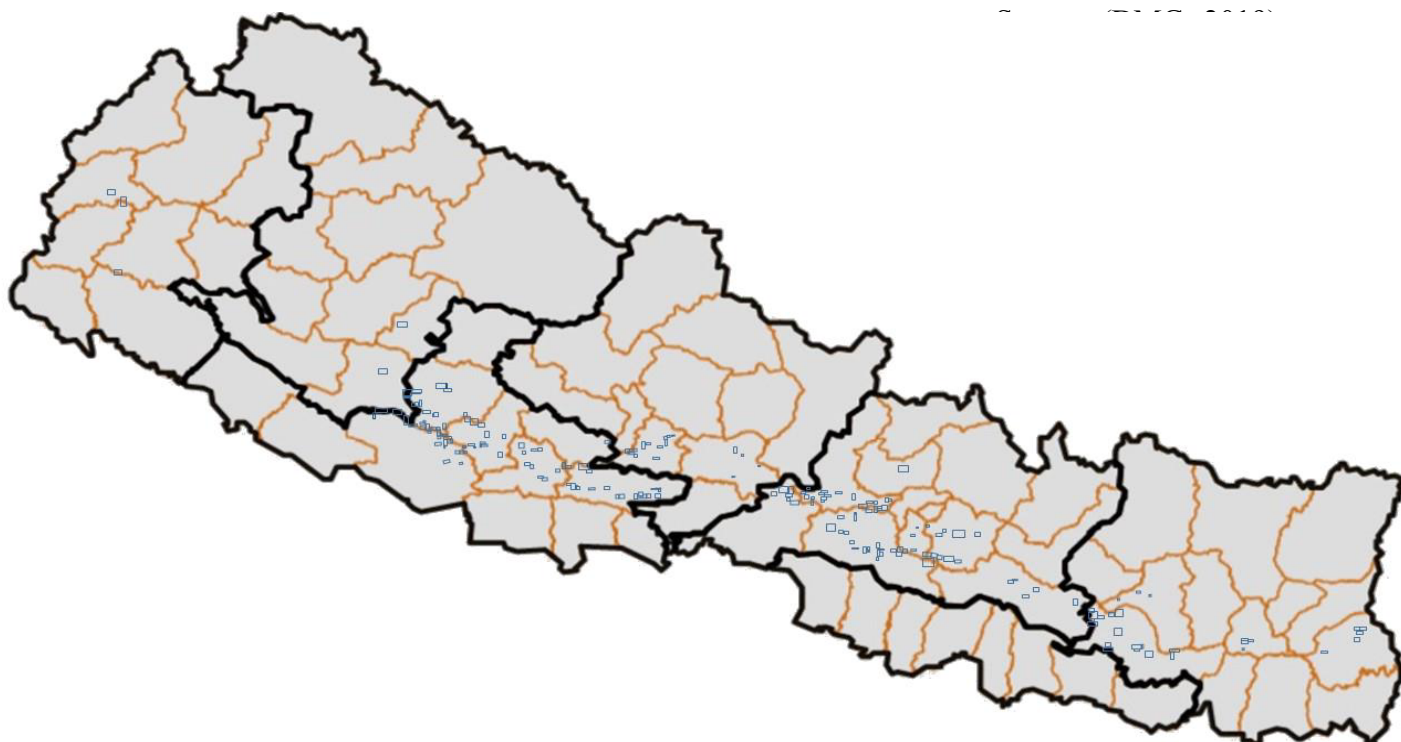
Limestone is the main raw material of cement and is composed mainly of calcium carbonate. Limestone required for cement production is estimated about 85 percent (Alsop 2007). Limestone is a sedimentary rock composed primarily of calcium carbonate (CaCO_3) in the form of the mineral calcite. It contains at least 50 percent calcium carbonate and a few percent other materials. Limestone usually contains admixtures of clay substance or of iron compounds, which influence

its color. With almost 83 percent of its territory in mountainous regions, Nepal has favorable geography for various mines and minerals.

A variety of limestone is found in Nepali territory, about 985 million tons of limestone reserves of different categories including 139 million tons of proved reserve have been reported by DMG in 2061. According to Economy Survey 2074-75, Nepal has about 1 billion 70 million tons of limestone including 54 million tons of certified, 11 million tons of semi-certified and 42 million tons of possible limestone in the various areas of the country.

Table 6-1: Highlights of Limestone in Nepal

S.N.	Headings	Information
1.	Main Limestone Ore Deposits	Udaypur, Dhankuta, Sindhuli, Makwanpur, Lalitpur, Dhading, Syangja, Arghakhanchi, Surkhet, Dang, Salyan, Baitadi and Palpa.
2.	Quantity and quality	1.25 billion metric tons of best cement grade limestone deposits. 540 million tons of limestone deposits has been proven, while that of 110 million tons has been semi-proven, and there are possibilities of having an additional 420 million tons ¹²
3.	Licensing Details	According to DMG record (FY 2074/75) 51 mining licenses and 171 prospecting licenses of limestone have been issued to the private sector.



Prospecting General of Limestone

Mining inspection & environmental monitoring is being done in 32 mines in the Kathmandu Valley, Dhading, Chitwan, Makawanpur, Dolakha, Sindhupalchowk, Kabhrepalanchok, Tanahun, Kaski, Palpa, Dang and Jajarkot districts. Proposals received for the promotion of cement grade and limestone industry promotion in Dhankuta and Salyan Districts are being evaluated. In addition, two sheet color geological map publication work and landslide study in Lamjung district are in progress (Ministry of Finance, 2018).

6.3 Clay Component

The quality of limestone is very important for excellent production of cement. The other raw-material required depends upon the quality of the limestone. The other important raw material for the production of cement is clay. Clay is formed by the weathering of alkali and alkaline earth containing aluminum silicates and of their chemical conversion products, mainly feldspar and mica.

The chemical composition of clay may vary from those close to the pure clay, to that containing a considerable amount of chemical admixtures as iron hydroxide, iron sulfide, sand, calcium carbonate, etc. Iron hydroxide is the principal coloring agent in clays; also organic matter may give the clay different colors, clay with no impurities is white. The major source of alkalies in cements is found in the argillaceous component of the raw mix.

6.4 Magnesium Oxide (MgO)

Magnesium Oxide is the auxiliary components of cement raw materials. The quantity of this in the cement are limited either by standard specifications or by manufacturing experience. This is combined up to 5 percent by weight with the main clinker phases with consideration of quality of limestone. Also, blast furnace slag sometimes contains a high amount of MgO. When selecting such slags as a replacement of clay as the argillaceous component of the raw mix, care should be taken, to keep the MgO content of the clinker within permissible limits.

Magnesium Oxide requirements for the industry is fulfilled by through importation from India and Singapore.

6.5 Gypsum

Gypsum is a mineral and is hydrated calcium sulfate in chemical form. Gypsum is added to control the “setting of cement”. If not added, the cement will set immediately after mixing of water leaving no time for concrete placing. During the cement manufacturing process, upon the cooling of clinker, a small amount of gypsum is introduced during the final grinding process. Generally, it is added up to 5 percent of total composition.

The cement manufacturing in Nepal totally relies on third country in gypsum. Gypsum is imported mainly from Bhutan and some from China, India, Pakistan, Oman and Iran.

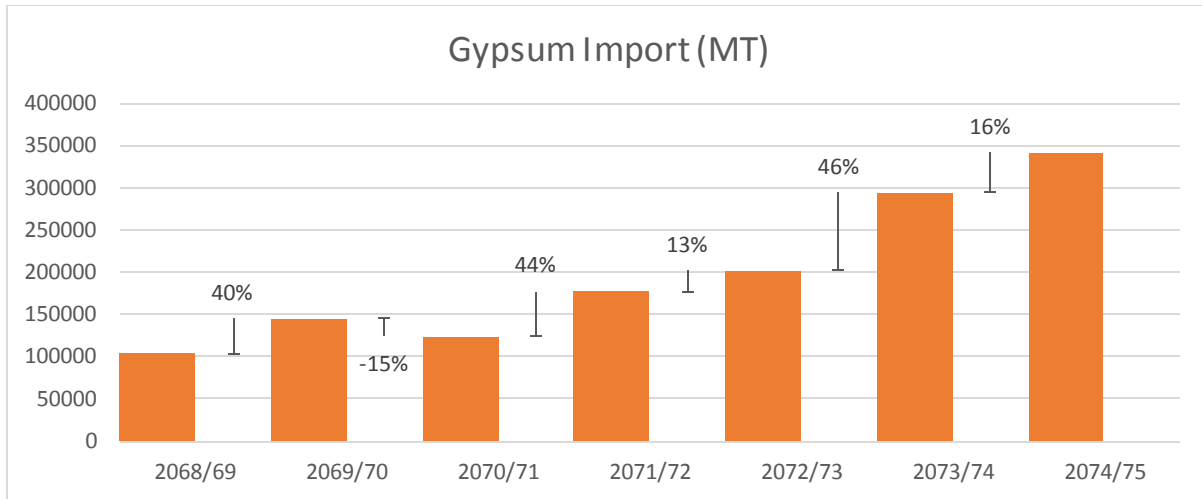


Figure 6-3: Gypsum Import in last seven years

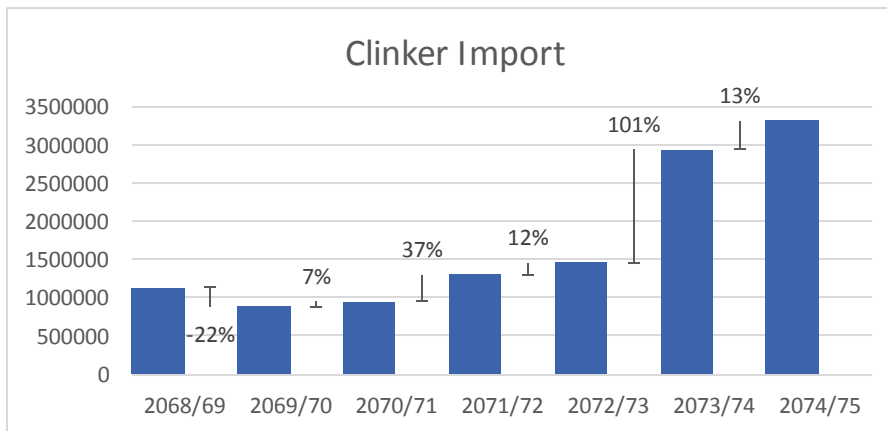
6.6 Clinker

Clinker is the raw material for those industries that are based on clinker i.e. for those who do not have their own mine for the limestone. Therefore, these industries procure the clinker and process further to produce cement. In Nepal most of the industries are clinker based industry who import or procure from the clinker industry with the country.

6.6.1 Trends and Status of Clinker Import and Production

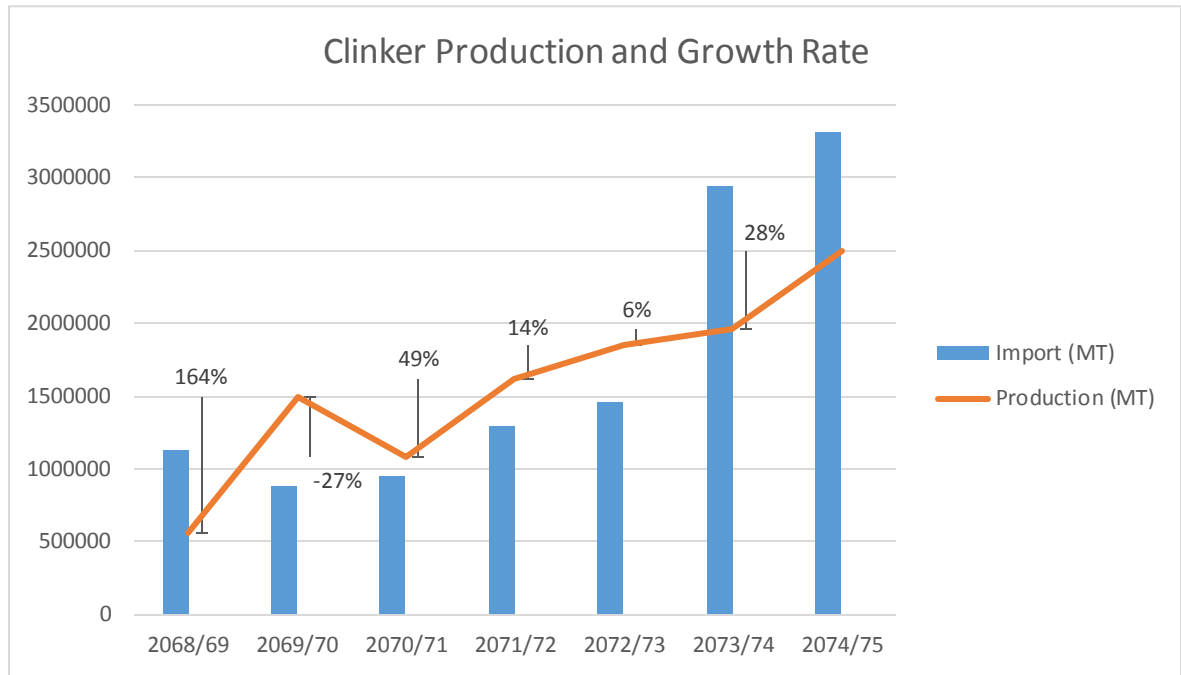
In recent times, the cement industry has been thriving in Nepal and has shown great potential in impacting the nation's economy in the long run. The Government of Nepal seeing such prospects have prioritized cement manufacturing industries and been providing support to cement related industry. Despite Nepal's abundance of limestone, Nepal still has been reliant on India for the clinker due to insufficient clinker producing industries. With the increase in industry within the country it is assumed that the country will be self-sufficient on clinker in the next few years.

Figure 6-4: Clinker Import Status



Source: (TEPC, 2019)

Figure 6-5: Domestic Clinker Production and Import Comparison



Source: (TEPC, 2019), Field Study

The domestic production of clinker has been in increasing rate in last 5 years whereas, import is increasing at decreasing rate. The demand of cement has been high in recent years prompting to more clinker requirement for the manufacturing. Clearly, deficient in domestic clinker has led to increase in import to meet the demand of cement production. But, latest growth in domestic clinker production can be buoyant for the cement manufacturing industry as clinker can be available with nation. This is also indication that Nepal can be self-sufficient within few years in domestic clinker production.

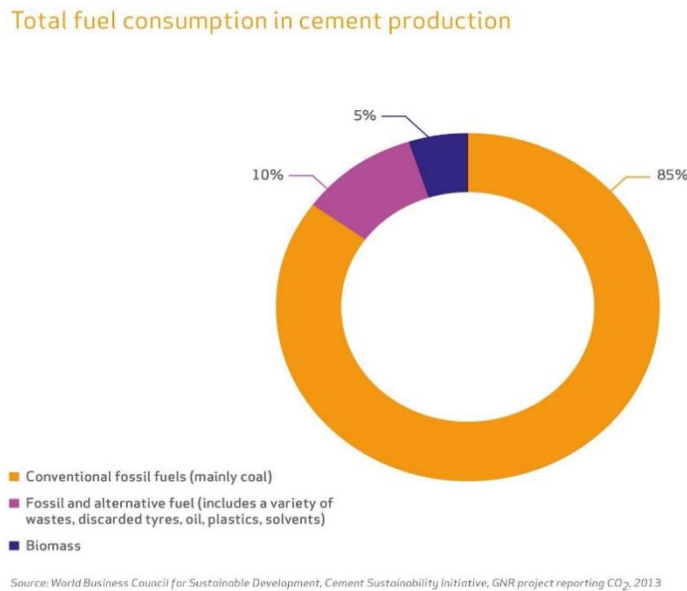
CHAPTER VII: ENERGY CONSUMPTION

7.1 Coal

The cement industry requires energy to produce cement and coal is an important source of the energy. According to World Coal Organization, it takes about 200 kg of coal to produce one ton of cement i.e. around 20 percent coal is required for per ton production of cement.

In the cement industry, coal qualities is very essential and among that volatility quality is of importance. The moisture content represents water that will have to be evaporated, subtracting from the available energy. Excessive free moisture also causes significant handling problems, meaning that the fuel cannot be fed at constant rate. The ash content ends up in the product, so its amount and chemical composition can have a profound effect upon the chemistry and uniformity of the clinker. The volatile matter defines the rank of the coal and affects the rate of combustion and therefore the shape and heat-generating profile of the flame. Coal represents the energy content of the fuel, the calorific value is the fundamental property from which assessments of the energy-efficiency of the manufacturing processes are derived.

Figure 7-1: Total Fuel Consumption in Cement Production



Source: (WCA, 2019)

Nepal's clinker manufacturing industry are heavily relies on third country for the sufficient coal required for the production. Coal is imported from South Africa, Australia, Russia and also from India. Around 80 percent of coal is imported from South Africa alone and the rest from other countries.

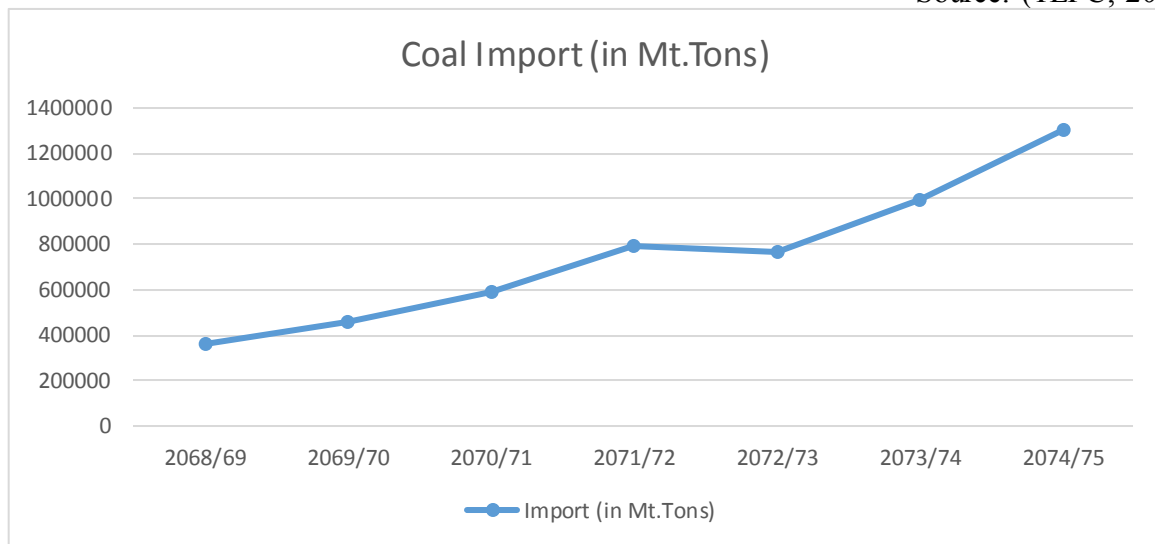
Table 7-1: Coal Import Status

FY	Import (in Mt.Tons)
2068/69	360174.11
2069/70	454139.36
2070/71	592478.76
2071/72	793651.63
2072/73	761949.93
2073/74	992434.31
2074/75	1302961.53

Source: (TEPC, 2019)

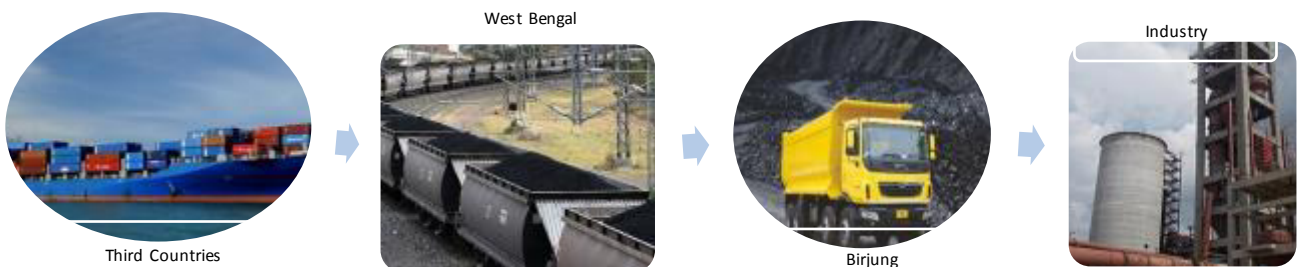
Figure 7-2: Coal Import Status

Source: (TEPC, 2019)



The country's coal importation is through the Indian border and only one dry port is available. The daily coal demand for cement related industry is 35000 TPD but only 20 percent of total demand is supplied into country due to transportation issue.

Figure 7-3: Coal Import and Transportation Process



There is no authority within the Government to track the coal status in Nepal therefore, coal import has been difficult due to lack of coordination with the Indian government. Also, there has been exploration of coal mines within Nepal but due to lack of efficient and modern technology they are still unused in the right amount leading to total dependency on third country.

7.2 Electricity

Based on 1998 Manufacturing Energy Consumption Survey (MECS) data fig 6.7 shows typical end use electricity consumption shares. Most of the usage is in the machine drive end use, associated with grinding, crushing, and materials transport. Cement industry natural gas consumption is concentrated in the process heating end use (about 90 percent of total gas consumption), which involves clinker production in large kilns. In most cases natural gas is used as a supplemental fuel to coal. Only one California plant utilizes gas as a primary kiln fuel. This is a relatively small plant that produces white cement. The remainder of the natural gas usage is associated with boiler and machine drive end uses.

Source: (MECS, 1998)

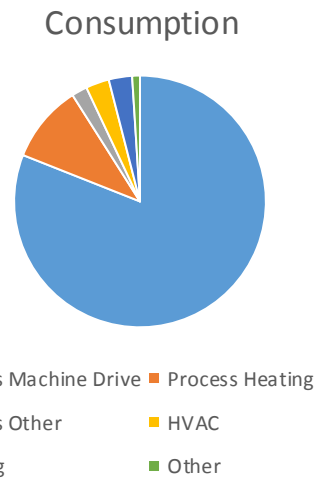


Figure 7-4: Electricity Consumption in Cement Industry

- **Energy Consumption in Nepal**

It is considered that the optimum energy consumption in cement manufacturing process is 105 kWh/Ton and of clinker in limestone based in-750 kCal/kg (3.138 MJ/kg) of clinker in limestone based industries standardized by Energy Efficiency Centre, Nepal. However, it was estimated that, the average specific energy consumption in cement industries is 156.08 kWh of electricity and 5.411 MJ/kg of thermal energy.

Figure 7-5: Electricity Consumption by Industries in Nepal

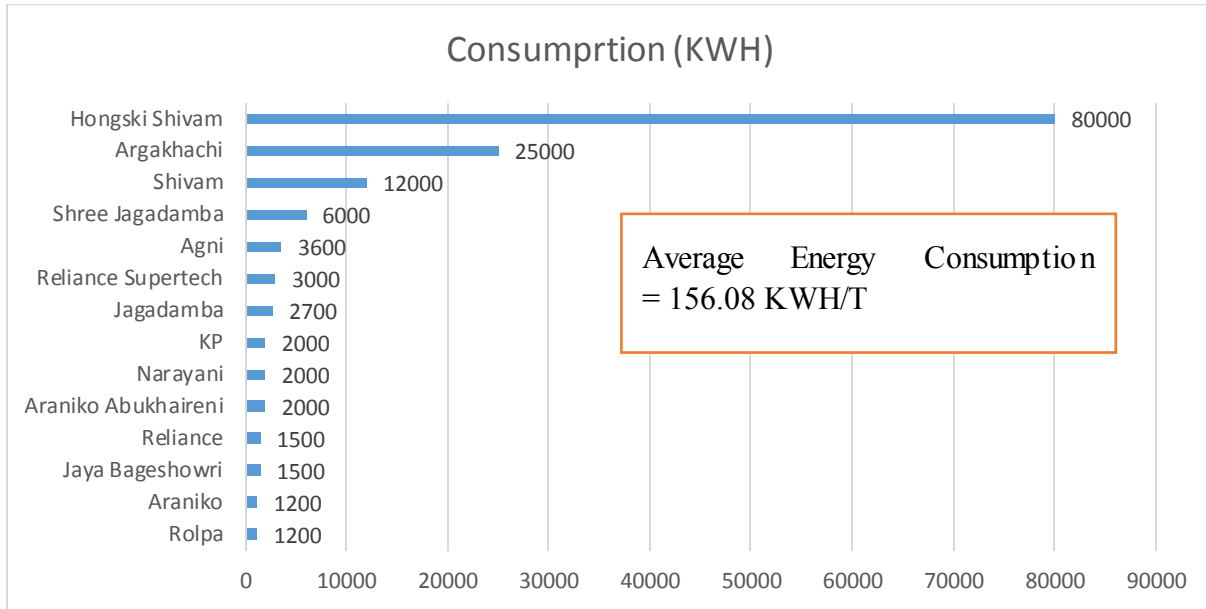


Table 7-2: Comparison of Average Energy Consumption of Cement Industry of Nepal and Other Countries

Country	Avg. Energy Consumption [kWh/Ton cement]	Consumption (MJ/Kg Clinker)
Nepal	156.08	5.411
Canada	110-155	3.6-4.5
China	110-125	3.0-4.0
India	85-120	3.0-4.5
Spain	90-110	3.0-4.0
Germany	80-120	3.0-4.0
Japan	80-110	3.0-3.5
Brazil	100-130	3.5-4.0
USA	100-155	3.5-4.0

Source: (Shrestha, Ghimire, & Singh, 2016)

Energy efficiency is a hot issue for cement manufacturing industry as it impacts the cost of production. Companies across the world are re-defining their technology and production process to escalate the energy efficiency. Nepal's cement industries are also focusing on energy efficiency approach with the use of latest use of technology and more scientific production process in recent times.

CHAPTER VIII: QUALITY ASSURANCE, MANAGEMENT AND MARKETING

In today's extremely competitive and unsettled business situation all present organizations are operating in vibrant changing scenario. Due to increasing complexities and cut throat competition running organizations effectively became challenge for employers. Managing quality, human resources and marketing is very challenging as compared to managing technology or capital and for its effective management.

8.1 Quality Assurance

NBSM is the NS authority under the Government of Nepal, Ministry of Industry. NBSM looks after the activities concerning standardization and quality control for qualitative improvement in the industrial production and to enhance productivity. Currently 369 domestic goods produced by 250 firms across the country have so far acquired NS certification from NBSM till ongoing fiscal year. The 65 cement factories operating within the nation are granted with licenses to use NS mark on their products. Regular monitoring by NBSM reassures the quality of the product to meet the standards set. The NS Certification scheme based on Type 5 model as per ISO/IEC 17067 for different products are set by the NBSM are as of follows:

- OPC: NS 49:1984
- PPC: NS 385:1997
- PSC : NS 384:1997

- **ISO Verification**

Nepal is certified as a full member of International Organization for Standardization (ISO) after being a correspondent member of ISO for 21 years in 2014. This has created opportunities to work with the world community in quality matters. ISO is a significant trade tool that can contribute to Nepal's export business. There are some standard set for cement manufacturing industry by ISO which are as follows:

- ISO 9001:2008 (Quality Assurance Management Requirement)
- ISO 14001:2004 (Environmental Management System Requirement)
- ISO 18001:2007 (Occupational Health and Safety Management System)
- ISO 50001:2018 (Energy Management System)

- **Grading System**

The grade of cement is usually distinguished to specify the strength of cement. The strength of cement is generally measured as compressive strength. Compressive strength is the strength of cement molded in a standard cube, after 28 days of curing. Compressive strength usually measured in Mega-pascal (MPA) or in N/mm². There are mainly three grades of cement

- 33 grade

33 grade cement has compressive strength of 33 MPA at the end of 28 days of curing. This grade of cement is used for common construction work under normal environment condition. In this grade of cement, strength gaining and hydration is also slow.

- 43 grade

43 grade cement has compressive strength of 43 MPA at the end of 28 days of curing. It is used to make concrete having a grade between M20 and M30 and is used for plain concrete and plastering work.

- 53 grade

53 grade cement has compressive strength of 53 MPA at the end of 28 days of curing. This grade of cement is used in making concrete mix above M25 and is mostly used for the structural purpose as in reinforced cement concrete.

8.2 Human Resources

8.2.1 Types of Human Resources Required

The employed are categorized in four categories namely; Management, Skilled, Semi- Skilled and unskilled. Most of the factories' corporate offices are in Kathmandu and most of the management staff are based in the corporate office. The other three categories of employees are working at the plant site. There is no issue of management or administrative staff but the supply of the technical staff is of growing concern to the industry. The new large plants with more than 3000 TPD offer good salary and perks to the experienced technical staff in the industry, therefore there is mobility of employee within the cement production industries.

8.2.2 Absorption of Human Resources

In the world scenario, the cement industry has been looking for efficiency gains that can be made through automation and the closure of outdated plants. As a result, over the past two decades, employment levels have decreased dramatically all over the world but in Nepal it is in an increasing trend. In terms of employment, the cement industry in Nepal has engrossed insignificant piece of the available labor force but, in 20017-18, employments in Nepali cement industry increased at a rate of 30 percent in comparison to early 2000s. One metric ton of cement generates job opportunities for around 80 people. As a result, there will be more employment in these sectors.

Figure 8-1: Status of employment of Cement Industry

Year	Industries	Install Capacity (MT)	No. of Employment
Before 2061	27	-	2005
2061/62	6	1347920	779
2062/63	4	315100	672
2063/64	1	15000	117
2064/65	6	641480	1264
2065/66	5	994500	979
2066/67	7	741300	964
2067/68	7	621240	930
2068/69	6	482696	697
2069/70	4	1564115	819
2070/71	4	1970817	375
2071/72	2	2204593	310
2072/73	7	2377203	1229
2073/74	8	3253928	1023
2074/75	13	4196414	2647
2075/76	7	2527980	1779
Total	114		16589

Source: (DOI, 2018)

The available statistics shows that employment opportunities in this sector have increased over years with establishment of industries. Today, the cement industry is one of the increasing sectors in the country. The cement industries of Nepal have helped in alleviating the unemployment problems of the country to some extent by availing employment opportunities. There are numbers of high level technical employment opportunities in the cement plant; like site engineer, packaging engineer, sift in charge, surveyor, geologist, contractor, supervisor and other posts. At the same time more and more unskilled labour manpower are also required in the production of cement. In fact, working in the cement industry is also considered as a lucrative career option for the novice's and the youngsters. The cement industry is one of the major sectors of job creation and employment. It was estimated that the industry has created over 16 thousand direct employment (Table: 8.1) and would create 80 man days to utilize a ton of cement in construction sector. If total installed capacity utilized the sector will create over 2.1 million jobs in the country.

8.3 Potential Market

The market of cement is on the rise from last decade as the country is on the path of swift development. The country's economy is in a booming state and the government's plan and policy are set according to development. The government has planned to develop 27 small towns, 13 smart cities and 5 Trans Himalayan city in various parts of the nation and it is assumed to impact 50-70 lakh people. Demand creation from these development work can be estimated to be around 5 million tons. Also, with growing of infrastructure works in the likes of hydropower, road, buildings and bridges, cement market is sure to size-up in the coming days.

The establishment of the milling plants in various locations and supply of clinker and production of cement as per demand can be addressed, this is also very important for quality assurance purpose. This helps the cement industry to fulfill demands at local and national level. The marketing system of the cement industry of Nepal is composed of both horizontal and vertical schemes. The establishment of milling plants in nearby localities is very fruitful to capture the market. It is cost effective for both consumers and industries for outreach to market within 100 km radius.

CHAPTER IX: ALTERNATIVE & SUBSTITUTION USE OF CEMENT AND CHALLENGES FACED BY CEMENT INDUSTRIES

9.1 Alternatives and Substitution of Cement

The use of cement can be traced back to ancient Egyptians era. Romans broaden the use cement in their construction work. The unique characteristics of cement being strength and adhesive has made cement a superior construction material. Its capability of binding the building material made a cement an irreplaceable material in the construction process. However, with advancement of technology and preference there are other materials used instead of cement. The downside of concrete is it releases a huge amount of CO₂ which has been an issue as regards climate change and to mitigate this, the concept of green building has been initiated in recent times. In green building concept, materials that offer alternatives to concrete are used in construction. Clearly, these are not the absolute substitute of cement but it can be used an alternative material.

Some of the alternatives of cement are:

- **AshCrete**

AshCrete is a concrete alternative that uses fly ash instead of traditional cement. By using fly ash, a by-product of burning coal, 97 percent of traditional components in concrete can be replaced with recycled material.

- **Timbercrete**

Timbercrete is an interesting building material made of sawdust and concrete mixed together. Since it is lighter than concrete, it reduces transportation emissions and the sawdust both reuses waste product and replaces some of the energy-intensive components of traditional concrete. Timbercrete can be formed into traditional shapes such as blocks, bricks and pavers.

- **HempCrete**

HempCrete is just what it sounds like – a concrete like material created from woody inner fibers of the hemp plant. The hemp fibers are bound with lime to create concrete-like shapes that are strong and light. HempCrete blocks are super-lightweight, which can also dramatically reduce the energy used to transport the blocks, and hemp itself is a fast-growing, renewable resource.

- **Recycled Plastic**

Instead of mining, extracting, and milling new components, researchers are creating concrete that includes ground up recycled plastics and trash, which not only reduces greenhouse gas emissions, but reduces weight and provides a new use for landfill-clogging plastic waste.

- **Wood**

Plain old wood still retains many advantages over more industrial building materials like concrete or steel. Not only do trees absorb CO₂ as they grow, they require much less energy-intensive methods to process into construction products. Properly managed forests are also renewable and can ensure a biodiverse habitat.

- **Mycelium**

Mycelium is a crazy futuristic building material that is natural – it comprises of the root structure of fungi and mushrooms. Mycelium can be encouraged to grow around a composite of other natural materials, like ground up straw, in molds or forms, then air-dried to create lightweight and strong bricks or other shapes.

- **Ferrock**

Ferrock is a new material being researched that uses recycled materials including steel dust from the steel industry to create a concrete-like building material that is even stronger than concrete. What's more, this unique material actually absorbs and traps carbon dioxide as part of its drying and hardening process – making it not only less CO₂ intensive than traditional concrete, but actually carbon neutral.

- **Silica fume**

Silica fume is a by-product from the manufacture of silicon. It is an extremely fine powder (as fine as smoke) and therefore it is used in concrete production in either densified or slurry form. Due to economic considerations, the use of silica fume is generally limited to high strength concretes or concretes in aggressive environmental conditions. The most commonly used proportion of silica fume in UK - produced combinations is 10 percent by mass of total cementitious content.

- **Bamboo**

Bamboo might seem trendy, but it has actually been a locally-sourced building material in some regions of the world for millennia. What makes bamboo such a promising building material for modern buildings is its combination of tensile strength, light weight, and fast-growing renewable nature. Used for framing buildings and shelters, bamboo can replace expensive and heavy imported materials and provide an alternative to concrete and rebar construction, especially in difficult-to-reach areas, post-disaster rebuilding, and low-income areas with access to natural locally-sourced bamboo.

- **Shifting the Technology**

The small and medium structure of the building construction are shifting to fabricated steel beam from heavy cement casting process. In metropolitan cities and town heading to cities are using the steel structure based construction methods, particularly in commercial building; this technology will reduce the use of cement.

9.2 Challenges of Cement Manufacturing Industry

- **Be competitive in domestic and external market**

There is price gap between Indian and Nepali cement due to cost of raw-material, transportation and manufacturing process. Following are the main reasons for price gap:

- The limit for MgO in Nepal is up to 5% and this results controlled manufacturing process which increased cost compare to other markets
- Coal cost almost twice than the neighboring nation
- Electricity and other energy cost
- Transportation cost

- **Minimizing the distance between Plant and the mines**

Due to diverse terrain and topography marketing of cement has been dreary in Nepal. The limestone is mainly found in Mahabharata range but it is hard to settle manufacturing industry there and most of the industries have established their plants in city area. This has caused to increase the cost of production. Therefore, minimizing this distance is a challenge.

- **Adaptation to the Federal Governance structure**

The country has recently gone into the federal system and there is change in government structure. With the local, province and central government, there seems to have some of beam situation in taxation policy. The country relies heavily on third countries for the import of coal and gypsum and the tax rate on these always has been concern to cement industry.

- **Limiting the license to new industry**

A total of about 1 billion tons of limestone deposits have been discovered in various parts of the country. Of this total volume, about 320 million tons is proven, 100 million tons are semi-proven, and 740 million tons is feasible. DMG has issued 228 limestone mine licenses out of which 51 are in operation and many of them are on verge of opening. If the trend goes in same manner, it is likely that Nepal will be exhausting all raw material and import. Therefore, putting the license into moratorium is one of great challenges.

- **Lowering the cost of coal**

Nepal reliant on third country like Russia, South Africa, Australia and India for the coal. Importing coal has been baffling task for the cement manufacturing industry therefore, have to stock the necessary for the 3-4 month. Rainfall, lead time, and transportation issue are the major cause for coal stock. This surely has increased the cost of production of cement.

- **More transit points with India**

There is only one import point available from India to Nepal to import coal. This has caused increase in price, higher transaction cost and time consuming. Therefore, having more than one transit point is another challenge.

- **Compliance with all legal and other safeguards**

As Environmental Act requires compensation for each tree to be replaced. This has added extra burden to the cement industries. Similarly, because of the provisions of Land Acquisition Act, the industries face the challenges to get the required land for industries establishment.

- **Lowering the cost of raw material**

The high price of limestone and gypsum has led to the higher cost of production. Minimizing this cost is a challenge.

- **Cement Grading System**

Grading system is not practiced. This has made off balance competition with Indian and other foreign cement.

- **Technology friendly human resources**

Most of cement industries lack the human resources who are knowledgeable to modern technology. This not only affects negatively the operation of the industry, but also increases the cost of production.

- **Mechanism to demand forecast of cement**

In Nepal, there is not any competent authority for demand forecast of cement. As the demand depends on the mobility of construction industry, government projects and pace of development in the country, the integrated approach to measure these does not exist. Therefore, cement industries are unknown of exact demand in next 5 or 10 years time.

CHAPTER X: FINDINGS, CONCLUSION AND RECOMMENDATION

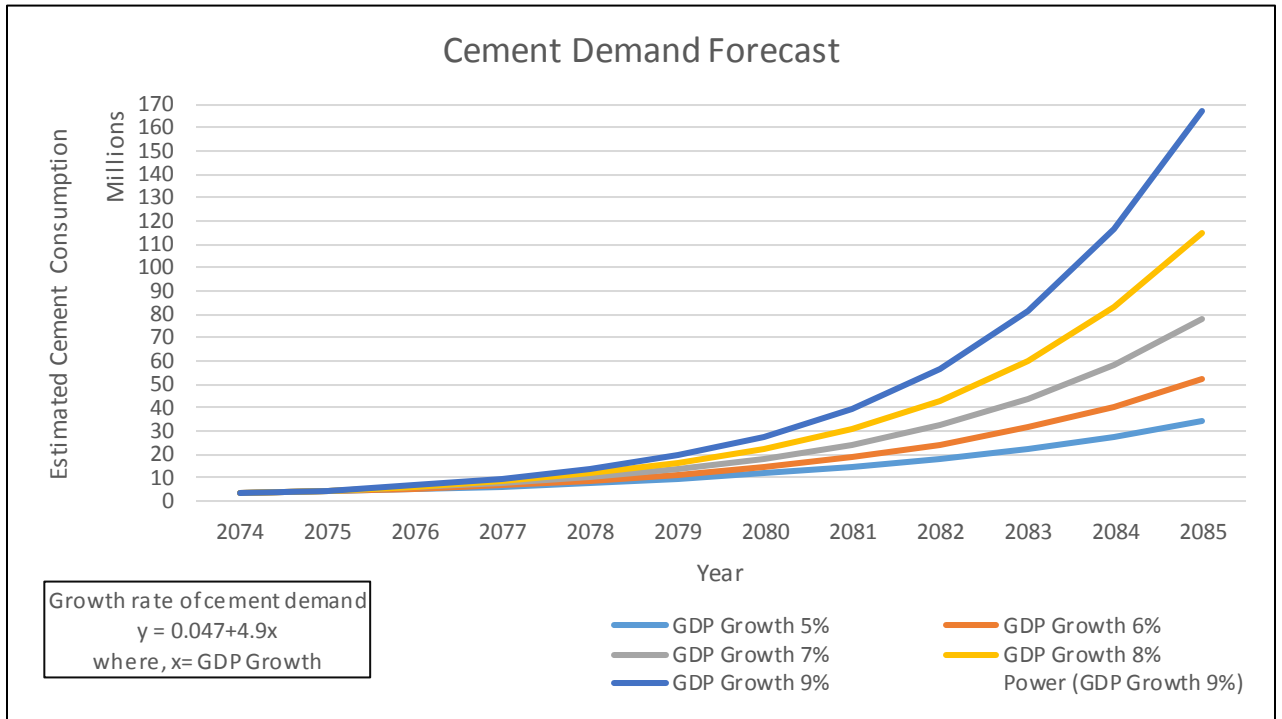
10.1 Findings and Conclusion

Cement industry is seen as lucrative for investors in current days.

- There are around 126 registered cement factories with the DOI, it seems the sector is overcrowded. Out of them the record shows that only 65 plants are in operation.
- Total capital investment in the Cement Industry is estimated around 20 billion Nepalese Rupee.
- Most of the factories are registered as Private Limited Company and few are with public limited structure. Only one company has gone to public through stock market.
- By the end of the year 2076, the installed capacity of the cement will be around 10 million tons per annum.
- By 2079, if the firms and industry upgrade and install the plants according to the plan submitted to the DOI, the total installation capacity will reach about 20 million tons in Nepal.
- Cement factories in China are searching for overseas market to manufacture the cement as a result, big cement factories with large production plants are keen to intervene Nepali market.
- Small cement plants of less than 500 TPD will be under threat in the future if they are unable to reengineer their business with the movement of market and demand.
- Total investment in the sector is only estimated by Nepal Rastra Bank and it does not have actual investment data from the commercial banks in Nepal.
- Access to information on human resources and revenue of cement industry in Nepal are limited. Contribution of cement factory obviously is high in the national economy but it is not easy to calculate exactly at what degree and magnitude the sector has contributed to the GDP growth, employment, import substitution and asset generation in the economy.
- Price and supply of cement in Nepal are not intercepting, small and medium sized cement producing companies are crowded, their cost of production is relatively high, economic scales are hard to improve, therefore to bring the supply, demand and price in equilibrium, few large industries should be established in Nepal. For the purpose FDI could be a vehicle to meet the national and local demand, not only will this ease the supply situation but it will also bring down the price of cement.
- With the increase in demand, the clinker domestic production seems insufficient which has prompted to increase import up to 30-40 percent from foreign countries.

- Growth of cement in Nepal since last 20 years is not linear, the cement production has increased significantly from 2067 as a result cement import in the year 2075 decreased tremendously. It seems that the domestic installed capacity and production of cement can substitute import of cement completely from the end of 2076. However, the consumption of coal is increased rapidly. A total of 64 racks per month of the coal is required to fill the current demand in entire cement industry in Nepal.
- Department of Mines and Geology has issued 171 licenses of lime stone mines until 2075/76 Fiscal Year.
- Regulation issues under the federal structure- role of province and local units on natural resources issues has complicated the regulation and licensing process. Creation of hassles due to ambiguity role of province and local unit.
- Energy Consumption has not been efficient as compared to global outlook. The electricity consumption is around 156.08 KWH/T cement which is more than standard i.e. 105 KWH/T. Similarly, thermal consumption is 5.411 MJ/Kg clinker which is also more than standard i.e. 3.138 MJ/Kg.
- Shortage of technical manpower in the manufacturing unit, industries are focused on minimum on training and self-development programs.
- Industries are facing difficulties in coal import and quality issues. Also, there are no government department to oversee the coal production and to address the problems related to coal issue.
- Demand of cement is directly related to the GDP growth of the any country, therefore, multiplier factor to the cement demand in Nepal stands at 4.79, i.e. if one percent point increased in GDP leads to 4.79 percent in demand of cement in Nepal.
- Demand sensitivity of the Cement for next ten years is depicted in figure below with accordance to Table 4.5.

Figure 10-1: Cement Demand Forecast



The demand for cement for the FY 2076/77 would be close to eight million tons and higher if the existing growth is attained. Total capacity for the same fiscal year is estimated at 10 million tons if 80 percent of the installed capacity utilized to meet the demand for cement and this will be at equilibrium of domestic demand and supply of cement in the country.

- Major raw materials for cement is limestone deposit of which, in Nepal, is estimated to be 1.39 billion tons reserve according to DMG 2004, 540 million tons are certified, 110 million tons are semi certified and 420 million tons are possibly deposit in various part of the country.
- Clinker demand is increasing at 12 percent annually. A total of 8.5 million tons of clinker will be required to fulfil the annual demand for the FY 2076/77. Department of Custom's import data shows that 2.93 million tons of clinker was imported mainly from India during the FY 2074/75, the amount will be less in the current fiscal year 2075/76 than the previous. It is estimated that the import of clinker could be in around 2.5 million tons till the end of this fiscal year 2075/76. The remaining demand will be fulfilled through domestic production.
- Domestic production of clinker is increasing at the same pace as cement production in Nepal because of the establishment of new large integrated plants.

- Landing price of the imported clinker at the factory was NPR 8.5 per kg in 2071/73 base price. Whereas the price is slightly increased in 2075/76 to NPR 9.41 per kg., according to the import data kept by TEPC and industry data as well.
- Clinker's average price at factory on board in some of the companies in Vietnam is \$41 per ton, i.e. per kg price at source could be around 5 Rupees. Average clinker price at source in Indian clinker manufacturing plant is about INR 3500 ie. NPR 5.6 per kg. Whereas comparing the price of clinker produced in Nepal is about NPR 8.5 to 9 Rupees. Therefore, there is no significant difference of price of clinkers importing from overseas and buying from the domestic market for the manufacturers.

10.2 Recommendations

A total number of 65 cement factories are producing cement around 10 million tons annually. A large factory with capacity of 6,000 TPD will start its production in two years times and the exiting factories are in process to upgrade their capacity. Small and medium size industries should reengineer their business model. Department of Industry should review the exiting cement production and market before granting the licenses in the future.

Over two billion rupees is invested in the sector, the industries borrowed from the Nepalese bank and financial institutions, therefore, the concerned institutions including banks should be cautious in the future before financing in the sector unless the external market is available.

The cement industry is being one of the biggest sector of industries by investment, revenue and contribution in the national economy; it is necessary to have a separate cement unit under the DOI, rather mixing other industries and SMEs in the same administration process.

Maintaining information of cement producers in Nepal is now become urgent; there are more than 124 registered cement company and 65 already in operation, detailed status of the cement plants are still unknown. However, DOI is involved to get updated their plants and manufacturing status, needed to get NS number from NBSM; and Department of Mine issued the mining license to the cement companies. These three departments are working independently for the same purpose. It would be more practical and easy to coordinate if all three departments share their centrally managed data based system incorporating all information in single platform.

Information desk with full physical infrastructure including information management software system, well trained human resources and required facilities at the DOI would improve the information dissemination and management system of cement in Nepal. Online report upload facilities to the industries and firms would make all stakeholders comfortable and all relevant information will be available in time.

A data sheet need to be developed to be filled by the cement factory to capture information of their annual production, capacity utilization, resources planning, clinker consumption and production, use and availability of inputs, import issues and market structure. The information received from the cement producers should be entered in to computer and should be analyzed when and necessary required to all stakeholders. This will enable DOI to produce annual report on cement industry.

Clinker production and cement production are two different procedure, while registering the cement company in the DOI there should be clearly mentioned the clinker production and cement

production category with respective quantity. The classification of the factories not only the capacity of cement but also their clinker production, and combined capacity should be mentioned in their documents and DOI data base as well.

An authorized coordinating body under the DOI encompasses representatives from cement manufacture to review, discuss and settle the issues on various level of taxes, power supply and tariff, road network to the quarry, raw material, quality issues and other relevant areas related to the industry would create a harmonious atmosphere in the industry sector and government sector as well.

Normally, integrated cements producers are producing clinker and cement. The cement producing industries are bringing their product in market in various product name without their brand registration that causes to frequently change the name of the brand. Therefore, the product brand should be registered with in NS and it should be updated to DOI.

Real picture of employment in the cement industry is not yet known. More than 2 billion rupees is invested in the sector, however, in what extent it has created the job market shall be known. Therefore, study on the job creation and impact of the job market of the cement factory should be conducted.

ANNEXES

ANNEX 1 : SCOPE OF THE STUDY

Over the past few years the demand for cement continues to rise stimulating the growth of Nepal's domestic cement production progressively. Cement manufacturers claim that the Nepali cement market is growing by 10 to 15 percent every year. The import has been decreasing year after year as Nepal is moving towards import substitution in cement production. In order to know the present status of cement manufacturing industries, the following were the scope of the works of this study:

- Annual demand of cement domestically and its import status.
- Industry details: (Name of industries, their detail address, production capacity, investment, number of employee, consumption etc.
- Capacity utilization
- Energy consumption
- Demand forecast
- Trend and status of Clinker import for cement production.
- Availability of Raw Materials domestically for cement manufacturing industries for upcoming years.
- Technology adopted
- Alternative and substitution use of cement
- Challenges faced by the cement Industries
- Financial position and area for improvement (policy level, association level and industries level)
- Possible suggestions

ANNEX 2 : METHODOLOGY

The scopes of the study were diverse and required wide range of both qualitative and quantitative information. The general quantitative data were mostly available through secondary sources, the specific quantitative data as well as qualitative data were obtained from direct interviews, focus group discussions (FGD) and key informant interviews (KII). Therefore, a mixed research method using open-ended and close-ended questions had been adopted. In order to acquire the aforementioned information and to derive the conclusion, semi-structured method (often preceded by observation, informal and unstructured interview) had been used for this study purpose.

Sample Universe

The fundamental purpose of the study was to analyze the present situation, identify gaps between supply and demand and analyze trends of cement industries and imminent period for cement industries in Nepal. For that reason, the cement manufacturing industries were the sample universe of this study. The industries were broadly classified in the following two categories:

- **Cement manufacturing industries that are in operation**
- **Cement manufacturing Industries that are not established yet**

Out of 124 cement manufacturing industries, 65 industries (Annex 3) are in operation. The table 1 shows the district wide concentration of those Industries.

Table 1: Concentration of industries according to district

District	Large	Medium	Small	Unspecified	Total	% Concentration
Banke	1	0	0	1	2	3.08
Bara	2	3	0	3	8	12.31
Chitwan	0	1	0	0	1	1.54
Dang	3	0	0	0	3	4.62
Dhadhing	4	0	0	0	4	6.15
Dhankuta	1	0	0	0	1	1.54
Dhanusa	0	1	0	0	1	1.54
Jhapa	1	5	0	1	7	10.77
Kapilbastu	3	4	0	1	8	12.31
Makwanpur	1	1	0	1	3	4.62
Morang	2	2	0	0	4	6.15
Nawalparasi	2	1	1		4	6.15
Parsa	0	4	0	0	4	6.15

Rolpa	1	0	0	0	1	1.54
Rupendehi	2	6	0	3	11	16.92
Siraha	1	0	0	0	1	1.54
Sunsari	1	0	0	0	1	1.54
Udaypur	1	0	0	0	1	1.54
Total	26	28	1	10	65	100
Proportion	38%	43%	2%	17%	100%	

The province wise concentration of cement industries has been shown in Table 2

Table 2: Concentration of industries according to province

Province	Large	Medium	Small	Unspecified	Total	% Concentration
1	6	7	0	1	14	22
2	3	8	0	3	14	22
3	5	2	0	1	8	12
5	12	11	1	5	29	45
Total	26	28	1	10	65	100

➤ **Tools**

The tools that were used for study purpose are as follows:

- **Questionnaire survey**
- **Stakeholders' Discussion (Direct interviews and KII)**
- **Statistics and Data Analysis**

➤ **Methods**

The different methods that was used for the data collection are:

- **Interview**
- **Observation**
- **Discussions and review of documents**

The data were collected via telephone interview, direct interview with the concerned stakeholder of cement manufacturing industry.

ANNEX 3 : TOTAL NUMBERS OF INDUSTRIES REGISTERED IN DOI

S. No.	Name of Industry	District	Scale	Date
1	Butwal Cement	Nawalparasi	Small	2/16/2053
2	National Cement Pvt.Ltd	Morang	Medium	6/9/2053
3	Mittal Cement Industry. Pvt. Ltd.	Jhapa	Medium	2/7/2056
4	Cosmos Cement Industries Pvt. Ltd.	Danusha	Medium	10/14/2056
5	Pashupati Cement Pvt. Ltd.	Kapilbastu	Medium	3/12/2057
6	Vijaya Cement Pvt. Ltd.	Kapilbastu	Medium	10/3/2057
7	Chitwan Cement Udhog Pvt. Ltd.	Nawalparasi	Medium	1/21/2058
8	Jagadamba Cement Ind. Pvt. Ltd.	Rupandehi	Medium	1/28/2058
9	Narayani Cement Udhog Pvt. Ltd.	Bara	Medium	3/5/2058
10	Krishna Cement Co. Pvt. Ltd.	Bara	Medium	11/1/2058
11	Brija Cement Ind. Pvt. Ltd.	Rupandehi	Medium	11/6/2058
12	Bishwokarma Cement Pvt. Ltd.	Bara	Medium	12/21/2058
13	Suprim Cement Pvt. Ltd.	Rupandehi	Medium	12/24/2059
14	Gorakhkali Cement Udyog Pvt.Ltd.	Jhapa	Medium	9/29/2060
15	Siddhartha Cement Udyog	Rupandehi	Medium	11/1/2060
16	Nepal Ambuja Cement Udyog	Rupandehi	Medium	12/2/2060
17	Reliance Cement Pvt.Ltd	Rupandehi	Medium	1/10/2061
18	Ambe Cement Pvt.Ltd	Parsa	Medium	4/15/2061
19	Shivam Cement Pvt.Ltd	Makawanpur	Medium	5/9/2061
20	Shree Cement Industry Pvt. Ltd.	Parsa	Medium	9/5/2061
64	Kailash Cement Pvt. Ltd.	Rupandehi	Medium	10/8/2061
65	Dang Cement Industries Pvt. Ltd	Salyan	Large	12/15/2061
66	Shree Krishna Cements Pvt. Ltd.	Jhapa	Medium	12/23/2061
21	Om Cement Pvt. Ltd.	Chitwan	Medium	4/30/2062
67	Koshi Cement Udhog Pvt. Ltd.	Sunsari	Medium	5/14/2062
22	Maruti Cements Ltd.	Siraha	Large	9/10/2062
23	Kp Cement Industries Pvt. Ltd.	Dhading	Large	10/19/2062

68	Jay Bageshwori Cement Industry	Banke	Medium	8/18/2063
69	Jayakali Cement Udyog Pvt.Ltd	Rupandehi	Medium	2/10/2064
70	Sagarmatha Cements Pvt.Ltd	Makwanpur	Large	2/17/2064
24	Shuva Shree Jagadamba Cement Mills	Parsa	Medium	6/24/2064
25	United Cements Pvt.Ltd	Dhading	Large	8/4/2064
26	Nigale Cements Pvt.Ltd	Dankuta	Large	10/29/2064
71	Sourya Cements Limited	Udaypur	Large	11/15/2064
72	Lotse Cement Pvt.Tld	Udaypur	Large	2/22/2065
73	Sangrila Cement	Kailali	Medium	5/3/2065
27	Ghorahi Cement Industries	Dang	Large	5/5/2065
28	Rolpa Cement	Rolpa	Large	6/13/2065
29	Sonapur Cements Pvt.Ltd	Dang	Large	10/6/2065
74	Delta Cement Pvt.Ltd	Nawalparasi	Large	12/18/2065
75	Laxmi Cement Pvt.Ltd Shakhaudyog 1	Lalitpur	Large	3/16/2066
76	Maiher Cement Pvt.Ltd	Rupandehi	Large	6/7/2066
30	Manasha Cement Industries Pvt.Ltd	Jhapa	Medium	7/18/2066
77	Unitake Cement Pvt.Ltd	Bara	Large	8/4/2066
31	Rmc Cement Pvt.Ltd	Bara	Large	11/5/2066
78	Morang Cement Industries Pvt.Ltd	Morang	Large	12/6/2066
32	Bishal Cement Industry Pvt.Ltd	Rupandehi	Large	3/20/2067
79	Ganesh Cement Udyog	Rupandehi	Large	3/20/2067
33	Ganapati Cement Ind= Pvt.Ltd	Kapilbastu	Medium	9/20/2067
80	Baba Cement Pvt.Ltd	Parsa	Large	9/26/2067
34	International Cement Pvt.Ltd	Parsa	Medium	11/12/2067
35	Routa Udayapur Cement Udyog Pvt.Ltd	Udaypur	Large	12/24/2067
36	Eastern Cosmos Cement Pvt.Ltd	Morang	Large	1/27/2068
81	Chatan Cement Industry Pvt.Ltd	Bara	Medium	1/30/2068
37	C.G.Cement Industry Pvt.Ltd	Nawalparasi	Large	2/5/2068

56	Lumbini Cement Pvt.Ltd	Rupandehi	Medium	3/17/2053
57	Surya Cement Pvt.Ltd	Sunsari	Medium	6/9/2053
58	Balaji Cement Udyog	Dhading	Large	2/22/2054
59	Kanak Cement Pvt. Ltd.	Makwanpur	Medium	1/5/2056
60	Buddha Cement Pvt. Ltd.	Kapilbastu	Medium	1/27/2057
61	Laxmi Cement Ind. Pvt. Ltd.	Banke	Medium	8/13/2057
62	Manakamana Cement Pvt. Ltd.	Siraha	Medium	3/26/2058
63	Buddha Cement Industries	Rupandehi	Large	6/30/2058
38	Kanchanjanga Cement Udyog Pvt.Ltd	Jhapa	Medium	4/19/2068
82	C.G.Cement Industry Palpa Pvt.Ltd	Palpa	Large	4/30/2068
83	Kapilbastu Cement Udyog Pvt.Ltd	Kapilbastu	Large	6/26/2068
39	Sarbottam Cement Pvt.Ltd	Rupandehi	Large	8/28/2068
84	Palpa Cement Industries Pvt.Ltd	Nawalparasi	Large	8/29/2068
85	Maruti Cements Ltd Unit 1	Siraha	Large	5/14/2069
86	Shreeram Cement Pvt. Ltd.	Rupandehi	Large	5/14/2069
40	Jaya Bageshwori Cement Pvt. Ltd.	Banke	Large	7/20/2069
87	Muktishree Cement Industries Pvt. Ltd.	Surkhet	Large	12/7/2069
41	Mahashakti Cement Pvt. Ltd.	Kapilbastu	Large	5/11/2070
42	Reliance Supertech Cement Pvt. Ltd.	Bara	Large	11/28/2070
88	Aadharsheela Cement Pvt. Ltd.	Dang	Large	12/14/2070
43	Samrat Cement Company Pvt. Ltd.	Dang	Large	1/23/2071
89	Shuvashree Agni Cement Uddyog Pvt. Ltd.	Arghakhachi	Large	3/31/2071
44	Mega Cement Industries Pvt. Ltd.	Jhapa	Large	11/11/2071
54	Riddhi Sidhhi Cement Pvt. Ltd.	Makwanpur	Large	11/20/2071
91	Gurans Cement Pvt. Ltd.	Makwanpur	Large	4/19/2072

45	Araniko Anbukhaireni Cement Industries Pvt. Ltd.	Dhading	Large	7/1/2072
52	Shuva Laxmi Cement Udhyog Pvt. Ltd.	Kapilbastu	Large	7/1/2072
53	Nepal Ultra Tech Cements Pvt. Ltd.	Morang	Large	8/8/2072
49	Hongshi Shivam Cement Pvt. Ltd.	Nawalparasi	Large	8/28/2072
46	Arghakhachi Cement Pvt. Ltd. Unit -2	Kapilbastu	Large	9/16/2072
50	Sunrise Cement Pvt. Ltd.	Jhapa	Large	11/14/2072
51	Mangala Cement Udhyog Pvt. Ltd.	Dhading	Large	5/1/2073
92	Balaji Cement Industries Pvt. Ltd.	Kapilbastu	Large	10/13/2073
93	Shikhar Cement Udhyog Pvt. Ltd.	Kapilbastu	Large	11/24/2073
90	Shubha Shree Jagdamba Cement Mills Branch Unit - 1	Parsa	Medium	2071-03-32
47	Annapurna Cement Company Pvt. Ltd.	Morang	Large	12/30/2073
94	Atal Cement Pvt. Ltd.	Kapilbastu	Large	1/3/2074
95	Bajra Cement Pvt. Ltd.	Chitwan	Large	1/11/2074
48	Bhugarbha Cement Udhyog Pvt. Ltd.	Kapilvastu	Large	1/12/2074
97	Adhunik Cement Pvt. Ltd.	Morang	Large	5/1/2074
96	Morang Cement Industry Pvt. Ltd.	Morang	Large	2074-02-31
98	Ghorahi Cement Industries Pvt. Ltd. Branch 1	Dang	Large	5/9/2074
99	Kapilvastu Cement Udyog Pvt. Ltd.	Kapilbastu	Large	5/28/2074
100	Tianyi Cement Industries	Nawalparasi	Large	7/26/2074
101	Nepal Jagadamba Cement Industries Pvt. Ltd	Nawalparasi	Large	8/12/2074
102	Huaxin Cement Narayani Pvt. Ltd.	Dhading	Large	8/29/2074

55	Janaki Cement Industries Pvt. Ltd.	Sunsari	Large	10/19/2074
103	Siddhi Laxmi Cement Pvt. Ltd.	Nawalparasi	Large	11/9/2074
104	Arun Cement Industries Pvt. Ltd.	Dang	Large	11/13/2074
105	I.M.S. Cement Pvt. Ltd.	Kapilbastu	Large	11/28/2074
106	Krishna Raj Cement Industries Pvt. Ltd.	Kapilbastu	Large	1/11/2075
107	Dhanusha Cement Industries Pvt. Ltd.	Dhanusha	Large	3/11/2075
108	A Plus Cement Pvt. Ltd.	Jhapa	Large	4/20/2075
109	Atharva Cement Pvt. Ltd.	Syangja	Large	5/28/2075
110	B.S. Cement Industries Pvt. Ltd.	Palpa	Medium	6/2/2075
111	Synergy Cement Pvt. Ltd.	Kapilbastu	Large	8/10/2075
112	Maruti Cements Limited Branch Unit 1	Siraha	Large	8/23/2075
113	Kabeli Cement Industries Pvt. Ltd.	Jhapa	Large	9/2/2075
114*	Garud Cement Industries Pvt. Ltd.	Kathmandu	Large	10/20/2075
115*	Agni CementP Ltd	Rupandehi		
116*	Araniko Cement Pvt ltd	Bara		
117*	Goenka Cement Pvt Ltd	Rupandehi		
118*	Hetauda Cement Udhyog ltd	Makawanpur		
119*	Himalayas cement	Jhapa		
120*	Jaya Mangalam Cements P Ltd	Banke		
121*	Mjaypee cement	Kapilbastu		
122*	Nepal Shalimar Cement P Ltd	Bara		
123*	Pathak Cement P Ltd	Rupandehi		
124*	Star cement	Bara		

* Record not found in DOI but listed in NBSM

ANNEX 4 : CLINKER IMPORT FROM INDIA IN 2016

Sample of clinker Import from India in 2016					
Month	Port of India	Clinker Qt Mt	CIF	NPR	
Nov	Raxull	12,501.71	490,144.91	53,915,940.10	4.31
October		41,922.66	2,068,556.54	227,541,219.40	5.43
Sept		30,460.35	1,906,552.34	209,720,757.40	6.89
Aug		44,245.71	2,312,367.19	254,360,390.90	5.75
Feb		1,188.70	37,989.38	4,178,831.80	3.52
May		7,496.66	430,972.89	47,407,017.90	6.32
June		29,979.72	1,505,430.81	165,597,389.10	5.52
Jul		15,150.28	904,903.89	99,539,427.90	6.57
March		7,447.17	245,785.60	27,036,416.00	3.63
Total		190,392.96	9,902,703.55	1,089,297,390.50	5.72

ANNEX 5 : IMPORT STATUS OF CEMENT, CLINKER, GYPSUM AND COAL

FY		Gypsum (kg)	Limestone (kg)	Clinker (kg)	Cement (kg)	Coal (kg)
2007/08	2064/65	43355965	111365	591545335	316277370	-
2008/09	2065/66	62229736	277925	649244171	586293520	-
2009/10	2066/67	63992474	1239715	1199725540	606085161	-
2010/11	2067/68	-	-	-	553145876.5	-
2011/12	2068/69	103,795,544	350,260	1,136,406,656	500,206,592	360174112
2012/13	2069/70	145,067,904	244,551	886,301,120	476,701,632	454139360
2013/14	2070/71	124003109	270461	946658432	388217296	592478755.50
2014/15	2071/72	178081548	381785	1300680960	295267406	793651625.00
2015/16	2072/73	201934180	900640	1460463488	212632059	761949925.00
2016/17	2073/74	294869048.1	1070040	2939152157	106624456.2	992434307.97
2017/2018	2074/75	342195372.3	1693928.5	3317972914	84513726	1302961532.33

**ANNEX 6 : OPERATING LIMESTONE MINES FROM DEPARTMENT OF MINES
AND GEOLOGY**

S.No	License Category	License No.	License Holder	Location			Total Area
				State	District	Local Level	
1	General	131/074/75	Keshab Kumar Budhathoki	1	Udayapur	Chaudandigadhi	3.44
2	General	26/069/70	Udayapur Mineral Tech Pvt. Ltd	1	Udayapur	Katari	2
3	General	161/068/69	Tadi Cement and Lime Industries Pvt.Ltd	3	Nuwakot	Tadi	3
4	General	10/062/63	Bhardeu Cement and Stone Ind. Pvt. Ltd	3	Lalitpur	Konjyosom	3
5	General	68/066/67	Century Cements Pvt.Ltd	3	Lalitpur	Bagmati	2
6	General	08/066/67	United Cements Pvt.Ltd	3	Lalitpur	Konjyosom	0.672
7	General	78/064/65	Shivam Cement Limited	3	Makawanpur	Makawanpurgadhi	2.88
8	General	78/066/67	Shivam Cement Limited	3	Makawanpur	Bhimphedi	9.99
9	General	09/066/67	United Cements Pvt.Ltd	3	Lalitpur	Konjyosom	1.25
10	General	23/071/72	Laxmi Mining Pvt. Ltd	3	Chitawan	Rapti	1.425
11	General	1370/031/11	Ajay Raj Sumargi	3	Makawanpur	Bhimphedi	1.012
12	General	218/394/042/43	Annapurna Quarries Pvt. ltd	3	Dhading	Benighat Rorang	2.592

13	General	36/063/64	Nawadurga Chundhunga Industries Pvt. Ltd	3	Dhading	Dhunibesi	0.75
14	General	22/074/75	R. S. Chala Industries Private limited	3	Kabhrepanchok	Bethanchowk	3
15	General	79/066/67	Shivam Cement Limited	3	Makawanpur	Makawanpurgadhi	3
16	General	47/063/64	Shivam Cement Limited	3	Makawanpur	Makawanpurgadhi	5
17	General	17/063/64	Star Lime Industries Pvt. Ltd	3	Chitawan	Kalika	1
18	General	138/067/68	Annapurna Quarries Pvt. Ltd	3	Dhading	Benighat Rorang	4.5
19	General	33/072/73	Nepal Shalimar Cement Pvt.Ltd.	3	Makawanpur	Bhimphedi	4.728
20	General	148/074/75	Barahi Quarries Pvt. Ltd.	4	Tanahu	Byas	3.85
21	General	211/071/72	Pashupati Quarry Pvt.ltd	4	Tanahu	Byas	1.812
22	General	35/063/64	Pashupati Murarka	4	Gorkha	Gandaki	5
23	General	119/064/65	Kanchan Quarries Pvt .Ltd	5	Palpa	Tinau	9
24	General	114/067/68	Sonapur Minerals and Oil Pvt. Ltd	5	Dang	Banglachuli	4.165
25	General	135/074/75	Satya Sai Coal Uddhyog Pvt. Ltd	5	Rolpa	Runtigadi	1.95
26	General	180/065/66	Siddhartha Mineral Pvt. Ltd.	5	Palpa	Tinau	2.991
27	General	102/071/72	Pradhan Khanji Udhhyog Pvt. Ltd.	5	Rolpa	Runtigadi	7.56

28	General	04/073/74	Jagdamba Cement Industries Pvt. Ltd.	5	Palpa	Rainadevi Chhahara	9
29	General	49/073/74	Tirupati Mines Pvt. Ltd.	5	Rolpa	Runtigadi	13
30	General	80/066/67	Sonapur Minerals and Oil Pvt. Ltd	5	Dang	Ghorahi	4.5
31	General	72/067/68	Bishow karma Mines and Minerals Pvt. Ltd.	5	Dang	Banglachuli	5.5
32	General	61/066/67	Rolpa Cement Pvt. Ltd	5	Rolpa	Tribeni	5.1
33	General	29/072/73	Satyawati Khanji Utakhanan Pvt. ltd.	5	Palpa	Tinau	8.663
34	General	150/071/72	Ganapati Quarries Pvt. Ltd	5	Dang	Ghorahi	3.993
35	General	07/073/74	Alpha Construction & Developers Pvt. Ltd	5	Palpa	Tinau	2.563
36	General	82/063/64	Dolomite Chundhunga Udhyog Pvt. Ltd	5	Palpa	Tinau	3.75
37	General	11/069/70	Sarbottam Cement Pvt. Ltd	5	Palpa	Tinau	11.946
38	General	06/073/74	Palpa Cement Industries Pvt. Ltd.	5	Palpa	Mathagadhi	5.85
39	General	44/069/70	Shubhashree Agni Cement Udyog P. Ltd	5	Pyuthan	Naubahini	15
40	General	213/071/72	Sonapur Minerals and Oil Pvt. Ltd	5	Rolpa	Runtigadi	3

41	General	42/074/75`	Hongshi Shivam Cement Pvt. Ltd.	5	Palpa	Nisdi	12
42	General	125/074/75	B S Cement industries PVt. Ltd	5	Palpa	Mathagadhi	17
43	Special	1/062/63	Nigale Cement Pvt. Ltd.	1	Dhankuta	Sangurigadhi	1.875
44	Special	303/479/045/46	Udayapur Cement Udhog Limited	1	Udayapur	Triyuga	5.387
45	Special	30/068/69	Cosmos cement industries Pvt.Ltd	1	Udayapur	Udayapurgadhi	17.105
46	Special	38/055/56	Shaurya Cement Limited	1	Udayapur	Katari	6.475
47	Special	91/074/75	Kamala Devi Khanij Udhog Pvt. Ltd.	3	Kabhrepanchok	Panauti	1.357
48	Special	150/326/042/43	Hetauda Cement Udyog Limited	3	Makawanpur	Hetauda	24
49	Special	1487/393/032	Hetauda Cement Udyog Limited	3	Dhading	Benighat Rorang	1.544
50	Special	1599/549/036/37	Hetauda Cement Udyog Limited	3	Makawanpur	Bhimphedi	1.319
51	Special	39/055/56	Bhugarbha Cement Udhog Pvt. Ltd.	5	Arghakhanchi	Sandhikharka	7.76

**ANNEX 7 : PROSPECTING LIMESTONE MINES FROM DEPARTMENT OF MINES
AND GEOLOGY**

S. No	License Category	License No.	License Holder	Location			Total Area
				State	District	Local Level	
1	General	49/074/75	K.K. Limes and Cement Industries Pvt. Ltd.	1	Udayapur	Chaudandigadhi	1.98
2	General	17/074/75	Shailu Koirala	1	Udayapur	Rautamai	1.8
3	General	15/062/63	Kishan Lal Dugadh	1	Udayapur	Katari	2.243
4	General	98/074/75	Raju Dahal	1	Ilam	Sandakpur	6.615
5	General	56/072/73	Nirendra Pradhan	1	Khotang	Rupakot Majhuwagadhi	0.992
6	General	21/074/75	Manoj Kumar Dawadi	1	Udayapur	Triyuga	1.274
7	General	24/074/75	Man Bahadur Shrestha	1	Udayapur	Katari	5.031
8	General	57/074/75	Everest Quarries Pvt. Ltd.	1	Dhankuta	Khalsa Chhintang Shahidbhumi	5.972
9	General	161/070/71	Prakash Tayal	1	Ilam	Illam	5
10	General	72/074/75	DantaKali Quarries Pvt. Ltd	1	Dhankuta	Khalsa Chhintang Shahidbhumi	5.946
11	General	98/072/73	Dantakali Cement Pvt. Ltd.	1	Dhankuta	Dhankuta	4.94
12	General	62/073/74	Sarad Golchha	1	Udayapur	Katari	4.445
13	General	52/073/74	Purna Bhadra Poudel	1	Udayapur	Katari	2.28

14	General	83/073/74	Bharat Golcha	1	Udayapur	Katari	16
15	General	56/062/63	Naresh Dugad	1	Udayapur	Katari	14.68 2
16	General	43/074/75	Sengbo Minerals Pvt.Ltd.	1	Udayapur	Triyuga	12.02 5
17	General	121/074/7 4	Chandra Kumar Golchha	1	Udayapur	Katari	20
18	General	55/072/73	Gyanendra Prasad Pradhan	1	Khotang	Halesi Tuwachung	2.99
19	General	92/073/74	Sashikala Shrestha	1	Dhankuta	Dhankuta	4
20	General	82/074/75	Jeevan Kumar Paudel	1	Dhankuta	Khalsa Chhintang Shahidbhumi	7.956
21	General	83/072/73	K.K. Limes and Cement Industries Pvt. Ltd.	1	Khotang	Barahapokhari	4.8
22	General	48/072/73	Kumud Kumar Dugad	1	Udayapur	Rautamai	11
23	General	02/075/76	Dhurba Bhattarai	1	Ilam	Sandakpur	4.961
24	General	54/074/75	Sitaram Neupane	3	Makawanpu r	Bhimphedi	1.378
25	General	237/070/7 1	Sabita Kediya	3	Makawanpu r	Kailash	6.525
26	General	86/074/75	Ram Krishna Regmi	3	Dhading	Benighat Rorang	2.903
27	General	75/072/73	Binay Malla	3	Chitawan	Rapti	2.45
28	General	132/068/6 9	Nepal Shalimar Cement Pvt.Ltd.	3	Makawanpu r	Bhimphedi	3.506
29	General	232/070/7 1	Star Lime Industries Pvt. Ltd	3	Chitawan	Kalika	2

30	General	3/070/71	Dhurba Raj Thapa	3	Sindhuli	Kamalamai	7.48
31	General	86/073/74	M/S Lulu Mines and Minerals Pvt Ltd	3	Sindhuli	Golanjor	9.006
32	General	109/064/65	Cosmos cement industries Pvt.Ltd	3	Sindhuli	Sunkoshi	31.68
33	General	74/072/73	Suman Budathoki	3	Kabhrepalanchok	Khanikhola	4.94
34	General	37/073/74	Hari Maya Dong	3	Makawanpur	Makawanpurgadhi	0.275
35	General	19/074/75	Udeep Shrestha	3	Makawanpur	Bhimphedi	5.125
36	General	49/071/72	Shyam Shrestha	3	Lalitpur	Bagmati	4.611
37	General	70/072/73	Anjana Shrestha	3	Makawanpur	Hetauda	2.49
38	General	264/070/71	Himalayan Microne mines& Minerals Makawanpur P. L	3	Makawanpur	Bhimphedi	2.875
39	General	46/073/74	Dibya Tara Minerals Industries PVt. Ltd	3	Dhading	Benighat Rorang	4
40	General	30/072/73	Himalayan Mines and Minerals Pvt.ltd	3	Chitawan	Ichchhyakamana	4.988
41	General	162/074/75	Shyam Krishna Subedi	3	Dhading	Dhunibesi	1.9
42	General	26/072/73	Manoj Kumar Kedia	3	Kabhrepalanchok	Roshi	4.715
43	General	89/072/73	Riddhi Siddhi Resources Pvt. Ltd.	3	Makawanpur	Bhimphedi	0.99
44	General	80/072/73	Advance Jayagurudev Mining Pvt. Ltd.	3	Sindhuli	Kamalamai	1.9

45	General	5/074/75	Mina Devkota	3	Makawanpur	Thaha	0.95
46	General	98/070/71	Septum Mining Industries Pvt.Ltd	3	Chitawan	Ichchhyakamana	9.826
47	General	135/068/69	Laxmi Lime Products	3	Makawanpur	Makawanpurgadhi	0.75
48	General	48/073/74	Chandra Jyoti Upadhyaya	3	Dhading	Benighat Rorang	0.935
49	General	78/073/74	Dharma Raj syangbo	3	Lalitpur	Bagmati	8.813
50	General	128/074/75	Gupta Bahadur Shrestha	3	Dhading	Benighat Rorang	2
51	General	108/070/071	Shivam Cement Limited	3	Makawanpur	Makawanpurgadhi	1.7
52	General	144/074/75	Rajendra Prasad Shrestha	3	Dhading	Benighat Rorang	3
53	General	223/071/72	Shyam Lama	3	Dhading	Dhunibesi	0.76
54	General	79/074/75	Shovakar Neupane	3	Makawanpur	Kailash	5.645
55	General	42/073/74	Agrim International Pvt. Ltd.	3	Lalitpur	Konjyosom	0.363
56	General	214/069/70	Shiva Ratan Sharada	3	Makawanpur	Bhimphedi	2.844
57	General	158/070/71	Dipak Lal Amatya	3	Dhading	Thakre	1.575
58	General	114/072/73	Bhim Bahadur Thapa Chhetri	3	Dhading	Dhunibesi	0.254
59	General	20/072/73	Advance Jayagurudev Mining Pvt. Ltd.	3	Sindhuli	Phikkal	10

60	General	76/072/73	Bijay Bista	3	Lalitpur	Bagmati	7
61	General	3/061/62	Manakamana Mines and Minerals Pvt . Ltd	3	Chitawan	Ichchhyakama a	11.80 6
62	General	45/072/73	Surendra Kumar Goyal	3	Chitawan	Kalika	15.95
63	General	125/069/70	Shivam Cement Limited	3	Makawanpu r	Bhimphedi	5.76
64	General	236/069/70	Riddhi Siddhi Cement Pvt. Ltd	3	Makawanpu r	Raksirang	23.15 6
65	General	105/074/75	Alpha Construction & Developers Pvt. Ltd	3	Kabhrepala nchok	Panauti	21.2
66	General	206/071/72	Binu Sauden	3	Makawanpu r	Thaha	3.938
67	General	52/075/76	Raju Bhandari	3	Dhading	Benighat Rorang	2.75
68	General	77/068/69	Kanchanjungha Ultratech Cement Pvt. Ltd.	3	Dhading	Dhumibesi	9
69	General	73/072/73	Garud Cement industries Pvt.Ltd	3	Kabhrepala nchok	Khanikhola	6.96
70	General	167/071/72	Aakash Kumar Agrawal	3	Dhading	Thakre	5.5
71	General	11/074/75	Himalaya Mines and Minerals Pvt. Ltd.	3	Dhading	Benighat Rorang	5.283
72	General	40/072/73	Devi Prasad Pandey	3	Makawanpu r	Bhimphedi	0.25
73	General	06/074/75	Shikha Maskey	3	Kabhrepala nchok	Mahabharat	3.988

74	General	41/072/73	Dangote Cement Nepal Pvt. Ltd.	3	Makawanpur	Makawanpurgha dhi	0.675
75	General	61/073/74	Nepal Shalimar Cement Pvt.Ltd.	3	Kabhrepalanchok	Khanikhola	10.25
76	General	168/071/72	Kamala Barahi	3	Kabhrepalanchok	Panauti	1
77	General	10/066/67	Shivam Cement Limited	3	Makawanpur	Makawanpurgha dhi	1.506
78	General	48/071/72	Jayashowari Joshi	3	Lalitpur	Bagmati	3
79	General	45/073/74	Siddhi construction material and mineral industrie	3	Dhading	Benighat Rorang	2
80	General	77/073/74	Aashish Khadka	3	Dhading	Dhunibesi	2.156
81	General	75/073/74	Laxmi Basyal	3	Kabhrepalanchok	Panauti	1.495
82	General	63/073/74	Ram Lal Thing	3	Makawanpur	Bhimphedi	1.034
83	General	58/072/73	Gaurab Goyal	3	Nuwakot	Suryagadhi	9.75
84	General	111/071/72	Mining and Mining Industries Pvt.Ltd	3	Makawanpur	Thaha	3.99
85	General	170/071/72	Ritesh Goyal	3	Dhading	Thakre	1.502
86	General	81/074/75	Golden Pyagoda Cement Industries Pvt.Ltd.	3	Dhading	Dhunibesi	3.6
87	General	134/070/71	Shree Sampanna Quarries Pvt. Ltd	3	Dhading	Thakre	0.6
88	General	23/073/74	Suyesh Khand Thakuri	4	Syangja	Putalibazar	1
89	General	93/074/75	Urmila Sharma	4	Syangja	Waling	3.884

90	General	4/074/75	Shreyaj Poudel	4	Syangja	Waling	3.8
91	General	81/073/74	Maiya Nani Dhamala	4	Syangja	Waling	3.019
92	General	66/072/73	Laxman Dev Acharya	4	Syangja	Waling	2.975
93	General	76/073/74	Harihar Prasad Lamichhane	4	Syangja	Waling	3.491
94	General	106/074/7 5	Machhapuchhre Gems Stone & Minerals Pvt.Ltd.	4	Syangja	Bhirkot	3.975
95	General	27/075/76	Bhakta Bahadur Rana	4	Tanahu	Anbukhaireni	1.875
96	General	26/073/74	Atharva Cement Pvt. Ltd	4	Syangja	Biruwa	3.975
97	General	24/073/74	Samip Dhoj Khand Thakuri	4	Syangja	Putalibazar	2.97
98	General	8/073/74	Madhyapaschimanc hal Khani Tatha Khanij Pvt. Ltd	5	Dang	Banglachuli	3.859
99	General	64/070/71	Anup Kumar Chachan	5	Dang	Banglachuli	8
100	General	179/071/7 2	Samrat Cement company Pvt.ltd.	5	Dang	Banglachuli	8.96
101	General	259/070/7 1	Shubhashree Agni Cement Udyog P. Ltd	5	Dang	Banglachuli	5.59
102	General	160/071/7 2	Dahaune Devi Mineral Pvt. Ltd.	5	Palpa	Purbakhola	4
103	General	139/071/7 2	Bibek Tayal	5	Dang	Ghorahi	1.76

104	General	132/074/75	Dipesh Karmacharya	5	Pyuthan	Pyuthan	20
105	General	96/073/74	Synergy Minerals Pvt. Ltd	5	Pyuthan	Mandavi	6
106	General	193/071/72	Prahladh Aryal	5	Dang	Shantinagar	25.5
107	General	64/074/75	Prakash Narayan Shrestha	5	Rolpa	Tribeni	1.969
108	General	97/074/75	Suresh Simkhada	5	Palpa	Mathagadhi	8.55
109	General	66/074/75	Murari Lal Agrawal	5	Pyuthan	Ayirabati	6
110	General	13/072/73	Maruti Minerals Pvt.Ltd	5	Arghakhanchi	Malarani	12
111	General	174/071/72	Ganga Mines Pvt.Ltd	5	Dang	Banglachuli	7.95
112	General	77/072/73	Bhim Bahadur Chanda	5	Rolpa	Rolpa	9.625
113	General	113/066/67	Shakti Minerals Pvt. Ltd	5	Palpa	Rainadevi Chhahara	15.663
114	General	25/074/75	Ram Krishna Sharma	5	Rolpa	Rolpa	2.475
115	General	70/071/72	Madan Kumar Archaya	5	Rolpa	Tribeni	4.991
116	General	126/074/75	Hemanta Prasad Tiwari	5	Palpa	Rainadevi Chhahara	3.983
117	General	124/064/65	Narayani Cement Udhog Pvt. Ltd	5	Arghakhanchi	Panini	9.44
118	General	215/071/72	Janak Raj K.C.	5	Rolpa	Suwarnabati	4.829
119	General	56/073/74	Durga Bahadur Gharti	5	Rolpa	Runtigadi	0.659

120	General	209/071/72	Shuvam Khanij Udyog Pvt. Ltd	5	Dang	Banglachuli	7.24
121	General	88/071/72	C. G. Cement Enterprises Palpa Pvt. Ltd.	5	Palpa	Rainadevi Chhahara	8
122	General	48/068/69	Kiran Coal Udhog pvt. Ltd.	5	Dang	Banglachuli	3.996
123	General	90/073/74	Rolpa Chundhunga Khani Pvt. Ltd	5	Rolpa	Tribeni	6.951
124	General	188/071/72	Aayu Cement Pvt. Ltd	5	Rolpa	Suwarnabati	8.945
125	General	33/074/75	Himkala Aryal	5	Pyuthan	Sarumarani	2.987
126	General	22/072/73	Palpa Cement Industries Pvt. Ltd.	5	Palpa	Mathagadhi	8.346
127	General	80/071/72	Shiva Sworup Khanij Udyog Pvt. Ltd	5	Rolpa	Tribeni	2.775
128	General	76/071/72	Topendra Kumar Sharma	5	Rolpa	Tribeni	10
129	General	38/071/72	Sagar Cement Industry Pvt. Ltd	5	Arghakhanchi	Sandhikharka	3.96
130	General	157/064/65	Sirish Kumar Muraka	5	Palpa	Tinau	1.4
131	General	60/074/75	Brihaspati Cement Pvt. Ltd	5	Arghakhanchi	Panini	5
132	General	100/072/73	Prem Lal Khanij Udhog Pvt. Ltd.	5	Dang	Banglachuli	2.97
133	General	42/071/72	Amit Tayal	5	Rolpa	Runtigadi	0.825
134	General	24/072/73	Shakti Minerals Pvt. Ltd	5	Palpa	Mathagadhi	5.658

135	General	29/073/74	Sagar Shrestha	5	Palpa	Nisdi	3
136	General	7/075/76	Tirupati Mines Pvt. Ltd.	5	Rolpa	Runtigadi	1.96
137	General	51/062/63	Makalu Cement Industries Pvt. Ltd.	5	Arghakhanchi	Sandhikharka	5.415
138	General	95/068/69	Sarbottam Cement Pvt. Ltd	5	Palpa	Tinau	4.524
139	General	12/073/74	Bijaya Cements Pvt. Ltd.	5	Arghakhanchi	Bhumekasthan	9.134
140	General	55/073/074	Krishna Poudel	5	Pyuthan	Mallarani	3.978
141	General	28/071/72	Jagdamba Cement Industries Pvt. Ltd.	5	Palpa	Nisdi	8.925
142	General	18/069/70	Sungava Mines Pvt. Ltd	5	Dang	Tulsipur	9.5
143	General	62/074/75	Tuka Man Mahara	5	Dang	Banglachuli	1.464
144	General	152/074/75	Aayan Minerals Pvt. Ltd	5	Gulmi	Kaligandaki	2.94
145	General	157/074/75	Sarita Poudel	5	Arghakhanchi	Chhatradev	4.125
146	General	5/072/73	P. T. Mines Pvt. Ltd.	5	Rolpa	Runtigadi	9.985
147	General	27/074/75	Maruti Minerals Pvt. Ltd	5	Arghakhanchi	Malarani	6
148	General	3/068/69	Shakti Minerals Pvt. Ltd	5	Palpa	Mathagadhi	4.838
149	General	06/072/73	Jay Prakash Sharma	5	Rolpa	Madi	12.128
150	General	68/074/75	Anup Giri	5	Dang	Babai	4

151	General	88/068/69	Samrat Cement company Pvt.ltd.	5	Dang	Banglachuli	3.22
152	General	208/071/72	Shuvam Khanij Udyog Pvt. Ltd	5	Dang	Banglachuli	8.97
153	General	59/069/70	Hemanta Dangi	5	Dang	Ghorahi	0.95
154	General	146/070/71	Khagi Maya Pun	5	Pyuthan	Mandavi	1.9
155	General	40/068/69	Chhuten Lama	5	Pyuthan	Mandavi	6
156	General	64/064/65	C. G. Cement Enterprises Palpa Pvt. Ltd.	5	Palpa	Rainadevi Chhahara	13.5
157	General	47/068/69	Kiran Coal Udhog pvt. Ltd.	5	Rolpa	Runtigadi	2.993
158	General	98/073/74	Rolpa Chundhunga Khani Pvt. Ltd	5	Rolpa	Runtigadi	1.615
159	General	178/068/69	Subash Chandra Yogi	5	Dang	Ghorahi	8.505
160	General	188/070/71	Binod Kumar Shrestha	5	Palpa	Purbakhola	5.876
161	General	63/068/69	Swargdawari Mines and Minerals Pvt. Ltd.	5	Dang	Ghorahi	3.99
162	General	17/072/73	P. T. Mines Pvt. Ltd.	5	Rolpa	Runtigadi	3
163	General	26/074/75	Ram Chandra Kandel	5	Pyuthan	Mandavi	4.97
164	General	35/064/65	Om Prakash Bhattarai	5	Dang	Ghorahi	3.6
165	General	276/070/71	Shivam Cement Limited	5	Palpa	Nisdi	10.178

166	General	32/074/75	Archale Mines and Minerals Pvt. Ltd	5	Palpa	Nisdi	3.372
167	General	18/072/73	Ganga Mines Pvt.Ltd	5	Pyuthan	Jhimruk	13.275
168	General	169/070/71	Shuvam Khanij Udyog Pvt. Ltd	5	Rolpa	Runtigadi	5.995
169	General	94/073/74	Shiva Sworup Khanij Udyog Pvt. Ltd	6	Salyan	Kapurkot	0.978
170	General	28/074/75	Appi Cement Pvt. Ltd.	7	Kailali	Dhangadhi	13.5
171	General	47/072/73	Sunita Goshali	7	Baitadi	Surnaya	8
172	Special	80/074/75	Maruti Cements Ltd.	1	Udayapur	Triyuga	0.938
173	Special	71/074/75	Huaxin Cement Narayani Pvt. Ltd	3	Dhading	Benighat Rorang	24.245
174	Special	84/074/75	United Cements Pvt.Ltd	3	Dhading	Benighat Rorang	20.935
175	Special	88/074/75	Swargadwari Multipurpose Pvt. Ltd	5	Palpa	Purbakhola	15
176	Special	78/074/75	IME Group Pvt. Ltd.	5	Palpa	Nisdi	15
177	Special	77/074/75	IME Group Pvt. Ltd.	7	Baitadi	Dogadakedar	15

ANNEX 8 : LIST OF EXPERTS CONSULTED DURING THE STUDY

Experts' Name	Institution	Designation	Remarks
Mr. Dhurba Thapa	Cosmos Cement		
Mr. Keshab Upreti	Kepy Cement	General Manager	
Mr. Bishnu Neupane	Saurav Group / Jagadamba Cement	Chairman	
Mr. Umesh Chandra Thakur	Narayni Cement Jaibageshwori Cement	General Manager	
Mr. Tara Pokharel	Agni Cement	General Manager	
Mr. Shiv Ratna Atal	Shivam Cement	DGM	
Mr. Jaganath Dahal	Jagadamba Cement	Sr. Brand Manager	
Mr. Raju Poudel	Arghakhanchi Cement	Finance Manager	
Mr. Gokul Dhital	Cement Manufacturing Association	Executive Director	
Mr. Bhisma Pandit	International Finance Corporation	Operations Officer; Global Infrastructure & Natural Resources	
Mr. Ram Prasad Ghimire	Department of Mine and Geology	Deputy Director	
Mr. Binod Prakash Singh	Department of Industry	Director General	
Mr. Krishna Kharel	Department of Industry	Director	
Mr. Pushpa Shiwakoti	Department of Industry	Statistical Officer	

References

- Global Cement & Concrete Association. (2019). *Guidelines for Co-Processing Fuels and Raw Materials in Cement Manufacturing*. World Business Council for Sustainable Development .
- American Geological Survey. (2018).
- CBS. (2018). *Central Bureau of Statistics*. Retrieved from <https://cbs.gov.np/national-accounts/>.
- DMG. (2019). *Department of Mines and Geology*. Retrieved from <http://gis.dmgnepal.gov.np/dmg/>
- DOI. (2018). *Department of Industry*. Retrieved from <https://www.doind.gov.np/>
- Fradinata, E., Sirivongpaisal, N., Suthummanon, S., & Suntiamorntuthq, W. (2014). ANN, ARIMA and MA timeseries model for forecasting in cement manufacturing industry: Case study at lafarge cement Indonesia. *Advanced Informatics*.
- GIZ/ NEEP. (2012). *Report on Baseline Study of Selected Sector Industries to assess The Potentials for more Efficient use of Energy*.
- Jayanth, N., & Vidyashankar, S. (2014). Optimization of Capacity Utilization in a Manufacturing Industry – A Case Study. *International Journal Of Modern Engineering Research (IJMER)*, 4(3), 28-29.
- Marcus V. Pollio. (1st century BCE). *Ten books of Architecture*.
- MECS. (1998). *Energy Consumption in Cemrent Industry*. Manufacturing Energy Consumption Survey.
- Ministry of Finance. (2018). *Economic Survey*.
- NBSM. (2018). *Nepal Bureau of Standards and Metrology*. Retrieved from <http://nbsm.gov.np/ne/>
- NRB. (2018). *Economic Activities Study Report*. Nepal Rastriya Bank.
- Shrestha, A., Ghimire, A., & Singh, A. (2016, December). Energy Use in Nepalese Cement Industries:Case of Udayapur Cement Industries Limited. *International Journal of Scientific and Engineering Research*, 7(12).
- TEPC. (2019). *Trade and Export Promotion Centre*. Retrieved from <http://www.tepc.gov.np/>
- Trading Economics*. (2018). Retrieved from <https://tradingeconomics.com/nepal/indicators>
- US Geological Survey. (2018). *Mineral Commodities Summaries*.
- WCA. (2019). *World Coal Organization*. Retrieved from <https://www.worldcoal.org/>
- World Cement*. (2018). Retrieved from <https://www.worldcement.com/>