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The contribution of economics to understanding environmental cost: A case study of the Libyan cement industry, 1988-2008

The contribution of economics to understanding environmental cost: A case study of the Libyan cement industry, 1988-2008

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A thesis submitted to the University of Huddersfield in partial fulfilment of the requirements for the degree of Doctor of Philosophy

February 2012

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This study considers how an increase in production costs following an action to reduce environmental pollution would be shared between the producer and the consumer. As such, it makes an interesting contribution to the literature on environmental economics by discussing, and modelling, how such a cost increase would be shared between the producer and the consumer. Producers might be more willing to undertake pollution control given that they are more than likely not going to have to bear all of the control cost. Consumers would bear some of that through a price increase. They would need to recognise that they should accept some of the responsibility for pollution control through higher prices that contribute to the cost of installing 'cleaner' production methods.

The method used in the study is a descriptive and analytical (time series analysis and the application of microeconomic analysis tools) to determine the potential effects of environmental policy on the case study company. In essence, the study calculates price elasticities of demand and supply and applies an appropriate value for the cost of environmental improvement. Then the relative elasticities are used to determine producer and consumer shares of the cost increase.

The student has selected one of the major cement producers in Libya – the Ahlia Cement Company and studied four of their cement manufacturing plants. He spent three months working with the plant managers to compile a database of costs and revenue; this data being previously unavailable in this form. Data was collected for the period, 1988-2008. The environmental cost used in the estimation is drawn from their company accounts.

The study starts by setting the world context for cement production, and pollution, and then puts Libyan environmental policy into that wider context. It then concentrates on the four separate cement manufacturing plants within the Ahlia Cement Company.

The specific lessons that can be drawn for managing environmental improvements in the Libyan cement industry can be extended somewhat to other Libyan industries and the wider global environment.

Copyright Statement

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Acknowledgements

I am very grateful to my supervisors Mr John Day & Dr Julia Meaton and the Allah Cement Company, for their efforts and guidance throughout the entire research.

Special thanks are addressed to Ahamemmed Omer Ahamemmed , Ali Kalf-Allah , Ahamed Al-Dhaash & Fathihe Abo-shafa and all the workers in Ahlia Cement Company and its factories for their help.

Dedication

This Thesis is dedicated to my parents, brother, sisters, my wife & my daughters Ruba and Lien. With Love and Respect.

Chapter One
Introduction

1.1. A Historical Overview of Pollution

Humankind has had a major role in causing environment pollution, and people have been creating waste since 'pre-history'. In those early days, the waste was burned, put into the water, buried in the ground or was piled on the surface. Since the waste from these early civilisations was mostly food waste or other organic material, it was easily broken down through natural decay. Equally importantly, the population was small and they were distributed over large areas of land. As a result, pollution was not an issue.

The spread of pollution started when groups of people began living together in cities, where unhealthy practices and the polluting of water resources caused a spread of collective epidemics in many ancient cities. These became the more serious, or dangerous, environmental problems of the eighteenth century and the beginning of the nineteenth century. An obvious role was played by the industrial revolution, which began in England and then spread to other European countries and North America. This period being characterized by the development of factories and urban crowding by those employed in the industrial sector.

The factories during the industrial revolution derived most of their energy from coal and most of the houses of the cities used coal as heating fuel. The burning of this coal led to the pollution of urban environments with smoke and soot. Poor health facilities and the contamination of drinking water resources in the cities by sewage led to typhoid fever and other diseases, and urban living become a significant health risk.

In the United States air pollution started to become a significant risk at the beginning of the twentieth century, by the 1930s many cities in the Middle East and the West had filled their atmosphere with smoke and soot emitted from the cement factories, steel factories, power stations and railway stations .

Although technological developments and the discovery of new, less obviously environmentally damaging fuels has led to the improvement of urban environments around the world, there are still many environmental problems that need attention. These problems include “outdoor urban smog, indoor air pollution, acid deposition, Antarctic ozone depletion, global ozone reduction and global warming“ (Jacobson, 1998). Although pollution has many sources (including natural phenomena) it is clear that industry can and does have a large and dangerous impact on the environment. The particular industry explored in this thesis is the cement industry.

1.2. Pollution caused by the world cement industry

In the booming economy that extends from Asia to Eastern Europe, cement is the raw material of progress. It is both capable of keeping other building elements together as well as being used to make concrete, and so cement is an essential component in buildings. As the world has developed the use of cement has increased and this is exemplified by the fact that China alone consumes 45% of global cement production, and Ukraine, a smaller emerging economy, has doubled the volume of production during the last decade. The demand for cement has therefore risen, and this is exacerbated by the non-recyclability of the product. (Ashargalawst, 2007)

Until recent times the dust and soot from cement plant chimneys was considered the most important, and serious, environmental problem in the cement industry. However, since the late 1980s / mid 1990s, a widening list of pollutants has come to the notice of scientists, citizens and legislators, which include the following (Aboud 2005):

- Nitrogen Oxide (NO_2): Formed when nitrogen (N_2) combines with oxygen (O_2) in the burning of fossil fuels, as well as from the natural degradation of vegetation, and the use of chemical fertilizers. NOx gases are a significant component of acid deposition and a precursor of photochemical smog. (Coal.ca, 2008). Also, harmful gases (which contribute to acid rain and global warming) are emitted as a by-product of fossil fuel combustion.(En.Mimi.hu, 2008)

- Sulphur oxides (SO_2): A family of gases, including sulphur dioxide (SO_2) formed when sulphur, or fossil fuels containing sulphur, burn in air. Airborne sulphur compounds may be converted to other substances which contribute to acid deposition. (Coal.ca, 2008)
- Carbon monoxide (CO). A colourless odourless poisonous flammable gas formed when carbon compounds burn incompletely because there is not enough oxygen. Also produced by the action of steam on hot carbon and used as a reducing agent in metallurgy and as a fuel. (Thefreedictionary, 2007)
- Hydrocarbons. A class of compounds containing hydrogen and carbon formed by the decomposition of plant and animal remains, including coal, mineral oil, petroleum, natural gas, paraffin, the fossil resins and the solid bitumens occurring in rocks. Gasoline is a mixture of hydrocarbons. (Coal.ca, 2008)
- Dioxins and furans. Dioxin is the general collective term for chlorinated aromatic compounds, consisting of a group called polychloro dibenzo-p-dioxins and polychloro dibenzofurans. The first group (PCDDs) consists of 75 and the second (PCDFs) of 135 congeners. The characteristic of all the compounds is a high melting point, a low vapour pressure, low water solubility and a reasonable solubility in and affinity for apolar media. These differences in affinity make it possible to predict where dioxins will occur and how to remove these compounds. (Seys, 2009)
- Carbon dioxide: A colourless, odourless, non-toxic radiative gas that is essential to plant and animal life. It is also emitted as a result of burning organic materials, including fossil fuels. It is the main greenhouse gas contributing to climate change, arguably the world's greatest environmental problem. (Coal.ca, 2008).

1.3. The pollution caused by the cement industry in Libya:

Cement production in Libya faces many of the problems found in both the developed and the developing world. The industry is fundamental to the success of Libya's attempt to industrialise and will necessarily have a negative impact on the environment both globally and locally. Whilst there are a variety of methods for reducing these impacts, the problem is how these methods might be implemented and, arguably, most importantly, who will pay for any ameliorating efforts.

International awareness, concern and interest in the impact of industry on the environment (and specifically the impact on climate change) is increasing and has taken on global dimensions. Concern is confined not only to industrialized countries but also has spread to developing countries, although progress in some of these areas has been woefully slow. Arabia (1998) argued that decision makers in many developing countries did not study the environmental impacts of a project for three main reasons:

(1) The belief that the preparation of these studies could delay the development process

(2) The lack of real awareness of the importance of environmental considerations with some decision makers in these countries.

(3) A dominant belief that such an assessment would result in economic burden on the project.

Libya is a developing country with an economy dependent on oil for both the main source of income and the main source of energy. The general development strategy is aimed both at reducing the reliance on this resource and correcting the structural imbalance (Thatit, 2005). The aim is to secure the necessary time to diversify the national economic structure by using oil revenues to ensure the continuation of economic development and social development through building an industrial sector to be an alternative source of income. Total expenditure on this strategy exceeded 26437.5 million Libyan Dinars during 1980 – 2000 and it is so clear from this spending that the priority was industry, agriculture and transportation. The share of these sectors was 17.4%, 17.2%, and 14.2% respectively (Thatit, 2005)

It has been the target of the industrial sector in Libya to achieve a high and sustained rate of industrial production, to use local raw materials and to reduce dependence on imports, whilst developing the export industry (Alme, 1991).This development will inevitably involve the greater use of cement with even greater impacts on the environment (Jafear, 2005).

1.4. The study problem

Industrial activity causes many types of pollution, including emissions, but also other types of wastes such as oil, grease and solid waste. The effect of this pollution is not limited to the atmosphere but extends to human beings, animals and life in general (Trhone, 2006). In Libya, in recent years, there has been an increase in the number of factories which do not take into account environmental considerations when they are established, and this is in addition to the lack of environmental awareness among the owners of these factories which exacerbates the problem. State owned factories, which are supposed to be designed in accordance with environmental standards, emit pollutants particularly because of the lack of spare parts (because of both the air embargo on Libya and the political and diplomatic problems between Libya and the countries of the developed world) and also the weakness, or lack, of maintenance programmes (Biaa, 2002).

It seems then that Libya (along with many other developing countries) has not fully considered the impact of industrial development on the local and global environments. Although there are many global environmental initiatives and charters concerning pollution, and particularly climate change (e.g. the Kyoto Protocol), it is unclear as to how seriously some countries take on these responsibilities and if how any concerns for these issues are translated into effective management at the country or plant level.

Cement, mining and chemical industries are those that cause significant environmental pollution. If these industries are to be incentivised to address these environmental issues there needs to be an application of economic policy that will result in limiting the damage from such pollution. This thesis explores the potential of one particular economic policy in the context of cement factories given that cement is necessary for almost all developments and installations, and is an essential material for housing projects and building projects.

This study will concentrate on two Libyan companies: the Ahlia Cement Company and the Libyan Cement Company who are the two most important in this industry. (Markise, 2007)

1.4.1. The Ahlia Cement Company is located in the Khoms area and has four factories and a Headquarters Building.

Figure (1-1) Ahlia Cement Company in Libya.

The Headquarters Building

Figure (1-2) El-Mergheb Cement Factory.

1.4.1.1. El-Mergheb Cement Factory: It is located in the Khoms area, 120 km to the east of Tripoli with an annual production capacity of 33000 tons and started production in 1969.

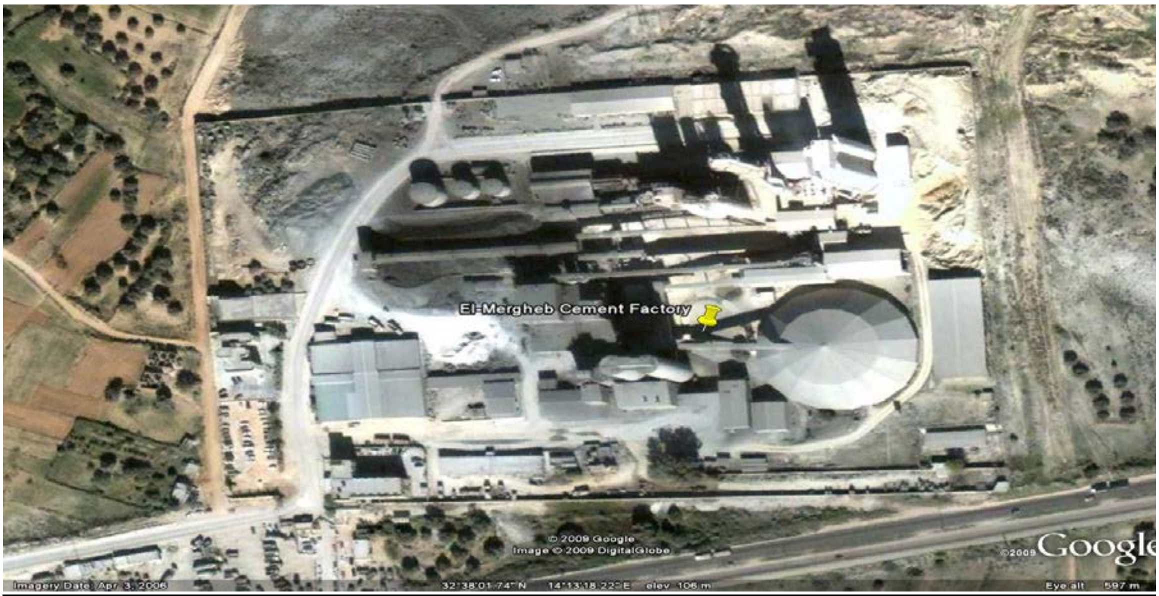


Figure (1-3) Suk El-Khamis Complex for Cement and Building Material.

1.4.1.2. Suk El-Khamis Complex for cement and Building Material: It is located in the Suk El-Khamis Msehel area, 80 km to the south of Tripoli, with annual production capacity of 1,000,000 tons and started production in 1977. It also produces slaked lime with an annual production capacity of 200,000 tons.

Figure (1-4) Libda Cement Factory.

1.4.1.3. Libda Cement Factory: It is located to the east of Tripoli by about 115 km, with annual production capacity of 1,000,000 tons, and it started production in 1981.

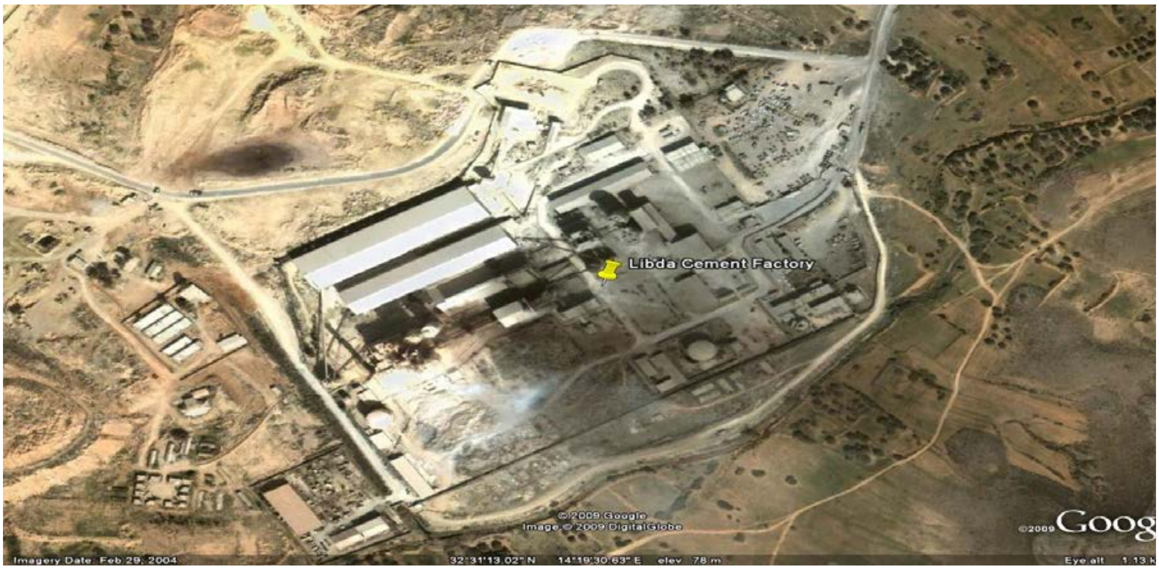


Figure (1-5) Zileten cement Factory.

1.4.1.4. Zileten Cement Factory: It is located to the east of Tripoli by about 140 km, with an annual production capacity of 1,000,000 tons and it started production in 1984.

1.4.2. The Libyan Cement Company: Has three cement factories as follows:

1.4.2.1. Benghazi Cement Factory: It is located to the east of Tripoli city by about 1000 km with an annual production capacity of 1,000,000 tons and it started production in 1977.

1.4.2.2. Hawwari Cement Factory: It is located beside Benghazi city in Howwari area, with an annual production capacity of 1,000,000 tons and it started production in 1984.

1.4.2.3. Fattaih Cement Factory: It is located to the east of Darrnah city by about 15km, with an annual production capacity of 1,000,000 tons and it started production in 1983.

Table (1-1) Details of the Libyan Cement Factories (in order of starting production)

Serial number	Name of cement company	Name of factory	The date of commencement of production	Number of ovens	Nominal annual capacity
1	Ahlia	El-Mergheb	1969	2	333,000
2	Libyan	Benghazi	1977	3	1,000,000
3	Ahlia	Suk El-Khamis	1977	2	1,000,000
4	Libyan	Hawwari	1984	2	1,000,000
5	Ahlia	Libdeh	1981	1	1,000,000
6	Libyan	Fattaeh	1983	1	1,000,000
7	Ahlia	Zileten	1984	1	1,000,000

Source: (Snaia, 2005)

1.5. Study questions:

This study aims to answer the following three broad questions:

1.5.1. Is there the possibility that there are some economic instruments that can help our understanding of environmental cost, and, would those instruments suggest how to reduce such environmental costs?

1.5.2. Is it possible to determine the amount of the environmental cost of the cement industry? How is it possible to determine the environmental cost of the cement industry?

1.5.3. If we know the (technical) costs that help to reduce the pollution caused by the cement industry, then how would this cost be borne between the producer and the consumer? Would all the costs fall on the consumer or on the producer alone, or would they be shared? If shared then who would bear the most - the producer or the consumer? Or would it be equally shared? Or is there a third party that will be bearing, or part bearing, it such as the government?

1.6. Study Methodology

This study aims to apply micro analysis tools to determine the effects of environmental policies. Appropriate economic analysis tools will be used to identify what happens when a *hypothetic* environmental economic policy is applied. The method used in this study is both descriptive and analytical. The descriptive element identifies the extent and types of pollution relevant to the industry and sets the context in which the analytical element can suggest the impact of an inevitable increase in production cost on the producer and the consumer.

This study falls under the general framework of research on environmental issues and specifically on industrial pollution and control. This matter has been considered in many studies but not precisely in the way considered in this study. In particular, this will be the first study to focus on, and apply an analytical tool to the cement industry in order to consider the impact of a change in environmental policy to this sector. The study aims to estimate the price elasticity of demand and price elasticity of supply for cement production in order to determine one effect of environmental policy, namely, the relative share of the assumed price increase following a voluntary, or compulsory, adoption of a environmentally improving project with the concomitant increase in cement price. The study uses a unique, and previously unavailable, dataset on production quantity, production inputs, and prices during the study period 1988 – 2008 for the two Libyan cement producers described in section 1.4 above.

1.7. The study objectives

This study aims to:

1.7.1. Having identified the general environmental cost of the cement industry to consider a method by which to consider the impact of the cost of environmental improvement on the producer and the consumer.

1.7.2. Know who will bear that environmental improvement cost and their relative share.

1.7.3. Assist decision-makers in the cement industry to know the impact of the environmental improvement costs on cement industry profits and then help them to understand both the magnitude of that cost and what proportion would be borne by them.

1.7.4. Reduce the consumer fear that they will bear the whole of an environmental protection / improvement cost. For normal demand and supply curves, the final cost will be shared.

In order to achieve these objectives, the research was concerned with the development of an economic model that estimated the production function for four Libyan cement plants (operated by the Ahlia Cement Company) and the demand curve for the primary consumer of the product within the Libyan marketplace.

1.8. The importance of the study

This study is important because environmental degradation is one of the most critical contemporary issues associated with economic growth. This study highlights the industrialization experience in Libya, and how this development as part of the overall strategy for economic development, has, perhaps by necessity paid little regard to environmental issues. The focus is on a major sector that drives such development – the cement industry. Whether at the University research level or at the published studies level in professional journals it is anticipated that this research will deepen environmental awareness.

1.9. Outlines of the study

Chapter One has introduced the topic and the context in which it will be studied. Chapter Two theoretical of the Production Function and Consumer Surplus. Chapter Three and Four will be further developing the context, by looking at international and local literature on international conventions and treaties and laws of Libya with its resolutions to reduce the environmental pollution. Chapter Five will be focused on History of Cement Industry with a Case Study of Ahila Cement Company in Libya. Chapter Six presents the methodology employed. Chapter Seven presents analysis and discussion and chapter Eight will provide a discussion of the conclusions drawn from the research.

Chapter Two

Theoretical of the Production Function and Consumer Surplus

2.1. Introduction

Production is one of the main focuses in economics. Production theories have existed long before Adam Smith, but were only refined during the late 19th century. When concerned with a one output firm the production function is a very simple construct. It explains the technology available to a firm. It tells us the maximum quantity of an output that can be produced using various combinations of inputs given certain knowledge. We can think of the production function as a type of transformation function where inputs are transformed into output. In principles of economics courses, we normally assume that only two inputs exist, labour and capital, this is for pedagogical simplicity only. In most production cases there exist many different types of inputs that are instrumental in the production process. As we will see later in this chapter, many of the production functions developed can be extended to a multi-input scenario. (Berndt and Laurits, 1973; and Gordon, 2011)

In economics a crucial distinction is made over the difference between the short run and long run. In some business disciplines, such as finance, a short term asset is considered one that has a maturity of a year or less and a long term asset is one with a maturity greater than a year. In economics, calendar time is not relevant in production theory. Time periods are dealt with in the following manner. The short run is considered that time period where at least one input used in the production process is fixed. This means that it cannot be increased nor decreased. The long run is considered that time period where all inputs are variable, no inputs are fixed. We will ignore the case of a quasi-fixed input. When using the simple case where only capital and labour are used it is customary to assume that capital is fixed in the short run, thus only labour can be used to change the selected level of output. The normal graphical aid used in showing this relationship is entitled a total product curve where product is short for the quantity of production. When we enter into the long run production isoquants indicating various levels of output take the place of the role played by the total product curve (Berndt and Laurits, 1973).

Several types of production functions exist. One way to categorize them is they are either fixed or flexible in form. Other common properties that can be categorized are also very important in economics. These include the type of returns to scale a production function exhibits, the elasticity of substitution and whether or not it is constant across output levels, the homogeneity, the homotheticity and the reparability of the functions (Gordon, 2011). Moreover, will be show in this chapter a brief background on consumer surpluses as well.

2.2. Discussion on the production function

Economics did not begin to become a separate discipline of academic study until at least the time of Adam Smith. Even then it was thought of in more general terms than we think of the discipline today. The history before Adam Smith is not deficient of economic writings though. Various Roman and Greek authors have addressed many issues in economics included cursory attention to production and distribution. The Scholastics, including Saints Augustine and Thomas Aquinas, also devoted substantial time to economic matters including discussion and inquiries into production. Several authors associated with the Mercantilist and Physiocratic schools of thought also paid even more careful attention to matters of production in the economy. For example, Anne Robert Jacques Turgot, a member of the Physiocrats, is credited with the discovery around 1767 of the concept of diminishing returns in a one input production function. Of course Adam Smith himself devoted much time to issues concerning productivity and income distribution in his seminal 1776 book The Wealth of Nations (Christenson, 1973; Laurits et al, 1973; Gordon, 2011).

The Classical economists who immediately followed Smith expanded on his work in the area of production theory. In 1815 Thomas Malthus and Sir Edward West discovered that if you were to increase labour and capital simultaneously then the agricultural production of the land would rise but by a diminishing amount. They both in effect rediscovered the concept of diminishing returns. David Ricardo later adopted this result in order to arrive with his theory of income distribution when writing his economic classic the Principles of Political Economy. The Marginalists also dabbled in the area of production. During the late 1800s W. Stanley Jevons, Carl

Menger and Leon Walras all incorporated ideas of factor value into their writings. What these early post-Smith economists all had in common is that they all used production functions that were in fixed proportions. In other words the capital to labour ratios were not allowed to change as the level of output changed. Although interesting, in practice most production functions probably exhibit variable proportions. (Brue and Randy, 2007; Chambers, 1988; and Christenson et al, 1973).

In the 1840s J. H. von Thunen developed the first variable proportions production function. He was the first to allow the capital to labour ratio to change. Von Thunen noticed that if we were to hold one input constant and increase the other input then the level of output would rise by diminishing amounts. In other words he applied the concept of diminishing returns to a two input, variable proportions production function for the first time. An argument could definitely be made that he is the original discoverer of modern marginal productivity theory. His work never received the attention it deserved though. Instead during 1888 American economist John Bates Clark received credit for being the founder of marginal productivity theory based on his speech at the American Economic Association meetings that year. Shortly after in 1894 Philip Wicksteed demonstrated that if production was characterized by a linearly homogeneous function (in other words one that experiences constant returns to scale) then with each input receiving its marginal product the total product would then be absorbed in factor payments without any deficit or surplus. Around the turn of the century, Knut Wicksell produced a production function very similar to the famous Cobb-Douglas production function later developed by Paul Douglas and Charles W. Cobb. Unfortunately this was never published in any academic journal and thus he never received any credit for the development of what Cobb and Douglas rediscovered in 1928. (Berndt and Laurits, 1973; Berndt and Laurits; 1973; Brue, Stanley and Randy, 2007).

In 1937 David Durand built upon the popular Cobb-Douglas production function. The Cobb-Douglas function assumed an elasticity of scale equal to one. In other words the exponents in their function summed to one. Durand assumed fewer restrictions on the values of the exponents. He allowed for their sum to be less than, greater than or equal to one. This meant the elasticity of scale was no longer restricted to one. The production function could now exhibit increasing or decreasing returns to scale in addition to constant returns to scale.

One other restriction on the Cobb-Douglas production function involved the elasticity of substitution. It assumed the value for this elasticity was equal to unity. In 1961, Kenneth Arrow, H.B. Chenery, B.S. Minhas and Robert Solow developed what became known as the Arrow-Chenery-Minhas-Solow or ACMS production function. Later in the literature this became known as the constant elasticity of substitution or CES production function. This function allowed the elasticity of substitution to vary between zero and infinity. Once this value was established it would remain constant across all output and/or input levels. The Cobb-Douglas, Leontief and Linear production functions are all special cases of the CES function. In 1968 Y. Lu and L.B. Fletcher developed a generalized version of the CES production function. Their variable elasticity of substitution function allowed the elasticity to vary along different levels of output under certain circumstances. (Arrow et al, 1971; & Gordon, 2011).

"Recently there have been many developments with flexible forms of production functions. The most popular of these would be the transcendental logarithmic production function which is commonly referred to as the translog function. The attractiveness of this type of function lies in the relatively few restrictions placed on items such as the elasticity of scale, homogeneity and elasticity of substitution. There are still problems with this type of function however. For example, the imposition of separability on the production function still involves considerable restrictions on parameters which would make the function less flexible than thought. The search for better, more tractable production functions continues".(Berndt and Laurits, 1973; Berndt, and Laurits, 1973; Brue and Randy, 2007; Chambers, 1988; Christenson, Laurits et al, 1973; and Gordon, 2011).

2.3. Examples of the production function

In last few years there are many studies on production functions, which is considered to be the most important economic instruments which will help to understand some of the economic effects at the microeconomic, macroeconomic and international economics levels, but as a consequence of its plentiful and widely varying aspects of its application, it become necessary to choose a number of them to illustrate the importance of a reliable measure to understand and determine the economic effects on the individual and the state. These studies are as follows:

The first study has been carried out by Growiec (2008) on production functions and distributions of unit factor productivities: Uncovering the link. Growiec derives a reversible "endogenous technology choice transform," according to which firm-level production functions and distributions of unit factor productivities are two sides of the same coin. The Cobb-Douglas function relates to Pareto distributions, and the CES to Weibull distributions.

Another study by Shields & Shields (2009) concerns estimating external returns to education in the US: a production function approach, and, the study is based on an explicit production function of the form suggested by Lucas. Strong evidence of the presence of external benefits to education for the US is found.

Another study has been done by Klump and Saam (2008) about the calibration of normalised CES production functions in dynamic models. Normalising CES production functions allows one to choose technology parameters of dynamic models in a plausible way.

Another study by Hong, Lee and Hwang (2011), is about Metafrontier Production Function Analysis of Horizontal and Vertical Integration in Korea's Cable TV Industry. With its remarkable growth, the cable TV industry has witnessed increasing business integration continuously. This study categorizes technology-based operators into three groups on the basis of business integration—vertically integrated, horizontally integrated, and isolated system operators, and estimates the efficiency of each group. In addition, metafrontier analysis is employed to compare the efficiencies of the groups. The results suggest that vertically and horizontally integrated system operators can improve technical efficiency by accomplishing economies of scope and scale, respectively.

Another study has been done by Thornton, (2002) on ‘Estimating a health production function for the US: some new evidence’. This study reports some new evidence on the impact of medical care, socioeconomic, lifestyle and environmental factors on the health status of the population of the USA. The results show that additional medical care utilization is relatively ineffective in lowering mortality and increasing life expectancy. The most important factors that influence death rates are related to socioeconomic status and lifestyle.

Another study has been done by Alonso-Rodriguez, (2000) about VARMA modelling of the production function. This paper models the elements of the production function by VARMA methods to gain empirical insight on which element leads the other. At the same time, we look for the possibility of detecting any characteristic which could help to differentiate between developed and developing economies.

From above studies it can be noted that the production function is an effective tool to deal with varieties of economic problems in general, and at the microeconomic level in the specific.

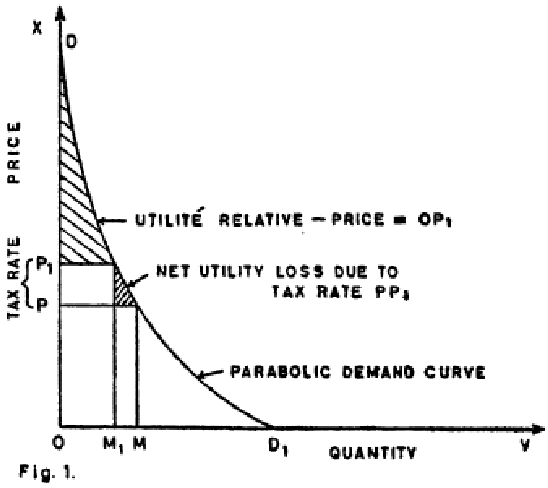
2.4. Discussion on Consumer’s Surplus

Consumer's surplus denotes the difference between the maximum amount of money a consumer would be willing to pay for a product or service and the amount he actually pays. The term was first introduced into economics by Alfred Marshall in his Principles of Economics, but the first person to enunciate the idea in a precise way appears to have been Jules Dupuit, a French engineer, in a paper published in 1844. Rudolf Auspitz and Richard Lieben (who knew of Dupuit's work but not Marshall's) gave an account of consumer's surplus in 1889 in their book Untersuchungen über die Theorie des Preises (”Investigations on the Theory of Price”); but their work was neglected, and it was Dupuit, and above all Marshall, who influenced modern economists. (Auspitz and Lieben, 1889; Dupuit, 1952; Dupuit, 1962; Marshall, 1949; Marshall, 1961; and Houghton, 1958).

Dupuit's work on utility theory appears to have derived from his interest in a contemporary debate concerning the financing of public enterprises. What was required, he realised, was a measure of utility that could be used in judging the worth of public works. He saw that J. B. Say's use of exchange value as a measure of utility was incorrect and pointed out that Say himself had advocated a method for determining whether public works were justified (this was to multiply output, or volume of traffic, by the diminution in costs) which did not involve his own utility measure but which was none the less quite wrong. Say's errors he attributed to a disregard of Smith's distinction between value-in-use and value-in-exchange. Dupuit, having a clear conception of the law of diminishing marginal utility, found no difficulty in the paradox of value. He pointed out that price cannot be relied upon to indicate total utility, which must be measured, albeit imperfectly, in terms of money. The total utility of an object may be estimated, he showed, by what a consumer would take to go without it, or (and he implied that this is the same thing) how much he would pay rather than go with-out it. The difference between this amount and the total price actually paid, which may be measured by the product of a finely graduated tax, Dupuit called utilite relative, in reality, it is of course Marshall's consumer's surplus. Dupuit discovered two "laws" of demand: the one (which we now recognise as the ‘Giffen’ exception), that as price falls the quantity purchased tends to increase; the other, that this increase is larger the lower the price at which the fall occurs. The second law was derived from the pyramidical structure of society: at each successive stage in a series of price reductions the demand of an ever larger class of consumers becomes effective. Dupuit therefore conceived the shape of the demand curve for a commodity to be typically that drawn in the diagram reproduced below. The source of the diagram – Houghton, having in his words, “Solely for the convenience of following customary practice, I have reversed Dupuit's axes”. He used this diagram to illustrate "utilite relative" and to demonstrate some of Dupuit’s applications of the concept. He provided a complete theory of discrimination, illustrated copiously with examples from railway tariffs and other sources; he analysed appropriate pricing policies for a private and a public monopolist; and he showed, too, how discriminatory charging might make profitable an enterprise which, if it charged a single price for its product, would make losses. Another interesting application involves the Dupuit taxation theorem. This is illustrated also on the diagram below.

Assuming for the purpose a constant rate of decline in consumption as price rises, Dupuit showed that the loss of utility due to the imposition of a tax on a commodity is proportional to the square of the tax rate. It follows from this that it is better to spread indirect taxes over a large number of commodities than to concentrate outlay taxes on a few particular goods. This is probably the first theoretical justification for a general sales tax. (Houghton, 1958)

Figure (2-1) illustration theoretical justification for a general sales tax.



Source: Houghton, (1958)

Dupuit's consumer's surplus analysis came in for heavy criticism from Walras. Although he recognised that Dupuit deserved high praise for his work on discriminatory pricing Walras found him guilty of a "capital error" in confusing demand and utility curves. Since Dupuit's utility measures were involved in this confusion, Walras concluded that the whole of his utility measurement analysis was vitiated and, having repeated almost exactly Bordas' objections to the method, his final judgment was that "Dupuit's theory is no improvement. This was not only an astonishingly bad assessment by a theoretician who is regarded by some as the greatest in economics, but it was framed in highly misleading terms. Dupuit's implied confusion of demand and utility curves was of course a much less serious blunder than Walras believed.

Moreover, as we have seen, Dupuit, in his reply to Bordas, if not earlier, showed a clear appreciation of many of the points which Walras accused him of having overlooked. It was most remiss of Walras that, having criticised Dupuit's work on utilite relative quite destructively, he did not offer a correct formulation. He either ignored or failed to appreciate the truth, so clearly expressed by Johnson, that the general problem of maximising utility is applicable just because there is this surplus.

The notions of producers' and consumers' benefits from trade (Marshall's producers' and consumers' rents) were first discussed in print, in England, by Jenkin, who used a graphical analysis to illustrate how these might be measured. Jenkin believed his measures to be "novel". In this, he was only partially correct, of course, but he was certainly the first to publish a discussion of producers' surplus and a demonstration that the amounts of the two surpluses depend, in each case, on the steepness of the appropriate curve. Jenkin applied his results to the problems of the incidence of a commodity tax, showing how the relative losses of producers and consumers due to the tax may be calculated and making the points that each party's loss is greater than the tax it pays and that these losses are greater the higher is the tax rate. Jenkin, however, paid no attention to the concept of the individual consumer's surplus and contributed nothing to the elucidation of the special assumptions required for a satisfactory analysis of this idea.

The first significant advance on Dupuit's work came from Vienna. Rudolph Auspitz and Richard Lieben published their Untersuchungen iiber die Theorie des Preises in 1889, just one year before Marshall's Principles appeared and ten years after his Pure Theory had been privately circulated. In a paragraph added to the preface of a French translation of their work (1914), the surviving author, Lieben, explained that they had no knowledge of the Pure Theory until some time after the first German edition. Since their consumer's surplus analysis was completed by 1889, it clearly can owe nothing to Marshall, and is simply a development of Dupuit's work. Although the treatment of the concept by the two Austrians is in many ways similar to Marshall's, there are some interesting and significant differences. Where these exist, it is by no means the case that the Austrian analysis suffers from comparison.

The Auspitz and Lieben investigations into price theory were more thorough than those of any comparable writer save Walras, with whose general equilibrium analysis their methods were in direct contrast. Philosophically, their approach was a highly sophisticated Jevonsian utilitarianism. They believed that: "les sentiments de l'individu ne sont pas susceptibles de mesure"; and that " encore moins saurait-on comparer Jes sentiments de deux individus". Nevertheless, they took the view that it is possible to measure the small changes in feelings (satisfactions, dissatisfactions) which are important for choice. Their position was that although his subjective evaluation of money changes according to an individual's circumstances, such variations may be disregarded so far as small changes in expenditure are concerned.

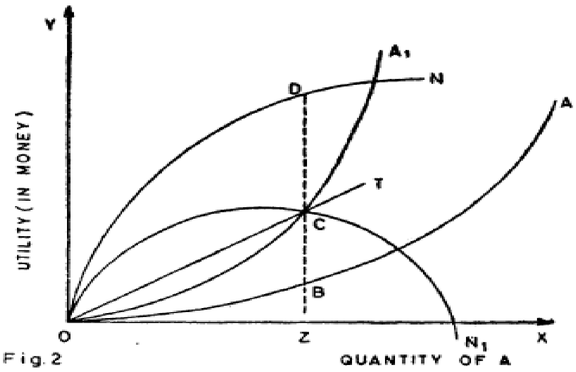
Auspitz and Lieben were meticulously careful to set out the abstractions necessary to their method and were at pains to emphasise the conditional validity of their results; in this respect their treatment is undoubtedly more satisfactory than Marshall's. Their three major abstractions from reality, important for consumer's surplus theory, were: that the marginal utility of money does not vary, that tastes remain unchanged, and that other prices remain constant, with respect to variations in the price of a particular commodity. These assumptions were made, not of course because they were believed to be realistic, but purely in the interests of simplicity. Two theorists who were well aware of the intricacies of commodity relatedness and who, it may be noted, made valuable original contributions to analysis in this field, could hardly have agreed lightly on their use. As is well known, Marshall's own assumptions in his consumer's surplus analysis were precisely these of Auspitz and Lieben.

One of the most significant features of the Auspitz and Lieben treatment of consumer's surplus is that they distinguish clearly between the individual and aggregative concepts. The first they measured as a quantity of money and called consumer's profit, the second they treated as an amount of utility which, given their assumptions, could be measured in money terms. In clearly distinguishing between the 'two ideas and in retaining Dupuit's conception of the individual surplus (utilite relative) as a utility difference, the two Austrians again scored over Marshall. The latter defined consumer's surplus in such a way that many interpreters have taken the individual concept to be essentially a money difference, whereas, of course, it is fundamentally a utility difference, which has a unique money measure only when the marginal utility of money is constant. The difference between Marshall and Auspitz and Lieben is that Marshall's definition appears to depend for its meaningfulness on this assumption of constancy, whilst the Auspitz and Lieben definition, like Dupuit's, is perfectly general and only their money measure of the surplus requires the: special assumption that the marginal utility of money is constant.

Along the Y-axis (the marginal utility of money being assumed constant) and quantities of a commodity A are measured along the X-axis (Fig. 2). The curve OA is a total cost curve, vertical distances from the X-axis representing the cost of producing corresponding quantities. OA1 is a total offer curve: its radius vectors are parallel to tangents to OA and along the Y-axis horizontal distances indicate the amounts which would be supplied at prices represented by the slopes of these vectors. ON is a total utility curve and along the X-axis vertical distances represent the utility of corresponding quantities. ON, is a total demand curve: its radius vectors are parallel to tangents to ON, and along the X-axis vertical distances represent total expenditure on X at prices indicated by the slopes of these vectors. The analysis shows (for CZ example) that with an output OZ, sold at price consumers' surplus is CD and producers' surplus CB.

Walras was as highly critical of this analysis as he was of Dupuit's work on consumer's surplus. He pointed out that the four curves can be reduced to two-the Marshall supply and demand curves-and went on to argue that, like Dupuit, Auspitz and Lieben had confused demand and utility curves. Walras concluded that their measure of consumer surplus was therefore wrong and he argued that in conditions of free competition producers' surplus does not exist. In both cases his criticisms seem wide of the mark and the two Austrians appear to have the better of the argument. In their discussion of the utility derived by a single individual from his consumption of a particular commodity, Auspitz and Lieben introduced a new construction, the curve of jouissance. The point B on OX indicates the maximum utility level which an individual can obtain, the commodity A being unavailable, with a given money income and given prices of all commodities. The curve BG traces the utility levels that can be obtained if the various amounts of A indicated by its abscissa are given to the consumer without charge. It is then supposed that commodity A is not given free but must be purchased. The total utility curve ON which measures the maximum amount which will be paid for various quantities of A can be derived from BG. Its position throughout must clearly be such that it is everywhere below BG by the distance OB, so that at any point on ON the consumer is indifferent between that amount of A together with other commodities, and some larger combination of those other commodities. In other words, any ordinate of ON indicates the total additional utility (in money terms) derived from the availability of A at a price indicated by the slope of the tangent to the curve at that point.

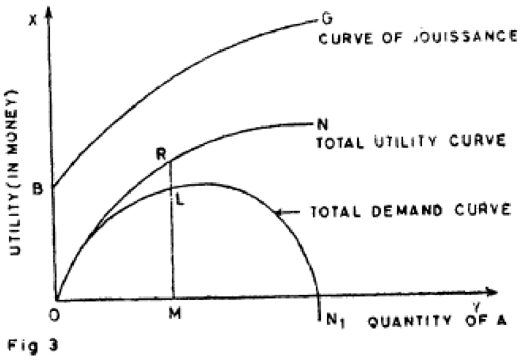
Figure (2-2) illstration the total utility.



Source: Houghton, (1958).

Auspitz and Lieben assembled an interesting though somewhat cumbersome diagrammatic apparatus to portray inter alia first, the aggregate consumers' and producers' surpluses and second, the individual consumer's surplus. Money and utility are both measured paid (the utility that is sacrificed) for this utility is indicated by that part of the ordinate (LM) which lies below its intersection with the total demand curve ON1; the part of the ordinate which lies above this intersection (LR) measures the consumer's surplus.

Figure (2-3) illustration the consumer's surplus.



Source: Houghton, (1958).

This is a particularly neat demonstration of the surplus which, while it gives a result in terms of money, never permits one to lose sight of the fundamental point that what is being measured is a utility difference. Many of the difficulties and confusions which gave the concept a bad name during much of the twentieth century might perhaps have been avoided if the Austrian treatment had been given a share of the close attention that was lavished on Marshall's work.

2.5. Examples for Consumer Surplus

There are many studies on consumer surplus, which is considered to be one of the most important economic instruments which will help to understand some of the economic effects at the microeconomic, macro economic and international economics levels, but as a consequence of its plentiful and widely varying aspects of its application, it become necessary to choose a number of them to illustrate the importance of a reliable measure to understand and determine the economic effects on the individual and the state. These studies are as follows:

The study which has been carried out by Shahmoradi (2008) about Gasoline subsidy and consumer surplus in the Islamic Republic of Iran" where it illustrated that "Gasoline subsidy in the Islamic Republic of Iran is a controversial issue. While a group of politicians believe that its merits outweigh its costs, some economists believe that its harms exceed the benefits. A new approach was taken to study the changes in social welfare because of gasoline subsidies for the period 1987–2005. The researcher indicated that the policy of gasoline support in his country had social and political advantages. Therefore, even if the gasoline production is higher than income, it is not important for the State and of course, the researcher relies on this analysis by using the consumer surplus.

Cameron (2008) has done a study on ‘E-Baying for blood?’ Non-competitive flexible pricing in entertainment ticketing -some demand side evidence. This study gives some exploratory results from estimating a consumer surplus type equation which features a number of economic and demographic variables as repressors. We calculate income elasticity for the maximum surplus that individuals would ever perceive themselves to be getting by being allowed to buy at a set price.

Chotikapanich and Griffiths (1998) carried out research about Carnarvon Gorge (Carnarvon Gorge: a comment on the sensitivity of consumer surplus estimation). In this study, Beal's (1995) method of estimating the value of Carnarvon Gorge for recreational use is re-examined. When an inconsistency in her estimation procedure is corrected, the estimated value of Carnarvon Gorge for camping is found to be six times higher than estimated in that study. The sensitivity of the estimate to the choice of functional form is examined, and standard errors and interval estimates for consumer surplus are provided. Comments are made about functional form choice and prediction in log-log models.

Another study has by Song (2007) considers measuring consumer welfare in the CPU market, where they: “estimate demand for the personal computer central processing unit and measure consumer welfare using the pure characteristic's demand model. The model is based on a quasi linear utility function with multiplicative random variables and does not have the idiosyncratic logit error term, so that consumer welfare directly reflects consumers' valuation of product characteristics.”

Baik (1999) has done study about Rent-Seeking Firms, Consumer Groups, and the Social Costs of Monopoly. This paper compared the social costs of monopoly in the RCS contest with those in the rent-seeking contest. The RCS contest is a two-stage game in which firms and consumer groups first compete to win their prizes, an unregulated monopoly for each firm and a regulated monopoly for each consumer group, and then after knowing the government's decision on the form of the monopoly, the firms compete against each other to win the monopoly. The rent-seeking contest is a game in which there is on a consumer group engaging in CS-defending activities and only the firms compete against each other to be the unregulated monopolist.

Morey (1985) has done research on characteristics, consumer surplus, and new activities. In this study that physical characteristics of activities and personal characteristics of the individual are incorporated into an expenditure function. This function is used to define the compensating and equivalent variation for changes in the costs or physical characteristics of the existing activities, or for a proposal activity as a function of its proposed characterises and cost. The model is used to estimate the demand for, and CVs and EVs associated with, the development of a Colorado ski area. These vary across skiers as a function of skiing ability, value of time, location of residence, and skiing budget.

Sugden (1979) has studied the measurement of consumers' surplus in practical cost-benefit analysis and this paper studies a problem that has been the source of confusion and controversy in the literature of practical cost-benefit analysis.

Cicchettiet al. (1976) has done research on an econometric evolution of a generalized consumer surplus measure: the Mineral King Ski Facility controversy. This study proposes a generalized approach for measuring the consumer surplus associated with a natural resource development project. The paper considers three key issues: a description of a general model of household behavior; benefit evaluation in an extended partial equilibrium framework; and, evaluation of the benefits of a ski facility at Mineral King.

The most important results which have been getting by these studies and the view of some researchers about the quality of using the consumer surplus tool were as follows:

The study which was carried out by Shahmoradi (2008) found that the consumers' surplus has declined over time for a representative consumer. A large population growth, inflation and non-substitutability of gasoline with other goods might have caused this phenomenon and the researcher justified this result. Therefore "This indicates that the gasoline subsidy policy still adds value to the consumer's surplus over time, although the consumer surplus is diminishing annually over this period of time."

Cameron's Study (2008) found that: "The results also show that those who attend the cinema are significantly less inclined to generate a surplus in flexible price event markets whilst young adults offer to pay quite a large amount more for their heavily desired entertainment. This suggests that part of the burden of a shift in ticket pricing methods may be borne by the parents of young adults".

The Chotikapanichet al. study (1998) found that it is evident from their results that estimating consumer surplus can be tricky. The results can be very sensitive to demand function specification and to the chosen estimation methodology. In addition to correcting and explaining some of Beal's results, the purpose of this article was to expose the sensitivity and to suggest ways in which the methodology could be improved by computing standard errors and developing consumer surplus estimates which are internally consistent with visitation rate equations.

The study which carried out by Song found that welfare calculations show that consumer surplus comprises approximately 90% of total social surplus and that large welfare gains have resulted from the introduction of new products.

Baik's (1999) study found that, given just one rent-seeking firm, the social costs of monopoly in the rent-seeking contest are in general less than those in the RCS contest, but given two or more rent-seeking firms, the social costs of monopoly in the rent-seeking contest are in general greater than those in the RCS contest. This result implies that lobbying by consumers general reduces the social costs of monopoly, compared with those incurred in the case where there is no lobbying by consumers.

Morey's (1985) study found that the demand for a proposed site can also be estimated as a function of its proposal characteristics and price. This technique for evaluating the demand for, and benefits from, a proposed site is superior to the currently used technique which assumes that the proposed site a perfect substitute for one of the existing sites.
Sugden argued that the cause of cost-benefit analysis has suffered because too often economists have been unable to agree on the correct procedures to follow. The frequent sight of economists in disarray …. A sight that was very visible at the time of the Roskill Commission (1971)…. has encouraged the belief that cost-benefit analysis has little to offer the public decision-maker. The author believes that the ideas presented in this paper can resolve at last some important issues of current confusion and dispute.

It has been noted from the results of previous studies that some people believe that the use of consumer surplus as a tool for measuring is not always accurate, as pointed out by Sugden who indicated that the consumer surplus analysis relies on the analysis of costs in general; the truth of this assertion is not accurate because some costs are accurate according to economists in the analysis of consumer surplus in understanding the direction of the micro economic market such as the monopoly market… etc. Whereas, it is the marginal cost which gives accurate results with the response between quantities and prices. Moreover, there is another opinion about the tool of consumer surplus as pointed out by Chotikapanich, et al., (1998), et al., that "… estimating consumer surplus can be tricky." (because) "The result can be very sensitive to demand function ….etc".

Perhaps this analysis which is pointed out by the author is correct in general, but not very accurate because, as is known there are many factors which affect the demand curve, some directly, such as price and some indirectly, such as income and consumer tastes. However, the problem arises from the fact that the non-quantitative factors cannot be measured numerically and this is controversial for economists to the present day in the theory of utility. Nevertheless, if we rely on quantitative factors, which, of course, have the biggest impact in the calculation of consumer surplus, such as cost, price and income, it is certainly possible to rely on these results with high confidence.

Nevertheless, contrary to this opinion there are other views referred to by Shahmoradiet al. (2008) and also as pointed out by Cameron (2008), Sugden (1979) and Morey (1985), who depended on their results that were obtained in their studies through the use of consumer surplus tools as measuring tool. However, this Author's study did not rely on the analysis of consumer surplus that required the measurement of intangible costs and benefits on for demand factors, whilst all the variables that were used in this study are quantity variables which could be measured and analysed accurately.

2.6. Conclusion

This chapter has outlined some of the historically important evolutions in the production function. We saw that writings regarding production began well before Adam Smith contributed his thoughts on the subject and they continue today in full force.

Production plays a major role in any principles of economics class. One of the first graphs an undergraduate student is introduced to is the production possibility frontier. Shortly thereafter the production function is introduced along with discussions of diminishing returns and returns to scale. At the intermediate level of micro and macroeconomics production plays an even more important role. Here is where isoquants and isocost lines are normally introduced as well as topics such as the expansion path and perhaps homogeneity. At the graduate level a more mathematical treatment of the production function is given with careful attention on the various structures of such a function. The relationship of the production function to the cost function is also thoroughly explored at the graduate level.

The importance of consumer's surplus is that it provides a monetary measure of the benefit that a consumer derives from the supply of a product given the terms on which it is made available. It seems therefore to offer the possibility of assessing the net effect on welfare of policies that alter the terms on which different products are supplied. Economists have used the concept to argue that some systems of taxation are worse than others because they lead to a greater loss of consumer's surplus. It has also been proposed that in decreasing cost industries in which consumers' expenditures for a product would not cover total costs - if the product were sold on the market at a uniform price or, in most modern formulations, at a price equal to marginal cost—the state should make possible production of the product by means of a subsidy when the gain in consumer's surplus would justify this. In effect, what consumers would be willing to pay but do not (or, more exactly, the state's estimate of this) should be treated as an auxiliary factor in addition to what they do pay, in determining production, because it indicates as much as what they do pay the worth of the product to them.

Supply and demand curves can also be used to illustrate the idea of market efficiency, an important aspect of normative economics. Consumer surplus is the difference between the maximum amount a person is willing to pay for a good and the current market price. (Karl, et al., 2012)

Producer surplus is the difference between the current market price and the full cost of production for the firm. At free market equilibrium with competitive markets, the sum of consumer surplus and producer surplus is maximized. The total loss of producer and consumer surplus from underproduction or overproduction is referred to as a deadweight loss. (Ray et al., 2012)

Chapter Three
Literature Review

3.1. Introduction

This literature review starts with a general overview of key issues and then explains in detail the technical aspects of cement production in order to identify and quantify the various pollutants released across the whole manufacturing process from quarrying to final bagged cement. The key pollutants are then examined and placed in the context of contemporary literature. Then attention is directed towards the various solutions that can be used singularly, or in combination to combat this pollution. Three particular solutions are considered: firstly, the use of fossil fuel substitutes comprising of non-hazardous organic and inorganic wastes and hazardous waste. Secondly, consideration is given to better fuel management processes and changes to core plant technology. Thirdly, two broad country / industry level schemes are reviewed – the EU ETS, and, the Cement Sustainability Initiative. Finally, because the cost of transportation of the finished product encourages cement plants to be relatively local to their marketplace, and thus pollution is often localised (although transboundary transmission of dust and harmful gases is obviously present but dependent upon geography), the chapter concludes with reviewing what literature is available on Libya itself.

3.2. Broad background

Manufacturing activities are known to have a major impact on the environment through the consumption of raw materials from natural resources, emissions to air, land and water, the generation and subsequent disposal of hazardous wastes, noise pollution, and the depletion of natural resources in production processes. The variations of economic activity are one of the major aspects to be considered while trying to understand the environmental performance of industrial processes. Despite the obvious benefit of manufacturing in terms of increased economic activity, it is recognised widely that economic growth will distress the environment though emissions and resources consumed by anthropogenic activities (González, 2005).

Cement manufacturing is not only a key industrial activity but output is correlated with the growth of a region or country given its use in a variety of construction projects, ranging from major civil infrastructure (e.g. road and airports) to small scale projects (e.g. housing, driveways, etc.).

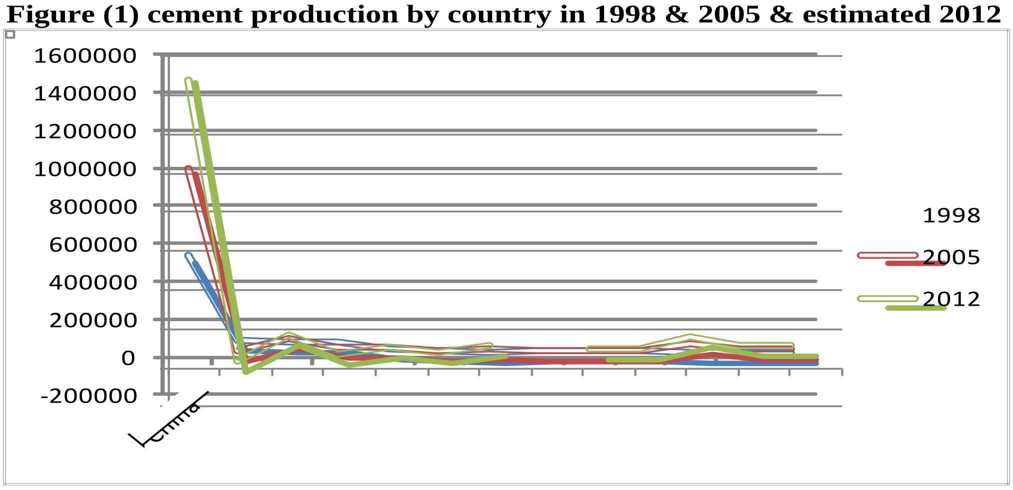
This is a well established industry whose importance has increased over time, the leading multinational producer of cement – Lafarge, which was established in France in 1833, is now a leading global building material manufacturer with transnational interests in 75 countries around the world. (Lafarge 2001; Nordqvist et al, 2002). Since 1999, its activities have been organized into four autonomous divisions, where cement is the dominant one. (Nordqvist et al, 2002). Through several mergers and acquisitions, the latest being the acquisition of the British Blue Circle brand in 2002, the cement division of Lafarge has become the world's largest producer of cement with production sites numbering around 160 and a total production in 2001 near to 90 million tonnes. Much of this production is in developing countries (Nordqvist et al, 2002). As might be expected they have some concern for their environmental impact, for example,

"The Copenhagen conference on climate change was an important event in 2009. As a very active member of the Cement Sustainability Initiative (CSI), Lafarge contributes to design policies adapted to national and regional situations and to mobilize industry towards sustainability. Our Group is pleased to have met, one year in advance, its commitment taken in 2001 to reduce its net CO_2 emissions per ton of cement produced by at least 20% over the 1990-2010 period" (Lafarge Media Centre, downloaded, 2011).

The biggest consumer in the word is China and so this country it good example through which to understand key issues. Figure One illustrates the magnitude of the Chinese cement sector in 1998, 2005 and estimated for 2012 compared with the aggregated shares of shows the 13 next-largest cement-producing countries. (Nordqvist et al. 2002), and Figure One that cement production in China saw an exceptionally large increase in 1998. And the estimate for 2012 follows that trend. Globally, reasons for these increases include population growth, urbanisation and the development of many emerging economies, as well as rebuilding following war damage and such increases in demand will lead to more cement production and associated pollution.

Figure (3-1) Cement production by country in 1998; 2005 and estimated 2012

Figure (1) cement production by country in 1998 & 2005 & estimated 2012

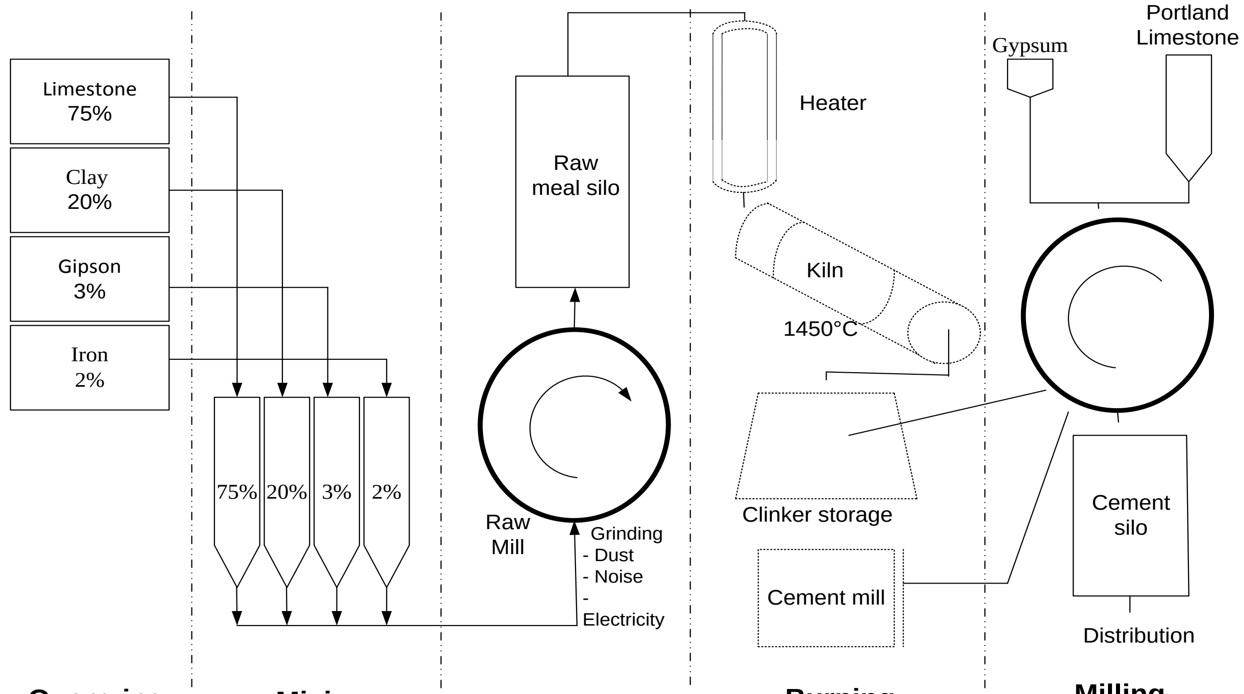


Source UN, (2001) ; & docstoc , (2010)

3.3. Technical Aspects of cement production relevant to pollution production

Figure (3-1) details the typical production process for the manufacture of cement and at each stage there is the potential for pollution generation. Table (3-1) details some key pollution issues at each stage of production and gives examples for reducing that pollution either by a 'technical fix' or by an 'economic fix'. Whilst this dissertation concerns policy driven out of an 'economic fix', one needs to understand how pollution is created in this production process.

Figure (3-2) illustrated the cement stages



Quarrying
-Particulates (Dust)
-- Cases : SO_2 , NO_X ,CO ,& CO_2
-Hydrocarbon compounds (THC)
- Noise
- Vibration
- Landscape impact
- Raw materials:
Limestone
Clay
Sand

Mixing
-Particulates (Dust)
-- Cases : SO_2 , NO_X ,CO ,& CO_2
-Hydrocarbon compounds (THC)
- Noise
- Vibration
- Landscape impact
- Raw materials:
Limestone
Clay
Sand

Grinding
-Particulates (Dust)
- SO_2 , NO_X ,CO ,& CO_2
-Hydrocarbon compounds (THC)
-Noise
- Electricity

Burning
-Particulates (Dust)
- Cases : SO_2 , NO_X ,CO ,& CO_2
-Hydrocarbon compounds (THC)
- Mercury
- Dioxins / Furans
-Hydrocarbon compounds (HIC)
- Cement Kiln Dust (CKD)
- Waste Heat
- Noise
- Heat
- Fuels

Milling
-Particulates (Dust)
- SO_2 , NO_X ,CO ,& CO_2
-Hydrocarbon compounds (THC)
-Noise
- Fuel

Source: 4eqt 2010; and Wbcsdcement 2010.

Table (3-1)	Illustrating key environmental issues from the cement industry.

Issue	Quarrying (off site)
Problems	The breaking up of limestone by quarrying creates limestone dust as a result of crushing transporting and (un) loading. Furthermore, gas emissions such as CO_2, CO, SO_2 and NO_X. Additionally, noise, vibration and landscape impact from machinery and process plant.
Technical fix	The limestone rock is crushed and sieved and then transported to the cement plant. Some quarries will use automated digging machinery that extracts crushes and delivers the stone via conveyor belt to the transport; other quarries may use more traditional 'explosive' methods. Obviously, there will be filters inside the crusher which prevent emission. Extraction of the limestone obviously causes dust. Stone can be sprayed with water to minimise dust.
Issue	**Mixing**
Problems	Emission of dust and gases from the fuel powering the mixing mill resulting in: CO, CO_2, SO_2 and NO_X.
Technical fix	The transfer of ground material from the grinding mill to the mixing tanks for mixing requires appropriate transfer and filtration.
Issue	**Grinding**
Problems	Grinding to crush and soften the material produces dust and emission from the fuel source that drives the machinery. Gases emitted as CO_2, CO, SO_2 and NO_X. Additionally, Noise, consumption of electricity.
Technical fix	The process requires venting to the outside air and so appropriate filtration should be in place. If this becomes clogged, then the process becomes less efficient, so filters require regular inspection and cleaning.
Issue	**Burning**
Problems	The process of materials burning in cement kilns it is a key step in this industry for production of the cement 'clinker' at temperature up to 1500°C. Complex filtration now needs to cope with the by-products of burning but there is still some dust which may also mix with the harmful gases. Gases emitted are CO_2, CO, SO_2 and NO_X. Additionally, micro-pollutants with identifiable health hazard, noise, heat, extensive fuel consumption (e.g., coal, electricity, etc.)
Technical fix	These filters are designed to reduce CO hazards, older filters perform to reduce the amount of material emitted to less than 20 mg/m^3 - 50mg/m^3. The latest solution is the installation of a filter bag system instead of electrical filters. Here dust emissions (as long as the bags are clean and maintained regularly) are close to zero.
Issue	**Milling**
Problems	Emission of dust and emission of gases from the burning of fuels such as CO_2, CO, SO_2 and NO_X. Additionally , noise , fuel and electricity consumption ,
Technical fix	After adding 3-5% of Gypsum, the clinker is grounded to a high smoothness and filters are employed to capture the dust from this process. Filters capture any dust during transporting this material to the cement tanks.
Economic fix for all stages	To know how to deal with this problem in terms of economics, there are two steps: Firstly, estimate the environmental cost, and, secondly, determine the way in which the environmental cost is divided between consumer and producer.

Footnote	Sources for this diagram and table from below and citations are in full under

	references. Many are discussed further in the literature review chapter.
Source:	Adejumo, et al (1994); Ademola, (1998); Alalem, (1999); Alam, et al (2007); Anon, (1996a); Anon, (2003b); Anon, (2005c); Anon, (2005d); Anonymous, (2008e); Anonymous, (2008e; Baik, (1999); Barghouti, (2007); Benestad, (1989); Bowermaster, (1993); Builders Merchants, (2007); Cameron, (.2008); Carpenter, (1993); Charles, (1998); Chemical Business, (1997); Cicchetti, (2005); Contract Journal, (2005); Contract Journal, (2006); González, (2005); El-fadel et al, (2003); Fernandedz, et al (1998); Hegazy, (1996); Hendriks, et al (1999); Hibbert, (2004); Hibbert, (2007); Johnson, (2002); Kaze , (1999); Kemezis, (1993); Liu ,et al (1997); Magat, (1986); Mander, (1997); Marneri, et al (2001); Mattos, (1997); Moore , (2003); Morey, (1985); Nebel, (2000); Ning, (1994); Ning, (1997); Nordqvist, et al (2002); Perfettini, et al (1989); Porto, et al (2006); Ragoutis , (1997); Rao, (1998); Satao, et al (1993); Shahmoradi, et al (2008); Sivakumar, (1995); Song, (2007); Ssic,.(2010); Stirling, (2005); Sugden, (1979); Syamala, (1999); Szabo et al, (2006); Teece, (1986); Tijan, et al (2005); Topie, (1999); Trovaag, (1983); Wasserbauer, et al (1998); Zubareva, et al (1999); Van Oss et al, (2003); USEPA, (1999).

3.4. The Environmental impact of cement manufacturing (Air emissions)

Table (3-2) Emissions and residuals (per ton of cement).

	Quarrying and Mixing	Grinding	Burning	Milling	Total
Particulates (kg)	1.208	0.050	0.36	0.024	1.642
SO_2 (kg)	0.004	0.0005	4.75	0.0005	4.755
NO_X (kg)	0.0325	0.005	2.85	0.005	2.891
CO (kg)	0.016	0.003	0.102	0.003	0.124
CO_2 (kg)	2.659	0.443	855	0.443	809
THC (kg)	0.012	0.002	0.021	0.002	0.037
Mercury (mg)	-	-	37.83	-	37.83
Dioxins / Furans (ng)	-	-	253.25	-	253.25
HCI	-	-	0.055	-	0.055
CKD	-	-	52.2	-	52.2
Waste Heat (M. kcal)	-	-	0.34	-	0.34

Source: Haftbaradaram, H (2000).

Where

SO_2	Sulphur dioxide	HCI	Hydrochloric acid
NO_X	Nitrogen oxides	CKD	Cement Kiln Dust
CO	Carbon monoxide	Mg	Milligram
CO_2	Carbon dioxide	M. kcal	Medium of Calories
THC	Hydrocarbon compounds	Kg	Kilo gram

One of the main environmental issues for cement manufacturing is air emissions from the manufacturing processes, which are mainly produced in the pre-processing stage (essentially the kilns) and also from the additional equipment used to re-circulate hot air to the initial stages so to preheat the raw feed (i.e., pre-heater using secondary and tertiary hot air). The largest fraction of air emissions are carbon dioxide, nitrogen oxides, water, and oxygen. The smaller portion of the exhaust emissions include dust, chlorides, fluorides, sulphur dioxide, nitrogen oxides, carbon monoxide, and still smaller quantities of organic compounds and heavy metals. This is shown in Table (3-3) which presents a general description of the main constituents and their generation mechanisms in the cement manufacturing process (González, 2005).

3.4.1 Particulate Matter (PM)

Sources of particulate matter during the manufacturing process for cement include quarrying for the raw materials, the raw material feeders, stackers, blenders, and reclaimers used to combine the raw materials to prepare the raw feed prior to the pyro-processing. Currently, the dry raw mills and their auxiliary equipment (i.e. their feeding system, conveyor areas, etc.) are all designed to run under negative pressure to suppress PM emissions. Fabric filters in the vent circuits for dryers, raw mills, and air separators are protected to mitigate any condensation which would significantly reduce the efficiency of the filtering system. The current best management practices to control and reduce PM emissions consider the use of water sprays and surfactants, foams, chemical dust suppressants, wind protection by means of screens, equipment-specific mechanical collectors and fabric filters, material storage units and silos with a filtration system. The resulting dust is re-introduced to the manufacturing process. Table Three presents the standard classification of particulate matter based on particle size. (González, 2005)

Table (3-3) Standard Characterization of Particulate Matter.

Type	Description
Total Suspended Particulate (TSP)	Mass of particles collected by a filtering device.
Condensable	Material in the vapour phase at stack temperature, which could condense and be collected by a filtering device.
Inhalable or inspirable	Particles greater than 10 micrometres that could be inhaled.
Respirable	Particles that can be inhaled and be trapped in the respiratory tract. Sizes between 10 and 2.5 microns.
MP_{10}	Particulate matter with a diameter of less than or equal to 10 micrometres.
$MP_{2.5}$	Particulate matter with a diameter of less than or equal to 2.5 micrometres.

Source: Adapted from Cembureaue, 1999; U.S. EPA 1999; and González, 2005.

Additionally, trace quantities of ammonia (NH_3) in the exhaust gas from a cement kiln probably result from pyrolysis of nitrogenous compounds in fossil fuels and raw materials. Ammonia emissions from cement kilns are of primary concern with regard to their potential contribution to regional haze. A synergistic effect occurs in the vicinity outside of the stack, where NH_3 compounds react with other air emissions (i.e., hydrogen chloride, sulphur oxides, etc.) and produce fine particles that are the precursor of regional haze in urban areas. Additionally, poor control of the use of NH3 as the reagent for control of nitrogen oxides (i.e., selective catalytic reduction) in the manufacturing process, means that un-reacted NH_3 could result in a release to the atmosphere that would contribute also to regional haze. (González,2005)

3.4.2. Sulfur Dioxide (SO_2)

Interest in the formation of sulfur dioxide (SO_2) is due to the formation of acid rain, and its effect on land and water (Nabel et al, 2000). In the cement manufacturing process, pyrite which is present in the coal used as fuel is one of main precursors of SO_2 formation. Additionally, other sources of sulfur-containing compounds include the raw materials used for cement manufacturing (Van Oss et al, 2003). The pyro process in cement manufacturing has long been considered as one with a 'self-scrubbing' characteristic in the matters of SO_2 emissions. This ability provides the cement industry with capacity of handing high sulphur containing fuels in their manufacturing process. Volatile alkali materials present in the raw feed stack reacting to form more stable compounds which are alkali sulfates in most of the cases. These reactions occur in the preheating zone or the kiln. The sulfates can end up attached to the cooler areas along the walls of the kiln, and in most cases are incorporated into the clinker. These formations should be avoided and should not be allowed to build up excessively due to the potential formation of clogs inside the kiln (Cembureaue, 1999: and González, 2005). Common concentrations for SO_2 compounds are reported to range from 100 to 200 ppm in the exhaust gas. A corresponding 0.5 kg of SO_2 per ton of clinker is related to a concentration in the exhaust gas from the process of 100 ppm of SO_x.

3.4.3. Nitrogen oxides (NO_X)

In cement manufacturing, nitrogen oxides (NO_X) form by the reaction of nitrogen with oxygen at the high temperatures inside the kiln resulting from the combustion of fuel. Emissions of NO_X from cement manufacturing are of concern as they can detrimentally affect air quality and human health, an example of which is its role in the production of ground-level ozone, which can aggravate the human respiratory system. It has been reported that almost 90% of the emission of NO_X are in the form of NO (nitrogen oxide) and the remainder is in the form of NO_2 (nitrogen dioxide). It has been reported that the best available technologies for controlling and reducing nitrogen oxides from cement manufacturing include the following measures:

- Primary measures to control NO_X emissions (flame cooling, low- NO_X burner)
- Staged combustion.
- Selective catalytic and non-catalytic reduction.

There are four mechanisms of NO_X formation that have been subject of continuous research, and have contributed to improving the pollution control equipment available for cement manufacturing. These mechanisms are: thermal $NO_{X,}$ fuel, feed (Van Oss et al, 2003).Thermal formation of NO_X results from the oxidation of molecular nitrogen with air at high temperature. This process occurs in and around the flame in the burning zone of a cement kiln at a temperature greater than 1200°C approximately. Fuel NO_X results from the oxidation of nitrogen in the fuel at any combustion temperature found in the cement process. Due to the lower temperature from combustion, the formation of fuel NO_X often exceeds that of thermal NO_X only in this stage of the process. Feed NO_X is the generation of nitrogen oxides resulting from the reaction between air at relatively high temperatures (approx. 350°C-750°C) and nitrogen present in the raw feed (e.g., materials with quantities of ammonia, etc.) (Van Oss et al, 2003 and González, 2005). In general the generation of feed NO_X is greater from wet and long dry processes, due to the lower temperature reached while compared to more recent technologies (e.g., cyanide which reacts with oxygen), (Van Oss et al, 2003; and González, 2005).

3.4.4. Carbon Oxides (CO and CO_2)

Carbon dioxide, the most important greenhouse gas, contributing to climate change, results from the combustion of carbonaceous fuel and the calcinations (decarbonisation) of the calcareous component of the raw material mix, an essentially unavoidable and fixed consequence of cement manufacture. Of the total amount of CO_2 emitted from a cement kiln, about half of the CO_2 originates from the raw material while the other half originates from the combustion process. There is about one ton of CO_2 emitted per ton of clinker production. More thermally efficient systems emit slightly less than one ton while less thermally efficient systems emit slightly more than one ton.(González, 2005)

Carbon monoxide(CO) is a by-product of the incomplete combustion of fuels in kiln, as a result of low oxygen concentrations available for combustion. An inefficient process will result in emission of CO due to the partial combustion of fuel, but this gas also been identified as one of the various control techniques for NO_X.

3.4.5. Organic Emissions

Emissions of volatile organic compounds from cement manufacturing have raised significant concern due to their association with the formation of atmospheric ozone and their classification as hazardous air pollutants by the Environmental Protection Agency in the United States. Continuous monitoring directly from the exhaust in the stack. has not been possible and so indirect measurement of volatile organic compounds has to from measuring total hydrocarbons. With regard to the formation of dioxins, the Environmental Production Agency (EPA) determined a maximum temperature of gas exhaust of 204°c for all the control devices for particulate matter that the formation of has determined that formation of dioxins are generated in PMCDs (Control Devices For Particulate Matter) serving the main and alkali bypass stacks of cement kilns and in-kilns/raw mills as a function of the temperature at the inlet of the PMCD. Although the mechanism of formation has not been fully determined, EPA has concluded that there is sufficient empirical evidence to establish the maximum inlet temperature to the PMCDs serving the pyro-process at as the maximum available control technology for cement kilns (USEPA, 1999).

3.4.6. Acid Gases (SO_3 and HCI)

As previously, mentioned, sulphur compounds may be present in the raw materials and fuels used in Portland cement kilns. All the oxidants necessary to convert SO_2 to sulphur trioxide (SO_3) are present in the combustion products of fossil fuel (Miller, 2002). Therefore, emissions of SO_3 and/or sulphuric acid mist are a possibility from cement plants. The emissions of sulphuric acid mist also may increase for those plants employing tailpipe wet scrubbers. Chlorine may be present in the raw materials and fuel inputs in the manufacturing system. The mechanism for the formation of HCI in cement kilns is not fully understood. However, emissions of HCI from cement kilns have been reported over a wide range of values. Perhaps because of the affinity of chlorine for calcium and alkali metals, there is limited evidence that HCI emissions may be independent of chlorine input to a kiln system. Should there be fluorine naturally present in the raw materials or added as a mineralize, the emission of hydrogen fluoride from a cement kiln system is a possibility (PCA, 2000; Cembureaue, 1999)

3.4.7. Cement Kiln Dust (CKD)

Large quantities of air are used for combustion and to carry the fuel to the burning zone. The air and combustion products entrain particles of clinker, raw materials, and partially of clinker, raw materials with the exhaust gases. The particulate matter that is collected from the kiln exhaust gases by air pollution control equipment is known as cement kiln dust (CKD). Some plants recycle all of the CKD generated back into the process, others recycle a portion of the CKD, and still some others do not recycle the CKD. The degree of return of CKD is dependent upon the composition of CKD which is a function of the composition of raw materials and fuels as well as the design and operating parameters of the specific kiln, and applicable cement specification. The volatile constituents of the feed to the kiln concentrate in the CKD. This occurs because the volatile constituents exit the kiln with the exhaust gases, condense and are collected as particulate matter. As the quantity of CKD recycled to the kiln is increased, the concentration of the volatile constituents in the kiln can be significantly increased. In fact, the concentration can be increased in many cases to the point where materials become "sticky" (Haftbatadarn, 2000) and develop "rings" (Haftbatadarn, 2000) or other obstructions within the kiln system (Chadboume, 1985).

In order to remove some of the alkalies (potassium and sodium) chlorides, and sulphates from the pre-processing system, portions of the generated CKD are often not recycled into the process. If the alkali salts accumulates to 1% to 2% in the preheated materials, build ups and operating problems can occur (Crolius, 1992). If the alkali concentration is allowed to continue to increase, the result will be a plugging of the system. Therefore, appropriate recycling or removal of CKD balances the internal chemistry of each pyro-processing system. In addition, the alkali specifications for some Portland cement products force many manufactures to remove some quantity of CKD from the pyro-processing system.

The average chemical composition of CKD can be taken from the Bureau of Mines study, which reported characteristics of CKD determined from 113 CKD samples received from 102 cement plants that were generating CKD (Hayness, 1982) the average composition of CKD is shown in Table (2-4).

Table (3-4) Average CKD composition.

Constituent	% By weight
CaCO3	55.5
SiO_2	13.6
CaO	8.1
K_2SO_4	7.6
$CaSO_3$	5.2
AI_2O_3	4.5
Fe_2O_3	2.1
MgO	1.3
NaCI	1.1
KF	0.4
Other	0.6
Total	100.00

Source: Hayness and Kramer (1982); and Haftbatadarn. H, (2000).

This composition shows that typical CKD is composed of constituents of the raw feed; principally calcium carbonate and silicon dioxide, oxides of metal constituents present in the feed, as well as calcium oxide, alkali chlorides and sulphates, Portland cement hydraulic minerals and other salts. The volatile salts and metallic constituents evaporate in the hotter portion of the kiln and travel toward the feed end of the kiln as gases or fumes. Upon cooling, these compounds condense onto surfaces such as entrained particles of raw feed. Generally speaking, an industry average of 63.3 Kg of CKD is generated per ton of cement. Approximately, 16 kg is beneficially used and is not included as residuals. (Portland Cement Association Survey CPA, 1993).

Variations in raw materials, kiln design, and kiln-operating parameters cause the composition and particle size distribution of CKD to vary from plant to plant. CKD will have smaller mean particle size diameter than the corresponding kiln feed. Particle size segregation can be used to control recycled material chemistry where an electrostatic precipitator is used as the air pollution control device (Freeman, 1989). Large particles of CKD that tend to be more like kiln feed, which is less enriched in volatiles, may then be favourably reintroduced into the process.

Historically, the cement industry has managed CKD through recycling to the extent that the production process and product specifications could accommodate the re-circulating alkali chlorides and sulphates. Nowadays, land disposal of the CKD, which is not returned to the process is common practice.

3.5. The Environmental impact of Cement Industry

3.5.1. Impacts on the earth and agriculture:

Table (3 -5) Studies that consider environmental damage directly to land, humans and buildings.

Reduction in crop yields	Olaleye et al., 2010; Semhi, 2010; Lukjanova et al., 2010; Tijan A.A et al., 2005; Han et al., 2003; Warren et al., 2003; Iqbal and Shafig, 2001; Kurtz et al., 2001; Reynolds et al., 2001; Rao,1998; Liu et al, 1997; Stoorvogel et al., 1997; Satao et al, 1993; Shukla et al., 1990; Akeredolu, 1989.	Particular evidence from work on Chinese agriculture specifically on reduced grape and rice yield
Reduction in soil fertility	Lukjanova et al., 2010; Semhi, 2010; Anonymous, 2008b; Mandre, 2008; Tijani. A.A. et al, 2005; Liblik et al., 2000; Mandre and Ots, 1999; Sivakumar and Britto, 1995; Mandre et al., 1995; Adeejumo et al., 1994; Kokk, 1988.	Showed that some toxic heavy metals such as arsenic (As), lead (Pb,) nickel (Ni), cobalt (Co), Zinc (Zn),copper (Cu) and phosphorus (P) were significantly enriched in the neighbourhood of cement factories in Nigeria.
Destruction of vegetation cover and environmental degradation	Tijani, A.A. et al. 2005; Topie, 1999; Hegazy, 1996; Raguotis, 1997; Semhi (2010), Namita et al (2009), Branquinho et al. (2008), Abdul-Wahab (2006), Razavi (2006), Ade-Ademilua (2008), Iqbal and Shafig (2001), Kurtz et al. (2001), Reynolds et al. (2001), Mandre, M and L. Twlnets (1997), Stoorvogel et al. (1997),and, Borka (1980).	For example, Topie (1999) indicated that the cement industry was the main cause of the destruction of vegetation cover and of environmental degradation in Solin and Kastela near Split, Croatia. Damage to coniferous trees by cement dust has been reported by several authors
Acute or chronic health effects;	Syamala and Rao, 1999; Adejumo et al., 1994; Fernandedz et al., 1998 and Tijani et al., 2005). (Adejumo et al. 1994). According to Syamal and Rao (1999); Nadal et al.(2009), Al-Khashman et al. (2006), Marengo et al. (2006), Reijnders (2007); Schuhmacher et al. (2004) Kabir et al. (2010);Jeff et al. (2004), Ian et al (2002), Anonymous (2008d), Huntzinger et al. (2009), Anonymous (2008f); Branquinho et al. (2008), Abdul-Wahab (2006), Razavi, (2006)	Toxic heavy metals listed above have been found to have serious health consequences for man. Humans feeding on plants contaminated with mercury may suffer from mercury poisoning. (cited by: Tijan, 2005),

Damage to dwellings	Perfettini et al. 1989; Wasserbauer et al., 1998; and Tijani et al. 2005).	Deposit of cement dust on roofs can cause microbiological and chemical disintegration of the roofs. Wasserbauer et al. 1998 and Tijani, 2005) indicated that the metabolic process of nitrifying bacteria (mainly Nitrosomonas and Nitrobacter) on cement dust which settle on roofs can increase porosity and thus weaken the strength of roofing materials (Tijani et al., 2005)
Cement related water pollution.	Ademola, 1998; Zubareva et al., 1999; Tijami et al., 2005; Olaleye et al 2010; Kabir et al. 2010;U.S. EPA, 1999a; Haftbaradaran, 2000)	According to Ademola (1998) water quality is dependent on the total dissolved substances in it and these substances when dissolved in water react to change the alkalinity, Ph and hardness of water. Hardness can affect the suitability of water for drinking, or for use in steam boilers, water heaters, and in others, and in other industrial activities. (Tijani et al., 2005)

The studies which have been listed below explain a lot about the damage from the cement industry to agriculture and land but on the other hand, we note that these studies had some shortcomings in their methodology which may result in questioning their accuracy in general. Some of the studies, for example, Tijani et al. (2005) focused on farmers aged between 35-78 and the age range 25-65. This selection may be appropriate to the developed world but in the developing world a person is probably participating in the work force well before the age of 25 and after the age of 65, particularly where education and higher education is less available and valued. Some of these studies do not report results based upon gender and there are likely to be differences between male and female views. Several of these studies did not involve the characteristics of the soil - clay is different from sand and soil, each type of soil has different results, and as it is very important to determine the fertility, the climate and the availability of water which had not been addressed in some of these studies.

3.5.2. Limiting or reducing pollution from cement manufacturing: Overview

Whilst there are substantial hazardous by-products from manufacturing such as dust, given the amount of energy required to produce cement much of the debate centres on reducing energy usage to gain environmental improvements. This can be achieved in the main by a combination of energy efficiency, for example, moving away from fossil fuels by using alternative fuels and/or additives such as sewage sludge Amongst others, Hendriks et al., (1999) and Nordqvist, Body and Keel. (2002) indicated that about 50% of CO_2 emission from cement production comes from the energy sources used in making the cement.

The cement industry is recognising that something has to be done in order to reduce the CO_2 emissions from their operations. Various reports have indicated that the industry is attempting to do this, for example, a report from the trade journal in the UK (Pit and Quarry, 1996a) has identified a move to reduce emissions by 10%, while reports from China indicate even higher targets (Pit and Quarry, 1996a).

Sautin (2005) reported that there was a strategy to reduce the energy consumption in the UK cement industry by 26.8% by 2010 both through more efficient use of energy and the use of fuel waste. (Contract Journal, 2005). This should lead to a substantial reduction of pollution from the cement industry equivalent to 10% of CO2 emission.

In the United States "the members of the Portland Cement Association have adopted the goal of reducing carbon dioxide emission by the year 2020. However, the goal is a reduction of only 10 percent per ton of product from 1990 levels. Although that goal was consistent with the Bush administration's climate change initiative "climate vision" "to reduce greenhouse gases through voluntary industry programmes" (Pit and Quarry, 2003). Whilst Nordqvist et al. (2002) noted that the cement factories in China had ambitions by 2020 to reduce CO_2 by nearly 30% of the 1990 levels.

However, most of these reports are not from independent sources and are not backed up by rigorous examination, or formalised targets. Thus it is difficult to investigate these reported numbers, which are often 'aspirational', in a formal academic way.

Of course, indirect effects should also be taken into account as fossil fuel extraction itself produces environment pollution and degrades the environment. However there are also indirect benefits from using cement in building compared to other materials. The Builders Merchants Journal (2007) reported however that cement is not an obstacle but "an essential component "of a low carbon economy. Arguing that it is the principal ingredient in concrete, which is described as:

"One of the most sustainable building materials, taking into account the energy consumed during its manufacture and its energy performance over the life of a structure. There are great advantages to be gained from concrete dwellings through the use of its thermal mass properties which mean that buildings made from concrete can absorb heat in high temperatures and release them again when the temperature drops", and, "the energy-efficient properties of concrete, which allow buildings to absorb and release heat pointing out that 27 % of the UK's CO emission arise from the energy used to heat, light and cool residential properties. No doubt the arguments will continue, but meanwhile they leave the rest of the industry wondering what to believe" (Builders Merchants Journal, 2007)

There is always the potential of new technology, for example, Chemical Business (1997) reported on a project in Lucerne, California, where the Mitsubishi Cement Corporation was introducing sewage sludge as part of the fuel mix for the kilns. Stoltenberg-Hansson and Steen (2007), pointed out that the reduction of dust emission was still the priority of the cement industry, as discussed by Nordqvist et al. in 2002. Obviously there is no single technological solution to pollution reduction and so the commentary by Alam et al., 2007, on cement production in Pakistan is a useful viewpoint:

"(The) cement industry is among the most advanced industries in Pakistan and has integrated production facilities based on locally available raw materials. It has implemented continuous technological up-grading, having acquired the modern dry process technology. It has installed the latest equipment for collection and is relatively environmental-friendly. It has recently converted oil fired furnaces to coal fired system, resulting in substantially reduced production cost".

However, the reduction of air pollution or emissions from the cement industry is not an isolated problem for that industry alone. Alam et al (2007) that whilst the conversion of oil furnaces to coal furnaces will result in a significant reduction in the cost of production, it ignores an important question –which fossil fuel is less damaging to the environment – coal, gas or oil? Even if we assume that coal causes less damage to the environment there is still the issue of whether the amount of coal which is used to produce a kilo of cement is greater or less than the other fossil fuels. There are studies which indicate that coal is causing damage to the environment, but it should be noted that Alam et al. (2007) does not consider this aspect. Thus we might consider such a view is taking too narrow a focus by not giving attention to what will happen more generally in the environment. Some commentators would argue that it is not possible to reduce cement industry pollution because irrespective of improvements in the technology of cement production, the ever increasing demand for the material will outweigh such gains. For example, the Managing Director of Athens based producer Titan Cement (Builders Merchants Journal, 2007) argued that it was impossible to 'change chemistry' and stop the emission of CO_2 because it is part of the cement production process.

"No matter what you do cement production will always release carbon dioxide. You cannot change the chemistry, so we cannot achieve spectacular cuts in emissions, there is a trade-off between development and sustainability"

Ning (1997) argued that the cement industry, by enabling the growth and development of countries, causes a consequential increase in air pollution. So even the use of new technology to reduce the emission will not be an optimal solution because of this direct, and inevitable, relationship between the cement industry, growth and pollution. This problem is confounded where there is both a lack of environmental awareness inside the cement sector and weakness in the application of the law which regulates the environment aspects. Nordqvist et al (2002), for example, cite China in this respect. From the above studies it could be thought that, there clearly differences between studies in determining what exactly is the reason leading to the impossibility, or difficulty, of reducing the air pollution from the cement industry. Some of them concluded that this problem cannot be solved while some argue that the problem of finding solutions is due to legalities, neglect, a lack of awareness and sometimes the issue of developing the right technology.

Other studies are more optimistic and whilst they see ways in which cement industry pollution can be reduced, there are severe obstacles in so doing. Back in the 1980s and 1990s, some authors argued that there was no significant stimuli for firms to engage in this (Ning 1997 and Magat, 1986) – but more recent developments suggest that pressure and awareness is rising, with more incentives for companies to invest in technological innovation. (Ning 1997 and Magat, 1986)

Several studies discuss a number of obstacles in the cement industry that prevent them ending or reducing polluting emissions of gas and dust to the atmosphere. Ning (1997), Ning (1994) and Krabb, (1992) reported the major impediment is the lack of technological innovations which may help to reduce greenhouse gas emissions. They recommend that this should be a priority area of research and discuss the concept of 'environmentally sound technology' but Ning (1997) and Magat, (1986) argue that our knowledge in respect of the stimuli for firms to adopt this and for it to diffuse through industry is limited. In general, Ning (1997) discussed a further set of constraints that prevent the application of appropriate pollution reducing technology. These are the management and/or administration system, awareness and desired protection of the environmental and the economic incentives for pollution prevention including issues with the adoption of ISO 14001.

3.5.3. Potential solutions to the pollution production

3.5.3.1. Non-hazardous organic and inorganic waste as alternative of fossil fuel

Several researchers believe that non-hazardous waste is a good alternative. Johnson et al (2002) reported that the use of waste as fuel along with fossil fuel will provide a double service to the cement industry. Firstly it uses the waste as fuel and secondly the volume of waste to be tipped will be reduced. Hibbert (2007), Nadal et al. (2009), and Huntzinger et al. (2009) also believe that both organic waste and inorganic waste (such as tyres) are a good alternative to fossil fuel. The Contract Journal (2006) reported that inorganic waste is a more convenient alternative to fossil fuels. Additionally, in general, one might be especially supportive of using inorganic waste given the limited choices to get rid of such waste. Whilst Hibbert (2007) reported that in 2008, cement companies will reduce by 30% of the use of coal as fuel and use the waste as an alternative, the Contract Journal (2006) had reported that European countries and specifically Britain had reduced fossil fuel usage through utilising wastes by only 12-14%. Other countries such as the Netherlands, did not favour the use of waste as alternative to fossil fuel, preferring to search for other alternative fuels. This lack of wholesale support for the use of waste as a fuel is furthered by the fact that those who advocate the use of the waste as an alternative fuel do not have a clear analysis concerning the best alternative fuel. There is no consensus on whether all kinds of organic wastes and inorganic wastes can serve appropriately as an alternative fuel. The literature review revealed a lack of research in this area and there is clearly a need to further explore the alternatives available and the environmental costs and benefits.

Tyres are one possible source of energy with some sources reporting that they are known for their very clean burning' (Moore, 2003). Johnson and Truini (2002) found that 114 million old tires were used for fuel in the United States in 1998, including 38 million used in cement kilns (Johnson and Truini, 2002) found that the tire chips provided the same energy per ton as coal, and thus were seen as an ideal alternative by many in the industry. Paul (1993) stresses that the use of alternative fuel such as tyres instead of fossil fuel will certainly reduce the emissions of gases harmful to the environment and ensure the appropriate high operating temperature in cement kilns. However, as Johnson and Truin (2002) point out, while the burning of tyres might provide the same amount of energy, such burning is likely to result in more chimney stack pollution. There is therefore an apparent contradiction and dilemma to be resolved when one fuel is substituted for another.

3.5.3.2. Hazardous waste

Whilst some studies have suggested the use of hazardous waste, Kemezis (1993) noted that the United States and The Environmental Protection Agency fear the use of hazardous waste as an alternative fuel because there may well be the associated higher costs of any required special treatment before the fuel can be used fuel cement kilns. The materials burnt may cause a bigger problem to the environment than the conventional fuel, yet the real weakness of these studies is that they do not discuss or clarify such fears. Whilst Bowermaster (1993) and Anon (2008b) have shown that more than twenty plants in the world use the hazardous waste they do not explain, or clarify, whether this has actually damaged the environment or not.

Moore (2003) found that a number of legal organizations and environmental groups were concerned about the burning of hazardous wastes as an alternative to fossil fuel because of the potential impact on air quality. An equally important question is whether the use of these hazardous wastes as an alternative fuel has already caused damage to air quality. A criticism of Moore (2003) is that the notion of risk, predicted risk and the sharing of that risk is underdeveloped. On the other hand we found that Bowermoster (1993) discussed a very important point, namely, the use of an alternative fuel instead of fossil fuel and coal leading to the disposal of wastes and the exact technical conditions (such as kiln operating temperature) required for safe and effective operation. Furthermore he noted that the emission from the hazardous wastes contained many dangerous chemical materials and indicated that nobody knew exactly its impacts on health. Others such as Kemezis (1993) report mixed reviews, some of which disagree with the use of hazardous waste as an alternative fuel and outline the harm to the consumer when consuming the cement material. Others would argue that there is no potential harm or damage from using such alternative fuels.

3.5.3.3. Reducing pollution through better fuel management

Anon (2003b) sets out the basic framework for the reduction of air pollution, "firstly to reduce emission through increased efficiency, decreased fuel use, and the greater use of alternative fuel and raw materials. Secondly to use a lower portion of calcinated material, thereby reducing carbon dioxide emissions per unit of product"

These studies indicate that part of the pollution from emission into the air or atmosphere has its source from the use of fuel in the cement plants. The Builders Merchants Journal (2007) pointed out that big amount of the pollution in the UK cement industry derives from the energy source used and the consensus of opinion from the following studies would argue a figure between 40%-50%; (Abdul-Wahab, 2006; Ade-Ademilua,2008; Akpinar et al., 2008; Anonymous, 2008j; Anonymous, 2009g; Anonymous, 2009h; Anonymous, 2009i; Branquinho et al., 2008; Cherem et al., 2008; Davidovits, 1994; Gosudarstvenny, 2006; Haftbaradaran, 2000; Härtling and Schulz, 1998; Hendriks et al., 1999; Kabir et al, 2010; Kuvarega et al.,2008; Mandre, 2008; Martí Nadal et al., 2009; Nordqvist et al.,2002; Pacyna et al., 2006;Pacyna et al., 2007; Pyta et al., 2009; Huntzinger et al., 2009; Razavi, 2006; Smith, 1990.Staaf and Tyler, 1995 ; TNO and Price Waterhouse Coopers, 2002; UN ECE, 1998; Zielonka et al 2005).

Nordqvist et al. (2002) recommends that the use of fossil fuels should be cut down in the cement factories and that they must try to rely on alternative fuels which are less harmful to the environment. It should be noted that many of the studies point out that a large part of the emission of carbon dioxide, dust and gases is harmful to the immediate area around cement factories. It has been noted by Alam et al (2007) that the demand for cement differs from one country to another, and there is greater demand for cement in countries which have large populations, for example, China. As a result, the supply will be large, which will lead to an increase in the manufacture of cement, thereby increasing the rate of pollution of this industry, especially in the near future.

Overall, from the above we see an on-going debate amongst researchers, experts and professionals in the cement industry regarding the best means of limiting pollution from the industry. One key area of discussion is concerned with the use of alternative fuels. Some commentators believe that hazardous waste has real potential as an alternative fuel while others think non-hazardous waste is the preferred option.

According to some the burning of waste in cement kilns is dangerous to the environment and must be ceased, whereas some believe that whilst it is dangerous, if organized properly, it may be used. Some others argue it is good but only for short term use on a temporary basis. Yet there are others who argue that any effort to keep down the use of fossil fuel and thereby reduce fossil fuel pollution is desirable.

Throughout all the research into alternative fuels no single alternative fuel has been agreed upon by all or some researchers.

3.5.3.4. Changes to core technology

Most of the above discussion has assumed an unchanging core technology in respect of how cement is manufactured and so has not considered how to alter parts of the process – fuel mix, fuel type, and, sub component design (for example filters) For obvious reasons, some consideration should be given to how technology impacts on pollution both for new plants and for retrofitting into existing plants.

One of the reasons there has been growing interest in new technology and new fuel solutions in the cement industry is because of the growing numbers of national, regional and international policies that aim to force heavily polluting industries to adapt to more benign operations. It is worthwhile looking at some of these initiative, even if they do not currently apply to Libyan industries, because it is likely that over time a global standard will be reached, to which all companies across the world may have to adhere.

3.5.3.5. EU ETS

The European Union Emissions Trading Scheme (EU ETS) is the largest multi-national, emissions trading scheme in the world, (EU ETS, 2007) and is a major pillar of EU climate policy. The ETS currently covers more than 10,000 installations with a net heat excess of 20 MW in the energy and industrial sectors which are collectively responsible for close to half of the EU's emissions of CO_2 and 40% of its total greenhouse gas emissions. (Wagner, M., 2004 and EU ETS, 2008)

Under the EU ETS, large emitters of carbon dioxide within the EU must monitor and annually report their CO_2 emissions, and they are obliged every year to return an amount of emission allowances to the government that is equivalent to their CO_2 emissions in that year. In order to neutralize annual irregularities in CO_2-emission levels that may occur due to extreme weather events (such as harsh winters or very hot summers), emission allowances for any plant operator subject to the EU ETS are given out for a sequence of several years at once. Each such sequence of years is called a Trading Period. The 1st EU ETS Trading Period expired in December 2007; it had covered all EU ETS emissions since January 2005. With its termination, the 1st phase EU allowances became invalid. Since January 2008, the 2nd Trading Period is under way which will last until December 2012. Currently, the installations get the allowances for free from the EU member states' governments. Besides receiving this initial allocation on a plant-by-plant basis, an operator may purchase EU allowances from others (installations, traders, the government.) If an installation has received more free allowances than it needs, it may sell them to anybody.

In January 2008, the European Commission proposed a number of changes to the scheme, including centralized allocation (no more national allocation plans) by an EU authority, a turn to auctioning a greater share (60+ %) of permits rather than allocating freely, and inclusion of other greenhouse gases, such as nitrous oxide and fluorocarbons.(EU Emissions Trading system, 2008). These changes are still in a draft stage; the mentioned amendments are only likely to become effective from January 2013 onwards, i.e. in the 3rd Trading Period under the EU ETS. Also, the proposed caps for the 3rd Trading Period foresee an overall reduction of greenhouse gases for the sector of 21% in 2020 compared to 2005 emissions. The EU ETS has recently been extended to the airline industry as well, but these changes will not take place until 2012. (Anon, 2008f; and The Commission to the Council; the European Parliament et al, 2007)

However, the Contract Journal (2005) reported that “The (European Union) Emission Trading scheme (EU ETS) is not giving the cement industry enough warning to invest in new technology. The sustainable development task force Chairman (and Lafarge Cement UK Managing Director) -Jean-Francois Sautin told the Contract Journal that the industry needs more time to invest in technology to reduce carbon emission “He said: we have made the point very clearly that we need longer-term visibility. The EU ETS leaves little time to meet the investments that need to be made” (Contract Journal, 2005)

3.5.3.6. Cement Sustainability Initiative

“The Cement Sustainability Initiative (CSI) is a global effort by 22 major cement producers with operations in more than 100 countries who believe there is a strong business case for the pursuit of sustainable development. Collectively these companies account for about one third of the world’s cement production and range in size from very large multinationals to smaller local producers” (Wbcsdcement, 2012). The CSI has been exploring a variety of policy options to see which offer opportunities for faster, more effective, large-scale responses to climate change. A sector-based analysis of the problem offers a number of possible advantages over more traditional geographically organized responses. A sectoral approach consists of a combination of policies and measures developed to enhance efficient, sector-by-sector greenhouse gas mitigation. Under this approach, producers and their host country governments adopt a set of emissions goals (which may vary by country) or take other coordinated action to help combat climate change. Such an approach offers significant national control to tailor the management of emissions and efficiency goals to local circumstances and capabilities. For developing countries, it offers a policy structure to encourage efficiency gains without limiting economic development, and it offers a chance to share and benefit from best practices and participate in technology development. The CSI’s economic model of the sectoral approach for the cement industry (2009) showed that this concept would result in significantly larger reductions in greenhouse gas emissions (GHG) in the cement industry worldwide compared to global intensity targets. In the CSI model, developed countries would adopt cap and trade systems and develop countries intensity targets.

"The main levers to reduce GHG emissions in the cement industry, identified by the CSI model, are:

> Thermal and electric energy efficiency – well understood by industry, but offers relatively small contributions as modern plants approach theoretical efficiency limits
>
> Alternative fuels – the use of alternative fuels and biomass to heat cement kilns should be incentivized; this needs respective changes in national and local waste management regulations
>
> Clinker substitution – this needs cement standards in some countries to be changed to allow more widespread use of blended cements
>
> Carbon capture and storage (CCS) – This will be a critical technology; it is however not yet developed for commercial application in cement plants. Additional research, development, and pre-commercial demonstration projects are necessary, for which government support and investment will be needed.

The CSI has developed a number of tools that can support the implementation of a Sectoral Approach, resulting in two recent public documents: The CO_2 accounting and reporting protocol and, the global database of plant-specific energy and emissions data (“Getting the Numbers Right”) used by the majority of the global cement industry. CSI members have their CO_2 reports assured by an independent third party (World Business Council for Sustainable Business Development, 2010)

Such an affiliation goes someway to answering Ning (1997) when he questioned the propensity for the cement industry to act:

“ we may identify the main obstacles, the firm’ s direct benefit, the good behaviour of entrepreneurs, the effective communication between demand and supply side [all concluding with a] practical demonstration of environmentally sound technology (EST) and the financial ability of firms to invest in such. Whether the conclusion will apply to the case of the cement industry remains a question”

Such questions regarding the cement industry’s activities are not new – Teece, writing over 20 years ago said:

“It should be reasonable that cement firms invest in dust removing technology instead of emitting pollution into environment under the push of maximum profit-making” (Teece, 1986)

This review has found that there are a range of barriers to the cement industry adopting less environmentally damaging practices and these include, social, administrative, financial, technical and legal. There is little agreement between the experts regarding which of these is the most significant. Ning (1997), for example focusses on administrative problems, while Jean-Flancois, the CEO of Lafarge, clearly sees the timeframe for change to be problematic. However, the Builders Merchant’s Journal (2007) commented that the cost of pollution reduction is the main obstacle.

Without a common agreement on these constraints or groups of obstacles it is difficult to formulate an effective policy. Furthermore the estimates of the potential for pollution reduction as discussed above are not consistent and range from optimistic estimates like (Nordqvist, et al (2002) stating that China can reduce 30% of the emission of carbon dioxide in 2020 over 1990) to the Athens producer -Titan Cement arguing that the increase in demand for cement cannot be reconciled to any reduction in pollution.

3.5.4. Key Environmental Challenges for the Cement Industry in Libya

Cement as a finished product is bulky, and hence, expensive to transport. Some industry commentators (for example: Nordqrist, J., Boyd, C., and Klee, H., 2002) argue that 200 kms by road, 400 kms by rail is about the viable economic distance. The only way to move over a large distance is by ship. Consequently whilst the industry may be multinational, and sometimes structurally very concentrated (for example, Lafarge) production plants often serve local or regional markets.

"The cement industry differs from many other industries in that the product generally cannot profitably be transported over large distances. Therefore, production has to be located in close proximity to the market, which means that for cement producers the notion of pollution havens does not apply. Instead, the cement Sustainability Initiative offers an opportunity to examine the possibility of a detectable pollution halo effect, not least within the restructuring process presently under way in Chinese cement production" (Nordqvist et al., 2002)

Another reason for an increase in local production would be that, as with Libya, it becomes cheaper to produce domestically than to import. The Libyan Government decided to increase the number of factories and this is supported by the Libyan Industry Minister in a meeting with the Jamahiriya newspaper (2008) when he said: "we had eight plants of cement inside Libya but still the demand of cement is high; so two more cement plants will be established inside Libya in the next two years (by 2010).

3.5.5. Libyan Local Impact Studies

These are only Two well known local studies Barghouti (2007) and Masoud (2007).

Barghouti (2007) reported that contamination results from the absence of efficient means of blocking and filtration of dust in the Libyan cement industry. He argued that the reason for this is management technique rather than technical issues. Furthermore, the transfer of cement to, and from, storage silos within and outside the factory has adversely affected the surrounding environment. Also it has been found that waste and dust emissions which cause environmental pollution (which have had a negative impact on the workers in the cement factory and the residents of nearby areas in particular, as well as on plants and animals in the vicinity) are likely to get worse because of the lack of investment in manufacturing technology.

This is supported by various studies including Barghouti's (2007) which looked at residents from areas near to the cement plants. Two hundred and sixty workers from four factories (a 10% sample) were included in the study.

Masoud (2007) focussed on agriculture and found that there was a low productivity of wheat in the fields adjacent to the Bengazi Cement Industry as a result of exposure to dust and gases which disseminated from the factory into the atmosphere. He also pointed out that cement plant dust from the Libda cement plant adjacent to Ein-kaame (the lake of kaame) in Libya led to the death of fish due to the deposition of dust. The cement industry is threatening certain flora and about 50% of one plant group (Libda group), is threatened with extinction. A significant number of wild animals are threatened to extinction.

These Tow Libyan studies suggest that as well as the global issues of climate change and energy use, the Libyan cement industry is also having a detrimental impact on local inhabitants and local ecosystems.

3.6. Conclusion

This chapter has considered the various environmental impacts of the cement industry and has looked at some of the possible solutions. It is clear that while there is a general consensus on the damage caused, there is still a lot of debate concerning the potential solutions and their possible contribution to ameliorating these environmental problems. Many possible solutions will be used if there is sufficient government intervention and if enough global, regional and local pressure is placed on the cement industry. For this reason the next chapter will focus on international conventions and treaties that aim to drive greater environmental responsibility. The laws of Libya will be explored as well as their status with regard to the key global directives, agreements and protocols.

Chapter Four
International conventions and Libyan local laws to reduce the pollution

4.1. Introduction

This chapter sets Libya into the context of key aspects of the international debate on environmental pollution. Given that the major pollution concern within the cement industry is air pollution, particular regard is paid to that. The international context, albeit covered briefly and selectively, is of concern as it may have been the backdrop against which Libya felt obliged to react as an opinion follower. Equally one might argue that despite the constraints of being a developing nation, and one that needed cement for development of buildings and infrastructure, Libya as a society aspired to a cleaner environment. This is demonstrated at the end of this chapter by considering specific environmental policies measures enacted by the government. This chapter therefore starts with a general (but still selective) overview at an international level before focussing down to the Libyan case.

Legislation that focuses on the protection of the environment is not something new or a novel since some specific actions were taken in this regard during the eighteenth century. For example, according to Mustafa et al. (2002) orders were issued by the governments of some provinces (Such as Egypt) that prohibited the dumping of dirt in the river, or prohibiting fishing, so as not to cause the destruction of some of the birds which are very beneficial to humans.

Technological progress and the expansion of industry along with the inevitable increase in pollution eventually raised human attention and consequently many countries started reviewing their legislation and their own laws. In this regard many of them were concerned with the issuance of new legislation concerned with desertification, biodiversity, the protection of water sources, the marine and agro-ecological environment, and the prevention of air pollution. These environment laws did not effectively and completely solve the problem of environmental degradation or reduce the suffering of many ordinary people from the seriousness of this pollution on all elements of the environment around them. As a result civil societies in many countries called for the need to protect the environment and preservation of pollution, and resisted everything which damaged any element of their environment, even if this damage was caused by the government or the state itself, (Abdulqawi, 2002).

This chapter will focus on the most important international conventions that deal with air pollution from industry, and these conventions are highlighted for three reasons. Firstly to explain how the international community (society) pay attention to the problem of pollution in general and to understand from these laws the seriousness of pollution from the industry (again in general). Secondly, to consider the cement industry in particular because this study is concerned with the impact of this industry on the environment; and thirdly to explain the dangerous problem of air pollution. Since air pollution causes the worst pollution to the atmosphere and comes from industries such as the cement industry. This will be followed by a case study of the Libyan state and the most important laws and decisions that were made by them to reduce, or manage, the pollution within its airspace. This will include the most prominent decisions that were taken by The Libyan Government on the limitation of pollution, Furthermore those regional and international agreements which were concluded by the Libyan Government with international organizations and the international community will also be reviewed. Finally the Blue Plan scenarios that were adopted in Barcelona by Spain and the Libyan state in 1975 about the future environmental situation of Libya between 2010 to 2025 will be considered.

4.2 .Conventions, protocols and international treaties that are organised by many international organizations on the protection of environment

There are many international conventions and treaties concluded by international organizations to reduce the environmental degradation. Table 4.1 below illustrates key examples.

Table (4-1)	**Illustrative examples of the international conventions and treaties concluded by international organizations, alphabetical and then by date.**

Name of organization	**Description**	**Note**
The Arctic Programme of Monitoring and Assessment (AMAP)	Concerning the level and source of human pollutants in the Arctic	1991
Helsinki Convention	Helsinki convention on the protection of the marine environment of the Baltic Sea Region, 24 March 1974, amended 9 April 1992..	1974
International Labour Organisation (ILO).	The use of white lead in paint. An early ILO Convention (13), 1921, ratified 1923 but not by all countries.	1921
	Protection from the danger of poisoning which emitted from petrol, Convention 136, 23 June.	1971
	Prevention and control of risk from exposure to carcinogenic substances and agents at work, Convention 139, 24 June.	1974
	Protection of workers from hazards in the work environment due to air pollution, noise and vibration, Convention 148, 20 June.	1977
	Realization of safety when using asbestos, Convention 162, 24 June.	1986
	Realization of safety when using chemicals at work, Convention 170, 25 June.	1990
	Prevention of major industrial accidents, Convention 174, 22 June.	1993
International Maritime Organization (IMO).	The Convention on the prevention of pollution from ships, 2 November.	1973
	The convention on the readiness, response and cooperation in the case of oil pollution and its protocol, 30 November.	1990
	The convention on the control of harmful anti-fouling systems on ships, 5 October.	2001
Organization for the Prohibition of the United States Chemical Weapons (OPCW).	The convention on the prevention of development and production of United States chemical weapons and destruction which result from them, 23 September.	1992
United Nations Environment Programme (UNEP).	The Vienna convention for the protection of the Ozone Layer, served as a framework for efforts to protect the globe's ozone layer. Adopted in 1985 and entered into force on 22 Sep 1988. In 2009, the Vienna Convention became the first Convention of any kind to achieve universal ratification. This Convention did not require countries to take concrete actions to control ozone depleting substances. Instead, in accordance with the	1985

	provisions of the Convention, the countries of the world agreed the Montreal Protocol on Substances that Deplete the Ozone Layer under the Convention to advance that goal (see below). The Parties to the Vienna Convention meet once every three years, back to back with the Parties to the Montreal Protocol, in order to take decisions designed to administer the Convention. (source: UNEP)	
	Montreal protocol on substances that cause the erosion the Ozone Layer.	1987
	Basel convention for the control of Movements of hazardous wastes across-borders and their disposal.	1992
	Framework Convention work of the United Nations especially on climate change and Kyoto Protocol, 9 May.	1992
	Convention on Biological Diversity, Rio de Janeiro, 5 June	1992
	Cartagena Protocol on Biosafety. On 29 January 2000, the Conference of the Parties to the Convention on Biological Diversity adopted this supplementary agreement to the Convention. The Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology.	2000
	Stockholm Convention on Organic pollutants (POPS); 22 May.	2001

UNEP Regional Conventions.	Regional Seas Conventions of (UNEP)	1974
	Barcelona Convention for protocol of the marine environment and coastal region of Mediterranean Sea, 16 February.	1976
	Kuwait regional convention for cooperation to protect the marine environment from pollution, 24 April.	1978
	The Convention for cooperation for the protection and development of the marine environment and coastal area of West and Central Africa, 23 March.	1981
	Lima Convention for the Protection of the marine environment and coastal regions of South-Eastern Pacific ocean, 12 November.	1981
	Convention relating to preserving the environment of Red Sea and Gulf of Aden, 24 March.	1982
	Cartagena Convention for the Protection and development of the marine environment of the Caribbean, 24 March.	1983
	Convention for the protection and management and development of coastal and marine environment of Eastern Africa, 21 June.	1985
	(Noumea) Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, Noumea, 24 November.	1986
	Bucharest Convention for the protection of the Black Sea from pollution, 30 September.	1992

United Nations Economic Commission for Europe (UNECE)	European Agreement related to international carriage of dangerous goods on the road, 30 September.	1957

	Convention on Long-range Transboundary Air Pollution, Geneva, 13 November.	1979
	Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki), 17 March.	1992
	Convention on mitigating the effects of industrial (pollution) accidents across borders, 19 April.	2000
	European Agreement on the International Carriage of Dangerous Goods by Inland Waterways, 25 May.	2000
North American Commission for Environmental Cooperation (NACEC).	The North American Agreement on Environmental Cooperation (NAAEC) came into force at the same time as the North American Free Trade Agreement (NAFTA). NAAEC established an international organization - the Commission for Environmental Cooperation (CEC) to oversee its mission. 1 January.	1994
OSPAR Committee:	The convention on the protection of marine environment of the North East of Atlantic Ocean (OSPAR Convention), 22 September.	1992

Note: Dates are when conventions were agreed not necessarily when they came into force and subsequent amendments are not usually noted.

4.2.1. Vienna Convention for the protection of the Ozone Layer

This convention was ratified on 22 March, 1985. (The United Nations Environment Programme UNEP, 1985). The aim was to support international cooperation to protect the Ozone layer from the adverse effects of various human activities and to provide a framework to exchange data on Ozone as well as to provide a basis for determining a legal framework. Those signed to the convention committed to under take the following activities: the management of scientific research and exchange of information on the situation of the Ozone layer, chemicals and processes that affect the Ozone layer, and the effects of change in the Ozone Layer on health and environment, and to develop the procedures to control human activities which are influencing adversely the Ozone Layer. For this reason protocols were developed at this convention for the development and transfer of technology and relevant knowledge. Accordingly, the countries of this convention were to receive appropriate advice about the technical matters which aimed to improve the Ozone Layer and to work with the World Meteorological Organisation to review and monitor appropriate Programmes.

The primary gas pumped into the air causing damage both to air quality and the Ozone Layers is carbon dioxide (CO_2), along with other industries, for example, oil, gas, iron and steel, and paper, the cement industry is a major source of CO_2. The cement industry discharges other pollutants that have a direct effect on both the atmosphere and the Ozone Layer. Gasses such as carbon monoxide, sulphur oxides, nitrogen oxides, in addition to other pollutions such as aldehydes, hydrocarbons, phenols, dust and noise. In 1987 agreement was reached on specific measures to be drawn out of the Vienna protocol and these were signed and agreed in the Montreal Protocol. (Eeaa.gov.eg, 2009)

4.2.2. Montreal Protocol On Substances that Deplete the Ozone Layer

The Montreal Protocol on substances eroding The Ozone Layer, was ratified on 16 September 1987 and has been amended several times since then to accommodate its work and support the objectives of this protocol. This protocol concerned the production and consumption of man made chemicals that damaged the Ozone Layer and set targets to reduce their usage. Those chemicals identified in this protocol (for example, CFCs) were to have their national production and consumption reduced taking 1986 levels as the base year. The rate of reduction varying and depending upon the type of chemicals, and also whether the contributing nation was a developed or developing country. Also the participating countries in Montreal protocol were to be prohibited from trading in these to be controlled substances with countries that were not a party to the Protocol (The United Nations Environment Programme UNEP, 1987:5).

Importantly, expert advice and help were to be provided for participating countries with regard to the protocol. Firstly, scientific assessment from governmental and other experts who would be reviewing the scientific information every four years, the so called Technology and Economic Assessment Panels. Also a multilateral fund was set up to be administered by an executive committee with equal membership from developed and developing countries to assist developing countries meet their Montreal Protocol commitments. This fund was operational from the first of January 1991,with an initial allocation of about one million American Dollars which was initially distributed among 107 states to implement the Programme of reducing Ozone Depleting Substance (ODS). “ (Since 1991) the Fund has approved activities including industrial conversion, technical assistance, training and capacity building worth over US $2.6 billion" (Secretariat of the Multilateral Fund for the Implementation of the Montreal Protocol, 2011).

4.2.3. The Arctic Programme of Monitoring and Assessment (AMAP)

This Programme was established in 1991 by the eight countries which are located near the Arctic area, namely Denmark, Canada, Finland, Norway, Iceland, Sweden, Russia, and The United States of America. The AMAP research programme was involved in monitoring and assessing the level source of some human pollutants to the environment in the Arctic area, so as to Programme activities to deal with persistent organic pollutants, heavy metals, radioactive materials, oxides of sulphur , nitrogen and sources of these materials inside and outside the Artic region. The Programme has identified the transport and deposition of a wide range of these pollutants because of the danger to human and wildlife in the north; and stressed the need for taking suitable measures at both the domestic and international levels to reduce and/or dispose of residues and emissions of these substance to protect the environment of the Artic. This research has thus contributed significantly to the work of the Council of Ministers of the Arctic, which was founded in 1996 to address environmental concerns for the governments and people of the Arctic. In 2001, this council in response to findings from the AMAP, made a recommendation on dealing with mercury on a global basis. It can be noted that the programme discussed many pollutants from the member countries that affected the Arctic Region and also that the programme had focused and highlighted on pollutants which were emitted by many industries, including the cement industry that emitted harmful gases such as oxides of sulphur and nitrogen oxides. One result of this programme was that the seriousness of pollution from the cement industry in this region of the world and the world in general was taken into account.

4.2.4. Convention number 148: The protection of workers from the risks of working environment due to air pollution, noise and vibration.

This convention was ratified on 20 July 1977, where the aim was to protect workers from the risk of noise, vibration and air pollution by hazardous substances that negatively affect their health. Member states have to establish legislation and

Programmes to protect workers from risk arising from their work by establishing standards, and exposure limits, in the work area, and to apply this procedure to current operations and installations. If it is not successful in implementing them, then the amount of air pollution in the work areas should be determined to the appropriate degree; suitable personal protection equipment should be available; the workers must be informed about the dangers of their work and the necessary procedures to protect them from these risks; and, their health should be assessed at appropriate times. (International Labour Organization, 1977). It is known that most industries suffer from the noise pollution but this is not equal from the industry to another. Many of the studies conducted on the cement industry found that the noise pollution of the cement industry caused suffering and harm to the workers.

4.2.5. (The Convention Number 139): Prevention and control of risk because of work as a result of material and causal factors of cancer

This convention sponsored by the International Labour Organization (ILO) was ratified on 24th June 1974 in order to protect workers from the risk of exposure to materials and causal factors which caused cancer. It requires the member states to replace the dangerous materials by other materials and factors which cause less risk and do not cause cancer. If there is no possibility of making a replacement, then appropriate operations must be legalised by the United States of America for these carcinogenic substances. This should aim to reduce the number of workers who are exposed to risk; and reduce the time of exposure by maintaining an appropriate system for registering cases of vulnerable workers (who must be informed of the risk); and take medical procedures during and after periods of work to assess the size of exposure and the health situation. (International Labour Organization, 1977). It was found from many of the studies which were carried out in the cement industry that many people living next to, or near, cement industries as well as the workers in these plants are exposed to the risk of lung cancer because of exposure to the gas and dust which are emitted from inside and outside the factory. Therefore this international convention gave attention to the pollution emitted from the cement industry and concluded that this pollution affects human life directly.

4.2.6. The convention which gave attention to biological diversity and Cartagena Protocol on biosafety. United Nations Environment Programme (UNEP)

The UNEP defined biotechnology as referring to:

"any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for a specific use. Common contemporary and historical uses being the fermenting of beer and the use of yeast in bread making. It has also been the basis of traditional animal and plant breeding techniques, such as hybridization and the selection of plants and animals with specific characteristics to create, for example, crops which produce higher yields of grain. The difference with modern biotechnology is that researchers can now take a single gene from a plant or animal cell and insert it in another plant or animal cell to give it a desired characteristic, such as a plant that is resistant to a specific pest or disease."

It was argued that the world community needed to have some form of protection that would ensure that no irreparable damage would be caused by misguided or foolhardy actions. There were particular worries in respect of enforcement since it was considered that developed nations had more appropriate, and robust, biosafety regimes in place than in the developing world. The Protocol used the term Living Modified Organism(s) to clarify the focus of interest and concern.

The Protocol refers to Living Modified Organism(s) as 'any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology.' Common LMOs include agricultural crops that have been genetically modified for either greater productivity or for resistance to pests or diseases –or both. Examples of modified crops include tomatoes, cassava, corn, cotton and soybeans. The Protocol concerned itself with the transboundary movement, transit, handling and use of any Living Modified Organism that had the potential to create adverse effects on human health, conservation and diversity.

The summary justification for the Protocol being "While advances in biotechnology have great potential for significant improvements inhuman well-being, they must be developed and used with adequate safety measures for the environment and human health. The objectives of the 1992 Convention on Biological Diversity are "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources." (UNEP and http://www.biodiv.org / biosafety / protocol.asp)

4.2.7. Convention on Long-range Transboundary Air Pollution, Geneva, 13 November, 1979.

This convention is under the government of the office of the United Nations Economic Council for Europe. Before summarising this convention it is worth remembering that most of the air pollution originating from industries in general, and the cement industry in particular, are: carbon monoxide, carbon dioxide, nitrogen oxides and hydrocarbons in addition to aldehydes, phenols, dust (particularly, silica) and noise pollution. **(**NACEC, 1994)

This convention was ratified on 13 November 1979 as the first international legal instrument dealing with the air pollution on a regional basis. It has been the aim of the convention to protect both health and the environment by the reduction of air pollution and prevention of long-term cross-border incidents by taking measures of cooperation with the participating states who are committed to developing strategies and policies to combat the atmospheric pollution. These to be achieved through information exchange, consultation, research, monitoring, and cooperation in research and development. This co-operation to cover: technology for reducing the emission of air pollution; monitoring techniques; measurement of the rates from emission of air pollution; concentration of air pollutants; long-term effects of the main air pollutants on health; and the environment. Lastly, training and education Programmes which are related to the environmental aspects of air pollution from the main pollutants. Eight protocols were developed from the convention but none of them included clauses relating to the technical aspects or a funding mechanism.

The protocol for the long-term financing of the cooperative Programme to monitor and evaluate long-range air pollutants in Europe was ratified in September 1984. According to this convention, the member states committed themselves to share the cost of

European monitoring, assessment and auditing of the data on the emission of sulphur, nitrogen dioxide, volatile organic compounds and other air pollutants, as well as to measure the degree of air purity and develop appropriate atmospheric models. Another protocol on reducing the emission of sulphur oxides and their cross border flow by at least 30%, was ratified in July 1985.

4.2.8. The Protocol on controlling emissions of nitrogen oxide and flow across the borders was ratified in November 1988. The member States agreed to control emissions of nitrogen oxide and its flow it across the border to the 1987 level, and to reduce this base figure by 30 % by December 1994. This was to be done by developing national standards for emissions from major new sources; and establishing procedures for controlling pollution at the main sources; and, by removing lead from petrol by 1993. Again provision was made for appropriate research, monitoring and information exchange.

4.2.9. In 1994 the Protocol to the 1979 convention on long-range transboundary air pollution and further reduction of sulphur emissions was implemented based on the concern that emissions of sulphur and other air pollutants were continuing to be transported across international boundaries and, in exposed parts of Europe and North America, and were causing widespread damage to natural resources of vital environmental and economic importance, such as forests, soils and waters, and to materials. (unece.org).

4.2.10. The air Programme to the convention on NACEC: The Commission for Environmental Cooperation (CEC) was set up to bring into action the aims and environmental hopes of the North American Agreement on Environmental Cooperation (NAAEC) which itself was set up alongside the North American Free Trade Agreement (NAFTA). One could argue that NAFTA was seen both as an opportunity to improve the environment of USA / Canada / Mexico and as a containment of any increased pollution that might arise from increased liberalisation and development of trade between the partners. It has three broad objectives:

- address regional environmental concerns

- help prevent potential trade and environmental conflicts
- promote the effective enforcement of environmental law

In the early years of 2000, it was reporting that:

"The CEC air programme is now in the beginning stages of developing the basis for a trinational air emissions inventory in North America. The pollutants of concern include carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOC_s), and aerosol particles." In addition to these traditional air pollutants, the CEC Council also directed the CEC to include greenhouse gases, such as carbon dioxide. Particularly as "Identifying major sources of greenhouse gases in North America is critically important in addressing climate change when we consider, for example, that Canada, Mexico and the United States collectively contribute more than 25 percent of annual global carbon dioxide emissions".

Ground-level ozone and aerosol particles pose a clear and substantial threat to human health and at lower ambient levels than previously thought. In order to address such health threats, as well as to improve scenic visibility in the USA, air quality planners need to understand the sources and, the amount and contributors to air pollution. They typically begin this effort by creating inventories of air pollution from all known sources. Because pollution problems are regional and transboundary in scope, air quality planners increasingly need to develop inventories for sources located over large areas, often across state, provincial, and national borders in North America. The CEC Council recognized this when it adopted Council Resolution 01-05 "Promoting Comparability of Air Emissions Inventories" at the Council's June 2001 meeting in Guadalajara, Mexico."

They argued that the two key reasons for pursuing this trinational overview initiative were:

"domestic regulatory and statutory planning requirements that involve atmospheric modelling of air sheds across international boundaries and the need for sufficiently detailed information that allows planners to focus on where effective and practical reduction targets exist, such as knowing whether emissions arise from combustion or process activities within a facility."

4.3. Local legal aspects which have been made by Libyan government to reduce the pollution problem

This section is concerned with how Libya has approached environmental protection by the development of both research initiatives and environmental legislation that reflect its concern for local and national environmental issues. Libya faces a range of environmental problems such as: air pollution, water pollution, soil and desertification, all of which come principally from industry, especially the cement industry. (Ohbabi, 2006)

The Libyan Government has passed a group of legislation aimed at protecting the environment and these can be identified as follows:-

1. The environment laws which are issued by the Libyan Government.
2. Libyan parliament resolution.
3. Centres and research institutions that care for the environment matters in various fields.
4. International and regional Conventions that are shared by Libya.

4.3.1. With respect to environment laws which are issued by the Libyan government they have understood the environment risk for a long time. It has enacted laws and legislation to deal with the care of the environment since the mid-twentieth century. It had passed Law Number 55 in 1955 concerning the production of oil and use of oil. This was followed by several laws paying attention to the environment. The Libyan State in 2003 issued Law Number 15 which concerned the protection and improvement of the environment. "This included a variety of penalties for those who caused damage to the environment " (Adali, 2003). This legislation can be considered to be the most important of all the legislation. It consists of seventy nine articles in eleven chapters, with rules to protect all elements of the environment from pollution. (Libyan Official Journal, 2003). For this dissertation, Chapter Three of Article Ten is particularly important.

It does not allow any facility or plant to cause any sort of air pollutant that breaks the law through not complying with the scientific criteria (that sets the appropriate pollution parameters). This applies particularly to the cement, oil and gas a dust and all ships in

Libya port, as well as ships waiting outside the port. Excluded from these provisions are the factories that are operating at the time of the application of this law, and those established within six months from the date of the formal operation of the legislation. (Libyan Official Journal, 2003). Article Number 11 of this law, requires each institution, factory or laboratory which emits pollutants to record the quality and quantity of components and contaminants. **(**Libyan Official Journal, 2003)

Article 12 allows that " any institution, factory and laboratory that changes its own building, its method of operation, its disposal of air pollutions, the type of fuel … and by doing this exceeds the normal pollution limit and so continues to endanger the public health, then it can be closed down for an unlimited period of time." (Libyan Official Journal, 2003). Article 13 states that all the industrial establishment are expected to take the necessary steps in the event of an accident or an emergency inside the factory that was caused by, or emitted, pollutants to eradicate the pollutants and re-establish the factory to full capacity operation.

When proved that the accident or emergency leads to damages public health, or results in pollution of the environment in the area surrounding the factory or institution, then it becomes necessary to issue instructions to take the necessary step to prevent the spread of damage. (Libyan Official Journal, 2003)

Whilst legislation exists to address the major concerns of pollution, it could be argued that, in practice, enforcement is weaker. Article 65 of the legislation concerns penalties for failing to meet the law on environmental protection. Here it states that anyone causing pollution is: "punishable by a fine of not less than 1000 Libyan Diners" this is equivalent to £400 sterling. A fine not exceeding 5000 Libyan Dinas (which is equivalent to £2000 sterling) is payable for each act which contravenes the provisions of Articles number 10, 11, 12, 14, 15, 20. **(**Libyan Official Journal, 2003). This might well explain why the industrial sector, in general, and the cement industry in particular, are not paying attention to penalties or laws which seek to preserve the environment in Libya. This suggests also that Libyan environmental legislation must be applied with more accuracy and intensity to prevent the pollution of all kinds, including severer penalties.

Industries such as cement and gas (to name two) do not only lead to air pollution but their adverse impact extends to soil, water, wildlife, people and to locations outside of their immediate plants. As a result laws have been passed to control the pollution and maintain a good standard free from pollution. For example law number 15 is aimed at protecting the sea, marine wealth, water sources, quality of food, environmental sanitation and the protection of wildlife.

Notwithstanding the forgoing, we find that the Libyan Government had introduced many laws in the hope that the government could find a legal solution and deterrent to this risk or threat. It will also be necessary to review now the many most important local laws and decisions which had been put by Libyan Government as described below.

4.3.2. Libyan Legislations and laws deal with sanitation and environment protection. (Krimidh, 2002)

Table (4-2) Illustrative Libyan legislations and laws on environment protection.

Law No.	Descriptive	Date
55	On safeguarding the oil.	1955
33	On protection of agricultural land.	1970
2	On mining and stone quarrying.	1971
81	On the protection of the ports from contaminants.	1971
8	On preventing the pollution of sea water by oil.	1973
106	On the health and the regulation of performance.	1973
93	On industrial safety.	1976
15	On the protection of animals and trees.	1980
2	On regulating the exploitation of ionizing radiation and prevention of its dangers.	1982
5	On the protection of grasslands and forests	1982
6	On protecting of grasslands and forests.	1982
7	On protecting of the environment.	1982
13	Concerning public cleansing and urban and rural solid waste collection and disposal, and Executive Regulation thereof.	1984
21	On regulating the confirmation of public ownership and disposition of the land.	1984

7	On abolition of land ownership.	1986
14	On regulating the exploitation of marine wealth.	1989
22	On industrial organization.	1989
5	On specifications and standards.	1990
15	On protection of agricultural land and its amendments to law number 14 in 1992.	1992
3	On the protection of monuments, areas, old towns and historic buildings.	1994
15	On protecting and improving the environment.	2003

Decisions which are made by Libyan government to protect the environment are the following:

Table (4-3) Illustrative Decisions made by the Libyan government to protect the environment.

Law No.	Descriptive	Date
107	The Decision of General People's Committee (Libyan Prime Minister) on secretary–designate of the people's committee on environmental problems (The Environment Minister).	1973
1062	The Decision on issuing of regulation which apply for general energy.	1981
3	The Decision of General People's Committee (Libyan Prime Minister) on regulating the exploitation of water sources.	1982
3	Decision of the General People's Committee (Libyan Prime Minister) for agricultural reconstruction and rehabilitation of land, on necessary measures for the prevention of fires in forest and grassland.	1984
912	The Decision of General People's Committee (Libyan Prime Minister) for protecting the technical centre for environment.	1984
567	The Decision of General People's Committee (Libyan Prime Minister) on amending some of the provisions to establish the technical centre for environment protection.	1986
7	The Decision of General People's Committee (Libyan Prime Minister) number 386 in 1998 on issuing a regulation to be applied to law number 7 in 1987 on protecting the environment.	1987
494	The Decision of reports on certain provisions concerning smoke emissions.	1989
127	Decision of the General People's Committee (Libyan Prime Minister) for agricultural reconstruction and rehabilitation of land, which reports on certain some provisions for the protection of animals and trees.	1990
61	The Decision of General People's Committee (Libyan Prime Minister) on organizing the national centre for transportation and standards.	1991
631	Decision of the general peoples committee (Libyan Prime Minister) on the regulation of natural environment and parks.	1992
676	The Decision on reporting some of the provisions about the cancellation of all processes which had been completed on public forest lands.	1993
199	The Decision on the formation of the national committee for control of desert locust.	1999
152	The Decision of General People's Committee (Libyan Prime Minister) number 152 in 1995 on the issue of applied regulation for law number 3 in 1994 on protecting museums, old towns, and historic buildings.	1995

4.3.3. The conventions and treaties of regional and international organisations which were concluded by the Libyan government:-

Table (4-4) Illustration of the conventions adopted by Libyan government specifically concerning air protection and the ozone layer.

Serial number	The name of the convention	The place of ratification of the convention	Dare of ratification	Date of certification	Note
1	The Treaty on principles of arranging for activities of states in exploration and use of outer space, including the moon and other celestial bodies.	London Moscow Washington	27.01.1998	16.07.1998	International convention
2	Vienna Convention on the protection of the ozone layer.	Vienna	22.03.1985	09.10.1990	International convention
3	Montreal Protocol on substances that deplete the ozone layer and its amendments.	Montreal	16.09.1987	11.07.1990	International convention
4	International convention on climate change.	New York	05.06.1992	14.06.1999	International convention

Source (Libyan Environment Public Authority, 2006b).

Table (4-5) Illustrative Convention and International Treaties concerned with which had been concluded by Libyan Government to reducing the pollution and conclud by the Libyan Government.

Serial number	The name of the convention	The place of ratification of the convention	Dare of ratification	Date of certification	Note
1	Convention on establishment of a central council of fisheries in the Mediterranean .	Rome	06.12.1949	14.05.1963	International convention
2	International convention for the prevention of sea pollution by oil , amended on 11 April 1962 and in October 1961.	London	12.5.1954	18.5.1972	International convention
3	Treaty on the prohibition of nuclear weapons for testing in the atmosphere, and also in outer space or under water.	Moscow	5.8.1963	15.07.1969	International convention
4	Convention on the prevention of marine pollution in the burning of waste and other materials	Barcelona	29.12.1972	22.12.1976	International convention
5	Convention on protecting the Mediterranean from the pollution.	Barcelona	16.02.1976	31.01.1979	Regional convention at

					the level of the Mediterranean
6	Protocol to prevent Mediterranean pollution caused by waste thrown out from ships and aircrafts.	Barcelona	16.02.1976	31.01.1979	Regional convention at the level of the Mediterranean
7	Protocol on cooperation on combating the pollution of the Mediterranean by oil and other harmful substances in cases of emergency.	Barcelona	16.02.1976	31.01.1979	Regional convention at the level of the Mediterranean
8	Protocol on the protection of the Mediterranean sea from pollution from land-based sources.	Athens	17.05.1980	06.06.1989	Regional convention at the level of the Mediterranean
9	The convention on the liability for nuclear accidents.	Vienna	26.09.1968	27.06.1996	International convention
10	Protocol for the protection of the Mediterranean Sea against pollution resulting from the exploration and exploitation of the continental shelf and the seabed and its subsoil	Madrid	4.10.1994	23.02.1998	

Source (Libyan Environment Public Authority, 2006c).

In addition, there are other conventions on the protection of the nature, the transfer, the use and the trading in chemicals.

4.4.Local institutions which are constituted by Libyan government for environment protection: The Technical Centre for Environmental Protection, other initiatives, and, private associations

4.4.1. A technical centre for environment protection:

This institution embodies the main regulatory attitude on governing and control of both activity and transactions related to the environment and environmental pollutants, and has been established for environmental protection in pursuance of the decision of General People's Committee (Prime Minister) number 912 in 1984 (and its amendment) in pursuance of the provisions of law number 7 in 1982. This is considered as one of the many scientific centres which deal with general utilities (Minister of Housing). It has a legal personality, its own budget and a high level discussion committee to approve scientific studies on the environment and to find scientific solutions to the problems of the environment and to encourage dissemination and action that leads to the implementation of environmentally sound policy. The responsibilities of the centre are as follows (Bosnian, 2004):

4.4.1.1. Propose plans and programmes for the environment and surveillance on its application and follow-up.

4.4.1.2. Supervise on sanitation and the environment.

4.4.1.3. Maintain the scientific and technical development in the area of environment protection.

4.4.1.4. Cooperation with international groups to remove pollution incidents.

4.4.1.5. Initiate campaigns of awareness on the different ways of defining and understanding the environment, the foundations and rules to protect it from pollution through eliminating causes of pollution.

4.4.1.6. To give the necessary authorizations for the exercise of appropriate activities in accordance with the rules and necessary conditions to ensure the recipient's commitment to the protection of the environment.

4.4.1.7. Express an opinion before construction on the environment impact of projects which are likely to result in the contamination of environment.

4.4.1.8. Follow-up the international treaties and conventions in the environment field and derive benefit from them.

4.4.1.9. Organize seminars, training courses and scientific conferences.

4.4.1.10. Review all legislations on governing the environment including proposals to monitor the Environment Protection law.

Nine other relevant centres, or research bodies have been introduced, these are:

4.4.2. Programme for research and environment studies by National Authority for Scientific Research (1996):

This programme was established to embody interest in scientific research on Libyan environment topics and to coordinate research programmes and studies by the national committee. Additionally, to develop research plans for implementing appropriate policy and supervising directly their implementations, (Bosnian, 2004).

4.4.3. Marine Research Centre of the Commission of the people's marine wealth (Minister of marine wealth):

4.4.3.1. Carrying out research and studies in the field of marine biology and providing national training to achieve this.

4.4.3.2. Working to publish this research and other studies and making tapes, and documentaries, to transmit their results for implementation.

4.4.3.3. Cooperation with scientific institutions, local and international organizations to arrange seminars, publications and scientific documents.

4.4.4. Arab Centre for Desert research and development of desert communities (Kabi, 2004). This centre seeks to achieve a number of aims as follows:

4.4.4.1. To conduct studies and research concerning both the development of desert areas and desert communities.
4.4.4.2. To study the latest scientific methods and practice to aid the development of natural and human resources in accordance with the current needs, and potential, of desert communities.
4.4.4.3. Participate in the development of programmes needed to protect the desert environment, particularly with regard to the protection and development of native animals and birds, and to support programmes for their reproduction. To protect water sources from pollution.
4.4.4.4. To stress the importance of economic feasibility studies and surveys of different economic activities, and to deepen scientific research on topics and issues for the development of desert communities.

4.4.5. Study centre of solar energy: The study centre of solar energy in 1978 to achieve the following objectives, (Salh, 2006):

4.4.5.1. Conducting research and scientific studies which are related to the exploitation of solar energy and other renewable energies.
4.4.5.2. Cooperation with national and foreign institutions to achieve scientific purposes.
4.4.5.3. Awareness of the spread of scientific knowledge in the exploitation of solar energy. In order for the Centre to achieve these aims it is necessary to conduct research and scientific studies in several areas relating to the exploitation of solar energy and other renewable energies.

4.4.6. Economic Sciences Research Centre. This centre was established by resolution number 320 in 1986 with the aims of achieving the following objectives (Libyan Environment Public Authority, 2003a):

4.4.6.1. To set out the aims and policies of scientific research in the area of specialization.
4.4.6.2. To identify, coordinate and finance the research projects with competence and monitor their implementation.
4.4.6.3. So provide the necessary elements for scientific research in the area of specialization.
4.4.6.4. To support cement research in collaborative with universities, and other association inside and outside Libya.

4.4.7. Agricultural research centre: This centre was established in pursuance of law number 109 in 1971 and aimed at achieving the following aims :-

(environment public attitude, 2006, page 80)

4.4.7.1. To making a general plan for scientific research on the purpose of agricultural development.

4.4.7.2. Collection, classification and evaluation of research and technical, economic and social studies which were to be done in the agricultural field in Libya.

4.4.7.3. To undertake studies and research on the development and maintenance of natural resources and agricultural problems in the oases, medicines, rain fed areas, dry areas, climate change on agricultural and economic studies, including research on the agricultural sector to develop and improve the means of agricultural production.

4.4.8. The Water General Attitude: It was established in pursuance with law number 26 in 1972 and the Water General Attitude which makes this work as follows, Libyan General People's Committee for Housing and Utilities (1998) and scientific research of national attitude (1996).

4.4.8.1. Proposal for a public policy on water and definition of priorities for projects that would benefit by water.

4.4.8.2. To make a study to carry out a scientific research on water and applications for Libya to ensure the proper exploitation of existing water sources and prospecting for new sources of water.

4.4.8.3. Research and study every thing submitted on the attitude by the institutions and public bodies, with regard to the exploitation of water.

4.4.8.4. Propose legislation on water and its implementation.

4.4.8.5. Supervising the implementation of projects which water extraction and exploitation of ways.

4.4.9. Industrial research centre scientific research of national attitude (1996): it was established in pursuance of law number 25 in 1970 and this centre was aimed at achieving a number of subjects as given below, (Bosnian, 2004):

4.4.9.1. To developing the national economy in Libyan which relating by all aspects of industry.

4.4.9.2. To provide a technical service on the economy and advice to the competent authorities in the industry sector.

4.4.9.3. To carry out biological research and undertake prospecting for new materials and evaluate it.

4.4.9.4. To record and evaluate patents on invention, and provide expertise and advice to achieve the aims of industrial development in Libya.

4.4.9.5. To carry out an applied research with the aim of lifting the level of industrial products of quantity and quality.

4.4.10. National centre for standards and metrology: This centre was established, in pursuance of the law number 5 in 1990 and is aimed at numbering subjects as described below :- (Bosnian, 2004):

4.4.10.1. To carry out everything with the specifications, standards and quality control, and prepare standard specifications for, its adoption in Libya, its diffusion, its review, its application and it's follow-up.

4.4.10.2. To plan and develop the control system, quality, and organise the operation and, the means of measurement and, calibration of legal and industrial standards.

Moreover, the Libyan Government had given permission to establish of private associations for the protection of environment which led to establishment of the first non-governmental organizations in Libya responsible for environmental protection, and the following section.

A- Organization name	Civil Association for Environmental Protection
Date established	1992
Address	Tobruk City- East Libya.
Goals	-To work for collecting papers; articles and publishing the information serving environmental protection. - To follow up technical and scientific development in area of environmental protection. - To organization seminars and conferences that serve the environment aspect. - To co-operation with local and Arab organization according to environmental international legislation.
Activities	- The association organized the Second Scientific Symposium on the environment - science and application (1993). - The association organized hygiene campaigns in all areas of Tobruk city through cooperation with public authorities. - The association organized sessions for housewives on the methods of garbage disposal and good use of water. - The association organized Public awareness campaigns, through distribution of leaflets by Scouts and the Youth of

	the Libyan Red Crescent. - The association organized the Third Symposium on the environment- science and application; under the logo of “our lives to protect our environment” (1994). - The association organized the Fourth Symposium on the Environment (1996). - The association participated in the conference of the optimal exploitation of natural resources and modern methods to protect the environment- in of Hungary (1996)

B-Organization name	Civil Association for Environmental Protection
Date of established	1995
Address	Derna City-East Libya
Goals	-To protect the environment and to contribute to finding solutions to avoid its risks. -To Support and encourage studies and scientific research on environmental pollution.
Activities	The Association has done many seminars and lectures via newspapers; local TV and radio in order to reach the largest number of the population.

C-Organization name	National Assembly to maintain wildlife
Date of established	1995
Address	Tripoli capital of Libya- west Libya.
Goals	The Association aims to do everything possible to maintain the environment leading to the protection of wildlife; plants and marine life and to as that via cooperation with the competent authorities.

D-Organization name	Association of Environmental Friends
Date of established	2009
Address	Hoon City – Middle Libya.

Goals	- To work on the treatment of the environment through increasing the vegetation and establishment of forest. - To protect wildlife and to establish of protected areas. -To protect local seeds from extinction.
Activities	- The association organized seminars, panel discussions and workshops to solve the problems which related to the environment. - The association organized awareness campaigns through radio; TV; newspapers and specialized publications

Source: (Honaderna, 2012; Maktoobblog, 2012a; and Maktoobblog, 2012b and Startimes, 2012)

All of the local and regional conventions and treaties; laws and legislation both nationally and internationally conventions; research centres concerned with the environment protection inside Libyan country, have helped to reduce pollution somewhat and reduced many abuses such as gas emission contaminating the soils and dust from the cement factories. These emissions having adversely affected agricultural land and lakes near gas plants, oil refineries and cement works, and, destroyed the wildlife and the quality of water which affected human life. Additional sources of pollution coming from shipbuilding and chemical industries. However, these laws and actions may not be sufficient to achieve environmental long term protection and to ensure sustainable economic development.

The aim of environment protection should fall within the objectives of economic and social development; so it is be considered as a public policy of society. Further it must take into account the interrelationship between those polices relating to water, population, industrialization, energy and tourism, including the integration between these policies in the economic context without conflicting effects on economic activity. Of course, the outcome of any such clash between economic activity and environment may be the degradation of the environment such as pollution of the environment and desertification, the resources of the nations will be limited, even the depletion of non-renewable resources and the destruction of historical monuments and landmarks.

An appropriate understanding of the interrelationship between economic and social variables on the one hand, and environment components on the other hand, can be found if we can find examples of planning for economic and social development which integrate an economic planning style with social development. One important example in the context of Libya is, the so called, Blue Plan adopted in Barcelona in 1975. This Plan represents the integrated planning of the Mediterranean Action plan, which aims to explore the future of the countries surrounding the Mediterranean Sea, by identifying the development prospects of these countries which are consistent with a strong management of the environment (Bosnian, 2004)

4.5. An environmental perspective to Libya (Prospect for the Blue Plan between 2010- 2025)

The study, called Blue plan scenarios, was aimed at preparing a development plan to provide an environmental perspective of Libya's prospects for the years 2010-2025. The plan is concerned with the industrial and environmental development, and carried out research on the possibility of industries understanding environment conditions. Thus being able to identify appropriate exploitation of our natural resources, and to discover whether the Libyan government is going in the true or wrong way in their exploitation of using oil, agricultural land, coastal land, marine wealth, and forest. Equally, if these natural resources can generate revenue or appropriate opportunities for future generations.

The method followed the scenario style, or followed the scenes and events, which can transform the economy from the present state to an important state later in the future.

Further details of the Blue Plan can be found in Appendix Five. The Blue Plan provides two kinds of scenarios, firstly a directional scenario and secondly, alternative scenarios from the perspective of Libya only (Environment Protection of Technical Centre and General Administration for Environmental Protection, 2007).

4.6. Conclusion

Despite the importance of these efforts at the global level, which are aimed at protecting the environment, there is no overriding international force between states, which has the authority (or power) to impose rules, treaties and conventions of the environment by force if necessary for the obvious reason that each single state has sovereignty over its territory. Additionally, each individual state has its own characteristics, geography, political structure and cultural which distinguish it from other states. As a result every country has its own environmental legislation which is consistent with its position, privacy, culture and social traditions, and the extent to which it may, or may not, wish to emulate other nations. Hence this chapter moved from an international and regional perspective to a Libyan one. But even within Libya there is a multiplicity and diversity of environmental pollution and these risks are still threatening Libya as well as the whole world.

Encouragingly, Libya has developed a plan (the Blue Plan) which is inspired by the Blue Plan on the Mediterranean Sea in 1975 in the Spanish city of Barcelona , in order to develop an environmental strategy and try to reduce the risk of pollution. The task of implementing this vision is daunting as it has to be set within the context of an increasing population and associated industrial development. This will obviously increase the demand for cement production.

Therein lies the dilemma, cement production is a key ingredient for the needed economic development but many studies and reports indicate that the cement industry in general, and in Libya, can impact negatively on the environment. For example, Ibrahim, (1993) citing the impact of cement dust on marine life and wildlife, and the death of fish in Lake Aean Kaam in the Libyan region of Ziltan. This lake being adjacent to the cement plant.

Chapter Five
History of Cement Industry and Case Study of this Industry in Libya

5.1. Introduction

Cement represents one of the most important and necessary materials for the implementation of major economic projects. Since the discovery of oil in 1957, the Libyan economy has grown rapidly and become a huge consumer of cement. Despite the multinational character of the industry, most of the impact is local and so we need to understand the particular nature of the industry within Libya. Given the use of time series data it is particularly important to understand the broad historical trends. Following that we present data on several sub components of the manufacturing process.

5.2. Emergence of the cement industry in Libya

This is clear from the resolutions for the establishment of companies and seven cement factories were established as follows.

5.2.1. The National Cement Company in 1961 in the area of Khoms through introduction into the stock market with a capital of 132,000 Libyan Dinars, which marked the beginning of the country's concern with this type of industry. (The National Cement Company, 1979).

5.2.2. The Libyan Cement Company under decision No. 579 in 1965. (Department of Information Systems, Libyan Cement Company, 1993).

5.2.3. The establishment of Suk El-Khamis as a public company for Cement and Building Materials under decision No. 48 in 1975, following the General Organization for Industrialization. (The Formal Newspaper, 1975)

5.2.4. The establishment of the Arabian Cement Company by the decision of General Peoples Committee (Office of the Prime Minister) No. 77 in 1988 by integrating the National Cement Company and Zileten Cement Factory into The Suk El-Khamis Company for Cement and Building Materials. (Zileten Cement Factory, 1990; Arabian Cement Company, 1991).

5.2.5. The General People's Committee (Office of the Prime Minister) and decision No. 45 in 2005 to lift the capital of The Arabian Cement Company to 600 million Libyan Dinars, where in light of this decision and in the restructuring of the implementation of the programme to broaden the base of ownership, the company's ownership was transferred and its name was changed to Ahlia Cement Company (ACC, 2009).

As for the establishment of the cement plants; it was carried out successively during the periods of development plans in the following manner:-

5.2.6. Establishing the El-Mergheb Cement Factory in Khoms City (the first production line) under the National Cement Company as part of the first fifth plan (1963 – 1967). This factory started production in 1969 with a production capacity of 100 thousand tons annually. (National Cement Company, 1979).

5.2.7. Establishing a cement plant in Benghazi City (the first production line) under the Libyan Cement Company, the implement as part of the second fifth plan (1969 – 1973). This factory started production in 1972 with a capacity of 200 thousand tons per year. (Department of Information Systems, Libyan Cement Company, 1993). Three other cement factories were also established as part of the third fifth plan (1976 – 1980), as explained in the following three points, (Zileten Cement Factory, 1990).

5.2.8. Establishing the cement factory of Suk El-Khamis which is owned by Suk El-Khamis Company for cement and building materials. This factory started production in 1977 with a production capacity of One million ton of cement annually.

5.2.9. Establishing the cement plant of Hawwari in Benghazi under the Libyan Cement Company, which started production in 1976 with a production capacity of one million tons of cement annually.

5.2.10. Establishing the Libda Cement Factory in Khoms under the National Cement Company, which started production in 1980 with a production capacity of one million tons of cement annually.

Another two important cement factories were also established during the fourth and fifth plans (1981 – 1985) as explained below, (Zileten Cement Factory, 1990)

5.2.11. Firstly, the El-Fattail Cement Factory in Darrnah City, with a production capacity of one million tons of cement annually. This factory falls under the Heavy Industries Ministry, and began production in 1983.

5.2.12. Secondly, the Zileten Cement Factory with a production capacity of one million tons of cement annually. This factory falls under Heavy Industry Ministry, and started its production in 1984.

Accordingly, the number of cement factories in Libya is only seven factories since no other factories have been established to date. From the previous discussion it can be said that the cement industry in Libya originated with the National Cement Company in 1961, at about the time the oil exporting operation started. Following that, other companies were established, as mentioned previously, which together made up the cement industry's framework and which has gone through a number of changes and developments as will be explained later. By studying the decisions made for the establishment of cement companies and cement factories and checking the various development plans for cement industry; the main goals sought from the cement industry, and the large amounts of money invested in it can be summarized in the following points:

5.2.12.1. Achieving self-sufficiency of the cement material which is considered to be essential for the infrastructure projects as roads, bridges, dams, housings, construction works and constriction in general.

5.2.12.2. Making use of local raw materials which are important in the cement industry process.

5.2.12.3. Saving foreign exchange that was previously used to import cement, and using it instead to import other materials that are not available locally.

5.2.12.4. Creating employment opportunities for the greatest possible number of citizens.

5.2.12.5. Increasing the export potential and thus acquiring additional incoming financial resources.

5.3. Restructuring of the cement industry in Libya

The restructuring of cement industry in Libya has been through a number of changes and has not stabilized on a single structure; this is due to the many development plans imposed by the Libyan government according to which companies and factories were established. Following is a brief summary of the changes that occurred during the previous stages:

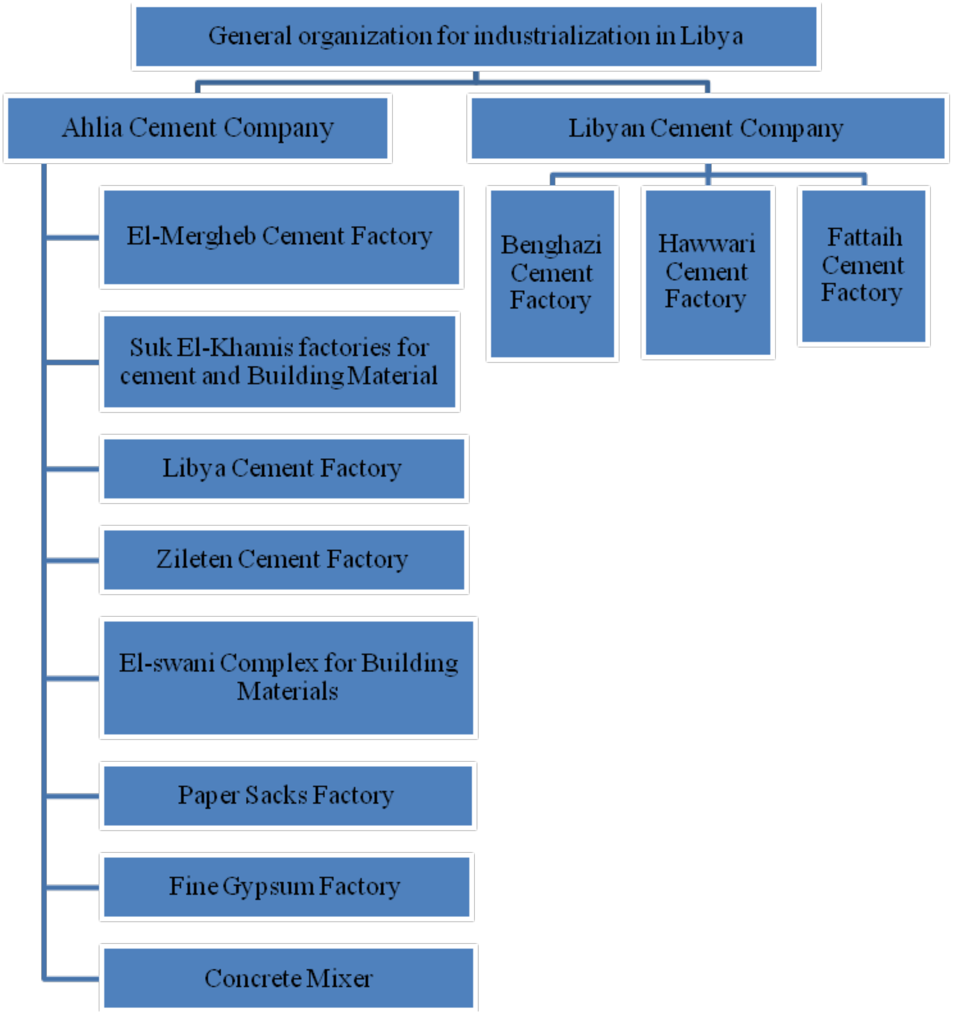
In the nineteen sixties, the restructuring of the cement industry was reflected in the Libyan cement company, National Cement Company and El-Mergheb Cement Factory. In the nineteen seventies, certain changes happened to the restructuring of the cement industry, where the public Suk El-Khamis Company of Cement along with other three factories were established; the three factories included Bengazi Cement Factory and Hawwari Cement factory under the Libyan

Cement Company, and Khoms Cement Industry under Suk El-Khamis public company for Cement and Building Materials. The eighties decade witnessed further restructuring of the cement industry in Libya, with another change with the addition of two manufactures of cement; one of these manufacturers was Fattaih in Darrnah City, and the other one was Zileten Cement Factory in Zileten City, which were established by the General Organization for Industrialization in Libya.

In 1988 an integration was made between the National Company and Zileten Cement Factory into the Public Suk El-Khamis Company for Cement and Building Materials, and the name was changed to the Arabian Cement Company according to decision No. 77 for the year 1988 (Zileten Cement Factory, 1990). And the Fattaih Factory was also integrated into the Libyan Cement Company in accordance with decision No. 66 for the year 1988. (Department of Information Systems in Libyan Cement Company, 1993). In 2005, The Arabian Cement Company was transferring its ownership to Ahlia Cement Company according to the decision of the General People's Committee (Libyan Prime Minister Office) No. 45 of 2005 (The Arabian Cement Company, 2009).

Since that year, the restructuring of the cement industry in Libya has stabilized and there have been no changes to date. So on this basis we can say that the structure of the cement industry in Libya is reflected now in the *Ahlia Cement Company* which consists of Suk El-Khamis Factories for Cement and Building Materials, the El-Mergheb Cement Factory, the Libda Cement Factory, and the Zileten Cement Factory, and *The Libyan Cement Company* which consists of the Benghazi Cement Factory, the Hawwari Cement Plant and the Fattaih Cement Plant. In other words, the structure of the cement industry in Libya is generally composed of two companies and seven plants under control of the General Organization for Industrialization. This is shown in the following figure number (5-1):

Figure (5-1) Restructuring of the cement industry in Libya



Source: author, (2009)

5.4. The Development of the Cement Industry in Libya

Major developments in the cement industry in Libya have happened; these included either structural developments that reflected in the number of companies and factories (as already noted previously), or production developments that reflected in the productivity of capacity and some concepts and indicators related to it. Such as the development of production, production of capacity, productivity of labour, development of capital, volume of investment and others as indicated next:

5.4.1 Development of the Production and Productive Capacities

The development which occurred in the production of cement in Libya during the period between 1969–2008 can be verified in the information and data contained in Table (5-1) and as illustrated in Figure (5-2).

Table (5-1) The development of production quantity and production energy or capacity for the cement industry in Libya and their development rates during 1969-2008.

Production according to capacities or energy								
Year	**Design Capacity**	***Growth rate**	**Target**	***Growth rate**	**Actual**	***Growth rate**	****Actual/ design %**	*****Actual / targeted %**
1969	100		100		68		68	68
1970	100	0.00	100	0.00	95	39.71	95	95
1971	100	0.00	100	0.00	73	-23.16	73	73
1972	300	200.00	300	200.00	179	145.21	59.67	60
1973	300	0.00	290	-3.33	259	44.69	86.33	89
1974	630	110.00	690	137.93	487	88.03	77.30	71
1975	1030	63.49	900	30.43	615	26.28	59.71	68
1976	1430	38.83	1300	44.44	664	7.97	46.43	51
1977	2430	69.93	2100	61.54	908	36.75	37.37	43
1978	3430	41.15	2150	2.38	1213	33.59	35.36	46
1979	3430	0.00	2500	16.28	1595	31.49	46.50	64
1980	4330	26.24	2500	0.00	1772	11.10	40.92	71
1981	4330	0.00	3180	27.20	2722	53.61	62.86	86
1982	4330	0.00	33280	3.14	3173	16.57	73.28	97
1983	5330	123.09	3330	1.52	3096	-2.43	58.09	93
1984	6330	18.76	4690	40.84	3167	2.29	50.03	68
1985	6130	-3.16	4690	0.00	2766	-12.66	45.12	59
1986	6130	0.00	4970	5.97	2008	-27.40	32.76	40
1987	6130	0.00	4870	-2.01	2685	33.72	43.80	55
1988	6130	0.00	45120	5.13	3358	25.07	54.78	66
1989	6130	0.00	4990	-2.54	3905	16.29	63.70	78
1990	6130	0.00	5238	4.97	4296	10.01	70.08	82
1991	6130	0.00	5238	0.00	4345	1.14	70.88	83
1992	6130	0.00	5250	0.23	3918	-9.83	63.92	75
1993	6130	0.00	5543	5.58	4091	4.42	66.74	74
1994	6130	0.00	5320	-4.02	3497	-14.52	57.05	66
1995	6130	0.00	5240	-1.50	3210	-8.21	52.37	61
1996	6130	0.00	5320	1.53	2983	-7.07	48.66	56
1997	6130	0.00	5070	-4.70	2791	-6.44	45.53	55
1998	6130	0.00	4120	0.99	2886	3.40	47.08	56
1999	6130	0.00	4500	-12.11	3051	5.72	49.77	68
2000	6130	0.00	4600	2.22	3240	6.19	52.85	70

2001	6130	0.00	4500	-2.17	3112	-3.95	50.77	69
2002	6130	0.00	4570	1.56	3249	4.40	53.00	71
2003	6130	0.00	4346	-4.90	3722	14.56	60.72	86
2004	6130	0.00	4801	10.47	3734	0.32	60.91	78
2005	6130	0.00	4550	-5.23	4019	7.63	65.56	88
2006	6130	0.00	4501	-1.08	3949	-1.77	64.42	88
2007	6130	0.00	4651	3.33	3881	-1.72	63.31	63
2008	6130	0.00	4771	2.58	4205	7.71	68.60	88
Average	**4656**	**14.69**	**3632**	**14.19**	**2575**	**13.98**	**58.02**	**71**

Source: 1- The annual production reports by the Ahilia Cement Company and its Factories for several years: (Department of Information Systems in Ahilia Cement Company (1998-2008) The Annual production reports, Libya).

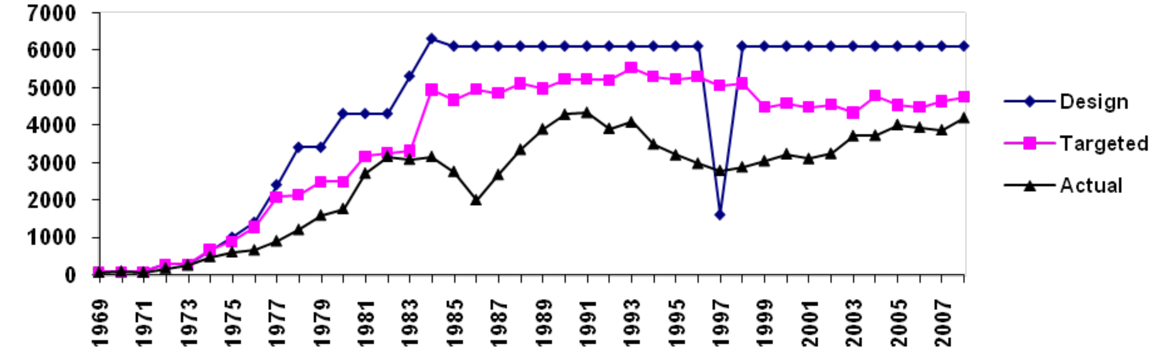
2- The follow-up reports issued by the Industry Minister.

Notes: * Growth rate was calculated by this equation = Current year – Previous year / Previous year x 100.

** The rate of actual production on design production = the actual production / Design production x 100.

*** The rate of actual production on targeted production = Actual production / targeted production x 100.

Figure (5-2) The development of production quantity and production energy or capacity for the cement industry in Libya and their development rates during 1969-2008.



Source: 1-The annual production reports by the Ahilia Cement Company and its Factories for several of years: (Department of Information Systems in Ahilia Cement Company (1988-2008) The Annual production reports. Libya).
2- The follows-up reports which das been issued by Industry Minister.

By checking the information contained in table number (5-1) the following points become clear:

5.4.1.1. The design capacity of production has developed considerably where it increased from 100 tons in 1969 to 6,330 million tons in 1984. This means that the design capacity of production has doubled more than 62 times during the period between 1969 – 1984, this has happened due to the establishment of factories and new production lines; particularly in the late seventies and early eighties. Then this declined slightly in 1985, where the design capacity went down to 6,130 million tons due to the first line in Benghazi factory being halted, which was working to a design capacity of 200 thousand tons.

5.4.1.2. The production target is also seen as a remarkable development as well, where it increased from 100 tons in 1969 to 5,543 million tons at a minimum in 1993, which means it has doubled more than 55 times during the period 1969 – 1993, and then began to decline gradually with some fluctuation until it reached 4,771 million tons in 2008. The reason for this decline is related to some factories becoming relatively outdated on the one hand; to a lack of routine maintenance due to a lack of spare parts, and thirdly, to the lack of construction or building of new factories or new production lines.

5.4.1.3. Actual production has also witnessed a remarkable development where it grew from 68 thousand tons in 1969 to 4,345 million tons at a maximum level in 1991, which means that it multiplied about 64 times during the period between 1969 – 1991, the values fluctuated during that period but did not reach more than the maximum levels achieved in 1991.

5.4.1.4. The growth rate of actual production was characterized by fluctuations between negative and positive; these fluctuations ranged between -27 % in 1986 and 145% in 1972, with a positive average annual growth rate that reached 13.98%.

5.4.1.5. The proportion of actual production to design capacity was also characterized by fluctuations that ranged between 32.8 % in 1986 and 95 % in 1970, with an annual average that did not exceed 58.02 %. As for the ratio of actual production to targeted production; this was also characterized by fluctuations that ranged between 40% in 1986 and 95% at its height in 1970, with an average that did not exceed 70.73%.

5.4.2 Evolution of Employment

The evolution of employment in the cement industry in Libya between 1969–2008 can be identified by consulting the data in Table (5-2) and as illustrated in the following figure 5-3:

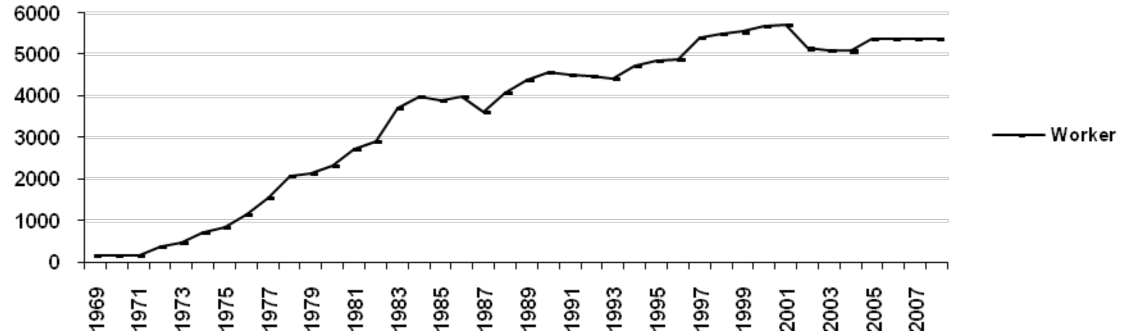
Table (5-2) Development of employment in the cement industry in Libya and its development rates during 1969-2008.

Year	Total of workers by the producer	Annual rate of development %	Year	Total of workers by the producer	Annual rate of development %
1969	145		1989	4385	8
1970	153	6	1990	4569	4
1971	153	0	1991	4499	-2
1972	361	136	1992	4469	-1
1973	461	28	1993	4402	-1
1974	706	53	1994	4712	7
1975	819	16	1995	4842	3
1976	1130	38	1996	4875	1
1977	1542	36	1997	5387	11
1978	2073	34	1998	5495	2
1979	2119	2	1999	5535	1
1980	2311	9	2000	5660	2
1981	2707	17	2001	5703	1
1982	2907	7	2002	5133	-10
1983	2685	27	2003	5094	-1
1984	3964	8	2004	5071	-1
1985	3886	-2	2005	5370	6
1986	3968	2	2006	5368	0
1987	3612	-9	2007	5366	0
Average				**3551.98**	**8**

Source:
1- The annual production reports by the Ahilia Cement Company and its factories for several years: (Department of Information Systems in the Ahilia Cement Company (1988-2008) and The Annual production reports, Libya).

2- The follow-up reports issued by the Industry Minister.

Figure number (5-3): The development employment in the cement industry in Libya and its development rates during 1969-2008.



Source: 1- The annual production reports by the Ahlia Cement Company and its factories for several years.
2- The follow-up reports issued by the Industry Minister (Department of Information Systems in Ahilia Cement Company (1988-2008) The Annual production reports. Libya).

So through considering and analyzing the data in Table 5-2, the following becomes clear: the size of employment has largely developed during the period between 1969-2008, where it increased from 145 in 1969 to 5703 in 2001, which means that it doubled more than 40 times roughly. The reason for this increase in the cement industry in Libya is the establishment of new factories and the adding of new production lines to the existing ones. But in 2001 it is noted that the values started declining to reach of a value of 5094 workers, the lowest rate since 1996.

In 2005, the workers increased to 5370 workers after which the number started to decline up to now. The decline in employment after 2001 is due to the stopping of some of the production lines in Suk El-Khamis Factories for Cement and Building Materials due to causing some technical problems. However, the stability observed in producer numbers during the period between 2005-2008 is mainly due to the reorganising of the El-Mergheb Cement Factory, Libda Cement Factory, Zileten Cement Factory and Suk El-Khamis Factory for Cement and Building Materials and joining to Ahlia Cement Company.

5.4.3 Development of Capital

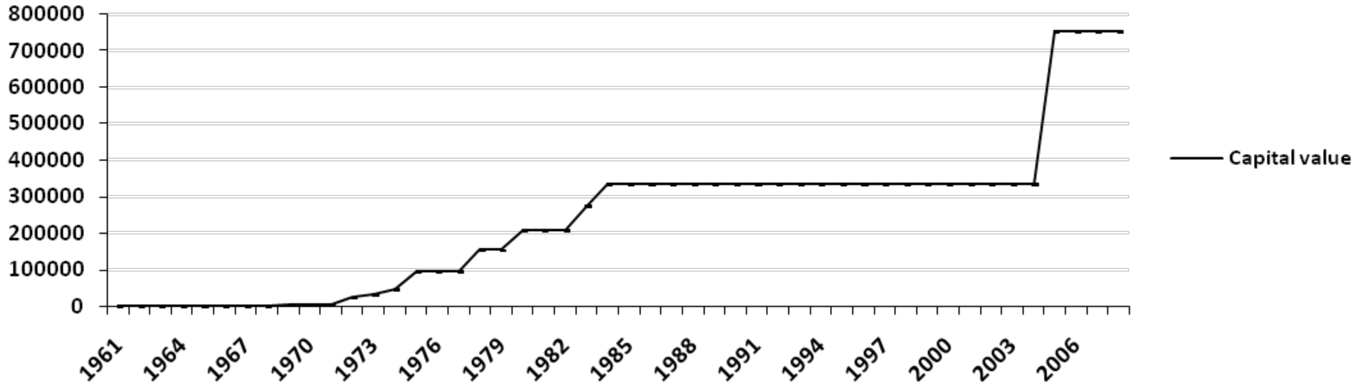
The extent of the development which occurred in the capital of the cement industry during the period 1969 – 2008 can be clarified by checking the information and data included in Table (5-3) as illustrated in the Figure (5-4):

Table (5-3) Development of capital in the cement industry in Libya During 1961-2008.

Year	Capital value in thousands of Libyan Dinars	Year	Capital value of thousands of Libyan Dinars
1961	132	1985	334532
1962	132	1986	334532
1963	132	1987	334532
1964	132	1988	334532
1965	1132	1989	334532
1966	1132	1990	334532
1967	1132	1991	334532
1968	1132	1992	334532
1969	3032	1993	334532
1970	3032	1994	334532
1971	3032	1995	334532
1972	24032	1996	334532
1973	33532	1997	334532
1974	46532	1998	334532
1975	96532	1999	334532
1976	96532	2000	334532
1977	96532	2001	334532
1978	153532	2002	334532
1979	153532	2003	334532
1980	208532	2004	334532
1981	208532	2005	753000
1982	208532	2006	753000
1983	274532	2007	753000
1984	334532	2008	753000

Source: Manuals issued by the company and the cement factories in Libya during several years.

Figure number (5-4): The development of capital of cement industry in Libya During 1961-2008



Source: Manuals issued by the company and the cement factories in Libya during several years.

Through checking and analyzing the data contained in Table (5-3), it shows to us that the amount of capital in cement industry in Libya has witnessed great developments during the period between 1969 – 2005, where it increased from 132 thousand Libyan Dinars in 1961 to 753 million Libyan Dinars in 2005, and stabilized at this level during the rest of the period of this research. So the amount of capital doubled more than 5700 times during the period 1961-2005 and that is reflected in the amount of expansion in plants and production lines which resulted from the ambitious development plans at that time in Libya.

5.5. Problems and Obstacles to the Cement Industry in Libya

From the perusal of follow-up reports issued by the secretariat of the General People's Committee (Ministry of Industry in Libya) during the period 1974-2008, and through the author's field visits to the majority of cement plants, and the many meetings with directors in the financial departments and technical departments inside the Libyan cement factories, it appeared to us that the cement industry in Libya has faced and still faces many difficulties and problems which resulted in a decrease in the actual productivity of cement factories, and failing to achieve the annual targets set on the one hand, and the cement factories incurring big financial losses on the other hand. The main problems and difficulties faced by the cement industry in Libya can be summarized in the following points:

5.5.1. Lack of spare parts and operating supplies which is mainly due to the following:

5.5.1.1. The severe deficiency in the local market in Libya for spare parts and operating supplies, which made the factories depend on themselves for provision their requirements and necessities.

5.5.1.2. Reducing the operational budget below the proposed budget for many years.

5.5.1.3. Lack foreign exchange, which pushed the administrations of the cement industry to focus on importing equipment and spare parts with the lowest price without considering their quality. This caused an increase in the technical problems and stoppages.

5.5.2. Lack of skilled manpower which is mainly due to:

5.5.2.1. Lack of technical people required for operation and maintenance in the cement industry which might be attributed to the fact that the cement industry in Libya is a relatively recent one.

5.6.2.2. Low level of education of the national employment in existing plants, which led to difficulties in training, upgrading and raising of the level of performance.

5.5.2.3. The instability of foreign workers due to reduction in the exchange rate (from Libyan dinars to foreign currency) and the cancelling of rewards.

5.5.2.4. Lack of administrative stability in factories, which led to fluctuations in the levels of work inside them, and the lack of accumulation of technical and managerial expertise.

5.5.2.5. Cessation of training outside Libya (abroad) without providing enough number of people for training locally. In addition, there was an increase in the implementation of various technical aspects in the cement plants in Libya.

5.5.2.6. Lack of workers (especially in some years) which is mainly due to sudden and repetitious military summons.

5.5.2.7. Lack of optimum utilization of the national qualified employment due to assigning them to handle administrative functions.

5.5.3. Many plants suffer from a problem of the deterioration of some of the machinery and equipment that exists in them and a lack of essential spare parts, which resulted in many emergency stops and a decrease in the quantity of production.

5.5.4. The problem of the cement and lime market stagnation in some years especially in 1984, which is due to the limited size of the domestic market, and not opening doors for the disposal of surplus production into foreign markets, which made the plants reduce their targets of production in some years.

The result of these problems and difficulties was that most of the cement plants in Libya were not able to achieve their targets at many periods of time. Accordingly, this requires a serious stand to solve these problem and difficulties out of concern to support the national industry and maintain it.

5.6. The Contribution of the Ahlia Cement Company

This part of chapter four comprises the study and analysis of the Ahlia Cement Company, which is done by presenting the data on two issues. The first point comprises the emergence and structuring of this company, while the second point deals with the evolution of the company.

5.6.1 The Emergence of Ahlia Cement Company

This case study starts by discussing the emergence and structure of the company and then discusses the evolution of the company. The Ahlia Cement Company was established according to the decision of The General People's Committee Number 77 in 1988 under the name of The Arabian Cement Company, this was changed to Ahlia Cement Company based on the decision of the General People's Committee (Prime Minister Office) No. 45 in 2005 according to which ownership of the Arabian Cement Company was transferred and its name changed to Ahlia Cement Company, with its headquarters located in Khoms city. This company became the holding company and oversaw the administration of the El-Mergheb Cement Factory; the Suk El-Khamis Complex for Cement and Building Materials; the Libda Cement Factory and Zileten Cement Factory with associated factories: the El-Swani Complex for Building Materials, a Paper Sack Factory, Gypsum Factory and finally Concrete Mixer .

The Ahlia Cement Company is considered to be one of the largest National Cement Companies working in the cement and building materials in Libya and it is also a member of the Arab Union for cement manufacture and construction materials.

From reviewing the basic system of Ahlia Cement Company which was adopted according to the decision of The Secretary-General People's Committee for the Strategic Industries No. 54 in 1991 (this decision was of course intended for the Arabian Cement Company which as explained earlier became the Ahlia Cement Company in 2005), it can be seen that the company was established to achieve the main objectives of controlling the cement factories and lime factories that it owns, provide their needs for raw materials and spare parts …etc, and build up essential expansion plans that cover construction of factories, new production plants, supervision of these plants and follow-up on various relevant activity aspects whether these aspects were related to production, or other administrative and financial aspects. In addition, the company is expected to devise and enact all policies and plans necessary to achieve its goals and schedule replacement and development of the factories and production lines. The company should also devise and manage programmes related to marketing operations, storage operations, training and rehabilitation and follow-up all matters related to the labour force in its factories or company.

5.6.2 Structure of the Ahlia Cement Company

As explained earlier; four plants fall under the Ahlia Cement Company including, El-Mergheb Cement Factory, Suk El-Khamis Complex for Cement and Building Materials, Libda Cement Factory and Zileten Cement Factory. These factories are considered to be the main focus or the backbone of the administrative structure of this company, in addition to some other public departments and organizational bodies that assist in the operation, supervision, and follow-up of these plants in respect of administrative, technical, financial and legal actions.

Through the field studies it became clear that the structure of Ahlia Cement Company is characterized by being relatively stable since establishment of the company until now, when no new factories were built or incorporated to the company. Through accessing the organizational structure of the company, which was issued according to the decision of Secretary of the People's Committee for Housing and Utilities No. 83 in 1998 on formation of a Committee for the preparation of the organizational structures of companies in the sector, and which was adopted according to Decision No. 135 in 1998, issued on 13.08.1998, it shows that the structure of the company is as follows:

5.6.2.1. People's Committee of the Company

5.6.2.1.1. Secretary of People's Committee of the Company and within that:

- Office of the Committee Affairs.
- Office of Legal Affairs.
- Office of Public safety and prevention industry.

5.6.2.1.2. Department of Internal Audit and within that :

- Internal Audit: Suk El-Khamis Factories.
- Internal Audit: Libda Cement Factory.
- Internal Audit: Zileten Cement Factory.
- Internal Audit: El-Mergheb Cement Factory.

5.6.2.1.3. Management of Systems and Information and within that:

- Systems and information: Suk El-Khamis Factory.

- Systems and information: Libda Cement Factory.
- Systems and information: Zileten Cement Factory.
- Systems and information: El-Mergheb Cement Factory.

5.6.2.1.4. Company office in Tripoli.

5.6.2.1.5. General Administration of Production and Technical Affairs divided into firstly: Production Administration and within that, the Department of Planning and Follow-up of Production, and, the Department of Quality Control. Secondly, Project Management, Research and Development and within that: the Department of Research and Development; and, Department of Projects.

Gypsum factory in Tripoli.
Gypsum Quarries unit in Bir El-Chanam.
Quarries unit in the Brac area.

General Administration of Financial Affairs

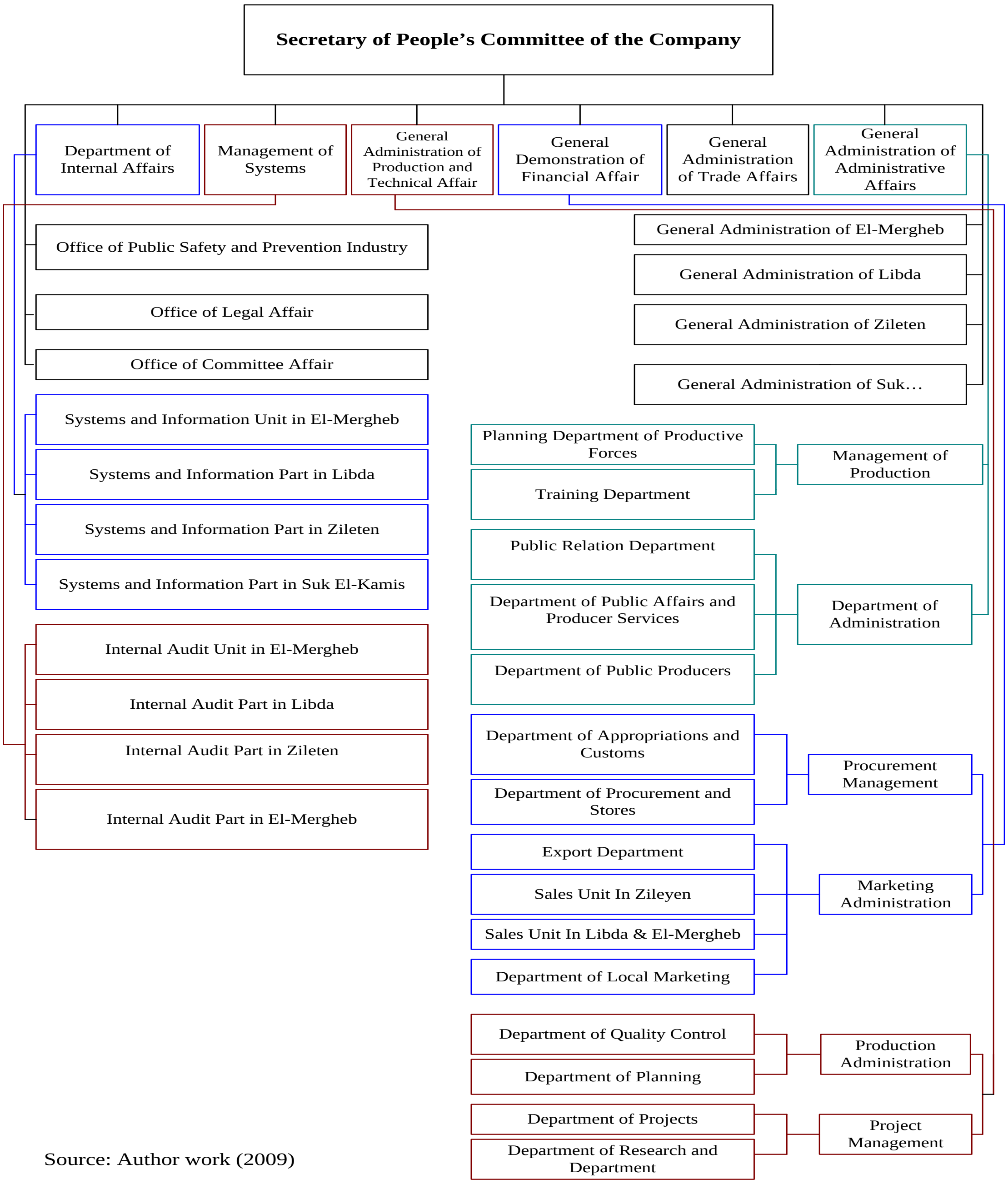
and within that:

- Department of the Public Accounts.
- Department of Costs and Quality Control.
- Department of Budgets.

General Administration of Trade Affairs and within that: firstly, Marketing Administration, itself organised into: the Department of Local Marketing, containing: Sales Unit: Libda and El-Mergheb; Sales Unit: Zileten; and an Export Department. Secondly, Procurement Management and within that: Department of Procurement and Stores, and the Department of Appropriations and Customs Declaration.

General Administration of Administrative Affairs and the Production and within that firstly the Department of Administration consisting of: Department of Public Producers; Department of Public Affairs and Producer Services, and, the Public Relations Department. Secondly, Management of Production Forces consisting of the Training Department and the Planning Department of Productive Forces. Thirdly, four General Administration divisions covering: Suk El-khamis factories for Cement and Building Materials; Zileten Cement Factory; Libda Cement Factory; and, the El-Mergheb Cement Factory.

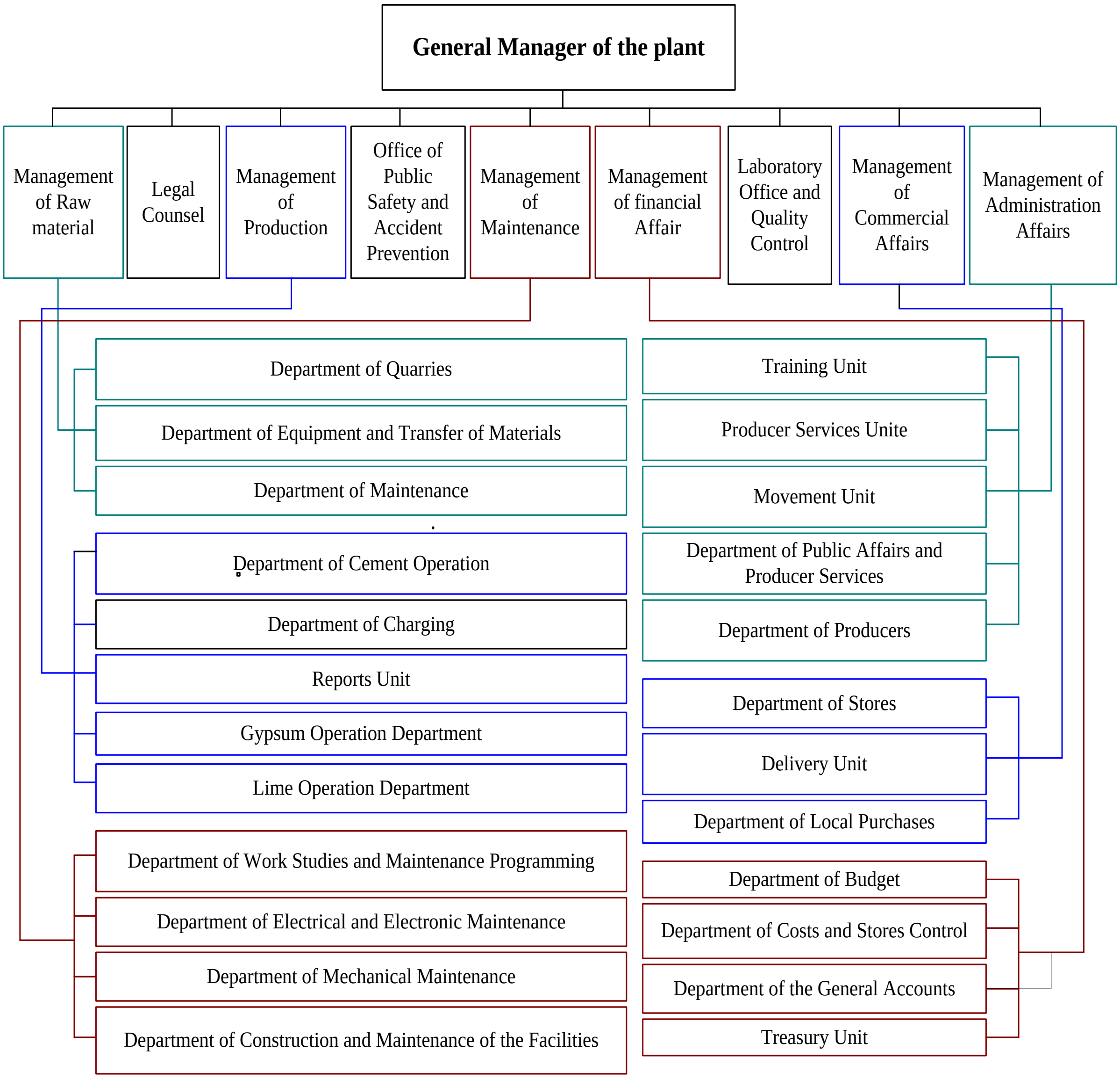
Figure (5-5) shows the structure of Ahlia Cement Company



Source: Author work (2009)

5.6.2.2. As for the internal structure of plants that are considered part of the general structure of the company; three factories consist of the same structure and these include Libda Cement Factory, Zileten Cement Factory and Suk El-Khamis factories, especially if we exclude the Department of Lime Operation and the Department of Gypsum Operation which are owned by Suk El-Khamis Factories for Cement and Building Materials since these departments do not exist in Libda Cement Factory, Zileten Cement Factory and El-Mergheb Cement Factory, the organizational structure of these three factories is shown in the Figure (4-6) below.

Figure (5-6) organizational structure of the three cement plants which already indicated in above. (Libda, Zileten. and Suk El-Khamis factories)



Source: Author (2009)

In the area of policy-making and planning of production; the plants in the company are operated by annual production plans that are prepared by the production departments in the factory according to the targets and indicators already identified by them and then the main administration in the company follows-up on the implementation of these policies and plans to ensure how many of the planned targets are achieved, and to help in overcoming and solving any of the difficulties and obstacles that may be encountered. Usually the company make two plans; one related to production and the other to marketing. Through these plans the company determines the quantity and quality of production and the methods and ways of sales and marketing; and that is referred to as the productivity plan. On the other hand, a second plan is the financial plan which attends to all aspects of finance; this plan is set in the form of an estimated budget that determines all the various incomes and expenses that are related to the production of the company, and is referred to as the financial plan.

5.6.2.4. Overall, the production plan is prepared as follows (this information was collected by the researcher during his meetings with five managers of production administration in the factories of the Ahlia Cement Company, 2009):

5.6.2.4.1 In the last quarter of the year preceding the plan year, the main administration for production and technical affairs of the company sets out to identify the target production capacity that is available to each plant of the company. This is dependent on the technical conditions in the factories, taking into account the long down time for purposes of maintenance or development and replacement operations to some main productivity equipment. This report is submitted to the Director General of the Company for approval.

5.6.2.4.2. After the approval and adoption of the production target rates by the Director General of the Company these directives are given to the respective production departments to prepare their plans in accordance with the productivity targets set.

5.6.2.4.3. The production managers in all the company plants coordinate the operations and consult with the technical departments of the factory, to identify and provide the necessary resources to implement the plan covering manpower, raw materials operating supplies, and expenditures on maintenance programmes during the plan period. Each production department then prepares a draft plan of the factory's production by identifying the targeted production volumes, quantities of raw materials, and operating supplies necessary to achieve the target and the scheduling of stop days programmed for all production lines.

5.6.2.4.4. After preparation of the production plan, it is forwarded to be adopted by the Director General of the plant and thereafter by the General Administration of Production and Technical Affairs. This is in order for the company to take into account individual factory plans in the preparation of the plan for the whole company. A copy of this plan is also forwarded to the financial management of the factory for the preparation of the financial plan.

5.6.2.4.5. The Department of The General Administration of Production and Technical Affairs prepares the combined production plan at the firm's level depending on the production plan prepared by the production factories and this is transferred to the People's Committee of the Company for approval, adoption and issuance of directives to the Department of Finance for preparation of the company's financial plan (budget estimate) that is necessary to achieve the targets set in the production plan.

5.6.2.4.6. After adoption of the combined production plan by the People's Committee of the Company, the General Administration of Production and Technical Affairs of the company supervises and follows-up on the work of the factories as prepared in this plan.

With respect to the financial plan, it is prepared using the following stages. This information was collected by the researcher during his meetings with ten managers of the financial administrations and managers of budget departments in the factories of the Ahlia Cement Company (Ahlia Cement Company, 2009):

5.6.2.4.7.1. After completion of all actions to come up with the consolidated productivity plan at the level of the company and having it adopted by the People's Committee of the Company; the People's Committee transfers the plan targets to the General Department of Financial Affairs in the company in order to set the financial plan (budget estimates) that is important for implementation of these targets. The General Department of Financial Affairs of the Company issues instructions to the financial departments in the factories to take the necessary procedures for the preparation of their financial plans or estimated requirements, which are important for the implementation and achievement of the production targets in their factories.

5.6.2.4.7.2. The Directors of Financial Management in all plants address the General Manager of the factory to make a committee for preparing a financial plan or budget estimates of the plant.

5.6.2.4.7.3. The General Manager of the factory issues a decision to form a committee responsible for the preparation of the financial or budget estimates for the plant. This Committee reads and checks the production plan of the factory as well as the budget estimates and actual figures for both incomes and expenses during the last nine moths of the current year; this is to set a clear picture of the average of all incomes and expenses. Based on these averages, the Committee coordinates and consults with the departments and sections that are concerned with estimating the incomes and expenses that are necessary to implement and distribute the plan to the various items, and accordingly, preparation of the estimate budget or financial plan of the factory.

5.6.2.4.7.4. The plan is then forwarded to the Director-General to present it and discuss it at a meeting with all the directors of departments and members of the committees, and accordingly have it approved and adopted.

5.6.2.4.7.5. The Department of Finance in each plant refers this plan to the General Department of the company's financial affairs, which accordingly works on preparation of the consolidated financial plan for the company. The General Administration of Financial Affairs of the company transfers the financial plan to the company's General Assembly for adoption and approval.

5.6.2.4.7.6. After adoption and approval of the plan by the General Assembly of the company, the relevant departments take all the necessary actions for implementation of the plan, whether at the level of the company or factories.

5.7. The Evolution of Ahlia Cement Company

This section provides a general overview of the changes and developments which happened in the Ahlia Cement Company between 1988-2008. It is particularly concerned with key events that relate to the following activities of this company: production, productive capacity, sales, employment and capital and various investment developments. .

5.7.1 Production Developments and Capacity of Production in the Ahlia Cement Company

Developments related to the production and the productive capacities of the company's products from cement, lime and gypsum were followed up by studying and analysing the data and information listed in Tables (5-4, 5-5 and 5-6) which indicated the following.

5.7.2 The Quantity and Value of the Company's Sales

The sales quantity evolution of the company production for cement, lime and gypsum during the study period is tracked by analysing the information listed in Tables (5-7, 5-8, and 5-9) as follows:

5.7.2.1. The Quantity and Value Evolution of Cement in the Company

The information in the following Table (5-4) illustrates the developments that occurred to all the quantities and values of cement, as well as their growth rates.

Table (5-4) **The development of quantity of cement sales and its growth rate the Ahlia Cement Company during 1988 – 2008.**

Units in thousand tons

Year	Quantity of Sales	The growth rate of sales quantity
1988	2187	
1989	2403	8.99
1990	2608	7.86
1991	2619	0.42
1992	2608	-0.42
1993	2548	-2.35
1994	2421	-5.25
1995	1732	-39.78
1996	1668	-3.84
1997	1668	0
1998	1820	8.35
1999	2014	9.63
2000	2119	4.96
2001	2109	-0.47
2002	2013	-4.77
2003	2115	4.82
2004	2396	11.72
2005	1940	-23.51
2006	2425	20
2007	2161	-12.22
2008	2474	12.65
Average	**2275**	**-1.47**

Source:	The monthly and annual reports of the Ahlia Cement Company and its factories.
Notes	The growth is calculated as current year on previous year.

5.7.2.2 The Sales Quantity and Value Evolution of Lime at the Company

Table (5-5) **The development of quantity and value of lime sales and its growth rate at The Ahlia Cement Company during 1988 – 2008.**

Units in thousand tons

Year	Quantity of Sales	The growth rate of sales quantity	Sales Value By thousand Libyan Dinars	Sales value growth rate
1988	42		756	
1989	32	-24	576	-24
1990	20	-38	360	-38
1991	10	-50	180	-50
1992	18	80	324	80
1993	19	6	342	6
1994	7	-63	126	-63
1995	8	14	144	14
1996	3	-63	54	-63
1997	14	367	252	367
1998	1	-93	31	-88
1999	26	2500	793	2458
2000	2	-92	61	-92
2001	4	100	122	100
2002	*9.4	125	289	137
2003	*4.2	-56	127	-56
2004	*4.2	0.0	130	2
2005	*5.3	25	371	185
2006	*2.8	-60	196	-47
2007	*7.8	250	524	167
2008	*2.4	-71	165	-69
Average	**12**	**136**	**282**	**139**

Source: The monthly and annual reports of Ahlia Cement Company and Suk El-Khamis complex For Cement and Building Materials.

Notes
- The units of quantity have been changed from a thousand units to single per unites.
- The Lime production line was stopped during this period of time; the reason for this problem was that the tanks were full, the lack of marketing, and the need fo maintenance.

5.7.2.3 The Sales Quantity and Value Evolution of Gypsum at the Company

Table (5-6) **The development quantity and value of gypsum sales and its growth rate at The Ahlia Cement Company during 1988 – 2008.**

Units in thousand tons

Year	Quantity of Sales	The growth rate of sales quantity	Sales Value by thousand Libyan Dinars	Sales Value growth rate
1988	1	-	25	-
1989	2	100	50	100
1990	6	200	150	200
1991	4	-33	100	-33
1992	3	-25	75	-25
1993	2	-33	50	-33
1994	1	-50	25	-50
1995	1	0	25	0
1996	1	0	25	0
1997	1	0	25	0
1998	1	0	28	12
1999	1	0	28	0
2000	1	0	28	0
2001	1	0	28	0
2002	0.57	-50	28	-43
2003	-	-	16	-
2004	0.41	-	-	-
2005	0.11	-75	3	-73
2006	0.16	0	5	33
2007	-	-	-	-
2008	-	-	-	-
Average	**1.4**	**2**	**33**	**5**

Source: The monthly and annual reports of the Ahlia Cement Company and the Suk El-Khamis complex for Cement and Building Materials.

5.7.2.4. The Development of Production and Productivity of the Company's Cement Industry production and cement productive capacities in the Ahlia Cement Company.

Table (5-7) **The Production Capacity of the Company in Cement Production Area and its Growth Rate during 1988 – 2008.**

Units in thousand tons

Capacity / Year	Production according to capacities				
	Design	**Targeted**		**Actual**	
	Quantity	**Quantity**	**Growth rate**	**Quantity**	**Growth rate**
1988	3330	2880		2158	
1989	3000	2650	-8.0	2456	12.1
1990	3750	3750	41.5	2659	7.6
1991	3000	3000	-20.0	2719	2.2
1992	3000	3000	0.0	2603	-4.5
1993	3248	3124	4.1	2609	0.2
1994	2250	2124	-32.0	2370	-10.1
1995	3330	2830	33.2	1738	-36.4
1996	3330	2830	0.0	1677	-3.6
1997	3330	2580	-8.8	1648	-1.8
1998	3330	2730	5.8	1797	8.3
1999	3330	2580	-5.5	1805	0.4
2000	3330	2580	0.0	2162	16.5
2001	3330	2580	0.0	2123	-1.8
2002	3330	2650	2.7	2029	-4.6
2003	3330	2526	-4.7	2193	7.5
2004	3330	2981	6.1	2390	8.2
2005	3330	2730	-8.42	2507	4.7
2006	3330	2651	-2.89	2432	-3.1
2007	3330	2651	0.00	2178	-11.7
2008	3330	2771	4.53	2502	12.9
Average	**3247**	**2772**	**0.34**	**2309**	**0.14**

Source: The monthly and annual reports of Ahlia Cement Company and its factories.

5.7.2.5. Development of Production the Productive Capacities of Lime Industry with the Ahlia Cement Company

Table (5-8) **The Production Capacity of the Company in Lime Production Area and its Growth Rate during 1988 – 2008.**

Units in thousand tons

Capacity / Year	Production according to capacities				
	Design	Targeted		Actual	
	Quantity	Quantity	Growth rate	Quantity	Growth rate
1988	200	100		43	
1989	200	85	-15.0	32	-25.6
1990	250	125	47.1	21	-34.4
1991	200	100	-20.0	10	-52.4
1992	200	50	-50.0	21	110.0
1993	150	75	50.0	17	-19.0
1994	200	75	0.0	8	-52.9
1995	200	100	33.3	9	12.5
1996	200	100	0.0	4	-55.6
1997	200	100	0.0	13	225.0
1998	200	100	0.0	1	-92.3
1999	200	100	0.0	27	2600.0
2000	200	100	0.0	2	-92.6
2001	200	100	0.0	5	150.0
2002	200	100	0.0	10.8	116.0
2003	200	100	0.0	4.1	-62.01
2004	200	100	0.0	2.5	-39.02
2005	200	100	0.0	6.4	156.0
2006	200	100	0.0	1.1	-82.81
2007	200	100	0.0	7.8	609.09
2008	200	100	0.0	3	-61.54
Average	**200**	**96**	**2.13**	**11.7**	**157.54**

Source: The monthly and annual reports of Ahlia Cement Company and Suk El-Khamis complex For Cement and Building Materials.

Table (5-9) **The production capacity of the company in gypsum production area and its growth rate during 1988 – 2008.**

Units in thousand tons

Capacity / Year	Production according to capacities				
	Design	Targeted		Actual	
	Quantity	Quantity	Growth rate	Quantity	Growth rate
1988	9	9		1	
1989	9	9	0.0	2	100.0
1990	11	11	24.4	6.3	215.0
1991	9	6	-46.4	4	-36.5

1992	9	6	0.0	3	-25.0
1993	9	6	0.0	2	-33.3
1994	7	5	-25.0	1	50.0
1995	9	6	33.3	1	-66.7
1996	9	6	0.0	1	0.0
1997	9	5	-16.7	1	0.0
1998	9	5	0.0	1	0.0
1999	9	5	0.0	1	0.0
2000	9	5	0.0	1	0.0
2001	9	5	0.0	1	0.0
2002	-	-	-	-	-
2003	-	-	-	-	-
2004	-	-	-	-	-
2005	9	6	-	0.19	-
2006	9	6	0.0	0.12	-1.3
2007	-	-	-	-	-
2008	-	-	-	-	-
Average	**6.9**	**4.6**	**-1.5**	**1.3**	**9.6**

Source:	The monthly and annually reports of Ahlia Cement Company and Suk El-Khamis complex For Cement and Building Material.
Notes:	– No production.

5.7.3 The Employment Evolution in the Company

Table (5-10) The development of national and foreign employment and its growth rate at The Ahlia Cement Company during 1988 – 2008.

Unit by employmer

Year	Libyan employment number by the Company	Foreign employment number by the Company	Total employment number by the Company	Nationals employment growth rate	Foreign employment growth rate	Total employment growth rate	*Libyans proportion of the total
1988	1607	625	2232				72
1989	1682	639	2321	5	2	4	72
1990	1790	644	2434	6	1	5	74
1991	1728	644	2372	-3	0.00	-3	73
1992	1826	612	2438	6	-5	3	75
1993	1947	510	2457	7	-17	1	79
1994	2315	419	2734	19	-18	11	85
1995	2463	372	2835	6	-11	4	87
1996	2513	290	2803	2	-22	-1	90
1997	2597	315	2912	3	9	4	89
1998	2629	279	2908	1	-11	0	90
1999	2677	304	2981	2	9	3	90
2000	2653	256	2909	-1	-16	-2	91
2001	2718	234	2952	2	-9	1	92
2002	2205	253	2437	-19	8	0.00	90
2003	2205	243	2437	0.00	-0.04	0.00	90
2004	2205	263	2437	0.00	8	0.00	90
2005	2498	263	2761	13	0.0	13	90
2006	2498	232	2761	-	-12	0.00	90
2007	2307	232	2550	-8	0.0	-8	90
2008	2591	232	2844	12	0.0	12	91
Average	2269	374	2643	3	-4	2	85

Source: The monthly and annual reports of Ahlia Cement Company its factories.

Notes: *Libyan's proportion of the total = Libyan employment number / Employment total number

5.8. Conclusion

This chapter has shown that the cement industry in Libya is not in its infancy as the Libyan Government had started this industry about five decades ago. This has given the cement industry in Libya nowadays a good background and depth of experience. But unfortunately it seems that most cement factories do not worry about the disadvantages associated with cement production, including environmental problems. The Ahlia Cement Company was chosen by the researcher as it representative of the cement industry in Libya. Additionally, It is the largest, and oldest, cement company in Libya. The details in this chapter have been drawn from the Ahlia Cement Company using both external and internal documents.

Chapter Six

Methodology

6.1 Econometric model for the application of environmental economic policy on the cement industry

6.1.1. Introduction

This chapter discusses the particular economic approach that has been taken in this study. Whilst an economic approach is often at the heart of environmental analysis, for example, Cost Benefit Analysis, this study considers a different economic issue. This is what happens to price when an industry is faced with an increase in production cost due to having to incur a technical (environmental) cost to reduce pollution. An obvious example being legislation that requires a factory to make a technical improvement to their production process, for example, installing better dust filters. For a situation involving normal demand and supply curves, the most likely outcome is that both the producer and consumer will share the cost increase which is itself reflected in higher prices. The relative share being determined by the relative price elasticities of demand and supply. This chapter reintroduces the three study questions and justifies why a quantitative approach was adopted and explains why the Ahlia Cement Company was chosen as the focus of the empirical research. Data collection is described in some detail as the author has had to assemble the dataset from various archive sources in the actual plants themselves. As such this is a unique dataset that has not been previously available to researchers. Whilst a previous section in this chapter justified a quantitative approach, the next section justifies and describes the econometric model used and considers some advantages and disadvantages of this method. The next section discusses the context of the approach and illustrates with three examples from microeconomic theory. Finally this chapter summarises the stages in the methodology used as an introduction to the analysis and discussion in Chapter Seven.

6.2. Study questions

6.2.1. Is there the possibility that there are some economic instruments that can help our understanding of environmental cost, and, would those instruments suggest how to reduce such environmental costs?

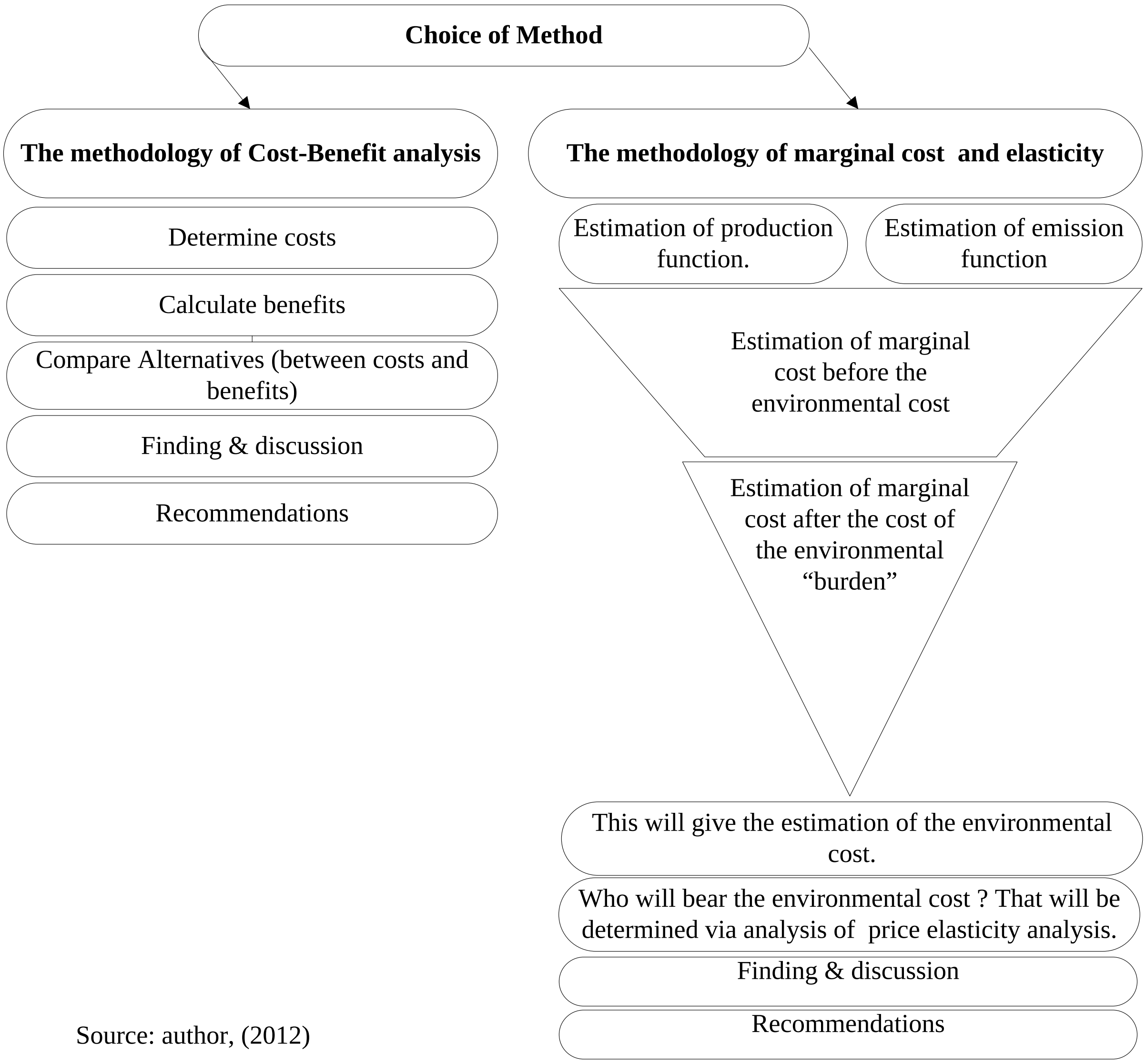
6.2.2. Is it possible to determine the amount of the (technical) environmental cost of the cement industry? How is it possible to determine the (technical) environmental cost of the cement industry?

6.2.3. If we know the (technical) costs that help to reduce the pollution caused by the cement industry, then how would this cost be borne between the producer and the consumer? Would all the costs fall on the consumer or on the producer alone, or would they be shared? If shared, then who would bear the most - the producer or the consumer? Or would it be equally shared? Or is there a third party that will be bearing, or part bearing, it such as the government?

6.3. Study Approach

This study is essentially quantitative and estimates appropriate economic functions. It is, however, not a large scale econometric analysis using an extensive national database(s). In that sense it has some of the characteristics of a qualitative analysis. Data was gathered at the micro level covering 35 variables consistently over, where possible, 1998-2008. Data collection took over three months with personal visits to the case company and their four plants.

Figure (6-1) illustration choice Method.



Source: author, (2012)

From the above figure, it can be seen why this study has employed this particular method, because:

(a) This study addresses a particular issue within the theory of demand and supply, which depends on estimating marginal cost curves. There are well established functions that are capable of the appropriate manipulation. They obviously require that numerical data be collected from available plant records. For example, Ibrahim, (1993) used such a methodology in investigating environmental considerations for desalination plants in Egypt. Moreover, the cost-benefit analysis cannot have any possibility to estimate the environmental cost such as microeconomic tools (marginal cost; production function; emission function; and elasticity of demand and supply price).

(b) Whilst there was the need for a great deal of discussion to compile the data, it was felt that a purely qualitative interview approach with company staff might have been open to bias, particularly when asking respondents to reflect over twenty years of corporate life. It would not have produced an appropriate dataset anyway given the objectives of this study.

(c) The overriding research objective was to see how an increase in production cost caused by improving pollution control technology would be shared between consumer and producer, and for this only quantitative data would be appropriate.

(d) Again, to emphasise that unlike traditional cost benefit analysis, the decision matrix is based upon costs and prices that are measurable. At present in the UK, the debate on the HS2 rail network is clouded by the main benefit being the hypothetical time saving of passengers and the imputed value of the worth of their time.

The methodology in this study will be adapted to gain a deeper understanding of the environmental issues concerning the cement industry. In particular the quantitative approach in this dissertation identifies the parties who will be bearing the environmental burden and how this (technical) cost would be borne between the producer and consumer. This study will produce a reference table by which one can identify the parties (or party) who will bear the (technical) environmental cost. Whilst the specific concern of this study is the sharing of a technical ‘environmental cost’ the results can be generalised to cover any additional costs resulting from industrial or commercial activities.

6.4. The study sample

The application of this methodology has relied on the Ahlia Cement Company in Libya and their factories. Chapter Five discussed the history of the Libyan cement industry more generally. There are two companies operating the cement industry in Libya and the industry is owned by the Libyan government which has a monopoly market. The details of the companies are as follows, and, the reasons for the choice of the Ahlia Cement Company for this study, rather than the Libyan Cement Company is made.

Comparison of the Ahlia Cement Company and Libyan Cement Company

Ahlia Cement Company — The biggest company for cement and building material in Libya and the production units or plants affiliated to the company as follows.

Factories and Plants	Location	Distance to:	Annual Production Capacity	Started Production
El-Mergheb Cement Factory:	Khams area	120 km to the east of Tripoli	333,000 tons	1969
Suk El-Khamis Complex for Cement and Building Material	Suk El-Khamis, Msehel area	80 Km to the south of Tripoli	1,000,000 tons	1977
	It also produces slaked lime with		200,000 tons.	
Libda Cement Factory	To the east of Tripoli	about 115 Km to the east of Tripoli	1,000,000 tons	1981
Zileten Cement Factory	To the east of Tripoli	about 140 Km to the east of Tripoli	1,000,000 tons	1984
El-Swani Complex for Building Materials	El-Swani area	40 Km to the south west of Tripoli		
it produced the following products:				
	Bricks		100,000 square meters.	
	Concrete Bridges		1,000,000 linear meters	
	Marble		100,000 square meters.	
Paper Sack Factory	In Mwsallata area,	about 120 Km to the south east of Tripoli	8,000,000 sacks	2004
Fine Gypsum Factory	In Bir El-Ghanam area		100,000 tons.	
Concrete Mixing Plant	In Tripoli area		120,000 cubic meters	2003

Libyan Cement Company — It owns currently four plants as follows:

Benghazi Cement plant	An Industrial Complex in Hawary area	15 of Km south Benghazi City	1,000,000 tons
Hawary Cement Plants	An Industrial Complex in Hawary area	15 of Km south Benghazi City	1,000,000 tons
Fattaih Cement Plant	East of Benghazi City in Derna area	350 Km. away from Bengazi	
Paper Sacks Factory	Hawary area beside the Industrial Complex	15 of Km south Benghazi City	53,000,000 sacks.

As mentioned previously, there are two companies for the cement industry in Libya, the first Ahlia Cement Company of Contribution, which has four factories and is considered as the largest producer of cement in Libya. The second company is The Libyan Cement

Company, operating three factories for the production of cement which are located along the 1,500 Km Mediterranean shoreline.

At the beginning of this research, the researcher felt that only one plant needed to be studied because the plants would be operated and managed in broadly the same way. So the methodology and analytical tools applied for one plant would be appropriate for the others. So to include more plants would simply be a repetition of results rather than improving the quality of the database and subsequent analysis. But after the researcher went to Libya on 07/01/2009 and conducted the field studies for this research, it was found that the management and finance system of these plants were operating differently and that each of them has a specific method to administer its work; a different approach for preparing the annual financial budgets for operating the factory, along with machines of varying sophistication age. This is despite the seemingly consistent and bureaucratic management style implied in the discussion in Chapter Four.

As a result the method of production varies from one plant to another; and, sometimes the machines stopped production for a period of time due to technical reasons. Although overall these plants follow the policies laid down by the parent company (Ahlia Cement Company). Despite the fact that the financial budget of the individual plants are consolidated annually into one budget, and there is a parent company wide marketing strategy- the researcher came quickly to the conclusion that each plant behaves like a separate manufacturer. Each plant having independent management and systems covering finance and production.

Therefore the researcher decided to collect data on all the four cement factories, as well as the data in the consolidated budget. This would not only give a more accurate picture but would allow the researcher the opportunity to study the differences between the working practices of these individual plants. Then by also studying the case study as a single company through the data in the consolidated budgets of the company, it would give the analysis more depth. Accordingly, a more accurate and logical result would be obtained.

One further reason for the researcher to take the Ahlia Cement Company factories is that these factories were fully owned by the State prior to 2005 but after that date they became part of Ahlia Cement Company capital, and its factories become part owned by Libyan citizens as the Libyan government sold part of the share capital to the Libyan citizens in Libya. As a result, the extension of ownership has led to more competition between factories to protect the environment, which ultimately helps the researcher to see which is the better plant dealing with environmental cost.

Therefore, the researcher chose Ahlia Cement Company and its plants both separately and together for this study. The reason for selecting specifically the Ahlia Cement Company and not the Libyan Cement Company or both is that the Ahlia Cement Company is the largest manufacturer of cement in Libya. Therefore, by choosing this company the study covers four plants out of the seven plants operating at the time of the study in Libya. Additionally, another reason is that most plants of this company are located all in together within an area of about 30 kilometres, and in densely populated areas. So the environmental impact (if any) on the surrounding environment of factories such as atmosphere, soil, plants and water would be more likely to be an issue than in an area of dispersed population and activity.

The reason for the concentration of these plants in the small geographical spot has been pointed out by many officials in these factories and the workers. When the researcher met them during his field study they said that the main raw material for the cement industry (limestone) is present in this area and the experts estimated that there is a huge amount of this raw material in this region and enough to run these plants for another 50 years or more. It was also commented that the establishment of these plants in the desert areas far way from the population would increase the cost of the cement production in these factories. This would either (or both) cause a reduction in the profits of the company or lead to competition for the industry through importing cement from neighbouring countries such as Tunisia and Egypt. Their existing cost advantage, due to closeness to raw material source and which is conveniently close to the densely packed end consumer as well, would be lost. Currently, manufacturing is done near the mining of raw materials and sold directly to the customer from the company warehouse.

In additional, all the four plants of Ahila Cement Company and Ahila Cement Company itself will be taken the same name of the following variables (To distinguish between them will be used the numbers):

CP	The production quantity of cement (per ton per year) in Ahlia Cement Company.
RM	The raw material used in cement production in Ahlia Cement Company.
D	Other inputs as equipment, machinery and other means, which can be expressed by the use of capital in Ahlia Cement Company.
MP	The emission amount from the cement production in Ahlia Cement Company.
$TechC$	The Technology cost which controls the pollution in Ahlia Cement Company.
QS	Sales of cement.
P	Cement price.

6.5. The Data collection

Data collection took more than three months, and the researcher collected 35 variables over period of time exceeding twenty years (1988-2008) on the company and its four plants. It is important to understand both how the data was collected and that the final dataset is unique to this research and so, in itself, a contribution to knowledge. What follows is personal diary of the data collection at each plant.

6.5.1. El-Mergheb Cement Plant

The researcher, on arriving in Libya on 07/01/2009 visited the El-Mergheb Cement Factory on the following day. This factory is located about 120 km east of Tripoli. There the researcher met the Financial Director of the factory, who told him that the official who was authorised with the letters would attend to him. (the first letter was from the University of Huddersfield giving approval to the field study and the second letter was from the Libyan Cultural Affairs in London concerning the conduct of the field work). The researcher went directly to the General Director of the Company, but unfortunately he could not see him because it would require an appointment and he was asked to re-apply for permission to undertake the work of the study. The researcher made this application and returned on the next day with the approval of the Director-General.

Then the researcher immediately went to El-Mergheb cement factory, where he was met by the Director of Management and Finance for El-Mergheb plant. After that the researcher was sent to the Chief of the Financial Officers, who directed the researcher to the Department of Costs. He met the Head of the Costs Department, and found that the variables, which were needed for the study, were not clear to him -although they had been translated into Arabic. Another problem was the period of time over which date was being requested by the researcher. However, the Head of The Costs Department said the financial terms were easy to give him but only for the last five years. Moreover, he needed to prepare the data as certain costs needed to be calculated firstly. for example, the information on the cost of raw materials existed in different places in their expenses records and, as result, material value appeared separately. The cost of limestone was separated from the oxide cost of. The variables for this study which the researcher needed during 2003-2007 should be available within three days.

After that, a staff member sent the researcher to the archive files with the Finance Officer for researching in the old files. It was then realised that this would take ten days of work. After that, the researcher went to the production department to obtain a summary of the plant’s history and specific operating information, including the current problems in the operation, the manpower, the available expertise, the techniques used in production and other information on the operating system. Furthermore, information explaining the reason for stopping production at the plant for ten years, and also on the operating plant, had been obtained together with some financial reports on administrative, marketing and technical functions which are special for the plant during the time of the study from the Department of Information Systems.

After that the researcher met some specialists working at the Chemical and Physical Laboratories inside this plant where the researcher observed the ways of extracting and examining the raw materials from mines. Then he went to the Commerce Department where this department supervisor explained the marketing programme and the pricing of the cement that is ready for sale. In fact, the researcher noted that the price of cement varied hugely inside Libya for various reasons particularly the growing demand for this commodity in the domestic market by individuals and public authorities, as well as the limited production capacity. Two other factors affecting production being, broad political problems, such as the 'Lockerbie Issue on 21st Dec 1988' and the trade blockade 'between 1992 to 2002' which resulted from it continued for more than ten years. Secondly, there was a high rate of inflation lowering the purchasing power of the Libyan Dinar at home and abroad. However, the researcher was not able to find the price of stocked and non stocked cement because unfortunately this Department had not archived their files and documents. That forced the researcher to return to this factory after the completion of the other Ahlia Cement Plants. Furthermore the researcher was unable to obtain the sales for the year 2008, because the annual budget of the plant was not yet ready. The Chief Financial Officer told the researcher that the budget for the year 2008 would be ready at the end of February.

As such, the researcher calculated the data for this plant and other factories of the company in his evenings and the weekends, the expenses list, financial reports, the administrative, technical and annual budgets for each year separately.

6.5.2. Libda Cement Plant

From the fourth week and until the end of the sixth week, the researcher went to the Libda Cement Factory, which is located 130 km east of Tripoli city. There he met the Chief Financial Officer, the Managing Director and the Financial Department, and he was told that under no circumstances would he receive any kind of help during the current period. During this period of time, all staff in the Finance Department were busy preparing an annual budget for the year 2008, and the researcher could not get any information for the period between 1988-1997. Generally, the researcher was able to get some booklets giving historical information about the facilities from the Department of Information Systems at the factory. But details of sales and production at the factory for the period 1988-2008 were not readily available. However, the Director of Production could obtain information on production and the workforce operating the machinery of the factory, in about five days. The researcher then decided to go back to studying their financial management, and this time through personal relationships, (classmates at his University) the researcher succeeded in obtaining the data which was needed but only for the period 1998-2007. Details for the period that preceded it could not be obtained in any way because the archive where financial statements and others were kept was destroyed in a fire and no other copy of the data was available. The researcher was then told, that the Head of Budgets Department could help to get information on financial matters but he was on leave until the following week. Thus, the fifth week of the field study was over and the researcher had only half of the information, which was needed to complete his study. At the beginning of the sixth week he went to the factory and met the Head of the Budgets Department, who was very cooperative and the researcher spent a full week alongside this official (18^{th} to 25^{th} February, 2009) estimating the variables for the lost period.

6.5.3. Zileten Cement Plant

At the beginning of the seventh week, the researcher went to Zileten Cement Plant which is located 130 km east of Tripoli City and spent three weeks in this plant. As usual the researcher met the Director of Administrative and Financial Affairs of the factory, to whom the researcher gave the letter of approval from the Director General of the Company. The researcher was then asked to obtain another approval from the Director of this factory. Accordingly the researcher gave a copy of the approval letter obtained from the Director General of Company and the researcher returned the next day, when he received the approval to collect the data and information from this factory, which the researcher noted was more organized. The factory has an electronic database as well as manual archive files, but even so, data collection was still not easy for the researcher. It took ten days to get some data from the Department of Costs because the employers were busy with annual budget for the year 2008. Furthermore, details for such a long period of time, which had been requested for this study, would require the specific approval from the Financial Management Department and the researcher obtained it a day later. However, after obtaining this data, the researcher met with some problems for the period between 1992-1994 as the financial year of the Christian calendar was changed to the Hijri calendar (which means, Muhammad's “peace be upon him” trip from Mecca to Medina), and it took some years and months after 1994 to return again to the Gregorian calendar. The researcher then used some specialists in the Financial Affairs Department of this factory, to recalculate the budgets for that period. The ninth week was spent in this plant and the last one was spent in the production and technical departments, in order to obtain information about the production and the technique which in used in this factory. Next the researcher went to the Department of Management Information Systems from where the researcher received details of the quantities of production and sales for the period 1988-2008, including historical information on this plant from the administration.

6.5.4. Suk El-Khamis Complex

At the beginning of the tenth week, the researcher went to Suk El-Khamis Complex, located 80km south of Tripoli City. In reality things were more complicated in this factory, where the researcher found the Administrative and Financial Director away on vacation. The researcher was then transferred to the Department of Information Systems but the researcher found that this person in this administration could not help him in the collection of any data or get the consent of the factory manager on the basis of the letter from the Director of the company. The Management Director, who read the letter, could not take any action. So the researcher waited until he returned on the next day. The researcher returned the next day, but could not meet the contact person. Nevertheless, he did obtain approval via the assistant to the Director of Information Systems Department, and the researcher got some monthly and annual reports of production and sales, as well as some booklets, which had the technical and historical information on the plant.

During weeks eleven and twelve, the researcher was based in the Financial Department, where the data for the study variables were not available. This meant that the researcher had to access the factory archives with an employee from the Department of Costs. The researcher spent all his days there until the end of week twelve but he did obtain all the data for the period of the study.

In the thirteenth week the researcher visited the General Administration of the company, which is 125 Km east of Tripoli City in order to obtain the combined information and data on plants, which represents The Ahlia Cement Company. Furthermore, the researcher visited all the factories again, in order to obtain the budget for the year 2008, which was under action at the beginning of field studies and the Department of Statistics of the company from where the researcher could obtained prices cement for 1988-2008.

The reasons for selecting the period of time between 1988-2008 are as follows:

6.5.4.1. This is as far back as the company archives exist.

6.5.4.2. Some factories have stopped work in the period before 1988, namely the El-Mergheb Cement Plant for development.

6.5.4.3. The fire in the Libda Cement Factory archive, made it difficult to obtain data before this period.

6.5.4.4. The many changes regulating the factories made it difficult to obtain the data and the information for a longer period of time.

6.6. The econometrics approach

At the beginning of this chapter, we discussed the reason for a quantitative approach and this section discusses the reason for an econometrics analysis.

1. Most of the studies carried out in Libya were qualitative such as a questionnaire or an interview. Therefore, there is the potential to add insight by working with a different dataset. These Libyan studies were discussed in the literature review (Chapter Three) (Barghouti, 2007; Masoud, 2007).
2. The researcher has experience in dealing with this type of analysis.
3. The nature of this study requires a quantitative method to achieve its objectives. For example, we cannot estimate the environmental cost of the cement industry by depending on a questionnaire or interviews. We are dealing with numbers. Therefore, those tools of analysis would be inaccurate and inadequate to help us to obtain realistic results.
4. Equally an important objective of this study is to understand consumer behaviour through an analysis of price elasticities of demand and supply rather than through a more general consumer survey.

Table (6-1) Rationale for research method and their relationship to the previous studies.

No.	Particular Question	Reasoning	Relation to previous studies
Specific Estimation of the Functions			
1	Estimates the production function for the cement plant $CP = \alpha_0 + \alpha_1 RM + \alpha_2 D + U$	The purpose of estimating this function is to obtain a coefficient to estimate a marginal cost per ton of cement produced.	Alalem, (1999); Almgri et al, (2005); Baik, (1999); Cameron, (2008); Charles, (1976); Chotikapanich et al, (1998); Cicchetti, (2005); Ibrahim, (1993); Kaze et al, (1999); Morey, (1985); Nasr, (2008); Obosadrh et al, (2000); Obosdra. (2005): Shahmoradi et al, (2008): Song, (2007); Sugden, (1979).
2	Estimates the emission function for the cement plant $MP = \beta_0 + \beta_1 RM + \beta_2 TechC + U$	The purpose of estimating this function is to obtain a coefficient to estimate a	Alalem, (1999); Almgri, (2005); Baik, (1999);Cameron, (2008); Charles et al, (1976); Chotikapanich et al, (1998);

		marginal cost per ton of cement produced including the pollution cost.	Cicchetti, (2005); Ibrahim, (1993); Kaze, (1999); Morey, (1985); Nasr, (2008); Obosadrh et al, (2000); Obosdra, (2005); Shahmoradi et al, (2008); Song, (2007); and Sugden, (1979).
3	Calculates Marginal Cost before the pollution cost $$MC_0 = \frac{P_x}{QS_x}$$	The purpose of estimating this function is to know the value of the marginal cost depending on coefficients of equation number one.	Alalem, (1999); Almgri, et al, (2005); Baik, (1999); Cameron, (2008); Charles, (1976); Chotikapanich, (1998); Cicchetti, (2005); Ibrahim, (1993); Kaze et al, (1999); Morey, (1985); Nasr, (2008); Obosadrh, (2000); Obosdra, (2005); Shahmoradi et al, (2008); Song, (2007); Sugden, (1979).
4	Calculates Marginal Cost after the pollution cost. $$MC_1 = \frac{P_x - P_m\left(\frac{\bar{f}_x}{\bar{f}_m}\right)}{QS}$$	The purpose of this function is to estimate a marginal cost per ton of cement production including the pollution cost.	Alalem, (1999) ; Almgri, (2005); Baik, (1999); Cameron, (2008);Charles et al, (1976); Chotikapanich et at, (1998); Cicchetti, (2005); Ibrahim, (1993); Kaze et al, (1999); Morey, (1985); Nasr, (2008); Obosadrh et al, (2000); Obosdra et al, (2005); Shahmoradi et al, (2008); Song, (2007); Sugden, (1979).
5	Calculates the price elasticity of demand for the cement. $$E_{11}QD = \frac{\partial QD}{\partial P} \times \frac{P_1}{QD_1}$$	The purpose of this function is to calculate a price elasticity of demand for cement production to estimate the amount of the pollution cost which the consumer will bear.	Alalem, (1999); Almgri et al, (2005);Baik, (1999); Cameron, (2008); Charles et al, (1976); Chotikapanich et al, (1998); Cicchetti, (2005); Ibrahim, (1993); Kaze et al, (1999); Morey,(1985); Nasr,(2008); Obosadrh et al,(2000); Obosdra et al, (2005); Shahmoradi et al, (2008) Song, (2007); Sugden, (1979).
6	Calculates the price elasticity of supply for the cement. $$E_{11}QS = \frac{\partial QS}{\partial P} \times \frac{P_1}{QS_1}$$	The purpose of this function is to calculate an price elasticity of supply for cement production to estimate the amount of the pollution cost which the producer will bear.	Alalem, (1999) ;Almgri, (2005); Baik, (1999); Cameron, (2008);Charles et al, (1976); Chotikapanich et at, (1998); Cicchetti, (2005); Ibrahim, (1993); Kaze et al, (1999); Morey, (1985); Nasr, (2008); Obosadrh et al, (2000); Obosdra et al, (2005); Shahmoradi et al, (2008); Song, (2007); Sugden, (1979);

Wider contextual questions

7	Air pollution	To know the impact of the cement industry on the air.	Anon, (2003a); Anon, (2005); Anon, (2007); Barghouti, (2007); Chemical

			Business, (1997); Contract Journal, (2005); Contract Journal, (2007), Dimitri Papalexopoulos and Krabbe , (1992); (The) Guardian and Builders Merchants, (2006); Hendriks et al, (1999); M.El-fadel et al, (2003); Magat, (1986); and Ning, (1994); Ning, (1997); Nordqvist et al, (2002); Teece, (1986).
8	An Alternative fuel	To know if there is more staple fuel than the official fuel or cool and if these sorts of fuel are main reason for an environmental problems.	Anon, (1999); Anon, (2000); Anon, (2006); Benestad, (1989); Bowermaster, (1993); Carpenter et al, (1993); Contract Journal, (2006); Hibbert, (2007); Hibbert, (2004); Johnson et al, (2002); Kemezis, (1993); Mattos et al, (1997); Moore, (2003); Porto et al, (2006); Szabo et al, (2006); Trovaag, (1983).
9	A New technology	To discuses the new technology which may help to reduce the cement pollution against our environment.	Anon, (1997); Anon, (1998); Anon, (2007); Marneri et al. (2001); Szab et al, 2006
10	Other aspects on life	To know the impact of cement industry on plants, human health and other important aspects for life in our world.	Adejumo et al, (1994); Ademola, (1998); Anon, (1999); Fernandedz et al, (1998); Hegazy , (1996); Liu et al, (1997); Mander et al, (1997); Perfettini et al , (1989); Stirling, (2005); Ragoutis, (1997); Rao, (1998); Satao et al , (1993);Sivakumar et al, (1995); Syamala et al, (1999); Tijan et al, (2005); Topie , (1999); wasserbauer et al , (1998); Zubareva et al, (1999)

Source: Author 2009

Where:

CP The production quantity of cement (per ton per year) in Ahlia Cement Company.

RM The raw material used in cement production in Ahlia Cement Company.

MP The emission amount from the cement production in Ahlia Cement Company.

TechC The Technology cost which controls the pollution in Ahlia Cement Company.

D Other inputs such as equipment, machinery and other means, which can be expressed by the use of capital in Zileten Cement Factory.

P_x The price per ton of raw material.

P_m Parameter referring to the environmental cost and which can be given different values to reflect the impact and the amount of increase which may happen to the marginal costs in the case of applying environmental policy .

$' f_x$	The amount of change in the level of emissions ($' f$) which resulting from the change in raw materials (x).
$' f_m$	The amount of change in the level of ($' f$) which resulting from the change in the technology of contaminated (m).
QS_x:	The amount of change in production (QS) which resulting from the change in raw materials (x).
P	The price of the commodity.
QD	The Quantity of demand.
∂ QD	Change in quantity demanded over a relevant time period
∂P	Change in price over a relevant time period
$E_{11}QD$	The price elasticity of price.
P	The price of the commodity.
QS	The quantity of supply.
∂ QS	Change in quantity supplied over a relevant time period.
∂P	Change in the price over a relevant time period.
$E_{11}QS$	The price elasticity of supply.

6.7. The Advantages and disadvantages of this study

With regard to the strengths and weaknesses pointed out in this study, certainly there are strength and weakness in any human action but in trying to do something better, and learn from their own, and others, it should in the future be possible to avoid such errors through experience. However, reflecting upon this research, the strengths and weaknesses of this methodology are as follows:

6.7.1. Advantages

6.7.1.1. The use of quantitative analysis led to clearer and more insightful results than in previous studies.

6.7.1.2. Estimating the pollution cost in this way will help decision makers in the cement industry to a deeper understanding for this issue.

6.7.1.3. The determination of which party will bear the environmental burden via a comparative price elasticity of demand and supply analysis gives a clearer understanding for dealing with how the pollution cost impacts on both the producer and the consumer.

6.7.1.4. This study calculates the impact for a wide range of price elasticity values, and therefore, creates a 'decision table' which is a good addition to assist decision makers and to help business owners to estimate the effect of any extra cost to their business.

6.7.1.5. This analysis can be extended to any cement plant in the world, having taken account any particularities of countries such as the type of market in which a cement company operates – a monopoly or oligopoly... etc. Results may be more approximate the more that an economy diverges from the features of the Libyan industry but the underlying economic principles are universal.

6.7. 2.The disadvantages

6.7.2.1. Data was not readily available, whilst this was somewhat anticipated especially in developing country such as Libya, it led to a lot of uncertainty for the researcher at the beginning of his work. This 'surprise element' created some early problems that are reflected in the data collection 'diaries'.

5.7.2.2. This type of methodology ideally requires data for a longer period (for example, more than ten years). Whilst this study has employed datasets of up to twenty-one years, in some cases this has meant a reliance upon estimation.

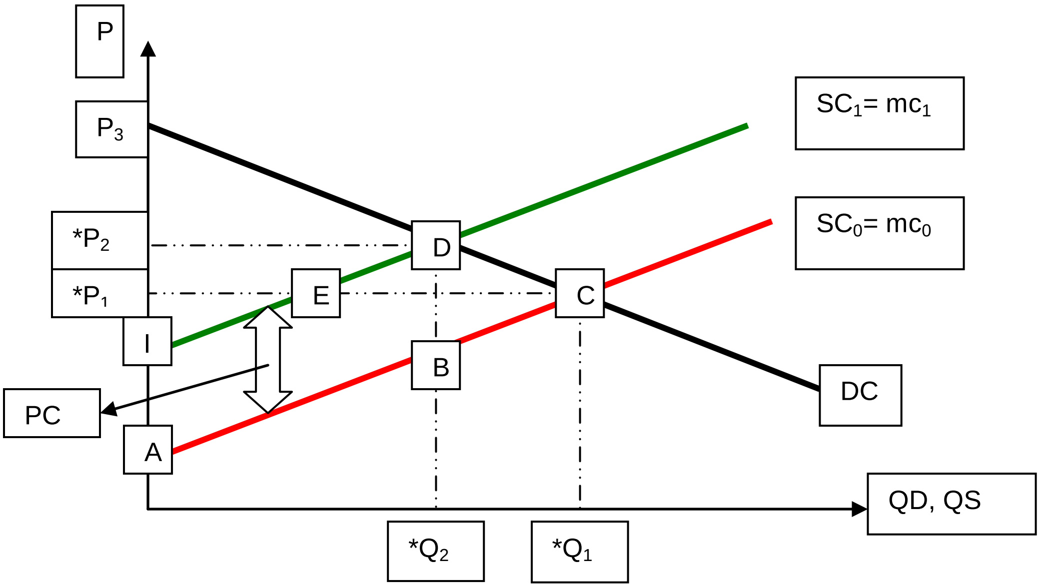
6.7.2.3. The researcher may not be able to determine all the variables for the study as accurately as desired. There exists therefore the possibility of drawing an incorrect conclusion through, for example, a measurement error.

6.7.2.4. The researcher must be careful in writing these equations because there are dependent upon each other and any error made will be magnified.

6.8. The application of economic policy on the cement industry in the framework of economic analysis

The following section reviews the classical theoretical approach to pollution control measures. The cost of pollution control is represented by an upward shift in the supply curve. There are resultant changes in the equilibrium in the market and a reduction in both consumer and producer surplus. In practice, the researcher needs to be able to estimate the demand curve and the supply curve, the latter is assumed to be the same as the marginal cost curve. Once these have been estimated – price elasticities of demand and supply form the co-efficients of the appropriate equations, and, consumer and producer surplus can be measured by integration of the appropriate function. The general argument is clarified in the (first) following figure, (Ibrahim , 1993; Alalem, 1999).

Figure (6-1) illustration what happen in the cement industry after the addition of the cost of pollution.



Source: Hara et al, (1997); Jehle et al, (1998); Mas-Colell et al, (1995); Mckenzie et al, (2006); Miller, (2003); Miller, (2008); Nichols et al, (2008); Obosadrh et al, (2000) and Varian, (1992).

Where:

$SC_0=mc_0$, $SC_1= mc_1$ A marginal cost curve in the cement industry (which is the

	economic supply curve).
DC	A demand curve for cement production.
P	The cement price.
QS	Produced quantities of cement.
QD	The required amount of cement material by consumers.
C	Equilibrium before the cost of pollution control is added.
$*P_1$	Equilibrium price $*P_1$ and quantity $^*Q_1$, before the cost of pollution control is added.
$*P_2$	Equilibrium price of quantity demand with a quantity supply $^*Q_2$, after the cost of pollution control is added.
PC	The cost of pollution control.

At this price ($^*P_1$) consumer surplus will be at a maximum point, which represented by the area of (or space) $P_3C^*P_1$, and producer surplus will be found by the area of FC^*P_1. Having applied the environmental economic policy, the cost of cement production will have increased, and, the supply curve will be moved up to left, from mc_0 (SC_0) to mc_1 (SC_1), which will lead to increase in equilibrium price from $^*P_1$ to $^*P_2$, and the equilibrium quantity of cement from $^*Q_1$ to $^*Q_2$.

This increase in the price of cement will lead to decrease in consumer surplus, to become represented by $P_3D^*P_2$ area, and there will also be a decrease in producer surplus which is now represented by ID^*P_2 square, of which the loss has been represented via this space AIDC. This is the loss which will be borne by manufacturers of cement to preserve the environment.

The actual cost of pollution control can be determined through the derivation of a demand function and function for the marginal cost of the cement industry.

If we consider the quantity supply of cement production (QS) is a direct function in the quantity of raw materials (X), alongside other inputs (U). See in particular, Bierens, (2005); Davidson, et al. (2004); Gujarati (2003); Koop, G. (2003); LeSage, (1999); Maddala, (1988); Hara et al (1997); Wooldridge, (2005)), such as equipment, spare parts and other operational requirements as the following, Farhat, (2005); and Kaze et al, (1999):

$$QS = QS(X, U)$$

$$\frac{\partial QS}{\partial X} = QS_X > 0$$

$$\frac{\partial QS}{\partial u} = QS_u > 0$$

And if the level of pollution (emission level) F depends on the amount of raw materials X and technical costs which control the level of pollution M and that as the following:

$$F = f(x, m)$$

And the assumption that the level of pollution is specific or limited so as to not exceed ′f, so the function can be formulated in the following way:

$$f^{-} = f^{-}(x, m)$$

If it had been symbol to the total overall costs for production of cement by symbol C, so it can be formulated the objective function mathematical as the following way:

$$Min\ C = P_x \cdot X + P_u \cdot U + P_m \cdot M$$

According to the following limitations

$$QS = QS(X, U)$$

$$f^{-} = f^{-}(x, m)$$

And (I) noted to that , I= m,u,x where Pi indicate all the price of raw materials , other inputs and cost of pollution respectively. In order to achieve the function in accordance with the method of LaGrange, a new function is (V) is made including the original objective function and its conditions after multiplying all the conditions with the known of LaGrange multipliers. Treating these LaGrange multipliers (λ1 , λ 2) as independent variables in the new function and their number must be equal with the restrictions contained in the function , and that as the following :-

$$V = P_x \cdot X + P_u \cdot U + P_m \cdot M + \lambda_1 \left(QS_0 - QS(x, u) \right) + \lambda_2 \left(f^-_0 - f^-(x, m) \right)$$

Two conditions must be met to achieve the target function, firstly the necessary condition, that all the first partial derivatives for all independent variables, and the LaGrange multipliers are zero. In addition, there is the other condition which is called the sufficient condition, and that is achieved when the matrix of Hessian (Border Hessian: the Hessian matrix or simply the Hessian) is confirmed positive. The Hessian matrix was developed in the 19th century by the German mathematician Ludwig Otto Hesse and later named after him. Hesse himself had used the term "functional determinants") is confirmed positive (Obosdra, 2005).

$$\frac{\partial V}{\partial X} = P_x - \lambda_1 \frac{\partial QS_x}{\partial X} - \lambda_2 \frac{\partial f^-_x}{\partial X} == P_x - \lambda_1 QS_x - \lambda_2 f^-_x = 0$$

$$\frac{\partial V}{\partial u} = P_x - \lambda_1 \frac{\partial QS_x}{\partial u} == P_x - \lambda_1 QS_x = 0$$

$$\frac{\partial V}{\partial m} = P_m - \lambda_2 \frac{\partial f^-_m}{\partial m} == P_m - \lambda_2 f^-_m = 0$$

$$\frac{\partial V}{\partial \lambda_1} = QS - QS(x, u) = 0$$

$$\frac{\partial V}{\partial \lambda_2} = f^- - f^-(x, m) = 0$$

By solving these equations:

From equation number (1) we find that

$$\lambda_1 = \frac{P_x - \lambda_2 \bar{f}_x}{Qs_x}$$

From equation number (3) we find that

$$\lambda_2 = \frac{P_m}{\bar{f}_m}$$

Thus,

$$\lambda_1 = \frac{P_x - P_m\left(\frac{\bar{f}_x}{\bar{f}_m}\right)}{Qs_x}$$

In this context (framework), the best policy which achieved the least possible cost by using raw materials (x) and other inputs (U) such as equipment and spare parts and that by the marginal cost of production quantities of cement (QS) .

Where:

$$MC = \lambda_1$$

$$MC = \frac{P_u}{QS_u} = \frac{P_x}{QS_x} = \frac{P_x - P_m\left(\frac{\bar{f}_x}{\bar{f}_m}\right)}{QS}$$

Where:

P_x	The price per ton of raw material.
P_m	Parameter referring to the environmental cost which can be given different values to reflect the impact and the amount of an increase in the marginal costs when applying the environmental policy .
$'f_x$	The amount of change in the level of emissions ($'f$) resulting from the change in raw materials (x).
$'f_m$	The amount of change in the level of ($'f$) resulting from the change in the existing technology (m).
QS_x	The amount of change in production (QS) which resulting from the change in raw materials (x).

6.9. Analysis of the price elasticity of demand and price elasticity of supply for the cement industry

The previous analysis of consumer and producer surplus, gives us a clear picture of the impact of a technical environmental cost on a cement factory, if it wanted to diminish the seriousness this industry on the environment. But an analysis of the cost of pollution and its impact on the market equilibrium in the cement industry is not enough. Therefore, there is an urgent question that should be raised and answered. This who will bear the cost of pollution the producer of cement or the consumer or both? If both, who will be more the producer or consumer or will it be shared equally? The answers to these questions are not easy or simple but through an analysis of the relative price elasticises of demand and supply we can answer this question. The next section discusses elasticity in theoretical context.

6.9.1. The Elasticity

Elasticity is the percentage change in the quantity of a good demanded (supplied) compared to the percentage change in the price. For example, we find that, there is for a normal demand curve an inverse relationship between quantity demand and price (an increase the price leads to a fall in the quantity demand). The ceteris paribus principle is applied which, in effect, imposes the stability of other factors such as consumer income, consumer tastes, income distribution, and the price of other goods. Thus, allowing consideration of only the relationship between price and quantity demanded or supplied. By varying this assumption, in turn, one can estimate:

6.9.1. 1. Demand → price elasticity of demand.

6.9.1.2. Income → income elasticity of demand.

6.9.1.3. Alternative good(s) → cross-price elasticity of demand.

6.9.1.4. Supply → price elasticity of supply.

6.9.2. Price elasticity of demand

There are two ways to calculate price elasticity of demand:

6.9.2.1. Point: where elasticity is calculated at a specific point on the demand curve for a very small price change.

6.9.2..2. Arc: used for finding the elasticity between two points and implicitly covering a larger price change than for point elasticity.

The First Way: point calculation of the price elasticity of demand.

Conceptually it is the response of quantity demand for a specific commodity to a change in the price and is measured as the following. (Nasr et al, 2008; Miller, 2008; Miller, 2003; Nichols et al, 2008; Mas-Colell et al, 1995; Hara et al, 1997; Jehle et al, 1998; Mckenzie et al, 2006; and Varian, 1992).

$$E_{11}QD = \frac{\text{The percentage of change in quantity demand of specific commodity}}{\text{The percentage of change in quantity price of specific commodity}} \rightarrow 1$$

Where:
$E_{11}QD$ Price Elasticity of Demand.

And also, where

The change in the quantity demand = $\frac{\partial QD}{Q} \rightarrow 2$

The change in the price of commodity = $\frac{\partial P}{P} \rightarrow 3$

From 1, 2 and 3 we find that.

$$E_{11}QD = \frac{\partial QD}{QD} \div \frac{\partial P}{P}$$

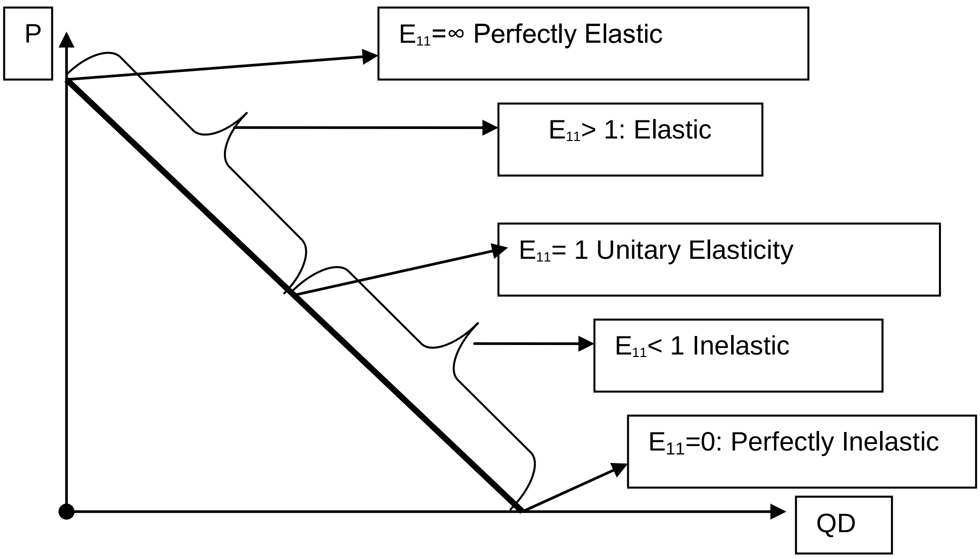
$$= \frac{\partial QD}{QD} \times \frac{P}{\partial P}$$

$$E_{11}QD = \frac{\partial QD}{\partial P} \times \frac{P}{QD} \rightarrow 4$$

Where:

P	The original price of the commodity.
QD	The Quantity of demand.
∂ QD	The change in quantity demand.
∂P	The change in the price.
E_{11}QD	The price elasticity of demand.

This figure (6-2) illustration of the range of price elasticity of demand on the cement industry (or any commodity or factory)



Source :Almgri et al (2005).

Where:

E_{11}QD = 0 Perfectly Inelastic, it means there is no response between the quantity of demand and the price for any small change to the price.

$E_{11}QD < 1$	Inelastic, it means a situation in which a price change leads to a less than proportionate change in quantity demanded.
$E_{11}QD = 1$	Unitary Elasticity, it means a situation in which price and quantity changes exactly offset each other. Total revenue remains constant following the change.
$E_{11}QD > 1$	Elastic, it means a situation in which a price change leads to a more than proportionate change in quantity demanded
$E_{11}QD = \infty$	Perfectly Elastic, it means the quantity demanded becomes zero if the price rises by the smallest amount and the quantity demanded becomes infinite if the price falls by the smallest amount.

The Second Way: The way of arc for finding the price elasticity of demand. Hara et al, (1997); Jehle et al, (1998); Mas-Colell et al, (1995); Mckenzie et al, (2006);Miller, (2003); Miller, (2008); Nasr et al, (2008); Nichols et al, (2008) and Varian, (1992).

$$\text{Elasticity Midpoint} = \frac{\Delta Quantity}{\text{Average of change in the quantity}} \Big/ \frac{\Delta price}{\text{Average of change in the price}}$$

$$E_{11}QD = \frac{\partial QD}{\frac{1}{2}\left(QD_1 + QD_2\right)} \div \frac{\partial P}{\frac{1}{2}\left(P_1 + P_2\right)}$$

$$E_{11}QD = \frac{\partial QD}{\partial P} \times \frac{P_1 + P_2}{QD_1 + QD_2}$$

6.9.3. Price elasticity of supply.

There are two ways to calculate price elasticity of supply with the first being point elasticity for calculating price elasticity at a specific point; and, the second way: arc: used for finding the price elasticity between two points on the supply curve

The First Way: point method for finding the price elasticity of supply.

Conceptually, it is a response of quantity supply from specific commodity to the change which happened on the price, and is measured as the following, (Almgri, et al (2005); Miller, (2008); Miller, (2003); Nichols et al, (2008); Mas-Colell et al, (1995); Hara et al, (1997); Jehle et al, (1998); Mckenzie et al, (2006); and Varian, (1992):

$$E_{11}QS = \frac{\text{The percentage of change in quantity supply of specific commodity}}{\text{The percentage of change in quantity price of specific commodity}} \rightarrow A$$

Where:

$E_{11}QS$ price elasticity of supply.

Where:

The change in the quantity supply = $\frac{\partial QS}{Q} \rightarrow B$

The change in the price of commodity = $\frac{\partial P}{P} \rightarrow C$

And from A, B and C we find that.

$$E_{11}QS = \frac{\partial QS}{QS} \div \frac{\partial P}{P}$$

$$= \frac{\partial QS}{QS} \times \frac{P}{\partial P}$$

$$E_{11}QD = \frac{\partial QS}{\partial P} \times \frac{P}{QS} \rightarrow D$$

Where:

P The price of commodity.

QS The Quantity of supply.

∂ QS The change in quantity supply.

∂P The change in the price.

$E_{11}QS$ The price elasticity of supply.

The Second Way: The way of arc for finding the price elasticity of supply (Miller, (2008); Miller, (2003); Nichols et al, (2008); Mas-Colell et al, (1995); Hara et al, (1997); Jehle et al, (1998); Mckenzie et al, (2006); Varian, (1992); and Rr4ee,(2009).

$$\text{Elasticity Midpoint} = \frac{\Delta Quantity}{\text{Average of change in the quantity}} \Big/ \frac{\Delta price}{\text{Average of change in the price}}$$

$$E_{11}QS = \frac{\partial QS}{\frac{1}{2}\left(QS_1 + QS_2\right)} \div \frac{\partial P}{\frac{1}{2}\left(P_1 + P_2\right)}$$

$$E_{11}QS = \frac{\partial QS}{\partial P} \times \frac{P_1 + P_2}{QS_1 + QS_2}$$

The coefficients of price elasticity of supply are interpreted as below:

Where:

$E11QS = 0$	Perfectly Inelastic, means that a shift in the demand curve has no effect on equilibrium quantity supplied. A change in price will lead to no change in the quantity supplied.
$E11QS < 1$	Inelastic means that a change in demand affects the price more than the quantity supplied. A percentage change in price leads to a smaller percentage change in quantity. A straight line supply curve will intersect the quantity axis.
$E11QS = 1$	Unitary elasticity. a percentage change in price will lead to an equal percentage change in the quantity supplied. Any straight line supply curve that intersects the origin will have unitary elasticity.
$E11QS > 1$	Elastic means that a change in demand affects the quantity supplied more than the price. A percentage change in price leads to a larger percentage change in the quantity supplied. A straight line supply curve will intersect the price axis.
$E11QS = \infty$	Perfectly elastic, means that any amount can be supplied at the same price and that any decrease in price will cause the quantity supplied to fall to zero.

Through using the price elasticity of supply and price elasticity of demand one can determine who will bear the cost of the environmental improvement (for example, the cost of new equipment to reduce pollution, alternative fuel or, say, the cost of legislation) and the following scenario shows the expected results from the price elasticity analysis for cement production and its consumption.

Table (6-2) illustration the Scenario about, who will be paid the cost of pollution the consumer or producer or both.

Elasticity	$E_{11}QD=1$	$E_{11}QD>1$	$E_{11}QD<1$	$E_{11}QD=0$	$E_{11}D=\infty$
$E_{11}QS=1$	Equal	Producer> Consume	Consumer> Producer	Consumer	Producer
$E_{11}QS>1$	Consumer> Producer	Equal	Consumer> Producer	Consumer	Producer
$E_{11}QS<1$	Producer> Consume	Producer> Consume	Equal	Consumer	Producer
$E_{11}QS=0$	Producer	Producer	Producer	unrealistic	Producer
$E_{11}QS=\infty$	Consumer	Consumer	Consumer	Consumer	unrealistic

Source: Author work (2008)

Where:

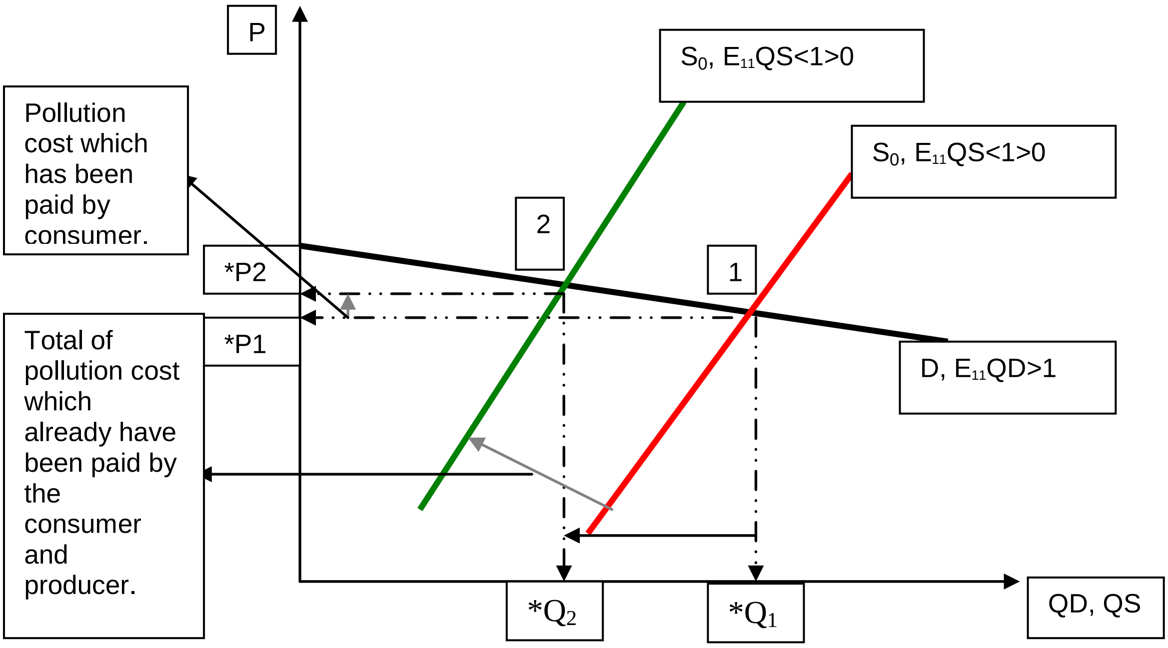
Equal	It is mean the consumer and producer will ray equal for the cost of pollution.
Consumer>Producer	It is meaning the consumer will pay mare then producer.
Producer>Consume	It is meaning the producer will pay mare then consumer.
Consumer	It is mean the consumer will pay all the cost of pollution.
Producer	It is mean the producer will pay all the cost of pollution
Unrealistic	This case may be applied mathematically or Graphic but in our live I did not think so.

Every case in the table above can be illustrated graphically, for further clarification we review two cases of price elasticity of demand and price elasticity of supply. If we have a demand curve that is elastic ($E_{11}QD>1$) and supply curve that is not elastic ($E_{11}QS<1>0$) :-

The producer will reduce production indicated by a shift in the supply curve the left. We can noted that the equilibrium quantity will be moved to $^{*}Q_1$ and the equilibrium piece will be goes up to $^{*}P_2$ but the change in the price balance less than the cost of pollution which means displacement rate of the supply curve from S_0 to S_1 biggest or greater than the sale price change from $^{*}P_1$ to $^{*}P_2$, and this indicates to that, the producer will bear the bulk (or most) of the cost of pollution. Because the supply curve is inelastic and demand curve is elastic. This is already has been explained in the table of scenario which illustration the impact of price elasticity of supply and price elasticity of demand on who will bear the cost of pollution.

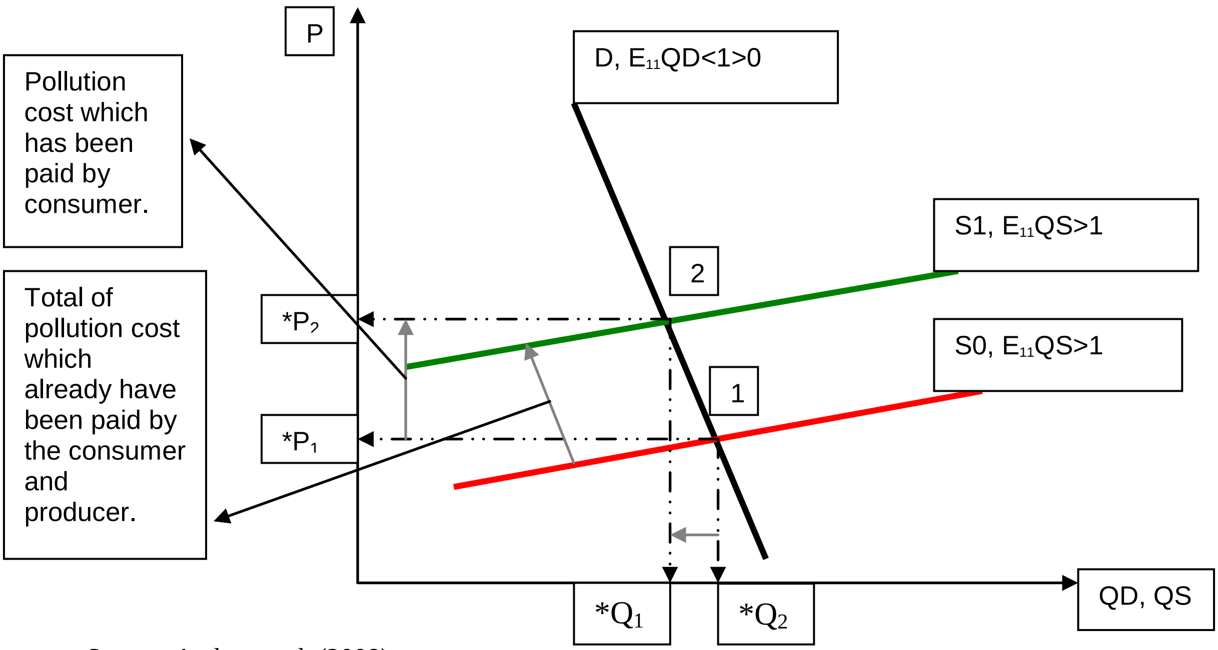
If we have demand curve is not elastic ($E_{11}QD<1>0$) and supply curve is elastic ($E_{11}QS>1$) :-

Figure number (6-3), Instruction the relationship between the cost of pollution and the elasticity



Source: Author work (2008)

Figure number (6-4), Instruction the relationship between the cost of pollution and the elasticity



Source: Author work (2008)

Figure number (6-3), illustrates the relationship between the cost of pollution and elasticity and explain the distribution of the cost of pollution between the consumer and producer. If we have a demand curve that is elastic ($E_{11}QD>1$) and a supply curve is not elastic ($E_{11}QS<1>0$).

We noted that, the equilibrium quantity $^{*}Q_1$ and the equilibrium quantity $^{*}p_1$ at point 1 , and this means that, the right (or suitable) amount of quantity supply that should be produced by the cement plant is Q_1 , and the suitable amount of quantity demand should be bought by the consumer is $^{*}Q_1$ and at price $^{*}p_{1.}$ Assuming the stability of other factors (such as the time , competition and consumer tastes …etc) .

If the manager of cement industry thought of adding the cost of pollution, control what will happens to the equilibrium of the cement industry ? ($^{*}Q_1$, $^{*}Q_2$).

Figure number (6-4), illustrated the relationship between the cost of pollution and elasticity and the distribution of the cost of pollution between the consumer and producer. If we have a demand curve is not elastic ($E_{11}QD<1>0$) and a supply curve is elastic ($E_{11}QS>1$).

We note that, the equilibrium before the cost of pollution was in point 1 and at quantity balance $*Q_1$ and price balance $^{*}P_1$, and after adding the cost of pollution, the result as the following, the supply curve shifts from S_0 to S_1 and supply is lower at any given price consequently, the quantity equilibrium declined from $*Q_1$ to $*Q_2$. The price equilibrium goes up by a larger amount almost equal to the cost of pollution which mean to $^{*}P_2$. We note the consumer here will pay big part of the cost of pollution because its elasticity was inelastic and this mean the amount of response to the change in the quantity to the change in the price is small. Referring back the previous scenario table, it will be found this result is true and verified, of course this is will be proven when doing the analysing in the case study of these research.

The conceptual framework includes extensive analytical capabilities help to determine conditions of economic efficiency to control in the environmental pollution, and show the distributional effects of this procedure. But this theoretical analysis is supposed to control in the pollution by application of environmental policy will be an effect on the price of cement and does not take into account the impact on other industries , some of these industries use of the cement material with greater intensity. For example, the construction sector, and also the application impact of environmental policy is not limited to the prices of cement material because increases the price of cement material let to rising the input of some other industries and this present to increase in the cost of their production, and the consequent of that exposure some of the production the elements which already involved (or use) in the other industries, to unemployment. And this is negative impact of the industry represented a loss of society or the country.

It has been previously reported that there is more than one way to measure or calculate the elasticity of demand and supply price. For example, it could be calculated it by the follows from. (Henderson, J.M and Richard E.Q. 1971 and Mokri, A.F and Moses, M.Z. 2010):

$$E_{ii}QD = \frac{\partial QD_i}{\partial P_i} \times \frac{P_i}{QD_i} = \frac{\Delta QD_i}{\Delta P_i} \times \frac{P_i}{QD_i}$$

The above form must be used when the changes with quantity or price of goods are very small, but when the changes of quantity or price of goods large, the what is the correct procedure? So in this case must be used the form of Arc – elasticity to measurement the elasticity. This is shown as the follows. (Almgri, A.F. 2005; Henderson, J.M and Richard E.Q. 1971; Mokri, A.F and Moses, M.Z. 2010 and Zahran, H; Tobar, S., and Aladl, M.R. 2008):

$$E_{11}QD=\frac{\Delta QD_i}{\Delta P_i}\times\frac{P_1+P_2}{QD_1+QD_2}=\frac{QD_2-QD_1}{P_2-P_1}\times\frac{P_1+P_2}{QD_1+QD_2}$$

However, in the case of this study it could be noted that the changes which happened with cement production and sales quantity as a result of changes of cement prices is large so we should use the form of Arc-elasticity to determine the elasticity of demand and supply price.

6.10. Summary of the methodology

The methodology consists of two stages as follows:

The first stage, eestimating the environmental cost rate as follows:

- Estimating the production function of cement production for Ahlia Cement Company plants
- Estimating the cost of pollution control function of the cement production for Ahlia Cement Company itself plants.
- Estimating the marginal cost for Ahlia Cement Company plants before the environmental cost.
- Estimating the marginal cost for Ahlia Cement Company plants after the environmental cost
- And then calculating the environmental cost rate by subtracting the marginal cost before and after the environmental cost.

The second stage in the analysis of the demand price elasticity and the supply price elasticity for cement production for Ahlia Cement Company plants, and the purpose for this stage is determined who would bear the environmental cost.

6.11. Conclusion

This chapter has outlined the method used and the nature, and source, of the dataset from the Ahlia Cement Company, Libya. The understanding, and application, of appropriate environmental policies is important for any nation. One aspect that might encourage both understanding and application is a consideration of who actually bears the cost of an increase in production due to a technical environmental cost following a change in production costs to meet more stringent pollution targets. Whilst this study focuses on an increase in production line costs, the approach would work equally well for a situation in which administrative costs might increase in order to maintain better records and monitoring to comply with environmental legislation.

This study considers only ‘first round’ effects on the initial consumers of cement and proposes that we need an understanding of how the price increase in cement would be shared between the consumer and the producer relative to their respective demand and supply price elasticities. In this chapter two obvious but important considerations were discussed: an appropriate framework by which to calculate production costs - with and without -a technical environmental cost imposed and then the calculation of price elasticities; and, secondly the gathering of appropriate data with which to populate the model.

It could be argued that producers might be more willing to make environmental improvements if they are able to pass on some of their costs in higher prices, and that consumers should bear some of the burden of environmental improvement through higher prices. In this study this issue has been firmly set within a wider consideration of pollution and one key outcome of the analysis is a scenario table that sets out the various permutations of cost sharing between the consumer and the producer.

Chapter Seven
Analysis and Discussion

7.1. Introduction

The fifth chapter of this study addressed the cement industry in Libya in general, but with a specific focus on the Ahlia Cement Company and its four factories: the Zileten Cement Factory, the Libda Cement Factory, the El-Mergheb Cement Factory, and the Suk El-Khamis Cement Factory for Cement and Building Material. Chapter Six considered a number of relevant economic tools of analysis.

Chapter Two of this study addressed those previous studies that attempted to explain, or to find, a solution to the problem of environmental pollution caused by the cement industry. Various points of view on the possibility of finding a solution were discussed in these studies. Some were focused on air pollution, and some tried to focus on an alternative source of fuel, while others focused on technical solutions to the problem of the environment cement contamination. Additionally, a significant number of research papers discussed several issues related to the impact of such contamination on life in general, such as its effect on agriculture and soil. On the other hand, some studies stressed the cost issues of pollution as another problem resulting from environmental crises.

From the above, it can be noted that the researcher's interests ranged widely on issues related to the environment and the pollution caused by industries in general, and pollution caused by the cement industry in particular (which is the subject of this the study). As would be expected, for this reason, researchers also had varying points of view regarding suitable methodological tools used in their research. Some used questionnaires as the tool to collect and analyze data, while others used personal interviews and observation.

This study has used: company data, interviews and personal observation to gather data which could be used in an econometric analysis. This study adds to the existing literature by considering the following three aspects that have not been considered previously:

This study sees that the control of pollution caused by the cement industry (for example) does not only have to do with the setting, or developing, of green technology alternatives that reduce environmental pollution, but also in determining which party or parties are responsible for such pollution, and deciding how the pollution costs will be determined and distributed, such that all responsible parties including the producer, the consumer, the government or any other parties can help to bear the real cost. Before considering those techniques that limit or reduce pollution, the producer in the cement industry considers the additional costs and compares them with the profits to be achieved. Logically, the producer does not see himself as concerned or responsible for bearing any additional costs that might reduce his profits. However, producers might be more receptive to accept and implement green techniques if such techniques were explained to them along with the exact costs that they would have to bear should these techniques be implemented. Such an approach might be more applicable for developing countries since environmental laws in these countries are not followed or implemented in such an organized or planned manner as in the case of developed countries. This is despite the fact that often the same environmental laws and conventions exist in both the developing and developed countries.

It can be noted that the studies looked at in Chapter Three have used different research tools than those used in this study. This is because this study tries to help beneficiaries, or those who are interested in understanding the contribution of economic science to reducing pollution, or possibly clarifying to the investors in the cement industry some of the financial problems related to environmental costs. It does this by encouraging them to accept that their initial increase in costs in varying degrees can be passed on to other parties such as the consumer, the government or other parties.

Whilst many studies have used economic tools to analyse the level and impact of environment cost, most of these studies are more likely to have taken a ‘traditional’ cost-benefit-analysis direction Research instruments are more likely to have been questionnaires, interviews and observation. interviews or observations). Of those studies that have used microeconomic analytical tools, such as those used in this study, none of these studies addressed the issue of which parties should bear the environmental costs.

7.2. Estimating the marginal cost function for cement production in the Zileten Cement Factory

7.2.1. Introduction

The concept of marginal cost is of special importance in economic analysis since this concept represents the additional cost for one unit of production, and features in determining the equilibrium position in the different theoretical market situations of perfect competition, monopoly, monopolistic competition and oligopoly. By using the available data in the current study, the cement marginal cost represents the change in the total of cement production costs which results from the increase in cement production by one unit (one ton). The marginal cost in this industry is affected by specific factors including: the amount of cement production, the factors that affect cement production such as raw materials, machines, equipment and other production tools; as well as the emission level caused by cement production, and the technology used to control these emissions.

Estimating marginal cost is not an aim in itself, but the cost has to be estimated to enable the application of the theoretical model for the identification and tracking of the effect of the application of the selected environmental policy.

The marginal cost in the Zileten Cement Factory, was calculated from data on production quantities and the inputs used in production. To estimate the marginal cost function of cement production, the production function for cement production needs to be estimated, as well as the 'emissions' function for this factory.

7.2.2. Estimating the production function of the cement for the Zileten Cement Factory.

The production function for cement production could be considered as a function of two main factors as follows:

$$CP_{LD} = CP\left(RM_{1,}\, D_1\right)$$

$$CP_{LD} = \alpha_0 + \alpha_1 RM_1 + \alpha_2 D_1 + U$$

Where:

CP_{LD}	The production quantity of the cement (ton per year by Libyan dinars) in the Zileten Cement Factory.
RM_1	The raw material used in cement production in the Zileten Cement Factory.
D_1	Other inputs such as equipment and machinery, which can be expressed by the use of capital in the Zileten Cement Factory.

By assuming that the production function is a homogeneous degree of b1+b2; the Cobb Douglas formula can be used in some cases, depending on the availability and robustness of the data, the precise economic situation of the factory and the degree of competitiveness in the economy. Since the late nineteen eighties, Libya could probably be described as more of a capitalist than planned economy. So the use of the Cobb Douglas function is justifiable in this mixed economy.

$$CP_{LD} = A\,RM^{b1} D^{b2}$$

Also, the function can be formulated in a linear form and estimated by using the least squares method after converting it to the following form:

$$LogCP_{LD} = Log\ A + b_1 LogRM_1 + b_2 LogD_1 + U$$

Where:

$$CP_{LD} = \frac{LogPC_{LD}}{LogRM_1} = b_1$$

indicates the amount of change in production (CP_{LD}) which results from the change in the quantity of raw materials (RM_1) and assuming the stability of the quantity of other inputs used.

$$PC_{LD} = \frac{LogPC_{LD}}{LogD_1} = b_2$$

Indicates the amount of change in production (PC_{LD}) from the change in the material and inputs (D_1) by assuming the stability of the quantity of raw material used. Table (6-1) shows the data for these variables between 1998-2008:

Table (7-1) The basic variables to measure and calculate a cement production function for the Zileten Cement factory during 1988-2008 (Libyan Dinars.)

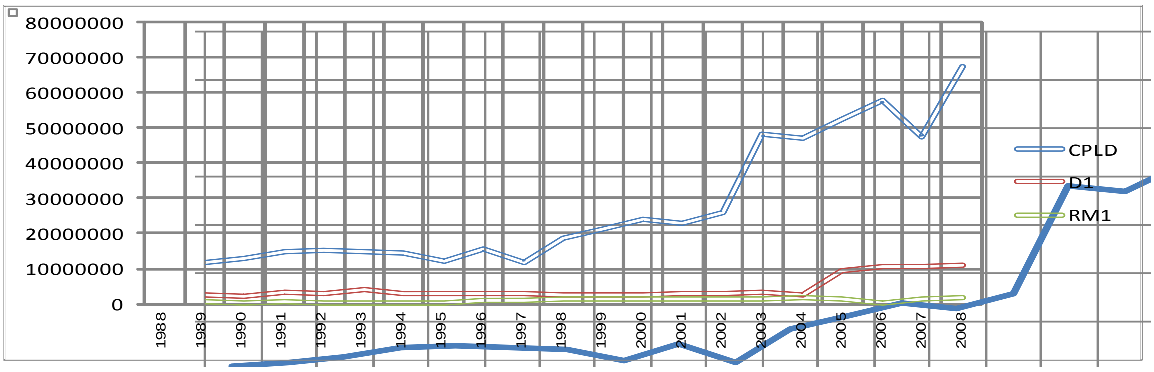
Year	RM_1	D_1	CP_{LD}
1988	493,899.87	2,236,086.28	11,009,241
1989	427,370.38	2,410,359.28	11,867,264
1990	405,522.91	2,311,202.64	12,752,740
1991	506,903.64	3,126,167.04	14,625,485
1992	387,703.36	3,072,408.78	15,067,705
1993	370,455.22	3,873,780.97	14,753,420
1994	283,348.73	2,980,326.66	14,249,175
1995	406,930.77	2,907,620.36	12,057,833
1996	890,557.36	2,889,932.31	15,576,530
1997	830,709.63	2,978,617.00	11,917,364
1998	1,354,988.49	2,641,631.00	18,559,580
1999	1,508,867.10	2,606,648.00	21,257,177
2000	1,479,453.58	2,517,832.00	23,919,336
2001	1,501,437.01	2,732,577.00	22,746,465
2002	1,347,749.87	2,771,000.00	25,816,868
2003	1,556,982.22	3,130,530.00	48,095,132
2004	1,737,410.83	2,667,553.00	47,235,006
2005	1,338,041.98	9,505,300.00	52,454,750
2006	137,588.06	10,756,937.00	57,640,424
2007	1,425,500.51	10,758,537.00	47,583,919
2008	1,720,220.13	10,987,110.00	67,513,271

Source: Department of budgets, 1988-2008c; Department of budgets, 1988-2008e; Department of Information Systems in the Zileten Cement Industry, 1990b; Department of Statistics, 1988-2008b; the Zileten Cement Factory, 1988-2008; the Zileten Cement Factory 2009a; the Zileten Cement Factory, 2009b; the Zileten Cement Factory, 2009c; the Zileten Cement Factory, 2009d; the Zileten Cement Factory, 2009e; the Zileten Cement Factory, 2009f and the Zileten Cement Factory, 2009g.

Notes: 1-All the figures in this table are in Libyan Dinars and are stated in real terms having been adjusted by reference to the Libyan Price Index to avoid the impact of economic inflation or deflation.
2-All the data in above table is Stationary Time Series dnd for more information see appendix six.
3-Stationary Time Series: In statistics, a time series in which the data in the series do not depend on time. That is, the mean, variance, and covariance of all data in the time series are adjusted to reflect true values not dependent on time or seasonality.

In general, it is noted that the data has been increasing in a direct relationship, but that in 2005, the data of the production function shows a' step change' due to re-evaluation of the factory assets and a change in the management system, when the factory started entering the stock market and new partners entered the business. This system was not known before, say, 1969 (i.e. before the Al-Fathih Revolution), and thus fragmentation appears in this data. This is shown in the following figure (6-1) and further clarification can be found in Chapter Five.

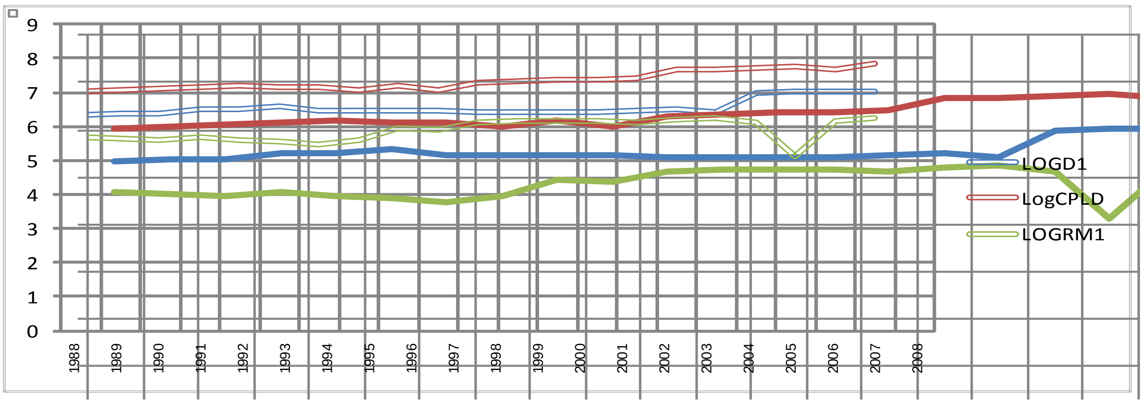
Figure (7-1) The relationship between production quantity, raw material and capital in the Zileten Cement Factory, 1988-2008.



Source: Author (2009)

It is noted that the data – especially that related to the production function – shows that this function is not linear. This is what was expected and noted in the previous discussion about the measurement of the production function. So, the logarithm of these data values was taken and this is shown in Figure (7-2). Table (7.2) illustrates the production function derived from this data and the log transformation.

Figure (7-2) The relationship between the production quantity, raw material and capital, the Zileten Cement Factory 1988-2008. Logarithm value for data



Source: Author (2009)

Table (7-2)	**Production function the Zileten Cement factory, 1988-2008.**		
Dependent Variable	**Independent Variable**		
$CP1_{LD}$	**Constant**	**RM_1**	**D_1**
Coefficient	-4116601	13.19115	4.316072
T-test	-0.994969	3.990809	7.313472
Significant	0.3329	0.0009	0.0000
R square=0.82	Adjusted R Square=0.80	F-test=40.09532 Significant=0.0000	D.W=1.69
So, b_1=13.19115; b_2=4.316072			

7.2.2.1. The Statistical Analysis

From Table (7-2) it could be deduced that all the independent variables were significant given the T-test at 5% (P<0.05). But the constant value is not significant at 5% even allowing for an increase in the amount of error. As for the value of R Square; this value is high and equals 0.82, and as well, the Adjusted R Square value is 0.80. This means that the independent variables (RM_1, D_1) were able to explain 0.82 of the changes in the cement production quantity (CP_{LD}) and the remaining 0.18 is due to other factors.

As for the analysis of variance, which can be determined via the overall explanatory power of the model through The F-test, this showed a significant level at P<0.05, which confirms the high explanatory power of this multiple regression model for the cement production function.

The Durbin–Watson statistic (D.W.) “is a test statistic used to detect the presence of autocorrelation (a relationship between values separated from each other by a given time lag) in the residuals (prediction errors) from a regression analysis. It is named after James Durbin and Geoffrey Watson. However, the small sample distribution of this ratio was derived in a path-breaking article by John von Neumann” (von Neumann, 1941). Durbin and Watson (1950, 1951) “applied this statistic to the residuals from least squares regressions” (Durbin, and Watson,1950).

Moreover, The D.W test is a test for correlation in the residuals of a time series regression. A value around 2.0 for the D.W statistic indicates that there is no serial correlation. (Economics, 2011)

7.2.1.2. The Economic Analysis

According to the economic theory, the supply quantity (cement production) is linked by a direct correlation with the raw material used in making the cement. So the more the amount of raw material used, the greater the increase in output and capital employed. The greater the increase in the capital, the greater the increase in the supply quantity. The results of the production function analysis for the Zileten Cement Factory agree with economic theory in this respect.

The coefficient of raw material (RM_1) equals 13.19115 and this is consistent with the logic of economic theory, which means that each increase in the raw material (RM_1) used in cement production (CP_{LD}) by one Libyan Dinar will lead to an increase in cement production (CP_{LD}) of 13.19115 Dinars. With regard to the capital of Zileten Cement Factory, this also conformed with the economic theory where the value was equal to 4.316072, which means that each increase in the capital by the employer of one Libyan Dinar will lead to an increase in the quantity of the cement production (CP_{LD}) (the quantity of Supply) of 4.316072 Dinars.

7.2.3. Estimating the Function of Cost of pollution control from Cement Production in the Zileten Cement Factory

The quantity of emissions from the production of cement can be considered as a function of two main variables as follows:

$$MP_{LD} = MP_{LD}\left(RM_{1,} TechC_{1}\right)$$

$$MP_{LD} = \beta_0 + \beta_1 RM_1 + \beta_2 TechC_1 + U$$

Where:

MP_{LD} The quantity of the emission from the cement production in the Zileten Cement Factory. It is worth mentioning here that the contaminated dust represents 13.5% from the weight of cement production (Alalem, A.A. 1999; Department of Budgets, 1988-2008a; Department of Budgets, 1988-2008d; Department of Budgets, 1988-2008e; Department of Budgets, 1988-

2008b; Department of Budgets, 1988-2008c; Department of Information Systems in the Ahlia Cement Company, and the Suk El-Khamis Factories, 1988-2008 and Centre for Economic Research, 1997,).

RM_1 The raw material which is used in the cement production in the Zileten Cement Factory. Thus row material variable was measured by lime stone cost, clay cost, gypsum cost and ferric oxide cost.

$TechC_1$ The Technology cost that controls the pollution level in the Zileten Cement Factory. A choice was made as to which were the main polluters as evidenced by dust, gas and soil contamination. Thus the technology cost variable was measured by the explosives cost, fuel cost, labour cost, gypsum transport cost and ferric oxide transport cost, since these are the main polluters.

According to the expenses list and the annual reports for the Zileten Cement Factory; the next table illustrates the quantity emission (MP_{LD}), raw material (RM_1) and the technology cost which controls the pollution during the period 1988-2008.

Table (7-3) Raw material and technology costs in the Zileten Cement Factory during 1988-2008 (Libyan Dinars).

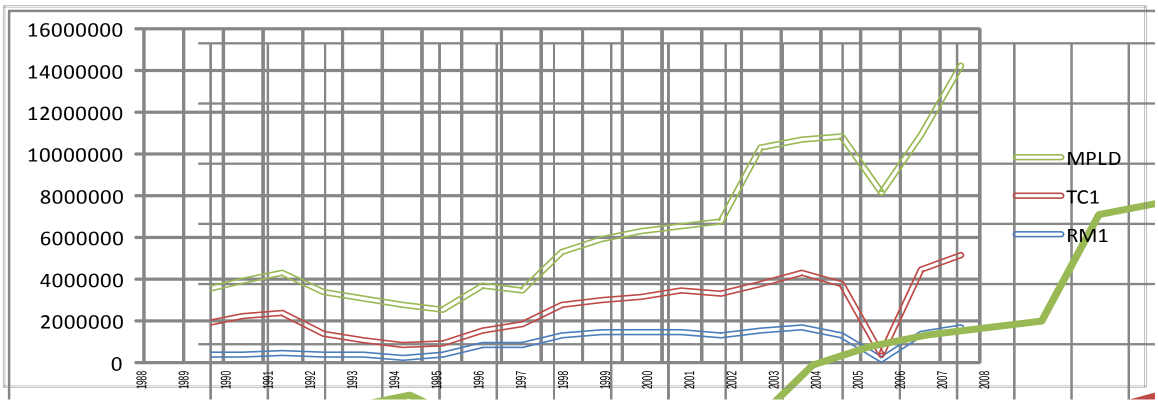
Year	RM_1	MP_{LD}	$TechC_1$
1988	493,899.87	1,486,247.5	1,354,251.00
1989	427,370.38	1,602,080.6	1,459,796.80
1990	405,522.91	1,721,619.9	1,813,118.17
1991	506,903.64	1,974,440.5	1,865,948.90
1992	387,703.36	2,034,140.2	1,016,478.00
1993	370,455.22	1,991,711.7	752,137.00
1994	283,348.73	1,923,638.6	596,346.00
1995	406,930.77	1,627,807.5	553,053.00
1996	890,557.36	2,102,831.6	680,709.00
1997	830,709.63	1,608,844.1	1,012,313.00
1998	1,354,988.49	2,505,543.3	1,442,089.60
1999	1,508,867.10	2,869,718.9	1,532,319.60
2000	1,479,453.58	3,229,110.4	1,655,040.50
2001	1,501,437.01	3,070,772.8	1,959,011.60
2002	1,347,749.87	3,485,277.2	1,989,202.80
2003	1,556,982.22	6,492,842.9	2,254,060.20
2004	1,737,410.83	6,376,725.8	2,590,522.50
2005	1,338,041.98	7,081,391.3	2,447,559.70
2006	137,588.06	7,781,457.2	262,292.00
2007	1,425,500.51	6,423,829.1	3,083,699.00
2008	1,720,220.13	1,486,247.5	3,434,672.00

Source: Department of Budgets, 1988-2008c; Department of Budgets, 1988-2008e; Department of

	Information Systems in the Zileten Cement Industry, 1990b; Department of Statistics , 1988-2008b; the Zileten Cement Factory, 2009a; the Zileten Cement Factory, 2009b; the Zileten Cement Factory, 2009c; the Zileten Cement Factory, 2009d; the Zileten Cement Factory, 2009e; the Zileten Cement Factory, 2009; the Zileten Cement Factory, 2009g and the Zileten Cement Factory, 1988-2008.
Notes:	1-All the figures in this table are in Libyan Dinars and are stated in real terms having been adjusted by reference to the Libyan Price Index to avoid the impact of economic inflation or deflation. 2-All the data in above table is Stationary Time Series and for more information see Appendix six.

As noted from the table the quantity of the emission from the cement production (MP_{LD}) and the raw material (RM_1) has increased steadily during the study time. The technology cost ($TechC_1$) also showed an increase but in 2005 onwards, it could be noted that the numbers of the readings showed a dramatic increase; this is due to the reasons mentioned earlier. So when doing a representation of this data graphically a dispersion or unreasonable increase between the variables is noted (due to the new administration system and re-evaluation of the company's assets) as in the following figure:

Figure (7-3) Technology cost, raw material and cement production in the Zileten Cement Factory 1988-2008.



Source: Author (2009)

Given this the researcher carried out data analysis after transforming the data into the logarithm values. However, the results were not statistically significant so several trials were considered to find the statistically significant results splitting the functions into two component was helped. The results obtained are shown in the following Table (6-4):

Table (7-4)	**Illustrates the results of the emission function with raw material and the technology cost at the Zileten Cement Factory during 1988-2008**

Dependent Variable	**Part 1**		
	Independent Variable		
MP_{LD}	**Constant**	**RM_1**	
Coefficient	5623924.8	1.711	
T-test	7.130	3.655	
Significant	0.000	0.002	
R square=0.80	Adjusted R Square=0.778	F-test=35.997 Significant=0.000	D.W=1.815

Dependent Variable	**Part 2**		
	Independent Variable		
MP_{LD}	**Constant**	**$TechC_1$**	
Coefficient	5448463.7	- 0.933	
T-test	4.974	- 2.454	
Significant	0.000	0.025	
R square=0.74	Adjusted R Square=0.710	F-test=25.465 Significant=0.000	D.W=1.604
So C_1=1.711, C_2=0.933			

7.2.3.1. The Statistical Analysis

At the beginning, the researcher was confronted with many difficulties to get statistically significant results, which led to the division of the function into two parts (functions) as follows:

$$MP_{LD} = C + RM_1 + U$$

$$MP_{LD} = C + TechC_1 + U$$

It could be concluded that, the independent variables were significant from a statistical aspect in both equations according to T-test at a significant level of 5%. But the constant was not significant according to T-test in both equations at 5% or even at 10%. This should not be worrying since the constant is not as important as independent variables, and represents the start point of these variables when drawn into graphs.

Table (7-4:Part 1) shows that the coefficient of R Square equals 0.80 and shows as well the Adjusted R Square equals 0.778, which means that the independent variable of the raw materials (RM_1) could interpret 0.778 of the changes which happen with the quantity of polluting emissions while the remaining 0.22 is due to other factors.

Table (7-4:Part 2) shows that the coefficient factor R Square equals 0.74 and the Adjusted R Square equals 0.710, which means that the independent variables are able to explain 0.710 of the changes which happen with the quantity of polluting emission while the remaining 0.26 is due to other factors.

The analysis in table (7-4:Part 1) shows the overall explanatory power of the model through the F-test, the significant level is very high where the F value equals 35.99 with a high significant level equal zero ($P<0.05$), which confirms the high explanatory power of the emissions module and the value of raw material from a statistical aspect.

Table (7-4:Part 2) also shows the overall explanatory power of the model through F-test, the significant level is very high where the value of the F-test equals 25.465 with high a significance level ($p<0.05$), which confirms the explanatory power of the equation of emissions and technology cost which controls pollution from a statistical aspect.

7.2.3.2 The Economic Analysis

According to the technical and economic logic, the rate of emissions associated is in direct correlation with the raw material (RM_1), so the more the quantity of raw material (RM_1) which is used, the more the quantity of the emission from the cement production (MP_{LD}) the more the rate of emission, and the opposite is true.

The table (7-4:Part 1) shows that, the coefficient of raw material for cement production equals 1.711 and this is consistent with both technical and economic logic, which means that any increase in raw materials (RM_1) by one Libyan Dinar will lead to an increase in the amount of pollution by 1.711 per unit. With regard to the technology cost which controls pollution, Table (7-4: Part 2) shows that the coefficient of technology cost which controls pollution value is -0.933, and this does agree with the technical and economic logic.

7.2.4. Estimation of the environmental cost rate in the Zileten Cement Factory

By using the estimated values of the coefficients included in the marginal cost equation it has been found that the results of the coefficients are as follows

$MP_{LDTechC}$ =-0.933, MP_{LDRM} =1.711, CP_{LDRM} =13.19115.

P= 89.5 (This value of cement price has been taken from official report of Ahlia cement company).

Where the marginal cost before determining the cost of emission or pollution is as follows:

$$MC_0 = \frac{89.5}{13.19115} = 6.784851965$$

After determining the cost of pollution or emission and giving different values for P_{1TechC}, the value of the marginal cost could be determined after applying the cost of pollution as follows:

If putting P_{1TechC} =0.5 (LD).

$$MC_1 = \lambda_1 = \frac{P - P_{1TechC}\dfrac{MP_{LDRM}}{MP_{LDTechC}}}{CP_{LDRM}}$$

$$MC_1 = \frac{89.5 - 0.5\dfrac{1.711}{-0.933}}{13.19115} = 6.854363$$

So any increase of the environmental cost by 0.50 Libyan Dinar per ton of cement in the Zileten Cement Factory will lead to an increase in the marginal cost by 0.0695 Libyan Dinar.

If putting P_{1TechC} =1 LD

$$MC_1 = \frac{89.5 - 1\frac{1.711}{-0.933}}{13.19115} = 6.923874661$$

So any increase of the environmental cost by one Libyan Dinar per ton of cement in the Zileten Cement Factory will lead to an increase in the marginal cost by 0.1390 Libyan Dinar.

7.2.5. Analysis of the elasticity of demand price and supply price for cement production at the Zileten Cement Factory

After analyzing the production function of the cement industry and the emissions function, and having estimated the environmental cost of the Zileten Cement Factory, it becomes necessary for us to identify who will bear the cost of environmental pollution, whether it is the consumer or the producer or both. Of course, this will depend on the relative response of the producer and consumer to the changes in the price of the cement; the one who is more responsive to the price change will bear less of the cost increase. Those who are less responsive to the change of the price who will bear more of the cost.

Table (7-5) below is an expanded version of Table (6-2), chapter six that illustrated the general principle of the analysis.

Table (7-5) illustrated the environmental cost distribution (It could be used this distribution for any sort of businesses)

Elasticity		EQS=0	EQS<1									EQS=1	EQS>1			EQS=∞
		0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	…	∞
EQD=0	0	U	C	C	C	C	C	C	C	C	C	C	C	C	C	C
EQD<1	0.1	P	E	C≥P	C≥P	C≥P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C
	0.2	P	P≥C	E	C≥P	C≥P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C
	0.3	P	P≥C	P≥C	E	C≥P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C
	0.4	P	P≥C	P≥C	P≥C	E	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C
	0.5	P	P>C	P>C	P>C	P>C	E	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C
	0.6	P	P>C	P>C	P>C	P>C	P>C	E	C>P	C>P	C>P	C>P	C>P	C>P	C>P	C
	0.7	P	P>C	P>C	P>C	P>C	P>C	P>C	E	C>P	C>P	C>P	C>P	C>P	C>P	C
	0.8	P	P>C	P>C	P>C	P>C	P>C	P>C	P>C	E	C>P	C>P	C>P	C>P	C>P	C
	0.9	P	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	E	C>P	C>P	C>P	C>P	C
EQD=1	1	P	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	E	C≥P	C≥P	C≥P	C
EQD>1	1.1	P	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P≥C	E	C≥P	C≥P	C
	1.2	P	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P≥C	P≥C	E	C≥P	C
	…	P	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P>C	P≥C	P≥C	P≥C	E	C
EQD=∞	∞	P	P	P	P	P	P	P	P	P	P	P	P	P	p	U

Source: Author 2009

Where:

EQD	Demand Price Elasticity
EQS	Supply Price Elasticity
E	Equal
P	Producer
C	Consumer
U	Unrealistic case

7.2.6. The Analysis of Price Elasticity of demand and supply for the Zileten Cement Factory.

The following table illustrates the elasticity of demand price and the elasticity of supply price for the cement production in the Zileten Cement Factory calculated for the period

1988-2008, but due to the stability of the price of cement in Libya during some periods of time the elasticity could not be calculated during these times as shown in following table(6-6).Thus, these years were excluded from the table for this reason, and the elasticity was calculated only for the years that witnessed a change in the cement price in Libya.

Table (7-6) The elasticity of demand price and supply price for cement production in the Zileten Cement Factory

Year	Cement price	Sales of cement	Quanitity of the cement production	Elasticity of demand price		Elasticity of demand price		Distribution of environmental burden
				Value	State	Value	State	
1988	14.5	756441	759258	-	-	-	-	-
1989	14.5	802239	818432	-	-	-	-	-
1990	17.5	751754	728728	0.34653	Inelastic	0.61845	Inelastic	C>P
1991	17.5	781621	835742	-	-	-	-	-
1992	20.5	769211	735010	-0.10136	Inelastic	-0.81231	Inelastic	C>P
1993	20.5	673063	719679	-	-	-	-	-
1994	22.37	695124	636977	0.369651	Inelastic	-1.39752	Elastic	C>P
1995	22.37	564598	539018	-	-	-	-	-
1996	31.5	506635	494493	-0.31926	Inelastic	-0.25419	Inelastic	P≥C
1997	31.5	418391	378329	-	-	-	-	-
1998	31.5	614706	589193	-	-	-	-	-
1999	31.5	715881	674831	-	-	-	-	-
2000	31.5	773074	759344	-	-	-	-	-
2001	31.5	718772	722110	-	-	-	-	-
2002	38.5	658971	670568	0.43405	Inelastic	-0.37009	Inelastic	P≥C
2003	58.5	785059	822139	0.423486	Inelastic	0.492474	Inelastic	C≥P
2004	58.5	835936	807436	-	-	-	-	-
2005	62.5	824204	839276	-0.21377	Inelastic	0.584899	Inelastic	C>P
2006	74.25	777070	776302	-0.34258	Inelastic	-0.43365	Inelastic	C≥P
2007	79.25	612478	600428	-3.63642	Elastic	-3.9158	Elastic	C≥P
2008	89.75	736188	752237	1.476379	Elastic	1.806362	Elastic	C≥P

Source: Author (2009)

After the analysis of the elasticity of demand price and supply price of cement industry in the Zileten Cement Factory, it has been shown that the response of producer and consumer for changes which happen to the price per ton of cement production is going in the same direction. So any increase in the price per ton of cement, as for example the increase in the cost of pollution, will be divided almost equally between the producer and consumer but is more important here to point out that the producer will bear a little bit more than the consumer and that is according the result of elasticity in Table (6-6).

This result supports the scenarios outlined in Table (6-2) in chapter six.

Based on this analysis, it can be recommended to the producer to apply the economic environmental policy, as they will not be bearing the costs of pollution only by themselves as the cost will be shared with the consumer almost equally.

7.3. Estimating the Marginal cost of cement production in the Libda Cement Factory

The production function and the emission function will be estimated followed by an estimation of the environmental cost for this factory, and then the elasticity of demand price and the elasticity of supply price will be calculated to identify who will bear the largest environmental burden in the Libda Cement Factory.

7.3.1. Estimating the production function of cement industry in the Libda Cement Factory.

Table (7-7) Main variables for measurement of the production function and the pollution function in the Libda Cement Factory, 1988-2008 (Libyan Dinars.).

Year	RM_2	D_2	CP_{2LD}	$TechC_2$	MP_{2LD}
1988	272,449	1,224,924	6,030,840	746,417	814,163.4
1989	716,878	1,301,437	6,407,550	1,214,705	865,019.3
1990	446,522	2,369,470	13,074,250	1,889,604	1,765,023.8
1991	438,710	2,705,605	12,657,925	1,614,924	1,708,819.9
1992	416,884	3,303,651	16,201,765	1,092,983	2,187,238.3
1993	446,695	4,671,011	17,789,695	90,928	2,401,608.8
1994	265,828	2,796,040	13,368,088	559,471	1,804,691.9
1995	295,706	2,112,086	8,758,772	401,849	1,182,434.2
1996	268,731	2,509,368	13,525,313	591,069	1,825,917.3
1997	789,028	3,039,852	13,857,606	4,391,295	1,870,776.8
1998	965,906	2,791,836	10,037,034	4,060,440	1,354,999.6
1999	1,086,576	2,876,426	11,286,545	4,646,542	1,523,683.6
2000	1,153,427	2,893,966	16,495,290	5,131,580	2,226,864.2
2001	2,091,809	1,673,708	21,420,000	4,029,753	2891,700
2002	798,784	1,409,242	19,160,218	5,002,924	2,586,629.4
2003	1,288,358	2,140,521	32,582,453	4,855,659	4,398,631.2
2004	1,322,440	1,670,924	33,742,800	4,431,512	4,555,278
2005	1,018,123	13,049,638	34,843,750	5,262,635	4,703,906.3
2006	1,550,947	13,118,732	45,663,750	5,388,325	6,164,606.3
2007	1,744,238	13,689,478	53,731,500	5,342,863	7,253,752.5
2008	1,931,921	12,726,390	54,657,750	6,978,373	8,141,63.4

Source: Department of Budgets, 1988-2008c; Department of Statistics, 1988-2008b; the Libda Cement Factory, 1988-2008; the Libdeh Cement Factory, 2009a; the Libdeh Cement Factory, 2009b; the Libdeh Cement Factory, 2009c; the Libdeh Cement Factory, 2009d; the Libdeh Cement Factory, 2009e; the Libdeh Cement Factory, 2009f; the Libdeh Cement Factory, 2009g.

Notes:	1-All the figures in this table are in Libyan Dinars and are stated in real terms having been adjusted by reference to the Libyan Price Index to avoid the impact of economic inflation or deflation. 2-All the data in above table is Stationary Time Series and for more information see Appendix seven.

The production function of the Libda Cement Factory could be considered as the function of two main factors:

$$CP_{2LD} = CP\left(RM_{2}, D_{2}\right)$$

$$CP_{2LD} = \alpha_{0} + \alpha_{2} RM_{2} + \alpha_{2} D_{2} + U$$

Where:

CP_{2LD} The production quantity of cement (per ton per year) in the Libda Ceme Factory.

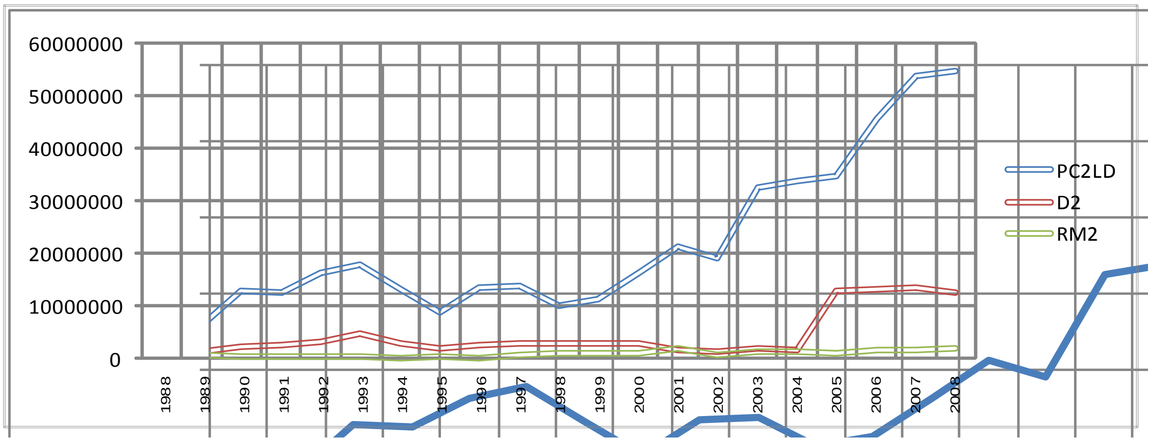
RM_{2} The raw material used in cement production in the Libda Cement Factory.

D_{2} Other inputs as equipment, machinery and other means, which can expressed by the use of capital in the Libda Cement Factory.

By using the statistical data on the variables of the function during the period between 1988-2008 which is illustrated in the following table:

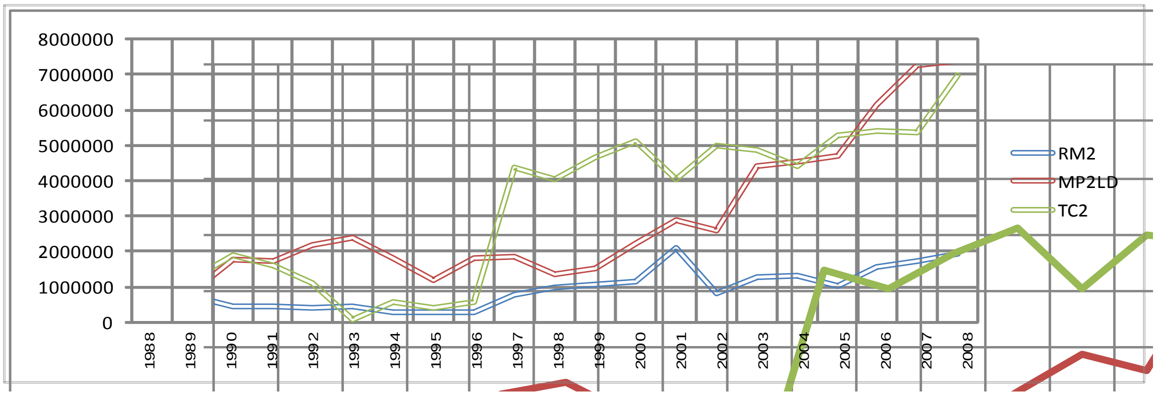
It can be noted that all the variables during the period of study are increasing steadily. This is due to the increase in the domestic market demand and the success of this industry in Libya and the increase in the number and users. But in 2005 a quite unusual increase is noted due to reasons related to re-evaluation of the factory assets by the Libyan government. This is illustrated in the following graphs.

Figure (7-4) the relationship between the production quantity, raw material and capital, 1988-2008.



Source: Author (2009)

Figure (7-5) The relationship between the emission amount, raw material and the technology cost, 1988-2008.



Source: Author (2009)

From the previous graphs it is noted that the variables which have been taken in this study are increasing and non-linear, so by using the statistical data of the variables of the function during the period between 1988-2008 the following result were achieved:

Table (7-8)	**The results of the production function in the Libda Cement Function during 1998-2008.**

Dependent Variable	**Independent Variable**		
CP_{2LD}	**Constant**	**RM_2**	**D_2**
Coefficient	1926851	11.31691	2.086649
T-test	0.717244	3.912750	5.528143
Significant	0.4824	0.0010	0.0000
R square=0.84	Adjusted R Square=0.82	F-test=46.33897 Significant=0.0000	D.W=1.77
So b_1=11.31691, b_2=-2.086649			

7.3.1. The Statistical Analysis

From the previous table it could be concluded that the independent variables were significant at 5% (P<5%) according to the T-test. However, even when increasing of the error level or the significant level at level equal to 1% (P≤ 0.01) the independent variables become significant.

While the limitation factor R Square value is 0.84 and the Adjusted R Square value is 0.82. This means that the independent variables (RM_1, D_2) are able to explain 0.84 of the changes in the production quantity of the cement of the Libda Cement Factory while the remaining changes are attributed to other factors.

The variance analysis helps in determining the explanatory power of the whole module through the F-test as seen in table (7-8), the F-test value is 46.33897 with a high significant level at 1%, which confirms the high explanatory power for the cement production function in the Libda Cement Factory.

7.3.1.2. The Economic Analysis

According to the logic of the economic theory; the supply quantity (the cement production quantity) of any commodity is related by a direct correlation with the production quantity, so the raw material for any commodity has this relationship with its production quantity as well, and the capital variable is also related by a direct correlation with the production quantity (the production quantity of cement has this relationship as well). By viewing table (76-8) it can be noted that the raw material and production have a direct or positive correlation with the cement production quantity, and this agrees with economic theory. Also, the capital variable has a positive correlation with the production quantity of cement (supply quantity).

The coefficients of raw material of cement production equals 11.31691 and this is consistent with the economic theory, which means that any increase in raw material by one Libyan Dinar would lead to an increase the production quantity of the cement by 11.31691 LD. On other hand, any increase in capital by one Libyan Dinar will lead to an increase of production quantity by 2.086649 LD.

7.3.2. Estimating the Cost of pollution control functions of the cement production in the Libda Cement Factory

The emission amounts at the Libda cement Factory could be considered as the function of two main factors as follows:

$$MP_{2LD} = MP\left(RM_{2}, TechC_{2}\right)$$

$$MP_{2LD} = \beta_0 + \beta_1 RM_2 + \beta_2 TechC_2 + U$$

Where:

MP_{2LD}	Emission amount from the cement production in the Libda Cement Factory.
RM_2	The raw material which is used in the cement production in the Libda Cement Factory.
$TechC_2$	The Technology cost which controls the pollution in the Libda Cement Factory.

At the beginning of the analysis it was expected that the analysis this kind of functions would give non-linear data, so the researcher expected it would follow the way of Cobb Douglas function in data analysis. However, when starting the analysis the researcher was confronted with several statistical difficulties in the results, and was therefore forced to use a number of mathematical ways to solve these problems. The results shown in the following table represent the best results achieved:

Table (7-9) The results of the emission function in the Libda Cement Function, 1993-2008.

Dependent Variable	**Independent Variable**		
MP_{2LD}	**Constant**	**RM_2**	**$TechC_2$**
Coefficient	40692.996	0.165	-0.38
T-test	2.891	3.440	-3.458
Significant	0.016	0.006	0.006
R square=0.69	Adjusted R Square=0.54	F-test=4.457 Significant=0.021	D.W=2.041
So C_1=0.165, C_2=-0.38			

7.3.2.1. The Statistical Analysis

From the previous table it can be concluded that the independent variables (RM_2,$TechC_2$) were significant from a statistical aspect and according to the T-test at a significant level 5% ($P<0.05$).

Also Table (7-9) illustrates that the R Square value is 0.69 and the adjusted R Square value is 0.54 roughly, which means that the independent variables (RM_2, $TechC_2$) are able to explain 0.54 of the changes in the pollution amount in the Libda Cement Factory, and the remainder are attributed to other factors (here it is expected that the lack of some data and the change of the administration system are among the reasons for the low value of the Adjusted R Square).

Table (7-9) illustrates that the F value is 4.957 with a significant level value of 0.021, which means that it is significant at 5 %. This confirms the explanatory power for the model of the emission function from a statistical aspect.

7.3.2.2. The Economic Analysis

According to the logic of the economic and technical aspects, the rate of emission is related by a positive or direct correlation with the raw material, so the more the raw material used in cement production the greater the increase in the emission rate, and the opposite is true.

It could be noted from Table (7-9) that the raw material coefficient for the cement production value is 0.165, and this agrees with the economic and technical logic, which means that for every increase in the raw material by one Libyan Dinar or unit there will be an increase of the emission amount by 0.165 LD.

With regard to the technology cost which controls pollution, Table (7-9) illustrates the technology cost coefficient which its value is -0.38, and this agrees with the logic of the economic and technical aspects, which means that every increase in the technology cost ($TechC_2$) by one Libyan Dinar will lead to a decrease in the pollutant emission by 0.38 LD.

7.3.3. Estimating the environmental cost rate in the Libda Cement Factory

By using the estimated values of the coefficients included in the marginal cost equation, it has been found that the results of the coefficients as the follows:

MP_{2LDRM}=0.165, $MP_{2LDTechC}$=-0.38, CP_{2LDRM}=11.31691

Where the marginal cost before determining the cost of emission or pollution is as follows:

$$MC_0 = \frac{89.5}{11.31691} = 7.908519198$$

After determining the cost of pollution or emission and giving different values for P_1tc the value of the marginal cost could be calculated after applying the cost of pollution as follows:

$$MC_1 = \lambda_1 = \frac{P - P_{2TechC}\dfrac{MP_{2LDRM}}{MP_{2LDTechC}}}{CP_{2LDRM}}$$

By putting P_{2TechC}=0.50 LD

$$MC_1 = \frac{89.5 - 0.5\dfrac{0.165}{-0.38}}{11.31691} = 7.927703345$$

So any increase of the environmental cost by 0.50 Libyan Dinar per ton of cement in the Libda Cement Factory will lead to an increase in the marginal cost by 0.01918 Libyan Dinar.

If putting P_{2TechC}=1

$$MC_1 = \frac{89.5 - 1\dfrac{1.165}{-0.38}}{11.21691} = 8.179422605$$

As can be seen, any increase in the environmental cost by one Libyan Dinar per ton of cement production will lead to an increase in the marginal cost by 0.2709 Libyan Dinar in the Libda Cement Factory.

7.3.4. The analysis of the demand price elasticity and the supply price elasticity for cement production in the Libda Cement factory

The following table addresses the important changes which happened with the cement price of the Libda Cement Factory as well as what happened with the cement production and the cement sales during the period between 1988-2008, where on the basis of these data the elasticity of demand price and the elasticity of supply price for cement production in the Libda Cement factory will be calculated.

Table (7-10) The elasticity of demand price and supply price for cement production in the Libda Cement Factory.

Year	Cement price	Sales of cement	Quanitity of the cement production	Elasticity of demand price		Elasticity of demand price		Distribution of environmental burden
				Value	State	Value	State	
1988	14.5	438760	415920	-	-	-	-	
1989	14.5	405900	441900	-	-	-	-	-
1990	17.5	673570	747100	2.644652	Elastic	2.737987	Elastic	C≥P
1991	17.5	697310	723310	-	-	-	-	-
1992	20.5	770330	790330	0.630209	Inelastic	0.560847	Inelastic	P≥C
1993	20.5	847790	867790	-	-	-	-	-
1994	22.37	578590	597590	-4.32665	Elastic	-4.22714	Elastic	P≥C
1995	22.37	366110	391541	-	-	-	-	-
1996	31.5	417470	429375	0.386739	Inelastic	0.271932	Inelastic	P≥C
1997	31.5	403750	439924	-	-	-	-	-
1998	31.5	314890	318636	-	-	-	-	-
1999	31.5	539200	358303	-	-	-	-	-
2000	31.5	518262	523660	-	-	-	-	-
2001	31.5	675254	680000	-	-	-	-	-
2002	38.5	500115	497668	-1.49008	Elastic	-1.54825	Elastic	C≥P
2003	58.5	536827	556965	0.17171	Inelastic	0.272692	Inelastic	C≥P
2004	58.5	575048	576800	-	-	-	-	-
2005	62.5	54357	557500	-25.0251	Elastic	-0.5147	Inelastic	P>C
2006	74.25	612198	615000	9.740111	Elastic	0.570748	Inelastic	P>C
2007	79.25	671250	678000	1.41252	Elastic	1.495824	Elastic	C≥P
2008	89.75	607818	609000	-0.7982	Inelastic	-0.86291	Elastic	C≥P

Source: Author (2009)

After analysis of the demand price elasticity and the supply price elasticity for cement production in the Libda Cement Factory, it was found that the response of the consumer and the producer for the change which happened with the price of the cement production per ton is going in the same direction. So any increase in the cost of cement production as the cost of pollution or tax , will be divided between the consumer and the producer almost equally.

But it is important to point out here that there has been some small variation for some years about who will bear more cost, so it could be noted that in some years the consumer has borne more, as in the years 1990, 2002, 2003, 2007 and 2008, and in other years the producer has borne more as in the years 1992, 1994, 1996, 2005 and 2006. This is indicated in Table (7-6) about the environmental cost distribution that has been done by the researcher. But in general these small differences in the elasticity of demand price and supply price for cement production in the Libda Cement Factory are not enough to interest the decision makers in the cement industry.

Accordingly, the producer or decision makers in the Libda Cement Factory could be advised to apply an environmental policy since the costs will not borne by them alone but will be shared with the consumer almost equally.

7.4. Estimating the marginal cost of the cement production in the Suk El-Khamis Cement Factories

The production function and emission function of the Suk El-Khamis Cement Factories will be estimated, as well as the rate of the environmental cost for these factories. After that the elasticity of the demand price and the elasticity of the supply price will be calculated to determine who will bear the largest amount of environmental cost.

7.4.1.Estimating the production function of cement production in the Suk El-Khamis Cement Factories

The production function of the Suk El-Khamis Cement Factories could be considered as a function of two main factors as follows:

$$CP_{3LD} = CP\left(RM_{3}, D_{3}\right)$$

$$CP_{3LD} = \alpha_0 + \alpha_1 RM_3 + \alpha_2 D_3 + U$$

Where:

CP_{3LD}	The production quantity of the cement (per ton per year) in the Suk El-Khamis Cement Factories.
RM_3	The raw material used in cement production in the Suk El-Khamis Ceme Factories.
D_3	Other inputs as equipment, machinery and other means, which can be expressed by the use of capital in the Suk El-Khamis Cement Factories.

By using the statistical data on the variables of the function during the period between 1988-2008 which are illustrated in the following table:

Table (7-11) Main variables for measurement of the production function and the pollution function in the Suk El-Khamis Cement Factories during 1988-2008 (Libyan Dinars.).

Year	RM_3	D_3	CP_{3LD}	$TechC_3$	MP_{3LD}
1988	439,225	4,825,837	10,582,550	3,555,902	1,428,644.3
1989	482,096	2,719,011	13,386,893	1,646,727	1,807,230.6
1990	2,235,794	2,981,277	16,450,070	4,051,485	2,220,759.5
1991	587,237	1,298,774	15,431,745	1,588,234	2,083,285.6
1992	635,480	1,298,774	17,077,792	1,631,766	2,305,501.9
1993	450,378	4,709,524	17,936,373	914,408	2,421,410.4
1994	274,932	2,103,088	19,728,864	1,692,398	2,663,396.6
1995	433,401	2,901,791	12,910,644	2,020,846	1,742,936.9
1996	334,902	2,116,625	16,346,579	2,146,070	2,206,788.2
1997	1,548,644	1,473,778	18,242,406	2,754,910	2,462,724.8
1998	979,703	1,099,650	19,387,148	20,352,479	2,617,265
1999	628,055	1,262,845	17,226,563	2,841,213	2,325,586
2000	721,084	1,430,357	19,420,191	2,882,180	2,621,725.8
2001	470,015	1,315,225	15,953,396	2,364,725	2,153,708.5
2002	900,271	1,402,652	22,439,764	3,145,576	3,029,368.1
2003	1,026,536	1,492,481	31,885,191	2,720,442	4,304,500.8
2004	1,148,292	2,206,916	48,180,483	3,724,871	6,504,365.2
2005	1,191,271	9,581,421	51,440,063	7,670,418	6,944,408.5
2006	1,319,040	10,094,496	58,296,868	4,053,222	7,870,077.2
2007	1,552,303	11,048,474	50,894,826	7,476,647	6,870,801.51
2008	2,006,406	10,835,140	79,624,495	12,050,367	1,428,644.3

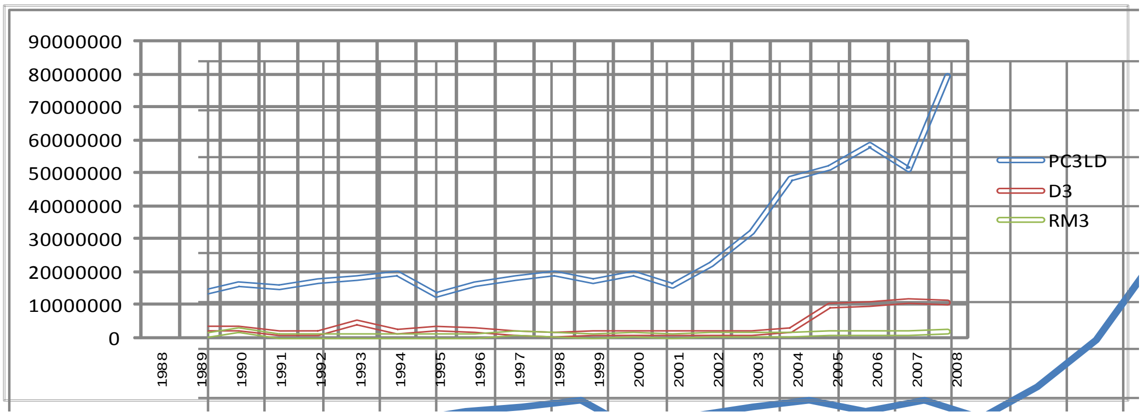
Source: Department of budgets,1988-2008d; Department of Information Systems in the Ahlia Cement Company and the Suk El-Khamis Factories, 1988-2008; Department of Information Systems in The National Cement Company, 1979. Department of Statistics, 1988-2008b; the Suk El-Khamis Cement Factories, 1988-2008; the Suk El-Khamis Cement Factory, 2009a; the Suk El-Khamis Cement Factory, 2009b; the Suk El-Khamis Cement Factory, 2009c; the Suk El-Khamis Cement Factory, 2009d; the Suk El-Khamis Cement Factory, 2009e; the Suk El-Khamis Cement Factory, 2009f; the Suk El-Khamis Cement Factory, 2009f.

Notes: 1-All the figures in this table are in Libyan Dinars and are stated in real terms having been adjusted by reference to the Libyan Price Index to avoid the impact of economic inflation or deflation.
2-All the data in above table is Stationary Time Series and for more information see Appendix eight.

It could be noted from the previous table that the production variables (CP_{3LD}, RM_3 and D_3) are increasing steadily but with a more significant increase over the last four years; the reason for this has to do with the re-evaluation of the factories assets and the change in the administration system in this factory as well.

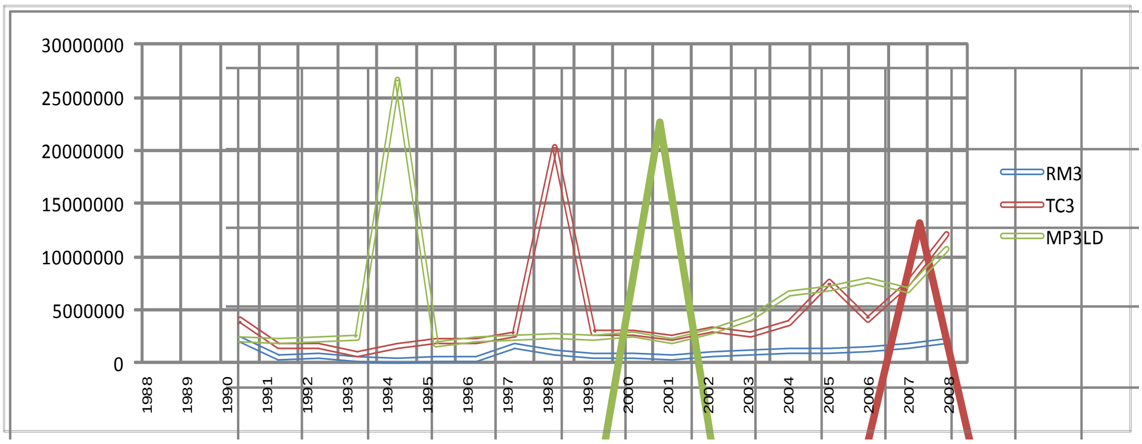
The data of emission amount has gone through many fluctuations due to some foul-up with some of the factory's machines, not using filters at some times, and the cessation of some production lines in the factory.

Figure (7-6) The relationship between the production quantity, raw material and capital of the Suk El-Khamis Cement Factories,1988-2008.



Source: Author (2009)

The figure (7-7) The relationship between the emission amount, raw material and technology cost of the Suk El-Khamis Cement Factories, 1988-2008.



Source: Author (2009)

From the previous graphs it can be noted that the variables are non-linear. In Figure (7-6) it is found that the data is increasing significantly, especially in recent years. In figure (7-7) it is noted that the data has 'spiked' twice and this is due to stopping the production lines and not using filters during some times which resulted in fluctuations in the rate of pollutant emissions.

Table (7-12) The results of the production function for the Suk El-Khamis Cement Factories, 1991-2008.

Dependent Variable	**Independent Variable**		
CP_{3LD}	**Constant**	**RM_3**	**D_3**
Coefficient	4840540	9.890827	3.576237
T-test	1.049038	2.019333	4.577053
Significant	0.3080	0.0586	0.0002
R square=0.71	Adjusted R Square=0.70	F-test=22.48616 Significant=0.0000	D.W=1.45
So b_1=9.5690827, b_2=3.576237			

7.4.1.1. The Statistical Analysis

From the previous table it could be concluded that the independent variables were significant from the statistical aspect at 1% ($P<0.01$) and that is according to the T-test result.

It is also noted that the resulting limitation factor R Square value is 0.71, and the Adjusted R Square value is 0.70, which means that the independent variables (RM_3, D_3) are able to explain 0.70 of the changes in the production quantity of cement in the Suk El-Khamis Cement Factories, while the remainder is attributed to other factors.

As for the variance analysis, which helps in determining the explanatory power of the whole model though F-test, it can be seen in table (7-12) that the F-test value is 22.48616 with high significant level at 5% up to ($P<0.000$), which confirms the high explanatory power for the cement production function in the Suk El-Khamis Cement Factories from a statistical aspect.

7.4.1.2. The Economic Analysis

According to the logic of the economic theory; the supply quantity (The cement production quantity) of any commodity is related by a direct or positive correlation with the production quantity, so the raw material for any commodity has this same relationship with its production quantity as well, and the capital variable is also related by a direct correlation with the production quantity. So the results of production function with the Suk El-Khamis Cement Factories agrees with the economic theory and gives the same results.

The coefficient of raw material (RM_3) value is 9.890827 and this is consistent with the economic theory (In terms of reference to the positive factor), which means that any increase in the raw material by one Libyan Dinar would lead to an increase in the production quantity of the cement by 9.890827 LD. With regard to the capital variable; it agreed with economic theory where it was equal to 3.576237, which means that any increase in the capital variable by one Libyan Dinar would lead to an increase the production quantity of cement by 3.576237 LD.

7.4.2. Estimating the cost of pollution control function of the cement production in the Suk El-Khamis Cement Factories

The emission amount in the Suk El-Khamis Cement Factories could be considered as a function of two main factors:

$$MP_{3LD} = MP\left(RM_3, TechC_3\right)$$

$$MP_{3LD} = \beta_0 + \beta_1 RM_3 + \beta_2 TechC_3 + U$$

Where:

MP_{3LD}	The emission amount from the cement production in the Suk El-Khamis Cement Factories.
RM_3	The raw material used in the cement production in the Suk El-Khan Cement Factories.
$TechC_3$	The Technology cost which controls the pollution in the Suk El-Khan Cement Factories.

When carrying out the data analysis of the Suk El-Khamis Cement Factories via the emission function and during the period between 1988-2008, the following results were reached as follows:

Table (7-13) **The results of the emission function in the Suk El-Khamis Cement Factories, 1997-2008.**

Dependent Variable	**Independent Variable**		
MP_{3LD}	**Constant**	**RM_3**	**$TechC_3$**
Coefficient	-146708	6.690	-0.112
T-test	-1.808	8.781	-1.875
Significant	0.108	0.000	0.098
R square=0.910	Adjusted R Square=0.887	F-test=40.291 Significant=0.000	D.W=1.970
So C_1=6.690, C_2=-0.112			

7.4.2.1. The Statistical Analysis

From the previous table it can be concluded that the independent variables (RM_3,$TechC_3$) were significant from a statistical aspect and according to the T-test at significance level 5% ($P<0.05$), but the constant coefficient is not significant at 5% even if the error value is increased to 10%, however this does not affect our function.

Also Table (7-13) illustrates that the limitation factor R Square value is 0.910, and the adjuster R Square value is 0.887, which means that the independent variables (RM_3, $TechC_3$) are able to explain 0.887 of the changes in the pollution amount in the Suk El-Khamis Cement Factories, while the remainder is attributed to other factors.

Table (7-13) illustrates that the F value is 40.291 with a high significance level which approaching 0.000, which means that it is significant at 5%, this also confirms the high explanatory power for the model of the emission function from a statistical aspect.

7.4.2.2.The Economic Analysis

According to the logic of economic and technical aspects; the rate of emission is related by a positive or direct correlation with the raw material. So the more the raw material used in cement production, the more the increase in the emission rate, and the opposite is true.

So it could be noted from Table (7-13) that the raw material coefficient for the cement production value is 6.960, and this agrees with the economic and technical logic, which means that for every increase in the raw material cost by one Libyan Dinar per unit there will be an increase in the emission amount by 6.690 LD.

With regard to the technology cost which controls pollution; Table (7-13) illustrates the technology cost coefficient which its value is -0.112. This agrees with the logic of the economic and technical aspects, which means that for every increase in the technology cost ($TechC_3$) by one Libyan Dinar there will be a decrease in the pollutant emission by 0.112 LD.

7.4.3. Estimating the environmental cost rate in the Suk El-Khamis Cement Factories

By using the estimated values of the coefficients which are included in the marginal cost equation, it has been found that the result of the coefficients are as follows:

MP_{3LDRM}=6.695, $MP_{3LDTechC}$=-0.112, CP_{3LDRM}= 9.890827

Where the marginal cost before determining the cost of emission or pollution is as follows:

$$MC_0 = \frac{89.5}{9.890827} = 9.048788337$$

After determining the cost of pollution or emission and giving different values for P_{3TechC}, the cost of pollution could be applied as follows:

$$MC_1 = \lambda_1 = \frac{P - P_{3TechC}\frac{MP_{3LDRM}}{MP_{3LDTechC}}}{CP_{3LDRM}}$$

By putting P_{3TechC}=0.5 LD

$$MC_1 = \frac{89.5 - 0.5\frac{6.690}{-0.112}}{9.890827} = 12.06836106$$

So for any increase in the environmental cost by 0.5 Libyan Dinar per ton of cement in the Suk El-Khamis Cement Factories, there will be an increase in the marginal cost by 3.01957 Libyan Dinar.

By putting P_{3TechC}=1 LD

$$MC_1 = \frac{89.5 - 1\frac{6.690}{-0.112}}{9.890827} = 15.08793379$$

So for any increase in the environmental cost by one Libyan Dinar per ton of cement in the Suk El-Khamis Cement Factories, there will be an increase in the marginal cost by 6.039145 Libyan Dinar.

7.4.4. The analysis of demand price elasticity and supply price elasticity for cement production in the Suk El-Khamis Cement Factories.

The following table addresses the important changes which happened to the cement price in the Suk El-Khamis Cement Factories. The elasticity of the demand price and the elasticity of the supply price for cement production and cement sales in the Suk El-Khamis Cement Factories have been calculated based on the cement production and the cement sales during the period between 1988-2008.

Table (7-14) The elasticity of demand price and supply price for cement production in the Suk El-Khamis Cement Factories, 1988-2008.

Year	Cement price	Sales of cement	Quanitity of the cement production	Elasticity of demand price		Elasticity of demand price		Distribution of environmental burden
				Value	State	Value	State	
1988	14.5	739764	729831	-	-	-	-	-
1989	14.5	926966	923234	-	-	-	-	-
1990	17.5	932387	940004	0.031099	Inelastic	0.096005	Inelastic	C≥P
1991	17.5	879366	881814	-	-	-	-	-
1992	20.5	812463	833063	-0.5009	Inelastic	-0.36009	Inelastic	P≥C
1993	20.5	879434	874945	-	-	-	-	-
1994	22.37	900449	881934	0.270676	Inelastic	0.091198	Inelastic	P≥C
1995	22.37	573246	577141	-	-	-	-	-
1996	31.5	509950	518939	-0.34478	Inelastic	-0.31331	Inelastic	P≥C
1997	31.5	582169	579124	-	-	-	-	-
1998	31.5	616060	615465	-	-	-	-	-
1999	31.5	533075	546875	-	-	-	-	-
2000	31.5	564389	616514	-	-	-	-	-
2001	31.5	501066	506457	-	-	-	-	-
2002	38.5	575905	582851	-	-	-	-	-
2003	58.5	523925	545046	0.69449	Inelastic	0.701308	Inelastic	C≥P
2004	58.5	801030	823598	-0.22922	Inelastic	-0.16256	Inelastic	P≥C
2005	62.5	775291	823041	-	-	-	-	-
2006	74.25	780728	785143	-0.49394	Inelastic	-0.01023	Inelastic	P≥C
2007	79.25	618013	642206	0.040666	Inelastic	-0.27426	Inelastic	C≥P
2008	89.75	877811	887181	-3.57132	Elastic	-3.07435	Elastic	P≥C

Source: Author (2009)

After analysis of the demand price elasticity and the supply price elasticity for cement production and cement sales in the Suk El-Khamis Cement Factories; the response of the consumer and producer for the changes that happen in the price of the cement production and the sales per ton were found to be going in the same direction. So any increase in the price of cement as tax or environmental cost…etc will be shared between the producer and the consumer approximately equally.

It should be pointed out here that there is some variance about who should bear the environmental cost, it is noted that in some years the consumer had borne a little bit more of the cost than the producer as what happened in the years 1990, 2002 and 2006, and in other years the producer had borne a little bit more of the cost than the consumer as in 1992, 1994, 1996, 2003, 2005, 2007 and 2008. This is referred to in table (6-6) which was prepared by the researcher about the environmental cost distribution or tax, but in general these small differences between the elasticity of demand price and the elasticity of the supply price of cement production in the Suk El-Khamis Cement Factories are not significant or important for the decision makers in the cement industry.

Thus, for a third time the producer or the decision makers in the Suk El-Khamis Cement Factories could be advised to apply an environmental policy because they will not have to bear the cost of pollution alone but the cost will be shared almost equally with the consumer.

7.5. Estimating the marginal cost of cement production in the El-Mergheb Cement Factory

Here, the production function and the emission function for the El-Mergheb Cement Factory will be estimated. The rate of the environmental cost for this factory will be estimated followed by a calculation of the elasticity of the demand price and the elasticity of the supply price to determine who will bear more of the environmental cost.

7.5.1. Estimating the production function of cement production in the El-Mergheb Cement Factory

The production function of the El-Mergheb Cement Factory could be considered as a function of two main factors as follows:

$$CP_{4LD} = CP\left(RM_{4,} D_4\right)$$

$$CP_{4LD} = \alpha_0 + \alpha_1 RM_4 + \alpha_2 D_4 + U$$

Where:

CP_{4LD}	Production quantity of cement (per ton per year) in the El-Mergheb Cement Factory.
RM_4	The raw material used in cement production in the El-Mergheb Cement Facto
D_4	Other inputs as equipment, machinery and other means, which can be expressed by the use of capital in the El-Mergheb Cement Factory.

By using the statistical data on the variables of the function during the period between 1988-2008 which are illustrated it in the following table:

Table (7-15) Main variables for measurement of the production function and the pollution function in the El-Mergheb Cement Factory, 1988-2008 by Dinars.).

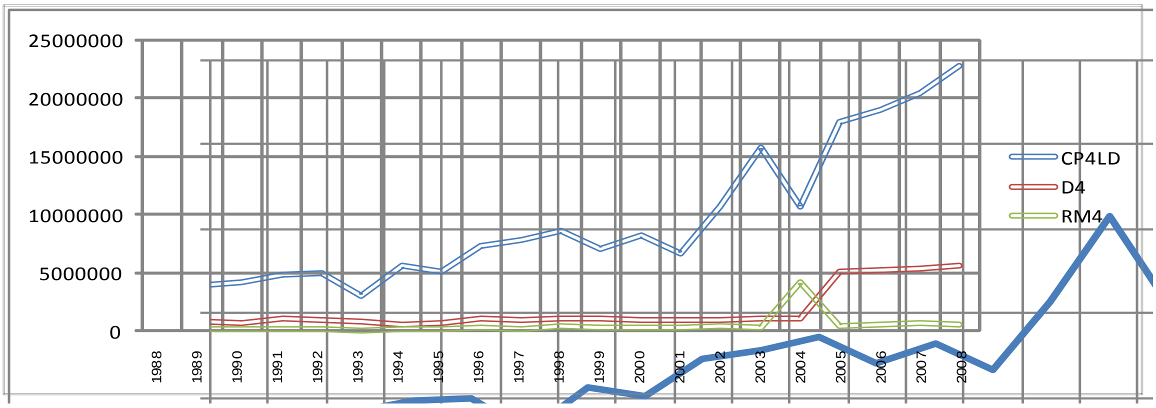
Year	RM_4	D_4	CP_{4LD}	$TechC_4$	MP_{4LD}
1988	164,633	745,362	3,669,747	451,417	495,415.8
1989	142,457	803,453	3,955,760	486,599	534,027.6
1990	135,174	770,401	4,250,908	604,371	573,872.6
1991	168,968	1,042,056	4,875,168	621,983	658,147.7
1992	129,234	1,024,136	5,022,562	338,826	678,045.9
1993	75,536	789,856	3,008,191	1,417,041	406,105.8
1994	123,721	556,879	5,670,482	1,480,343	765,515.0
1995	243,595	760,210	5,161,743	1,584,138	696,835.3
1996	299,566	1,044,926	7,383,380	1,717,867	996,756.3
1997	215,517	927,340	7,901,996	377,936	1,066,769.5
1998	411,486	1,066,751	8,608,635	429,873	1,162,165.7
1999	328,884	1,069,579	7,093,076	424,470	957,565.3
2000	380,852	949,473	8,257,221	363,255	1,114,724.8
2001	355,899	996,857	6,742,323	391,848	910,213.6
2002	444,783	1,003,055	10,686,176	486,902	1,442,633.8
2003	309,579	1,090,580	15,721,407	398,114	2,122,389.9
2004	4,161,380	1,068,283	10,685,844	740,145	1,442,588.9
2005	474,232	5,129,646	17,932,250	790,741	2,420,853.8
2006	565,667	5,263,853	18,978,894	701,820	2,562,150.7
2007	649,471	5,400,385	20,428,510	837,505	2,757,848.9
2008	578,522	5,681,662	22,738,252	667,598	3,069,664.0

Source: Department of Budgets,1988-2008b; Department of Statistics, 1988-2008b; the El-Mergheb Cement Factory, 2009a; the El-Mergheb Cement Factory, 2009b; the El-Mergheb Cement Factory, 2009c; the El-Mergheb Cement Factory, 2009d; the El-Mergheb Cement Factory, 2009e; the El-Mergheb Cement Factory, 2009f and the El-Mergheb Cement Factory, 2009g.

Notes: 1-All the figures in this table are in Libyan Dinars and are stated in real terms having been adjusted by reference to the Libyan Price Index to avoid the impact of economic inflation or deflation.
2-All the data in above table is Stationary Time Series and for more information see Appendix nine.

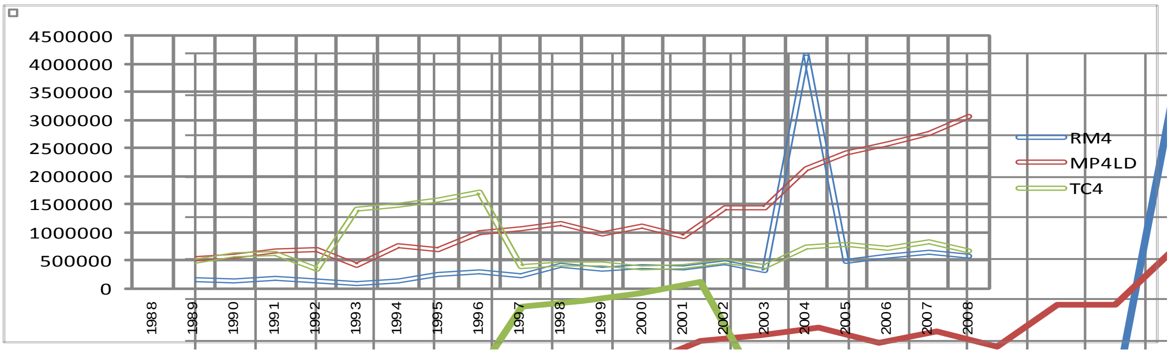
It can be noted that production capacity for this factory is about one third of the other three factories. It could be also noted that the data continues to increase but in the last four years the increase is more significant; this is due to the change in the administration system and the ownership of the factory.

Figure (7-8) The relationship between the production quantity, raw material and capital of the El-Mergheb Cement Factory, 1988-2008.



Source: Author (2009)

Figure (7-9) The relationship between the emission amount, raw material and technology cost of the El-Mergheb Cement Factory, 1988-2008.



Source: Author (2009)

From the previous graphs of the study variables it could be noted that the variables are non-linear, and thus need special treatment to make them less dispersed by using logarithms, where the results became as follows:

Table (7-16)	**The results of the production function in the El-Mergheb Cement Factory, 1991-2008.**

Dependent Variable	**Independent Variable**		
CP_{4LD}	**Constant**	**RM_4**	**D_4**
Coefficient	2.125390	0.281583	0.529159
T-test	3.885426	3.389371	5.517402
Significant	0.0011	0.0033	0.0000
R square=0.81	Adjusted R Square=0.79	F-test=38.31950 Significant=0.0000	D.W=1.89
So b_1=0.281583, b_2=0.529159			

7.5.1.1. The Statistical Analysis

From the previous table it could be concluded that the independent variables were significant in the statistical aspect at 5% ($P<0.05$) and according to the T-test result.

It is also noted that the limitation factor R Square value is 0.81 and the Adjusted R Square value is 0.79 roughly, which means that the independent variables (RM_4, D_4) are able to explain 0.76 of the changes in the production quantity of cement in the El-Mergheb Cement Factory and the remainder is attributed to other factors.

While the variance analysis which helps to determine the explanatory power of the whole model though F-test can be seen in table (6-15), where the F-test value is 38.31950 with high significant level at 5% up to zero ($P<0.05$), which confirms the high explanatory power for the cement production function in the El-Mergheb Cement Factory from a statistical aspect.

7.5.1.2. The Economic Analysis

According to the logic of the economic theory; the supply quantity (the cement production quantity) of any commodity it is related by a direct or positive correlation with the production quantity and this correlation applies to raw materials for any commodity, so the more the raw material used the more the production quantity. This also applies to the capital variable which is related by a direct correlation with the production quantity. So the results of production function in the El-Mergheb Cement Factory agree with the economic theory and has given the same results.

The coefficients of raw material (RM_4) value is 0.281583 and this is consistent with the economic theory, which means that for any increase in the raw material by one Libyan Dinars there will an increase in the production quantity of cement by 0.281583 LD. With regard to the capital variable; this variable agrees with the economic theory as well and value is 0.529159, which means that for any increase in the capital variable by one Libyan Dinar there will be an increase in the production quantity of cement by 0.529159.

7.5.2. Estimating the Cost of pollution control function of cement production in the El-Mergheb Cement Factory.

The emission amount in the El-Mergheb Cement Factory could be considered as a function of two main factors:

$$MP_{4LD} = MP\left(RM_{4}, TechC_{4}\right)$$

Where:

MP_{4LD}	The emission amount from the cement production in the El-Mergheb Cement Factory.
RM_4	The raw material used in the cement production in the El-Mergheb Factory.
$TechC_4$	The Technology cost which controls the pollution in the El-Mergheb Cement Factory.

$$MP_{4LD} = \beta_0 + \beta_1 RM_4 + \beta_2 TechC_4 + U$$

When carrying out the data analysis of the El-Mergheb Cement Factory via the emission function and during the period between 1988-2008 the following results were reached:

Table (7-17)	**The results of the emission function in the El-Mergheb Cement Factory, 1997-2008.**

Dependent Variable	**Independent Variable**		
MP_{4LD}	**Constant**	**RM_4**	**$TechC_4$**
Coefficient	-926085.8	3.640	- 2.601
T-test	-1.710	2.471	- 2.048
Significant	108	0.026	0.059
R square=0.870	Adjusted R Square=0.826	F-test=20.030 Significant=0.000	D.W=1.840
So C_1=3.640, C_2=2.601			

7.5.2.1. The Statistical Analysis

From the previous table it could be concluded that the independent variables (RM_4,$TechC_4$) were significant according to T-test at significant level is 5% ($P<0.05$), but the constant coefficient is not significant at 5% and 10%, but this however should not be a problem.

Also Table (7-16) illustrates that the limitation factor R Square value is 0.87 and the adjuster R Square value is 0.826, which means that the independent variables (RM_4, $TechC_4$) are able to explain 0.826 of the changes in the pollution amount in the El-Mergheb Cement Factory, while the remainder of changes are attributed to other factors.

Table (7-16) illustrates that the F value is 20.030 with high significant level is 0.000, which means that it is significant at 5 % and also confirms the high explanatory power of the emission function from a statistical aspect.

7.5.2.2. The economic Analysis

According to the logic of the economic and technical aspects; the rate of emission is related by a positive or direct correlation with the raw material. So the more the raw material used in cement production the more the increase of the emission rate, and the opposite is true.

It could be noted from Table (7-16) that the raw material coefficient for cement production value is 3.640 and this agrees with the logic of the economic and technical aspects, which means that every increase in the raw material by one Libyan Dinar or per unit will lead to an increase of the emission amount by 3.640 per unit.

With regard to the technology cost which controls pollution, Table (7-16) illustrates that the technology cost coefficient value is -2.601 and this agrees with the economic and technical logic.

7.5.3. Estimating the environmental cost rate in the Mergheb Cement Factory

By using the estimated values of the coefficients which were included in the marginal cost equation it was found that the results of the coefficients are as follows:

MP_{4LDRM}=, $MP_{4LDTechC}$=-.601 (For the same reasons which have been noted in the economic analysis, the sign is changed by the researcher), CP_{4LDRM}=0.281583

Where the marginal cost before determining the cost of emission or pollution is as follows:

$$MC_0 = \frac{89.5}{0.281523} = 317.8458927$$

After determining the cost of pollution or emission and giving different values for P_{4TechC} the cost of pollution can be determined as follows:

$$MC_1 = \lambda_1 = \frac{P - P_{4TechC}\dfrac{MP_{4LDRM}}{MP_{4LDTechC}}}{CP_{4LDRM}}$$

By putting P_{4TechC}=0.5 LD

$$MC_1 = \frac{89.5 - 0.5 \frac{3.640}{-2.601}}{0.281583} = 320.3308824$$

So for any increase in the environmental cost by 0.50 Libyan Dinar per ton of cement in the Mergheb Cement Factory there will be an increase in the marginal cost by 2.4850 Libyan Dinar.

When substituting P_{4TechC}=1

$$MC_1 = \frac{89.5 - 1 \frac{3.640}{-2.601}}{0.281523} = 322.8158722$$

As noted, increasing the environmental cost by one Libyan Dinar per ton of cement production will lead to increasing the marginal cost by 4.9650 Libyan Dinar in the Mergheb Cement Factory.

7.5.4. The analysis of the demand price elasticity and the supply price elasticity for cement production in the Mergheb Cement Factory.

The following table addresses the important changes which happened to the cement price of the Mergheb Cement Factory, as well as the changes which happened to the cement production and the cement sales during the period between 1988-2008. Based on these data the elasticity of the demand price and the elasticity of the supply price of cement production and cement sales for the Mergheb Cement Factory will be calculated.

Table (7-18) The elasticity of demand price and supply price for cement production in the Mergheb Cement Factory, 1988-2008.

Year	Cement price	Sales of cement	Quanitity of the cement production	Elasticity of demand price		Elasticity of demand price		Distribution of environmental burden
				Value	State	Value	State	
1988	14.5	252147	253086	-	-	-	-	-
1989	14.5	267413	272811	-	-	-	-	-
1990	17.5	250585	242909	-0.34652	Inelastic	-0.61846	Inelastic	C>P
1991	17.5	260540	278581					
1992	20.5	256404	245003	-0.10134	Inelastic	-0.81233	Inelastic	C>P
1993	20.5	147427	146741					
1994	22.37	247193	253486	5.795826	Elastic	6.114389	Elastic	C≥P
1995	22.37	228387	230744					
1996	31.5	234393	234393	0.076575	Inelastic	0.049288	Inelastic	P≥C
1997	31.5	264076	250857	-	-	-	-	-
1998	31.5	273884	273290	-	-	-	-	-
1999	31.5	225714	225177	-	-	-	-	-
2000	31.5	263503	262134	-	-	-	-	-
2001	31.5	214046	214042	-	-	-	-	-
2002	38.5	277591	277563	1.292519	Elastic	1.292115	Elastic	C=P
2003	58.5	268745	268742	-0.07853	Inelastic	-0.07831	Inelastic	P=C
2004	58.5	183805	182664	-	-	-	-	-
2005	62.5	285670	286916	6.563536	Elastic	6.715838	Elastic	C≥P
2006	74.25	255123	255608	-0.6574	Inelastic	-0.67162	Inelastic	C≥P
2007	79.25	259549	257773	0.264009	Inelastic	0.129466	Inelastic	P≥C
2008	89.75	252158	253351	-0.23248	Inelastic	-0.13925	Inelastic	P≥C

Source: Author (2009)

After carrying out the analysis of the demand price elasticity and the supply price elasticity for cement production and cement sales in the Mergheb Cement Factory it could be noted that the producer responses and the consumer responses to the changes which happened in the cement price per ton of the cement production and the cement sales are going in the same direction. So any increase in the price of cement per ton as tax or environmental cost …etc, will be shared between the producer and the consumer almost equally.

But it should be pointed out here that some small difference exist about who had borne the cost of pollution or the environmental cost; where it is noted that in some years the consumer had borne a little bit more of the cost than the producer as in the years 1990, 1992, 1994, 2005 and 2006, and in other years the producer had bone a little bit more of the cost as in the years 1996, 2007 and 2008, while in other years the cost had been shared equally between the producer and the consumer as in the years 2002 and 2003. This of course was illustrated in Table (6-6) about the environmental cost or tax distribution.

But in general these small differences in the elasticity of demand price and supply price of cement production in the Mergheb Cement Factory are not large enough to draw any attention to them to the decision makers in cement industry. Thus, it could be recommended for the producers or decision makers in the Mergheb Cement Factory also to apply an economic environmental policy because the cost will not be borne by themselves alone but will be shared with the consumer almost equally.

6.6. Estimating the marginal cost of the cement production in the Ahlia Cement Company

The Ahlia Cement Company was also referred to in chapter five where this company includes all the factories that have been addressed in this chapter, and so when carrying out data analysis of the Ahlia Cement Company this would ultimately mean an analysis of all the previous factories together (the Zileten Factory, the Libda Factory, the Suk El-Khamis Factories and the El-Mergheb Factory). The objective of this analysis is that as a result of the change in the administration and financial system that took place in 2005 part of the company became owned by the Libyan government, while the other part was owned by owners of shares and bonds. Another reason for analysis of this company is that the researcher wanted to thoroughly analyse and conclude about the impact of all the factories together as one company on the environmental cost, and to conclude as well who would bear such a cost or any extra cost on this industry in Libya. From another viewpoint, this would provide the study results with a deep analyses that would aid in our, discussion and analysis of this issue. Finally, the Ahlia Cement Company is one of the biggest cement producers in Libya, so when such an analysis is carried out in this way it would definitely provide a general impression on the impact of the cement industry in Libya on the environmental cost. Accordingly, for these reasons it is important to carry out this analysis of all factories as one company to evaluate the environmental cost of cement industry and who would bear such a cost.

Here, the production function and emission function of the Ahlia Cement Company will be estimated (all the four factories together). Then the rate of the environmental cost for this company will be also estimated, followed by a calculation of the elasticity of the demand price and the elasticity of the supply price to determine who would bear the largest amount of the environmental cost.

7.6.1. Estimating the production function of cement production in the Ahlia Cement Company

The production function of the Ahlia Cement Company could be considered as a function of two main factors as follows:

$$CP = CP\left(RM , D\right)$$

$$CP = \alpha_0 + \alpha_1 RM + \alpha_2 D + U$$

Where:

CP	The production quantity of cement (per ton per year) in the Ahlia Cement Company.
RM	The raw material used in cement production in the Ahlia Cement Company.
D	Other inputs as equipment, machinery and other means, which can be expressed by the use of capital in the Ahlia Cement Company.

By using the statistical data on the variables of the function during the period between 1988-2008 which are illustrated it in the following table:

Table (7-19) Main variables for measurement of the production function and the pollution function in the Ahlia Cement Company, 1988-2008 (Libyan Dinars.).

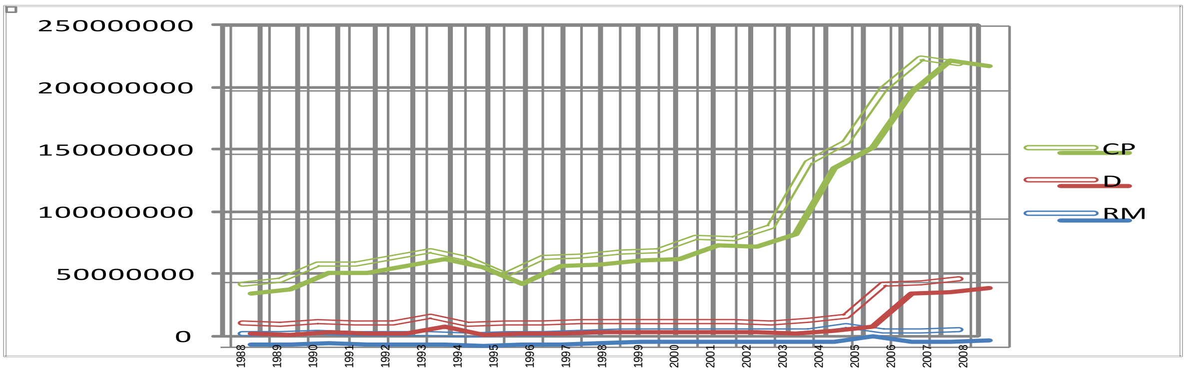
Year	RM	D	CP	TechC	MP
1988	1,370,207	9,032,209	31,292,378	6,107,987	4,224,471
1989	1,768,801	7,234,260	35,617,467	4,807,828	4,808,358
1990	3,223,013	8,432,351	46,527,968	8,358,578	6,281,275.7
1991	1,701,819	8,172,602	47,590,323	5,691,090	6,424,693.6
1992	1,569,301	8,698,970	53,369,823	4,080,053	7,204,926.1
1993	1,343,064	14,044,172	53,487,678	3,174,514	7,220,836.5
1994	947,829.7	8,436,334	53,016,609	4,328,558	7,157,242.2
1995	1,379,633	8,681,707	38,888,992	4,559,886	5,250,013.9
1996	1,793,756	8,560,851	52,831,800	5,135,715	7,132,293
1997	3,383,899	8,419,587	51,919,371	8,536,454	7,009,115.1
1998	3,712,083	7,599,868	56,592,396	26,284,882	7,639,973.5
1999	3,552,382	7,815,498	56,863,359	9,444,545	7,676,553.5
2000	3,734,817	7,791,628	68,092,038	10,032,056	9,192,425.1
2001	4,419,160	6,718,367	66,862,184	8,745,338	9,026,394.8
2002	3,491,588	6,585,949	78,103,025	10,624,605	10,543,908.4
2003	4,181,455	7,854,112	128284182	10,228,275	17,280,000
2004	8,369,523	7,613,676	139844133	11,487,051	18,900,000
2005	4,021,668	37,266,005	156670813	16,171,354	21,195,000
2006	3,573,242	39,234,018	180579935	10,405,659	24,435,000
2007	5,371,513	40,896,874	172638755	16,740,714	23,355,000
2008	6,237,069	40,230,302	224533768	23,131,010	30,375,000

Source: Department of Budgets,1988-2008b; Department of Statistics, 1988-2008b; the El-Mergheb Cement Factory, 2009a; the El-Mergheb Cement Factory, 2009b; the El-Mergheb Cement Factory, 2009c; the El-Mergheb Cement Factory, 2009d; the El-Mergheb Cement Factory, 2009e; the El-Mergheb Cement Factory, 2009f and the El-Mergheb Cement Factory, 2009g.

Notes: 1-All the figures in this table are in Libyan Dinars and are stated in real terms having been adjusted by reference to the Libyan Price Index to avoid the impact of economic inflation or deflation.
2-All the data in above table is Stationary Time Series and for more information see Appendix nine.

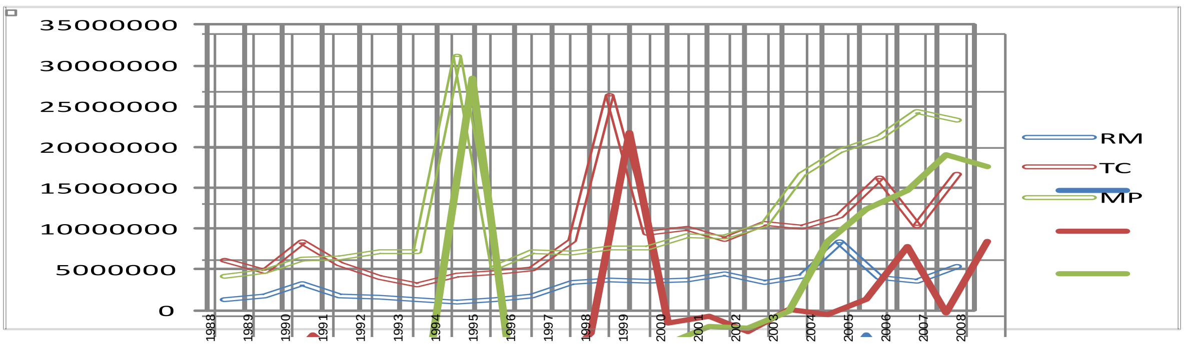
It is noted from the table that all the values of variables are relatively high if compared with the previous factories individually; this is due to the fact that this company includes all the previous four factories together. It could be noted as well that the values are generally increasing, but in recent years the increase is more dramatic, this is because of the restructuring of the company and the change in its administration system. For further clarification, the variables are drawn in the following graphs:

Figure (7-10) The relationship between the production quantity, raw material and capital of the Ahlia Cement Company, 1988-2008.



Source: Author (2009)

Figure (7-11) The relationship between the emission amount, raw material and technology cost of the Ahlia Cement Company, 1988-2008.



Source: Author (2009)

From the previous figures it is noted that the variables are non-linear and show a direct correlation, so by using statistical data of the function of production during the period between 1988-2008 the following results were obtained:

Table (7-20)	**The results of production function for the Ahlia Cement Company, 1991-2008.**

Dependent Variable	**Independent Variable**		
CP	**Constant**	**RM**	**D**
Coefficient	-5168330	14.33864	3.047358
T-test	-0.620645	6.202194	8.965533
Significant	0.5426	0.0000	0.0000
R square=0.911	Adjusted R Square=0.901	F-test=92.45792 Significant=0.00000	D.W=1.89
So b_1=14.33864, b_2=3.047358			

7.6.1.1. The Statistical Analysis

From the previous table it can be concluded that the independent variables were significant from a statistical aspect at 5% (P<0.05) and according to the T-test result. But the constant coefficient is not significant even at 10% error level, this however is not important since this constant coefficient has no impact on our analysis.

It is noted that the R Square value is 0.911 and the Adjusted R Square value is 0.901, which means that the independent variables (RM, D) are able to explain 0.901 of the changes in the production quantity of the cement in the Ahlia Cement Company, while the remainder of changes are attributed to other factors.

As for the variance analysis which helps to determine the explanatory power of the whole model though the F-test, as seen in table (6-19) the F-test value is 92.45792 with a high significance level at 5% up to zero (P<0.05), which confirms the high explanatory power for the cement production function in the Ahlia Cement Company from a statistical aspect. On the other hand, the D.W. test refers to no problem of autocorrelation where the result value is 1.89.

7.6.1.2. The Economic Analysis

According to the logic of the economic theory, the supply quantity (the cement production quantity) has a direct correlation with the raw material used in producing cement, so the more the raw material used the more the production of cement, and the same goes for the capital variable where more capital will lead to more supply quantity (the cement production). The results of the production function analysis of the Ahlia Cement Company agree with the economic theory and gives the same results.

The coefficients of raw material (RM) value is 14.33867 and this is consistent with the economic theory, which means that for any increase in the raw material by one Libyan Dinar there will be an increase in the production quantity of cement by 14.33867. With regard to the capital variable this also agrees with the economic theory as well, where it value is 3.047358, which means that for any increase in the capital variable by one Libyan Dinar there will be an increase in the production quantity of cement by 3.047358.

7.6.2. Estimating the Cost of pollution control function of the cement production in the Ahlia Cement Company

The emission amount in the Ahlia Cement Company could be considered as a function of two main factors:

$$MP = MP\left(RM\ _{,} TC\right)$$

$$MP = \beta_0 + \beta_1 RM + \beta_2 TC + U$$

Where:

MP	The emission amount from the cement production in the Ahlia Cement Company.
RM	The raw material used in the cement production in the Ahlia Cement Company.
$TechC$	The technology cost which controls the pollution in the Ahlia Cement Company.

When analyzing the data of the Ahlia Cement Company via the emission function and during the period between 1988-2008 the following results were obtained:

Table (7-21) **The results of the emission function in the Ahlia Cement Company, 1988-2008.**

Dependent Variable	Independent Variable		
MP	**Constant**	**RM**	**TechC**
Coefficient	3767148.3	-17.036	7.536
T-test	0.626	-2.549	2.970
Significant	0.541	0.023	0.01
R square=0.60	Adjusted R Square=0.457	F-test=4.202 Significant=0.015	D.W=2.252
So C_1=-17.036, C_2=7.536			

7.6.2.1. The Statistical Analysis

From the previous table it is conclude that the independent variables (RM,TechC) were statistically significant, according to the T-test at a significance level of 5% (P<0.05). But the constant coefficient is not significant at 5% and 10%, but that however is not be a problem.

Also Table (7-20) illustrates that the R Square value is 0.60 and the adjuster R Square value is 0.46, which means that the independent variables (RM, TechC) can explain 46% of the changes in the pollution amount in the Ahlia Cement Company, while the reminder of changes can be attributed to the other factors, where such factors could be explained as follows:

Instability of the legal and administration system during the period of the study, the stopping of the production lines due to technical problems; the lack of provision of spare parts for them as soon as they were required; the absence of a real competitor to this company before 2005 because it was owned by the state, and therefore it lacked the incentive to improve and increase the quality. Additionally, work at the El-Mergheb Factory was stopped for ten (10) years, and generally the weakness of the national experience which forced the company to rely on foreign experts and the instability of the financial situation (salaries) led to the experts working at the company to leave. Furthermore, some of the raw material sources are hundreds of kilometres away from the company which in some cases caused more increase in expenses and the disruption of production.

All this has led to the overall explanatory power of this consolidated production function being weaker. It is important to stress here that the impact of these influencing factors on the factories separately is weak (Because some of the problems that happened in one factory would not necessarily happen in other factories at the same time). Therefore, the results of analysis carried out on the factories separately yielded the best results, this is due to the fact that these influencing factors do not affect all factories together at the same time (simply because most of the problems or reasons occur unpredictably and at different times at the separate plants), on the other hand some reasons have strongly affected one factory but had no impact on other factories; as for example what happened in the El-Mergheb Factory when it stopped working for 10 consecutive years.

Table (7-20) illustrates that the F value is 4.202 with significant level is 0.015, which means that it is significant at 5%, this also confirms the explanatory power of the emission model from a statistical aspect especially with R Square. On the other hand, the D.W. test refers to no problem of autocorrelation where D.W value is 2.252.

7.6.2.2. The Economic Analysis

It could be noted that there are no contradictions with the coefficients of regression from technical and economical aspects.

7.6.3. Estimating the environmental cost rate in the Ahlia Cement Company

By using the estimated values of the coefficients included in the marginal cost equation, the results of the coefficients were as follows:

MP_{RM}=-17.036, MP_{TechC}=-7.536 .CP_{PM}= 14.33865

Where the marginal cost before determining the cost of emission or pollution is as follows:

$$MC_0 = \frac{89.5}{14.33864} = 6.241875101$$

After determining the cost of pollution or emission and giving different values for P_{TC}, the cost of pollution could be calculated as follows:

$$MC_1 = \lambda_1 = \frac{P - P_{TechC}\dfrac{MP_{RM}}{MP_{TechC}}}{CP_{RM}}$$

By substituting P_{TechC}=0.5 LD

$$MC_1 = \frac{89.5 - 0.5\dfrac{-17.036}{7.536}}{14.33864} = 6.399534106$$

So for any increase in the environmental cost by 0.50 Libyan Dinar per ton of cement in the Ahlia Cement Company there will be an increase in the marginal cost by 0.07883 Libyan Dinar.

When substituting P_{TechC}=1 LD

$$MC_1 = \frac{89.5 - 0.5\dfrac{-17.036}{7.536}}{14.33864} = 6.320704603$$

As seen, any increase in the environmental cost by one Libyan Dinar per ton of cement production will lead to an increase in the marginal cost by 0.15766 Libyan Dinar in the Ahlia Cement Company.

7.6.4. The analysis of the demand price elasticity and the supply price elasticity for cement production in the Ahlia Cement Company

The following table addressed the important changes which happened to the cement price of the Ahlia Cement Company, and those changes that happened as well to the cement production and the cement sales during the period between 1988-2008, and based on the resulting data the elasticity of the demand price and the elasticity of the supply price for cement production and cement sales in the Ahlia Cement Company were calculated.

Table (7-22) The elasticity of demand price and supply price for cement production in the Ahlia Cement Company,1988-2008.

Year	Cement price	Sales of cement	Quanitity of the cement production	Elasticity of demand price		Elasticity of demand price		Distribution of environmental burden
				Value	State	Value	State	
1988	14.5	2187112	2158095	-	-	-	-	-
1989	14.5	2402518	2456377	-	-	-	-	-
1990	17.5	2608296	2658741	0.438046	Inelastic	0.421994	Inelastic	P≥C
1991	17.5	2618837	2719447	-	-	-	-	-
1992	20.5	2608408	2603406	-0.02527	Inelastic	-0.27614	Inelastic	C≥P
1993	20.5	2547714	2609155	-	-	-	-	-
1994	22.37	2421356	2369987	-0.58296	Inelastic	-1.10119	Elastic	C>P
1995	22.37	1732341	1738444	-	-	-	-	-
1996	31.5	1668448	1677200	-0.11085	Inelastic	-0.1058	Inelastic	P≥C
1997	31.5	1668386	1648234	-	-	-	-	-
1998	31.5	1819540	1796584	-	-	-	-	-
1999	31.5	2013870	1805186	-	-	-	-	-
2000	31.5	2119228	2161652	-	-	-	-	-
2001	31.5	2109138	2122609	-	-	-	-	-
2002	38.5	2012582	2028650	-0.23426	Inelastic	-0.22634	Inelastic	P≥C
2003	58.5	2114556	2192892	0.119835	Inelastic	0.188693	Inelastic	C≥P
2004	58.5	2395819	2390498	-	-	-	-	-
2005	62.5	1939522	2506733	-3.18383	Elastic	0.717979	Inelastic	P>C
2006	74.25	2425119	2432053	1.294842	Elastic	-0.17598	Inelastic	P>C
2007	79.25	2161290	2178407	-1.76599	Elastic	-1.68897	Inelastic	P≥C
2008	89.75	2473975	2501769	1.08575	Elastic	1.11205	Elastic	C≥P

Source: Author (2009)

After carrying out the analysis of the demand price elasticity and the supply price elasticity for cement production and cement sales in the Ahlia Cement Company it was found that the responses of the producer and the consumer to the changes which happened to the price of cement production and sales per ton went in the same direction. So any increases in the price of cement per ton as tax or environmental cost …etc will be shared between the producer and the consumer almost equally.

But it should be noted that there are some small variations regarding who had borne more of the cost; where it could be noted in the previous table that in some years the producer had borne a little bit more the environmental cost than the consumer as in the years 1990, 1996, 2002 and 2007, and in other years the consumer had borne a little bit more as in the years 1992, 2003 and 2008, while in other years the producer had borne quite a lot more than the consumer as in the years 2005 and 2006 which are the years during which the administration and financial system in the Ahlia Cement Company started to change (Re-evaluation of the company's assets) which might have caused these changes as a result. In 1994 it could be noted that the consumer has borne more of the environmental coat which might be due to the El-Mergheb factory stopping work for a long time, and the loss of documents in the Libda factory which resulted in inability to acquire accurate data from the factory.

In general, it could be noted that the producer and the consumer will share equally the cost of pollution. So it is recommended that the producer or decision makers in the Ahlia Cement Company do not hesitate to applying an economic environmental policy which preserves the environment; because the environmental cost will not be borne by them alone but will be shared with consumer almost equally.

7.7. A brief presentation of the production function results about the Ahlia Cement Company and its factories

In the following table it can be noted that all the results are statically significant in terms of the strength of the relationship, their independent variables, and the explanatory power of the production functions of the models as a whole. Therefore, these results could be relied on to answer all the research question and to test the research hypotheses.

The results are also reliable to achieve the aims of the study, where the researcher has already carried out a detailed analysis of each institution in this chapter.

Table (7-23) A brief presentation of production functions (CP) results in the Ahlia Cement Company and its factories

The Organization's name	RM			D			D.W		R Square	
	Value	Sig.	State	Value	Sig.	State	Value	State	Value	State
The Ahlia Cement Company	14.34	0.000	√	3.05	0.00	√	1.89	√	0.91	√
The Zileten Cement Factory	13.19	0.003	√	4.32	0.00	√	1.69	√	0.82	√
The Libda Cement Factory	11.32	0.00	√	2.09	0.05	√	1.77	√	0.84	√
The Suk El-Khamis Cement Factories	9.89	0.05	√	3.58	0.00	√	1.45	√	0.71	√
The El-Merghab Cement Factory	0.28	0.003	√	0.53	0.00	√	1.89	√	0.80	√

Source: Author (2009)

Note: √ Confirms significant result.

7.8. A brief presentation of the emission function results about the Ahlia Cement Company and its factories

From the following table it can be noted that all the results are statically significant in terms of strength of the relationship, their independent variables, and the explanatory power of the production functions of the models as a whole. Therefore, these results could be relied on to answer all the research question and to test the research hypotheses. The results are also reliable to achieve the aims of the study where the researcher has already carried out a detailed analysis of each institution in this chapter.

Table (7-24) A brief presentation of the emission functions (MP) results in the Ahlia Cement Company and its factories.

The organization's name	RM			TechC			D.W		R Square	
	Value	Sig.	State	Value	Sig.	State	Value	Sig.	State	Value
The Ahlia Cement Company	17.036	0.023	√	-7.536	0.010	√	2.252	√	0.60	√
The Zileten Cement Factory	1.711	0.002	√	-0.933	0.025	√	1.815 and 1.604	√	0.74 and 0.80	√
The Libda Cement Factory	1.165	0.006	√	-0.38	0.006	√	2.041	√	0.69	√
The Suk El-Khamis Cement Factories	6.690	0.000	√	-0.112	0.098	√	1.970	√	0.91	√
The El-Merghab Cement Factory	3.640	0.026	√	2.601	0.059	√	1.840	√	0.87	√

Source: Author (2009)

Note: √ Confirms significant result.

7.9. The impact of applying an environmental economic policy on cement material production

The actual application of an environmental policy on the production of cement material could be in the form of a monitoring or follow-up system; a tax; the installation of pollution control equipment, or the decrease in production quantities of this industry, since increases in the cost of pollution control is not offset by an increase in the production, so application of an environmental policy as a result of the pollution resulting from the cement production will have a negative impact on the quantity of cement produced as a result of transferring economic resources away from the service toward the final production for the purpose of protecting the environment. In addition, the cement industry may face difficulties in the expansion of the industry due to the cost of pollution control.

7.10. The impact of applying environmental economic policy on the industries based on cement

The potential impact of pollution control in the cement industry extends to other industries as well, especially those industries that use large amounts of cement material. For example, the construction sector, airport development projects, and building bridges, roads...etc projects. Such industries are affected more than others by the increase in the cement price as a result of applying an environmental policy to control pollution, and also the high price of cement may lead industries that use the cement intensively to replace cement by another element or introduce changes into their production, that will lead to a reduction of production in this industry. However, this study was concerned itself only with the immediate impact as the cement industry and not these secondary effects.

7.11. Conclusion

From the previous analysis it can be noted that any increase in the cost as tax or increases in the costs related to cement industry will lead to lifting of the marginal cost per unit, and this has been proven in the largest cement production company in Libya i.e. The Ahlia Cement Company and all its factories.

However, it is noted that during the same period of time the marginal cost of each factory and the company as a whole as well has slightly different values but is going in the same increasing direction (positive figures of marginal cost); and the reason for this was mentioned earlier by researcher in chapters five and Six. There are a number of problems and difficulties in the cement industry in Libya due to the lack of administrative and financial stability in these factories, technical difficulties such as the lack of spare parts in Libya, instability of foreign workers due to instability in their salaries (with no reason for this), stopping the production lines in some periods due to breakdowns, the lack of experience, and stopping production for long times for purposes of development. Such reasons have created (obviously) these slight differences in the marginal cost value between the factories and the company.

Despite the problems in collecting the data, the researcher has shown that it is possible to calculate marginal cost with some confidence P.E.O. so we could consider that this approach and method would be equally applicable to cement plants in developed countries. With, of course, the added advantage of more accessible factory data. Then the researcher moved on to another part of the practical side related to who would bear the environmental cost; the producer or the consumer or both, where it was found in this study that both parties will share the environmental burden.

Thus, this study has provided a good basis for decision makers in Libya generally and the Ahlia Cement Company specifically. To know how much the environmental burden would be borne, a special table was developed to help the decision makers in cement industry (or those concerned with planning economic activity.) to know who will bear the burden of environmental cost; whether it is the producer or the consumer, and who would bear a larger amount of cost if both. This table, or distribution, is considered as a major contribution in this study which could be applied in any country or with any sort of industry which has an impact on the environment.

Chapter Eight
Conclusion

8.1. Introduction

This study is an attempt to clarify the potential contribution of three economic tools (estimating the production function; estimating the marginal cost; and the analysis of the demand and supply price elasticity) to understand the control of environmental pollution. There has been a great deal of published research that has discussed the problem of pollution in the cement industry. Nevertheless, it can be noted that the problem of pollution which results from this industry is aggravating day by day in both developing countries and developed countries. However, the problem is more complicated in developing countries since perhaps lower compliance limits are placed by their laws than those that prosecute offenders in developing countries. This study is different in that it seeks to understand how an increase in price due to the imposition of a technical control cost would be divided between the producer and the consumer.

This study has discussed many of the pollution issues caused by cement industry that have been raised in previous research, and the researcher found that this research focused basically on:

8.1.1. Air pollution from the cement industry: The researcher found that these papers discussed two main issues related to this point as follows:

8.1.1.1. Some authors argue that there is a possibility to solve this problem (Alam, et al., 2007; Anonymous, 2008a; Chemical Business, 1996a; Il'ina, 2008; Liblik, et al., 2000; and Lukjanova, et al. (2010). Other authors argue that it is only possible to reduce the pollution from this industry (Ning, 1997; Nordqvist, et al., 2002). However, there is no perfect solution to this problem, at least at the current time, where many difficulties exist in applying these solutions. (for example, studies such as the EU Emissions Trading System, 2008; Anon, 2008f; Limiting Global Climate Change, 2007; and authors such as Magat, 1986; Ning, 1994; Teece, 1986; and Wagner, 2004).

8.1.1.2. Another research theme concerns the relative contribution of the cement industry to air pollution. Here some argue that the cement industry is the most powerful source causing air pollution, while others believe that cement is not the main source of air pollution (Abdul-Wahab, 2006; Ade-Ademilua, 2008; Anonymous, 2008j; Anonymous, 2009g; Anonymous, 2009h; Anonymous, 2009i; Branquinho et al., 2008; Cherem et al., 2008; Davidovits, 1994; El-fadel et al., 2003; Gosudarstvenny, 2006; Haftbaradaran, 2000; Härtling and Schulz, 1998; Hendriks, et al. 1999; Kabir, et al., 2010; Kuvarega, et al., 2008; Mandre, 2008; Nadal, et al., 2009; Pacyna, et al., 2006; Pacyna, et al., 2007; Pyta et al., 2009; Razavi, 2006; Smith, 1990; Staaf & Tyler, 1995. Other researches, for example, Alam et al (2007) and Masoud (2007) emphasise the importance of cement in developing and developed countries.

8.1.2. Alternative fuel: Given the reliance on fossil fuel in the production process one can identify a cluster of studies that discuss reducing pollution by focusing on finding an alternative to fossil fuel as follows:

8.1.2.1. The first group discusses issues around the best alternative fuel. Some of them believe that organic and mineral fuels are good alternatives for fossil fuel (Contract Journal, 2006; Hibbert, 2007; Huntzinger. et al., 2009; and Nadal, et al., 2009), while others believe that hazardous waste is a good alternative fuel for coal (Bowermaster, 1993 and Kemezis, 1993). The third group believes that coal could be supplemented by waste (either hazardous or non-hazardous) rather than being replaced by waste alone. (Jian et al., 2010), and a fourth group believes that tyres are the best alternative to fossil fuels (Johnson and Truini, 2002 and Moore, 2003).

8.1.2.2. However, of course, even alternative fuel will impact on the environment. Here a number of opinions believe that such an alternative will not have any adverse impact on the environment (Hibbert, 2007 and Jian, et al., 2010), while a second group of researchers fears the use tyres as an alternative fuel (Carpenter and Bowermaster, 1993; Moore, 2003). A third group believes that the burning of waste in cement kilns poses a threat to the environment (Mattos, et al., 1997 and Porto, 2006). A fourth group of researchers find the burning of waste dangerous. However, if this is to be done in an organized way the risks could be reduced but with the condition of applying this for a temporary period only (Kemezis, 1993). Finally, there are other views which argue that good management of traditional fossil fuels could help in reducing the pollution (Contract Journal, 2006).

8.1.2.3. There is another group of research that focuses on the economics of utilizing an alternative fuel. Some researchers believe that an alternative fuel is not economic when combined with the environmental burden. Another group believes that for oil producing countries – where the price of oil is relatively cheap – they do not need to search for an alternative fuel especially in the case of developing countries that produce oil, where the concern is only about growth coupled with little priority for environment aspects (Szab et al., 2006).

8.1.3. There are some previous studies that focus on the technology used in cement industry and the potential of preservation of the environment. Here scientific papers have discussed two aspects.

8.1.3.1. The first group considers the control technology used. Some see that it is Dioxin that is the major issue, others see it is limited to red mercury emissions, some see it as being limited to reducing particular materials emission, while others believe that it could reduce hydrogen chloride emission (Air Pollution Consultant: 1999, 2003, 2006, and 2007)

8.1.3.2. The second group discussed the new technology. Here, some feel that technology is the good choice since it will help in reducing or controlling the pollution, while other groups believes that there is a potential to introduce amendments to the old technology to make it less polluting to the environment. The final group believe that the best technology to reduce pollution is Best Available Technology (BAT) technology

(Marner and Loizidou, 2001; Szabo et. al, 2006 and World Bank Group, 1998).

8.1.3. 3. Another group of studies focused on the impact of cement industry on agriculture and earth (Akeredolu, 1989; Han, et al., 2003; Iqbal and Shafig, 2001; Kurtz, et al., 2001; Liu et al, 1997; Lukjanova et al., 2010; Olaleye et al., 2010; Rao, 1998; Reynolds et al., 2001; Satao et al, 1993; Semhi, 2010; Shukla et al., 1990; Stoorvogel et al., 1997 & Warren et al., 2003). Some concentrated on human aspects (Tijan, 2005), while other studies focused on housing (Perfettini et al., 1989 and Wasserbauer et al. 1998). Others on water (Ademola, 1998; Haftbaradaran, 2000; Kabir et al., 2010; Olaleye et al 2010; and Zubareva et al., 1999).

In fact, all the previous studies that were discussed in Chapter Three of this study were good studies that have added several contributions. From the standpoint of the researcher, the search for a technology or an alternative fuel that causes less pollution to the environment is a good idea, and the first step. Particularly given that the cement industry causes a great deal of pollution to the environment. But unfortunately there is a real problem concerning the direct bearer of the environmental cost or environmental tax, which means the producers or the decision makers in the cement industry. If we supposed that there is a technology that could reduce pollution by a large amount, it is possible – of course – that developed countries focusing on cement production in their countries might use this new technology. The problem in developing countries might be than such a change would need enacting laws to be enforced. However, developing countries may not have the potential to apply and control legislation. Even in developed countries, governments cannot ultimately require managers in the cement industry to completely change their factories and lose their capital in order to apply a new technology that would help in reducing the environmental pollution.

So what is the solution, or what can be done, to convince companies in the cement industry to accept environmental burden (as a tax or installation of new techniques or equipment). Unfortunately, all previous studies – at least the ones that this researcher managed to find and discuss in this study – did not discuss this issue. This led the researcher to the belief that the issue of estimating the environmental burden cost and then clarifying who will bear this burden or cost is an important issue. It would help managers of cement factories to accept and discuss all types of environmental solutions by providing producers in the cement industry with an idea about what would happen to their profits after taking into account the environmental cost. However, in the opinion of the researcher, decision makers – especially those in developing countries – do not see themselves obligated to bear any of the environmental costs or other extra costs that would reduce their profits. Therefore, this study attempts not only to estimate the cost but also tries to determine the parties who will bear such a burden. This may well influence their decision making positively and to implement environment improvement. It is from this approach that the researcher believes that this study draws its strength and its contribution.

This goal can be achieved by estimating the marginal cost since it reflects the cost per unit of production. Accordingly, this study has estimated the production function of Ahlia Cement Company and its factories (as the largest company in the cement industry in Libya), and accordingly calculated the marginal cost for each of the company's factories before applying the environmental cost, after that the marginal costs were calculated for all factories together as one factory, followed by a calculation of the emission function in the same way. This was done in order to calculate the marginal cost after applying the (technical) environmental cost.

The researcher took the results of the previous functions and then calculated the difference between the marginal cost results before and after applying the cost of pollution on each factory separately as well as on all factories together 'as one'. It was found that for all the factories individually and the company as whole that the cost per ton of cement has risen, which indicates increased costs that would result in loss or reduction in the profits of this industry.

The final step of the study was a calculation of the elasticity of the demand price and the elasticity of the supply price of the cement. This was done in order to determine whether the producer or the consumer would bear the largest share of the cost of pollution control. This has helped the researcher in developing a distribution scenario especially for environmental cost or any additional cost. The researcher hopes that such a distribution will help decision makers both in Libya specifically and elsewhere in the world generally, in taking the right decisions more confidently and with fewer associated risks.

Returning to the third chapter, this attempted to show key examples of the international conventions and laws that are trying to establish control over pollution, both in general, and in the cement industry. The fact was, and remains, that there are major international efforts concerning environmental objectives and problems. This research has focused on the Libyan market. It has been found that: there are many local laws attempting to limit several kinds of pollution; that Libya is a party to international conventions on the environment; and that the Libyan government had produced a future vision on the environmental situation in Libya that is known as the Blue Plan. This considers environmental matters in Libya up until 2025. However, the real environmental problem in Libya has to do with raising the awareness of the people and is not related to international conventions or laws nor even to domestic laws. It is how to apply these and control their application in Libya and require the people abide by them. Nevertheless, it is still important to set Libyan environmental legislation into the wider international context as was done in Chapter Four. This wider perspective could be seen as either a 'benchmark' for Libya, or to remind us that of through its own culture and choices that Libya is itself as concerned with the environment as developed countries. Such aspirations being codified in the 'Blue Plan'.

8.2. The Study Aims.

As noted, this study aims to assist decision makers in understanding the economic contribution which may help them to understand the economic dimensions of the environment. There were five aims of this study to identify the amount of the environmental cost in cement industry, as well as to identify the parties who will bear the cost of the environmental cost in such a way that is expected to assist the decision makers in the cement industry in Libya to realize the impact of the environmental cost on their activity, and know whether the cost will be borne by them alone or shared with others. This study also considers the Libyan consumer since cement material in Libya is considered as a very important output. Indeed, one that is ranked only after water and food in terms of its importance to consumers. It is important to remember here that housing in Libya is constructed with a very high percentage of cement that may exceed 50%, and so it is considered the most important material of all in the construction of housing other buildings. Finally, the aim of the researcher is for this study is to contribute to research on this issue which would help future researchers and studies.

8.3. The research questions

This study was built on three questions, which the researcher hoped to have been able to answer through the analysis in this research, they were:

8.3.1. Is it possible for economic tools (such as estimating the production function; estimating the marginal cost and the analysis of the demand & supply price elasticity) to help in understanding or reducing the environmental pollution?

Yes, economic tools can be used to clarify the financial effects on the activities which affect the environment. They can clarify what would happen to the net income (the profit) if the cost of production increases or decreases. There are also many other financial issues that could be clarified by the economic science and its theories. In this study we were able to take advantage of production theory and cost theory in estimating the environmental cost. We were able also to identify the financial impact on the producer and the consumer in case of adding an environmental cost to production costs of the cement industry. Although the study was conducted on specific plants of one Libyan cement company only, we believe that the framework and method can be generalised more widely to other Libyan cement plants and other industries in Libya and other countries.

8.3.2. Is it possible to determine the amount of the environmental cost of cement industry? How possible is it to determine the environmental cost of the cement industry?

In fact, the knowledge of the real values of the environmental cost depends on several things including the technical cost which helps to reduce or control the pollution such as filters, environment-friendly techniques or the use of appropriate fuel. If it was possible to determine these production costs, it would be simple to estimate the cost which follows per unit of the production. Whilst only one part of overall environmental cost was calculated –the technical cost of plant improvements to reduce pollution, the method has a more general application. It is invariant to the generator of the cost increase. For example, the producer and consumer shares of a pollution tax could be calculated. If the pollution control policy was legislation that increased the cost of administrative compliance for the company, this method would work equally well. If this study was carried out in developed country like Britain, it would be possible to reach a closer estimate of the real value of the environmental cost as we assume that factory records would be more easily available.

As for the possibility of measuring the environmental cost of the cement industry in Libya, it was done by calculating the marginal cost before and after the environmental cost and the difference is the environmental cost. Marginal cost was chosen because it reflects the changes that are happening per unit of changed production (per ton of cement).

8.3.3. If the environmental costs which help to reduce the pollution caused by the cement industry are known, who would bear this cost; the producer, the consumer or both? In addition, if both would bear the cost, who would bear more of it? the producer or consumer? Or will it be shared equally? Or is there a third party who will be bearing it such as the government?

After calculating the elasticity of the demand price and the elasticity of the supply price of the cement industry in Ahlia Cement Company and its factories, it was noted that all factories of Ahlia Cement Company during the period of the study between 1988-2008 have shared the environmental cost almost equally between the producer and the consumer. The reason for that is that the response of the consumer and the producer to changes which happen to the cement industry in Libya in most cases go in the same direction and the same percentage, thus additional increases in the cost will be shared almost equally between the producer and the consumer. It is important to point out here that in this part of the analysis, the amount of the environmental cost was not assumed but was done through the analysis of results which related the prices and amounts of sales and production.

8.4. The results of the study

This study has found eight results as follows:

8.4.1. The environmental policy on combatting the environmental pollution caused by the cement industry has led to an increase of the cement production cost, which would result in lower output (production quantity). This reduction in income (increase in operating costs) could divert funding away from increasing the output of cement and growing this vital industry.

8.4.2. After analysing the demand price elasticity the Ahlia Cement Company and its factories it appeared that in general it is inelastic. This means that the response of the consumer to changes that happen to the cement price is less responsive, which indicates that the environmental cost added to the cement production cost will lead to price increases that will be partly borne by the consumer.

8.4.3. With regard to analysis of the elasticity of the supply price of the cement industry in Ahlia Cement Company and its factories, it appeared that in general it is not elastic, which means that the response of producer to changes which happen to the cement production cost is slow. Thus, the producer will bear part of this additional cost in the cement industry.

8.4.4. It could be noted from the results of analysis of the demand price elasticity and the supply price elasticity of cement production in Ahlia Cement Company and its factories and from the previous results about the elasticity analysis referred to in this section, that the elasticity of the demand price and the supply price are not elastic (are inelastic), which means that the amount of additional cost will be borne almost equally between the producer and the consumer. Therefore, the environmental cost will be shared almost equally between the consumer and the producer. This is as indicated in the distribution Table (7-6) in Chapter Seven.

8.4.5. There are many pieces of legislation, international laws and international treaties that attempt to limit the environmental impact of industry and sources of the environmental pollution, but these still have not been able to achieve the intended objectives because there is a clear weakness to commitment in the international community, nevertheless this does not mean that there are no successes in this area.

8.4.6. There is a lot of local legislation in Libya, and the Libyan government has entered into a number of treaties and international conventions on environmental protection. However, as a result of weak application and oversight further exacerbation to the environmental problem in Libya has resulted. This is not only the case in Libya but in most developing countries particularly as they seek to become developed countries, and therefore, need large amounts of cement for the construction of infrastructure as a major first step towards progress.

8.4.7. There are many studies on the pollution problem and, in particular, the problem of pollution caused by the cement industry, most of these studies discuss the issue from several aspects, such as: production technology, alternative fuels, emission levels and their impact on air and others aspects of life such as agriculture, earth, humans and others. But unfortunately only a small number of studies attempted to consider those two important parties in the cement industry, the producer who will face less profits or losses if new technical installations that cause less pollution to the environment are installed, and also the consumer who needs this material in their life. So this study attempted to discuss the possibility of estimating the cost of pollution control as well to provide an economic analysis, and an explanation to the producer and the consumer. This explanation concerning the environmental cost, and its impact on the price, and additional cost which will be borne by the producer and the consumer for this environment protection.

8.4.8. The application of an environmental economic policy in the cement industry will have an impact on other industries which for their production depend upon cement material.

8.5. The Study Recommendations

There are six recommendations that the researcher believes would deeply help in the raising of environmental awareness of interested people, as well as helping in developing an understanding of the role and contribution of the economic theory and its tools to understand and control environmental pollution.

8.5.1. The establishment of an international organization to control the cement industry in developing countries. Such an organization should aim to provide a timetable for the implementation of an environmental tax or the use of technology that is more environmental-friendly. We would hope also that this organization takes into account the economic aspects and that it would try to provide support to states that do no have the ability to apply an economic environmental policy that would help in reducing environmental pollution.

8.5.2. It should not neglect the environmental studies in general and the economic studies in particular, because these discuss the parties which have a direct relation with environmental cost, i.e. the producer and the consumer.

8.5.3. This study recommends the developed countries be aware of applying the environmental-friendly technology excessively because there is no current technology that would fully preserve the environment. The best technology nowadays does not exceed a 20% reduction in pollution output (Contract Journal, 2005 & Lafarge Media Centre, downloaded, 2011). Therefore, if that is true, even when applying appropriate technology just because developing countries will need cement as a raw material in order to develop, paradoxically pollution will increase in total. The reduction in the amount of polluting substances using new technology will be compensated for by the significant increases in the amounts of production.

8.5.4. This study recommends that developing countries -especially oil countries -to take into account the environmental dimension and not to neglect environment risks and excessive depletion of oil in exchange for rapid economic development.

8.5.5. To ensure that the producers and the decision makers in Libya, in particular, and in the rest of the world, in general, will not be the only parties to bear the environmental burden when applying an environmental policy, but the burden should rather be shared with the consumer or the state. It should also be determined who will bear more of the environmental burden by carrying out the analysis of the elasticity for the producer and the consumer and then going back to the table of the environment burden or cost distribution which has been prepared in this study to reveal who will bear the environmental cost. That is either the consumer or the producer or both, and accordingly a decision can be made with more confidence.

8.5.6. The researcher recommends carrying out studies about the reasons for the lack of application and follow-up of industrial and local laws as well as international treaties and conventions on the environment in developing countries.

8.6. Study Contribution

The Study Contribution of this study as follows, and have been diveided into contributions to literature; to knowledge (practice); and, to policy:

To Literature:

This work builds upon existing theory, which as seen in Chapter Two has a long, and honourable, history of economic thought. This study employed the first 'modern' production function (Cobb-Douglas) and shows that despite the more general debate, and relative limitations of this function, it still delivers viable and meaningful results.

The work develops the theory in two respects, it considers in some detail how the resultant costs following an action to reduce pollution from a cement plant are shared potentially between the producer and the consumer. Secondly, it considers and builds into a production function, 'an emissions function' for cement plant production. Thus facilitating consideration of important environmental issues. The data is unique to the cement plants studied and before this study, the data was not available in the form in which it is employed in this study. The base point from which the theory develops is well known and introduced in all introductory economic courses but often only briefly in the way that it is treated in this thesis. It deserves more attention and case studies to illustrate the concept.

To Knowledge (practice):

By showing that both the producer and the consumer share the costs of installing pollution control equipment, this acts as both an incentive for the producer and the consumer. In a real sense, the producer will seek to minimise the extra cost, whilst the consumer may often assume that they have to bear the full cost. Paradoxically, cost sharing may well create an incentive for both parties to agree to pollution control measure. The work has produced a unique and previously unavailable database for the manufacture of cement by the key player in this industry. Given this study, the approach, and the dataset, then the Author will be able to work with his students to a greater depth on this important but often undervalued topic.

To Policy:

This study will help to understanding the implications of a positive environmental policy for a developing country that is dependent upon cement and rightly aspires to become a developed nation. It raises a debate around the inevitable ‘trade-offs’ that the country and citizens need to consider in moving forward in their economic development. The study has produced a ‘reference table’ that would help with such a debate, and which in principle, is transferable to other countries both developed and developing. The issues framed by this thesis are equally relevant for consideration by developed nations as they seek to meet their aspirations. In the particular context of the study for Libya, it would seem that elasticity of the demand price and the supply price are not elastic (inelastic), which means that the amount of additional cost will be borne almost equally between the producer and the consumer. It is encouraging that the participant companies in this study are keen to see the results of the analysis. Whilst there is both relevant international legislation on this form of pollution, adherence is not always extemporary either by developed and developing nations. There may be both a clear weakness to commitment in the international community, and, despite there being a great of local legislation in Libya, weak application and oversight which further exacerbates the environmental problem in Libya. Therefore, any work that adds to the debate on local and international pollution may help to increase the resolve of the concerned parties, and, their consideration of the real and always present constraints on maintaining and improving our environment.

The part of the ‘jigsaw’ that this study attempted to discuss is the possibility of estimating the cost of pollution control as well to provide an economic analysis, and an explanation to the producer and the consumer. This explanation concerning the environmental cost, and its impact on the price, and additional cost which will be borne by the producer and the consumer for this environment protection.

8.7. The conclusion

The target of this study was to identify the impact of the environmental burden on the cement industry in Libya, in particular, the Ahlia Cement Company and its factories during the period 1988-2008.

Many previous studies which discuss the pollution problem caused by the cement industry have been offered, and each study has a particular viewpoint. However, these studies raised many important points about this issue by considering the problem of air pollution, alternative fuel sources and the technology which relates to the cement industry, as well as other important aspects of human life.

This study has as well taken an overview on the international laws, international conventions, international treaties in general, and local Libyan laws about the environment in particular.

The study has also tried to introduce a general idea about the cement industry's history in Libya, and then focused on the history of Ahlia Cement Company and its factories as they are the case study for this research.

This study has added to the work on the cement industry in Libya and set out to give an estimate of the environmental cost for this industry and used appropriate economic tools to determine the parties who will bear this cost.

Finally, this study found out that the environmental cost per ton of cement in Libya is relatively low with the additional reassurance that the environmental cost will be distributed almost equally between the producer and the consumer. Therefore, the decision makers in the Libyan cement industry would not face a major loss following an imposition of extra costs to upgrade their production facilities. Equally, other environment policy options are available to the Libyan state, for example taxation policies or industry support, education and the supporting of technical research.

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Zileten Cement Factory, (2009d), “Interview with Head of Costs Department”, Zileten, Libya, February.

Zileten Cement Factory, (2009e), “ Interview with Head of Finical Department”, Zileten, Libya, February.

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Appendix One

Permission letter from Head of Libya Culture Affairs in London for Yusef Y Masoud to do a field study and this letter had been sent to Director of Scholarships in Libya.

الجماهيرية العربية الليبية الشعبية الاشتراكية العظمى
المكتب الشعبي - لندن
الشؤون الثقافية

إن العلاقات الدائمة بين الشعوب وليست بين الحكومات

التاريخ:

الرقم الإشاري:

التاريخ : 05/12/2008
الرقم الاشاري: 08/12/1459
رقم الملف : 4768
قرار الايفاد : 251/73
بداية الصرف: 01/05/2006
نهاية الصرف: 31/08/2010
أشهر المنحة: 48

اسم الطالب : يوسف يخلف مسعود يخلف
الدرجة العلمية : دكتوراه
التخصص : اقتصاد

Permission letter from Head of Libyan Culture Affairs in London for Yusef Y Masoud to do field study and this letter had been sent to Director of Scholarships in Libya.

الاخ / مدير ادارة البعثات الدراسية

بعد التحية،،،

الموضوع :دراسة حقلية

تقدم إلينا المعني بطلب لموافقتكم على إجراء دراسة حقلية في الجماهيرية وذلك لجمع بعض البيانات والمعلومات المتعلقة بدراسته، حسب رسالة الاستاذ المشرف المرفقة.

نأمل منكم موافاتنا بالخصوص.

والسلام عليكم ورحمة الله وبركاته ،،،

د. سعد عبد العزيز مناع
الخبير التعليمي
المكتب الشعبي الليبي - لندن

Cultural Affairs LONDON
The People's Bureau of the Great Socialist People's Libyan Arab Jamahiriya

صورة لملف الطالب 4768
صورة للملف الدوري العام

Printed by: Fineer

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Appendix Two

Permission letter from Head of Libya Culture Affairs in London for Yusef Y Masuod to do a field study and this letter had been sent to all Cement Companies and Cement plants in Libya.

الجماهيرية العربية الليبية الشعبية الاشتراكية العظمى
المكتب الشعبي - لندن
الشئون الثقافية

إن العلاقات الدائمة بين الشعوب وليست بين الحكومات

التاريخ:
الرقم الإشاري:

Permission letter from Head of Libyan Culture Affairs in London for Yusef Y Masoud to do field study and this letter had been sent to All Cement Companies and Cement Plants in Libya.

2009/01/02

الى/ الأخوة

شركة الاسمنت الليبية
الشركة الليبية للاسمنت – بنغازي
مصنع لبدة للاسمنت
مصنع اسمنت زليتن
مصنع سوق الخميس امسيحل
مصنع المرقب للاسمنت

بعد التحية،،،،

يشهد القسم الثقافي بأن الأخ / يوسف يخلف مسعود يخلف احد الطلبة الموفدين لدراسة الدكتوراه في مجال الاقتصاد في الساحة البريطانية منذ 2006/05/01. يرغب الطالب إجراء دراسة حقلية في مجال تخصصه مما يتطلب زيارة شركاتكم ومصانعكم ، يرجى إبداء المساعدة له بما لا يتعارض مع القانون.

وشاكرين حسن تعاونكم معنا.

و السلام عليكم ورحمة الله وبركاته،،،،،،

د. سعد عبد العزيز مناع
المستشار الثقافي
المكتب الشعبي الليبي لندن

الشركة الأهلية للاسمنت المساهمة
الإدارة العامة
وارد خارجي
التاريخ /
الموافق / 2009.01.19
رقم القيد / 158
المرفقات /
المستلم / ...... التوقيع /

المكتب الشعبي للجماهيرية العربية الليبية الشعبية الاشتراكية العظمى – لندن – الشئون الثقافية Cultural Affairs – London – The People's Bureau of the Great Socialist People's Libyan Arab Jamahiriya

صورة إلى:
ملف الطالب.

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Appendix Three

Permission letter from General Director of Administration and Finance of Ahlia Cement Company for Yusef Y Masoud to do a field study.

الجماهيرية العربية الليبية الشعبية الاشتراكية العظمى

الشركة الأهلية للإسمنت المساهمة

شركة مساهمة ليبية

الفاتح ابدا

42/2/2

258

التاريخ: 19 / 1 / 1377 و.ر

الموافق: 19 / 1 / 2009م

Permission letter from General Director of Administration and Finance of Ahlia Cement Company for Yusef Y Masoud to do Field study

الإخوة / المدراء العامون لمصانع الإسمنت

بعد التحية ....

بناء على تأشيرة الأخ / رئيس مجلس الإدارة-المدير العام للشركة نحيل إليكم صورة من رسالة الأخ / المستشار الثقافي بالمكتب الشعبي الليبي بلندن بشأن مساعدة الطالب / يوسف يخلف مسعود يخلف أحد الطلبة الموفدين للدراسة بالساحة البريطانية للحصول على بعض المعلومات التي تفيده في مجال بحثه لنيل شهادة الدكتوراه في مجال الاقتصاد .

وذلك لإمكانية المساعدة...

والسلام عليكم ورحمة الله وبركاته ..

حسن خليفة شلبه

مدير عام الإدارة العامة للشئون

الإدارية والمالية

صورة إلى

مدير إدارة القوى المنتجة.

الصادر الداخلي.

(ع.ح. قناو المزوغي)

Appendix Four

Confirmation letter from Director of Scholarships in Libya to give Yusef Y Masoud permission to do field study.

الجماهيرية العربية الليبية الشعبية الاشتراكية العظمى

اللجنة الشعبية العامة للتعليم العالي

المعرفة حق طبيعي لكل انسان

الرقم الإشاري: ت د ع / 2131

التاريخ: 4 / 3 / 2009

الموافق: / /

Confirmation letter from Director of Scholarships in Libya to give Yusef Y Masoud Permission to do field study.

الأخ / الملحق الثقافي بالمكتب الشعبي - لندن.

تحية طيبة وبعد،،،

بالاشارة الى مراسلاتكم بشأن الموافقة على الدراسة الحقلية للطلبة الدارسين بالساحة البريطانية وعددهم **(13)** طالب وطالبة يبدأ باسم / أبوالقاسم على أبوالقاسم الربو وينتهي باسم / **يوسف يخلف** مسعود **يخلف**.

عليـــــه،،،

نفيدكم بالموافقة على إجراء الدراسة الحقلية ولمدة شهر واحد وفق اللائحة

والسلام عليكم ورحمة الله وبركاته.

د . محمد عزالدين بن عثمان

مدير إدارة البعثات الدراسية

صورة إلى:
- الأخ / الأمين المحترم
- الشؤون الإدارية والمالية
- مدير مكتب المتابعة والتفتيش
- وحدة الإعداد والتجهيز
- الملف الشخصي

Appendix Five

An environmental perspective for Libya (the prospect for the Blue Plan between 2010- 2025)

1. Introduction

The objective of this study called the Blue Plan scenarios was to provide an environmental perspective on Libya's prospects for the years 2010-2025. The plan is concerned with industrial and environmental development and understanding how best to exploit Libyan natural resources and to discover whether the Libyan government is going in the right or wrong way in using oil, agricultural land, coastal land, marine wealth and forest and also if these natural resources can generate revenue or community value for future generations .

The method followed is the scenario style, or followed the scenes and the BLUE Plan provides two kinds of scenarios, the first one, a directional scenario and the second being alternative scenarios.

2. Directional Scenarios

Directional scenarios show the consequences of continuing current development and assumes there are no severe disruptions, or movement away from two key strategic positions: to continue to reducing the role of crude oil exports as source of income and to give priority to other sectors as agriculture and industry; and, secondly to achieve self-sufficiency in food production.

2.1. The first directional scenario: This scenario is based on the premise of the current direction relating to population growth, distribution, urbanization, agriculture, industry, transport and the continuing international economic relations which had been established between the southern countries, in particular the economic relations between Libya and its neighbours, so that they remain as before without with any change.

2.2. The second directional scenario: This scenario is based on the premise to achieve economic and industrial growth slowly, (growth rates relatively less than what is being achieved).

2.3. The third directional scenario: this scenario is based on the assumption of achieving strong economic growth (growth rates relatively stronger than they are already). There might well be noticeable problems for the environment. The large growth in population and industry should be accompanied by a similar increase in food production.

3.1. Strategic direction for development and possible development in the prospects for the year 2010-2025

In summary, the three scenarios and their individual implications are as follows:

	First directional scenario	Second directional scenario	Third directional scenario	Supporting Data Tables
The structure of GDP:	According to this scenario it is expected that the value of GDP in 2010 will reach 26035.46 Million Libyan Dinars, while in 2025 it is expected to be 4130.74 Million Libyan Dinars.	According to this scenario it is expected that the value of GDP in 2010 which reach 23897.41 Million Libyan Dinars, whereas it is expected to be worth 39166.69 Million Libyan Dinars in 2025.	According to this scenario the value of GDP is expected to reach 28173.51 Million Libyan Dinars in 2010, while it is expected to be worth 43442.79 Million Libyan Dinars in 2025.	1 and 2
The population:	According to this scenario, population is expected to reach population 6.4 million in 2010, while it is expected to be 8.6 million in 2025.	According to this scenario, population is expected to reach 6420.81 thousand people in 2010 while it is expected to reach in 2025 to reach 7.9 million in 2025	According to this scenario population is expected to reach the 6.5 million in 2010, while it is expected to be 8.1 million in 2025.	3 and 4
National productive work force:	According to this scenario the national productive workforce is expected to reach 1659.154 thousand in 2010, while it is expected to reach 2289.221 thousand people in 2025.	According to this scenario the national productive workforce is expected to reach 1642.512 thousand people in 2010, while it is expected to reach 2272.78 thousand people in 2025.	According to this scenario the national productive workforce is expected to reach 1675.795 thousand people in 2010, while it is expected to reach 2306.063 thousand people in 2025.	3 and 4

Non national productive work force	According to this scenario non national productive workforce is expected to reach 146.417 thousand people in 2010, while it is expected to reach 146.903 thousand people in 2025.	According to this scenario, the non national workforce in 2010 is expected to reach 144.569 thousand people, while expected to be worth in 2025 to reach 145.054 thousand people.	According to this scenario the non national productive workforce is expected to reach 148.265 thousand people in 2010, while it is expected to reach 148.271 thousand people in 2025.	3 and 4
The use of employment:	According to this scenario it is expected that the number of people in employment in all economic sectors in 2010 will be about 1893.096 thousand people, while it is expected to reach 2596.579 thousand people in 2025.	According to this scenario it is expected that the number of people in employment in all economic sectors in 2010 will be nearly 1861.999 thousand people, while it is expected to reach 2565.481 thousand people in 2025.	According to this scenario it is expected that number of people in employment in all economic sectors in 2010 will be nearly 1924.194 thousand people, while it is expected to reach 2627.676 thousand people in 2025.	5 and 6
Oil derivatives:	According to this scenario the production of oil derivatives in 2010 is expected to be valued at 22688.08 million Libyan Dinars, while it is expected to be worth in 2025 to 27005.29 million Libyan Dinars. The consumption of oil derivatives is expected to reach in 2010 the value of 12270.88 million Libyan Dinars, while it is also expected to be worth 15969.4 million Libyan Dinars in 2025	According to this scenario production of oil derivatives is expected to be valued at 21661.15 million Libyan Dinars in 2010, while it is expected to be worth 27005.29 million Libyan Dinars in 2025, The consumption of oil derivatives is expected to reach 12228.77 million Libyan Dinars in 2010, and it is expected to be worth 15495.29 million Libyan Dinars in 2025.	According to this scenario production of oil derivatives in 2010 will be to the value of 23715.01 million Libyan Dinars, while it is expected to be worth 29059.15 million Libyan Dinars in 2025, The consumption of oil derivatives is expected to reach 13176.99 million Libyan Dinars in 2010 and it is expected to be worth 16443.5 million Libyan Dinars in 2025.	7 and 8 9 and 10

Agricultural production and livestock:	According to this scenario agriculture and livestock production is expected to reach 4695.986 million Libyan Dinars in 2010 while it is expected to be worth 5551.039 million Libyan Dinars in 2025.	According to this scenario agricultural and livestock production is expected to reach 3050.539 million Libyan Dinars in 2010, while it is expected to be worth 4705.592 million Libyan Dinars in 2025.	According to this scenario agricultural and livestock production in 2010 is expected to reach 5541.433 million Libyan Dinars, while it is expected to be worth 6396.486 million Libyan Dinars in 2025	11 and 12
Production of industrial goods:	According to this scenario the production quantity of industrial goods in 2010 is expected to reach 944.9786 million Libyan Dinars, while in 2025 it is expected to be worth 659.9964 million Libyan Dinars.	According to this scenario the production quantity of industrial goods in 2010 is expected to reach 739.1244 million Libyan Dinars while it is expected to be worth 454.1422 million Libyan Dinars in 2025.	According to this scenario production quantity of industrial goods in 2010 is expected to reach 1150.833 million Libyan Dinars while it is expected to be worth 865.85 million Libyan Dinars in 2025.	13 and 14

There are approximately 2.3 Libyan Dinars to one UK pound.

Table Number (1): Expectations of GDP and economic sectors by Million Libyan Dinars, according to in 2010.

Economic Activities	First directional scenario	Second directional scenario	Third directional scenario
Agriculture, forestry and fishing.	3249.929	3102.163	3397.694
Oil extract and natural gas.	8165.75	6937.247	9394.253
Mining and other quarrying.	426.4964	386.438	466.5549
Manufacturing industries.	1112.786	1009.029	1216.543
Electricity and natural gas.	444.6286	438.2233	451.0339
Construction.	1433.268	1286.098	1580.437
Trade, restaurants and hotels.	320.146	3079.042	3329.251
Transport, transportation and storage.	2021.829	1989.114	2054.544
Finance, insurance and real estate.	702.9964	651.3223	754.6705
Home ownership.	718.3321	704.3152	732.249
General services.	1269.914	1216.205	1323.624
Educational service.	1616.854	1542.283	1691.424
Health Services.	1025.689	966.5691	1084.809
Other service.	642.8393	589.3585	696.3201
Total of GDP	26033.46	23897.41	28173.51

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (2): Expectations of GDP and economic sectors by Million Libyan Dinars, according to in 2025.

Economic Activities	First directional scenario	Second directional scenario	Third directional scenario
Agriculture, forestry and fishing.	5710.196	5562.431	5857.962
Oil extract and natural gas.	13669.88	12441.37	14898.38
Mining and other quarrying.	685.9786	645.9201	726.037
Manufacturing industries.	1326.089	1222.332	1429.846
Electricity and natural gas.	676.8964	670.4911	683.3017
Construction.	2263.857	2116.688	2411.027
Trade, restaurants and hotels.	5155.879	5030.774	5280.983
Transport, transportation and storage.	3099.096	3066.381	3131.811
Finance, insurance and real estate.	1099.229	1047	1150.903
Home ownership.	1038.118	1024.101	1052.132
General services.	1301.236	1247.526	1354.945
Educational service.	2568.121	2493.551	2642.692
Health Services.	1758.261	1699.141	1817.381
Other service.	951.9107	898.4299	1005.392
Total of GDP	41304.24	36166.69	43442.79

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (3): The Expectations of Libyan population and labour by thousands in 2010.

Serial number		First directional scenario	Second directional scenario	Third directional scenario
1	population	6493.696	6420.81	6566.583
2	National productive forces	1659.154	1642.512	1675.795
3	Non National productive forces	146.4176	144.5693	148.2659

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

.

Table Number (4): Expectations of Libyan population and labour by thousands in 2025

Serial number		First directional scenario	Second directional scenario	Third directional scenario
1	population	8067.179	7994.292	8140.065
2	National productive forces	2289.421	2272.78	2306.063
3	Non National productive forces	146.9026	145.0543	148.7509

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (5): Expectations of people in employment by thousands in 2010

Economic Activities	First directional scenario	Second directional scenario	Third directional scenario
Agriculture, forestry and fishing.	288.8821	286.9336	290.8306
Oil extract and natural gas.	75.38214	70.75529	80.00899
Mining and other quarrying.	16.83214	16.5267	17.13758
Electricity and natural gas.	258.0143	253.9322	262.0963
Construction.	53.52143	53.24873	53.79413
Trade, restaurants and hotels.	315.9786	311.4686	320.4885
Transport, transportation and storage.	65.80714	61.78986	69.82443
Finance, insurance and real estate.	207.8536	203.328	212.3792
Home ownership.	52.23571	51.4625	53.32517
General services.	136.925	135.7328	138.1172
Educational service.	233.0464	230.8796	235.2133
Health Services.	107.675	106.7831	108.5669
Other service.	80.94286	79.47407	82.41164
Total of GDP	1893.096	1861.999	1924.194

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (6): Expectations of people in employment by thousands, in 2025.

Economic Activities	First directional scenario	Second directional scenario	Third directional scenario
Agriculture, forestry and fishing.	366.1679	364.2194	368.1164
Oil extract and natural gas.	129.1679	124.541	133.7947
Mining and other quarrying.	23.61786	23.31242	23.9233
Electricity and natural gas.	388.5857	384.5037	392.6678
Construction.	72.62857	72.35587	72.90127
Trade, restaurants and hotels.	465.2464	460.7365	469.7564
Transport, transportation and storage.	64.09286	60.07557	68.11.14
Finance, insurance and real estate.	312.3714	307.8458	316.897
Home ownership.	82.78929	81.69983	83.87875
General services.	165.175	163.9828	166.3672
Educational service.	289.1536	286.9867	291.3204
Health Services.	141.05	140.1581	141.9419
Other service.	96.53214	95.06336	98.0093
Total of GDP	2596.579	2565.481	2627.676

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (7): **Expectations of domestic production of oil derivatives by millions of Libyan Dinars in 2010**

Serial number	**Local production of oil derivatives**	**First directional scenario**	**Second directional scenario**	**Third directional scenario**
1	Liquefied gas	6493.696	6420.81	6566.583
2	Gas	1050.836	1006.146	1095.525
3	Aviation	3000.543	2688.534	3312.525
4	Gas oil	5076.543	4880.391	5272.695
5	A heavy fuel oil	7066.461	6665.265	7467.656

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (8): Expectations of domestic production of oil derivatives by millions of Libyan Dinars in 2025

Serial number	**Local production of oil derivatives**	**First directional scenario**	**Second directional scenario**	**Third directional scenario**
1	Liquefied gas	8067.179	7994.292	8140.065
2	Gas	1449.889	1405.2	1494.579
3	Aviation	4743.757	4431.748	5055.766
4	Gas oil	6714.132	6517.98	6910.284
5	A heavy fuel oil	7057.264	6656.069	7458.46

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (9): Expectations of domestic consumption for oil derivatives by millions of Libyan Dinars in 2010

Serial number	**The domestic consumption of oil derivatives**	**First directional scenario**	**Second directional scenario**	**Third directional scenario**
1	Liquefied gas	482.6964	480.5079	484.885
2	Gas and Aviation fuel.	8067.179	7994.292	8140.065
3	Gas oil	6452.207	6283.365	6621.05
4	A heavy fuel oil	967.3143	7371.1257	1197.504

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (10): Expectations of domestic consumption for oil derivatives by millions of Libyan Dinars in 2025

Serial number	**The domestic consumption of oil derivatives**	**First directional scenario**	**Second directional scenario**	**Third directional scenario**
1	Liquefied gas	349.3039	347.115	351.4921
2	Gas and Aviation fuel.	6493.696	6420.81	6566.583
3	Gas oil	4416.743	4247.9	4585.585
4	A heavy fuel oil	1443.136	1212.946	1673.325

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table number (11): Expectations of the agricultural production and livestock by millions of Libyan Dinars in 2010

Serial number	The agricultural production and livestock	First directional scenario	Second directional scenario	Third directional scenario
1	The grain	218.8929	119.3195	318.4662
2	The vegetable	1054.379	989.9132	1118.844
3	The fruits	406.0643	356.841	455.2876
4	The olive	117.6786	94.00465	141.3525
5	The meat	61.37286	9.57699.8	113.1087
6	Milk	21.44643	-55.7836	98.67644
7	Egg	-6.60357	-409.174	395.9664
8	Honey	2822.786	2745.841	2899.731

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table number (12): Expectations of the agricultural production and livestock by millions of Libyan Dinars in 2025

Serial number	The agricultural production and livestock	First directional scenario	Second directional scenario	Third directional scenario
1	The grain	208.3571	108.7838	307.9305
2	The vegetable	989.1464	924.681	1053.612
3	The fruits	383.3857	334.1924	432.609
4	The olive	83.57143	59.89751	107.2453
5	The meat	-28.9429	-80.7087	22.823
6	Milk	-176.071	-253.301	-98.8414
7	Egg	-725.121	-1127.69	-322.551
8	Honey	4816.714	4739.769	4893.659

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table number (13): Expectations of production quantity of industrial goods by millions Libyan Dinars in 2010

Serial number	The production quantity of industrial goods	First directional scenario	Second directional scenario	Third directional scenario
1	Grinding of grain and semolina	287.1786	245.8956	3228.4616
2	The vegetables and fruits	4.45	-0.24105	9.141052
3	Feed	651.5	497.095	805.905
4	Salt	12.65357	10.58132	14.72582
5	Detergent powder	-10.8036	-14.2065	-7.40066

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

Table Number (14): Expectations of production quantity of industrial goods by millions Libyan Dinars in 2025

Serial number	The production quantity of industrial goods	First directional scenario	Second directional scenario	Third directional scenario
1	Grinding of grain and semolina	108.0714	66.78841	149.3544
2	The vegetables and fruits	-20175	-6.86605	2.516052
3	Feed	586.5	432.095	740.905
4	Salt	10.67143	8.599177	12.74368
5	Detergent powder	-43.0714	-46.4743	-39.6685

Source: (Anon, 1974e) and Department of Statistics (1974-2025)

5. Conclusion of these scenarios about development impact on the environment for the years 2010-2025

These directions are aimed at advancing our knowledge of what might result from the economic policy for development. Pollution arising from industrial development in general, and, the cement industry in particular being of interest. It can be noted that the future scenarios (obviously) all consider more reliance on industry, construction, quarrying and house building, all of which will lead to an increase in the demand for cement from Libyan local cement plants.

5.1. Conclusion of first directional scenario: According to this scenario, it is noted that sectors which depend on the cement industry, including cement industry, transport industry and construction sector, will reach 1138.30 million Libyan Dinars in 2010, and expected industrial production will reach 16619.3716 million Libyan Dinars in 2025. This growth would be a big problem in a country like Libya as pollution from industry in general especially from the cement industry in Libya, will increase to high levels by this estimate and perception. Other pressures on pollution will come from the demand for housing which will be in great demand and hotels if, and when, a viable tourist industry develops. Further clarification can be found in Tables 1 and 2 in this appendix.

The value of the manufacturing deficit excluding education and health is expected to reach 382.96968 million Libyan Dinars in 2010, while it is expected to be in this value of 808.49178 million Libyan Dinars in 2025. Also it is expected that employment in the services sector and trade, restaurants, hotels and all public services (except health) will be reduced to 31.047 thousand workers in 2010, while a shortfall reaching 65.544 thousand workers is expected in 2025.

The agricultural and livestock production is expected to be in deficit to 2010 reaching 1833.2926 million Libyan Dinars, while it is expected to be in the value of 3870.2847 million Libyan Dinars in 2025. The production of industrial goods is expected to be in deficit in 2010 estimated to be 591.572 million Libyan Dinars, while in 2025 the deficit is estimated to be 1248.8745 million Libyan. The production of oil derivatives is expected to reach 1981.4226 million Libyan Dinars from 2010 to 2025, while the deficit of derivatives production is expected to reach 4183.00471 million Libyan Dinars in 2025 as the consumption of these products will be go down by 9863.5716 million Libyan.

5.2. Conclusion of second directional scenario: According to this scenario the GDP contribution of industries such as cement, the construction sector, mining and quarrying is expected to be 2681.565 million Libyan Dinars in 2010 which in 2025 is expected to reach 3894.9401. According to estimates in this scenario, it also shows that the rate of pollution will increase from the cement industries and other industries in Libya.

It is also expected that, while it may not be possible to achieve the expected value of manufacturing industries, in the public services it is expected that education and health in 2010 will reach 509.39353 million Libyan Dinars and 934.91563 million Libyan Dinars in 2025. The same is true of other sectors such as commerce, other service industries, restaurants, hotels and all public services particularly the health sector to have 33.781 thousand workers in 2010 while the shortage in 2025 is expected to reach 68.242 thousand workers. Agriculture and livestock production is expected to meet with a deficit of 250.1922 million Libyan Dinars in 2010, while this value in 2025 is expected to be 4597.1843 million Libyan Dinars. Furthermore the production of industrial goods is expected to face a deficit of 780.17978 million Libyan Dinars in 2010. This is expected to reach 1437.4822 million Libyan Dinars in 2025. The production of oil derivatives may not reach the value of 2281.0632 million Libyan Dinars in 2010 due to lower consumption of these derivatives in the same year by 11543.4926 million Libyan Dinars, while in 2025; it is expected to reach 4482.6447 million Libyan Dinars with the consumption of these products going down by 2209.233 million Libyan Dinars.

5.3.Conclusion of third directional scenario : It is noted that in this scenario the forecasts of GDP share of the industries in Libya , comprising the cement industry , construction sector and quarrying in 2010 would be 3263.5369 , while in 2025 it is expected to be in the region of 4566.9150 which shows the rate of pollution in Libya will be on the rise so that the Libyan government should be looking to a policy which would help it to reduce the emission of pollution in line with the commitment of international treaties and conventions whilst it continues its ambitions and plans for its economic development .

It is also expected that the value of manufacturing industries and public service except education sector and health may not amount to 282.24319 million Libyan Dinars in 2010 while it is expected reach 682.0679 million Libyan Dinars in 2025. The total employment in the services sector, such as restaurants, hotels, and all public services except the health sector is expected to reach 68.350 thousand works in 2010, while it is expected to face a shortage of 5500 workers in the same sectors in 2025. The deficit value of the agricultural and livestock production is expected to reach to 1129.5132 million Libyan Dinars in 2010, while it is expected to be 3143.3851 million Libyan Dinars in 2025. Further the production of industrial goods with a deficit is expected in 2010 to reach 402.064 million Libyan Dinars in 2010, which in 2025 it is expected to be 1060.2668 million Libyan Dinars.

The production of oil derivatives in 2010 may reach the total value of 1681.782 million Libyan Dinars, with a low consumption of these derivatives in the same year amounting 746.83974 million Libyan Dinars, while in 2025 the deficit value of derivatives production is expected to reach 3883.3635 million Libyan Dinars, and with the consumption of these products going down to reach a total of 1802.5802 million Libyan Dinars.

Appendix Six

Unite root testes for data of Zileten Cement Plant (Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic)

Null Hypothesis: LCP1 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.485881	0.0875
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP1) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.459165	0.0003
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP1) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.833604	0.0001
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LRM1) has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.384426	0.0000
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LRM1) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.134355	0.0000
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LD1) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.802337	0.0013
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LD1) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.964918	0.0044
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: MP1 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-55.00739	0.0001
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(MP1) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-43.18995	0.0001
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: TC1 has a unit root

Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-16.80174	0.0001
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TC1) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.59047	0.0000
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LTC1 has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.109118	0.0421
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LTC1 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.345904	0.0876
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LTC1) has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.842629	0.0000
Test critical values:	1% level	-3.831511	

	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LTC1) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.819207	0.0000
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Appendix Seven

Unite root testes for data of Libda Cement Plant (Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic)

Null Hypothesis: CP2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.930013	0.0464
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CP2) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.856008	0.0822
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CP2) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.847962	0.0055
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.665962	0.0159
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LD2 has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.727673	0.0978
Test critical values:	1% level	-4.121990	
	5% level	-3.144920	
	10% level	-2.713751	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LD2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.20965	0.0000
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LD2) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.935580	0.0000
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RM2 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.544817	0.0615
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(RM2) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.926697	0.0000
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	

	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(RM2) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.982704	0.0000
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LMP2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.530161	0.0049
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LMP2) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.611777	0.0013
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LMP2) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.601935	0.0088
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: TC2 has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.688110	0.0205
Test critical values:	1% level	-4.121990	
	5% level	-3.144920	
	10% level	-2.713751	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TC2) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.806204	0.0795
Test critical values:	1% level	-3.920350	
	5% level	-3.065585	
	10% level	-2.673459	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TC2) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.661593	0.0078
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Appendix Eight

Unite root testes for data of Suk El-Khamis Cement Plant (Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic)

Null Hypothesis: LCP3 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.046835	0.0007
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP3) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.716944	0.0011
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP3) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.595920	0.0089
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RM3 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.412240	0.0780
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(RM3) has a unit root
Exogenous: Constant

Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.794336	0.0000
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(RM3) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-10.80700	0.0000
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(D3) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.558364	0.0022
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(D3) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.998970	0.0041
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: TC3 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.618685	0.0149
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	

	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: TC3 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.136997	0.0202
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TC3) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.813897	0.0000
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LMP3 has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.436934	0.0292
Test critical values:	1% level	-4.057910	
	5% level	-3.119910	
	10% level	-2.701103	

*MacKinnon (1996) one-sided p-values.

Appendix Nine

Unite root testes for data of El-Mergheb Cement Plant (Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic)

Null Hypothesis: LCP4 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.901162	0.0318
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP4) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-10.59814	0.0000
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP4) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-14.39635	0.0001
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RM4 has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.158249	0.0047
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LRM4 has a unit root
Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.859961	0.0049
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LRM4) has a unit root
Exogenous: Constant
Bandwidth: 18 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-19.03968	0.0000
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LRM4) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 18 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-18.30498	0.0001
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LD4) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.419882	0.0029
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LD4) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.323997	0.0022
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LTC4 has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.947453	0.0668
Test critical values:	1% level	-4.057910	
	5% level	-3.119910	
	10% level	-2.701103	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LTC4 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.575444	0.0771
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LTC4) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.735995	0.0989
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LCP4 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.901162	0.0318
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP4) has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West using Bartlett kernel)

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-10.59814	0.0000

Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LCP4) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 9 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-14.39635	0.0001
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Appendix Ten

Unite root testes for data of Ahlia Cement Company (Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic)

Null Hypothesis: CP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.769053	0.0010
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CP) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.495407	0.0015
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(CP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.031652	0.0038
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: RM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.483404	0.0702
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(RM) has a unit root
Exogenous: Constant

Lag Length: 1 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.619240	0.0003
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(RM) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 13 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.26244	0.0000
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(D0) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.295097	0.0038
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(D0) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.511758	0.0104
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: MP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.769054	0.0010
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(MP) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.495407	0.0015
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(MP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.031652	0.0038
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: TC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.578565	0.0579
Test critical values:	1% level	-4.498307	
	5% level	-3.658446	
	10% level	-3.268973	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TC) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.103260	0.0001
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: TC has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-3.530876	0.0631

Test critical values:	1% level	-4.498307
	5% level	-3.658446
	10% level	-3.268973

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TC) has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.519882	0.0000
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TC) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.104526	0.0000
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

*MacKinnon (1996) one-sided p-values.

Appendix Eleven

Production function in Zileten Cement factory, 1988-2008.

Dependent Variable: CP1
Method: Least Squares
Date: 12/20/11 Time: 17:59
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4116601.	4137417.	-0.994969	0.3329
RM1	13.19115	3.305384	3.990809	0.0009
D1	4.316072	0.590154	7.313472	0.0000

R-squared	0.816683	Mean dependent var	26985652
Adjusted R-squared	0.796315	S.D. dependent var	18050583
S.E. of regression	8146503.	Akaike info criterion	34.79564
Sum squared resid	1.19E+15	Schwarz criterion	34.94486
Log likelihood	-362.3542	F-statistic	40.09532
Durbin-Watson stat	1.685557	Prob(F-statistic)	0.000000

Appendix Twelve

Production function in Libda Cement factory, 1988-2008.

Dependent Variable: CP2
Method: Least Squares
Date: 12/20/11 Time: 18:05
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1926851.	2686467.	0.717244	0.4824
RM2	11.31691	2.892315	3.912750	0.0010
D2	2.086649	0.377459	5.528143	0.0000

R-squared	0.837366	Mean dependent var	21680614
Adjusted R-squared	0.819296	S.D. dependent var	14911525
S.E. of regression	6338792.	Akaike info criterion	34.29384
Sum squared resid	7.23E+14	Schwarz criterion	34.44306
Log likelihood	-357.0853	F-statistic	46.33897
Durbin-Watson stat	1.771951	Prob(F-statistic)	0.000000

Appendix Thirteen

Production function in Suk El-Khamis Cement factory, 1988-2008.

Dependent Variable: CP3
Method: Least Squares
Date: 12/20/11 Time: 18:09
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4840540.	4614268.	1.049038	0.3080
RM3	9.890827	4.898067	2.019333	0.0586
D3	3.576237	0.781340	4.577053	0.0002

R-squared	0.714160	Mean dependent var	27278234
Adjusted R-squared	0.682400	S.D. dependent var	18793430
S.E. of regression	10591225	Akaike info criterion	35.32051
Sum squared resid	2.02E+15	Schwarz criterion	35.46973
Log likelihood	-367.8654	F-statistic	22.48616
Durbin-Watson stat	1.953856	Prob(F-statistic)	0.000013

Appendix Fourteen

Production function in El-Merghab Cement factory, 1988-2008.

Dependent Variable: LCP4
Method: Least Squares
Date: 12/20/11 Time: 18:16
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.125390	0.547016	3.885426	0.0011
LRM4	0.281583	0.083078	3.389371	0.0033
LD4	0.529159	0.095907	5.517402	0.0000

R-squared	0.809804	Mean dependent var	6.898781
Adjusted R-squared	0.788671	S.D. dependent var	0.261999
S.E. of regression	0.120443	Akaike info criterion	-1.263725
Sum squared resid	0.261115	Schwarz criterion	-1.114507
Log likelihood	16.26911	F-statistic	38.31950
Durbin-Watson stat	1.893057	Prob(F-statistic)	0.000000

Appendix Fifteen

Production function in Ahlia Cement factory, 1988-2008.

Dependent Variable: CP
Method: Least Squares
Date: 12/20/11 Time: 18:20
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5168330.	8327349.	-0.620645	0.5426
RM	14.33864	2.311866	6.202194	0.0000
D0	3.047358	0.339897	8.965533	0.0000

R-squared	0.911293	Mean dependent var	85478829
Adjusted R-squared	0.901437	S.D. dependent var	56722473
S.E. of regression	17807878	Akaike info criterion	36.35974
Sum squared resid	5.71E+15	Schwarz criterion	36.50896
Log likelihood	-378.7773	F-statistic	92.45792
Durbin-Watson stat	1.890489	Prob(F-statistic)	0.000000

Appendix Sixteen

Results of the emission function with raw material and the technology cost at Zileten Cement Factory during 1988-2008

Dependent Variable: MP1
Method: Least Squares
Date: 12/21/11 Time: 19:50
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5623924.8	788812.88	7.130	0.0000
RM1	1.711	0.468	3.655	0.0020

R-squared	0.800	Mean dependent var	3643063.
Adjusted R-squared	0.778	S.D. dependent var	0.13780.
S.E. of regression	1148769.5	Akaike info criterion	35.25498
Sum squared resid	2.4E+013	Schwarz criterion	35.56875
Log likelihood	274.94525	F-statistic	35.99721
Durbin-Watson stat	1.815	Prob(F-statistic)	0.000000

Dependent Variable: MP1
Method: Least Squares
Date: 12/21/11 Time: 20:10
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5448463.7	1095282.8	4.974	0.0000
TC1	-0.933	0.380	-2.454	0.0000

R-squared	0.739	Mean dependent var	3643063.
Adjusted R-squared	0.710	S.D. dependent var	1245244.
S.E. of regression	1312603.4	Akaike info criterion	25.32659
Sum squared resid	3.1E+013	Schwarz criterion	25.72569
Log likelihood	325.54986	F-statistic	25.465
Durbin-Watson stat	1.604	Prob(F-statistic)	0.000000

Appendix Seventeen

Results of the emission function with raw material and the technology cost at Libda Cement Factory during 1988-2008

Dependent Variable: MP2
Method: Least Squares
Date: 12/21/11 Time: 22:45
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	40692.996	14076.857	2.891	0.16
RM2	0.165	0.048	3.440	0.006
TC2	-0.38	0.011	-3.458	0.006

R-squared	0.690	Mean dependent var	73387.375
Adjusted R-squared	0.535	S.D. dependent var	10445.336
S.E. of regression	12792.872	Akaike info criterion	37.32641
Sum squared resid	1.6E+009	Schwarz criterion	37.85642
Log likelihood	-366.2549	F-statistic	4.457000
Durbin-Watson stat	2.041	Prob(F-statistic)	0.000000

Appendix Eighteen

Results of the emission function with raw material and the technology cost at Suk El-Khamis Cement Factory during 1988-2008

Dependent Variable: MP3
Method: Least Squares
Date: 12/20/11 Time: 23:06
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1464708.	8099890.52	-1.808	0.108
RM3	6.690	0.762	8.781	0.0000
TC3	-0.112	0.060	-1.875	0.098

R-squared	0.910	Mean dependent var	5090100.
Adjusted R-squared	0.887	S.D. dependent var	858986.0
S.E. of regression	960375.64	Akaike info criterion	38.25469
Sum squared resid	7.4E+012	Schwarz criterion	38.52148
Log likelihood	377.22254	F-statistic	40.291
Durbin-Watson stat	1.970	Prob(F-statistic)	0.000000

Appendix Nineteen

Results of the emission function with raw material and the technology cost at El-Mergheb Cement Factory during 1988-2008

Dependent Variable: MP4
Method: Least Squares
Date: 12/20/11 Time: 23:18
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-926085.8.	541512.94	-1.710	0.108
RM4	3.640	1.473	2.471	0.026
TC4	-2.601	1.270	-2.048	0.059

R-squared	0.870	Mean dependent var	1277821.6
Adjusted R-squared	0.826	S.D. dependent var	294214.65
S.E. of regression	339729.81	Akaike info criterion	40.251689
Sum squared resid	1.7E+012	Schwarz criterion	40.325468
Log likelihood	358.26895	F-statistic	20.030
Durbin-Watson stat	1.840	Prob(F-statistic)	0.000000

Appendix Twenty

Results of the emission function with raw material and the technology cost at Ahlia Cement Company during 1988-2008

Dependent Variable: MP
Method: Least Squares
Date: 12/20/11 Time: 23:31
Sample: 1988 2008
Included observations: 21

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3767148.3	6018021.0	-0.626	0.541
RM	-17.036	6.683	-2.549	0.023
TC	7.536	2.537	2.970	0.010

R-squared	0.600	Mean dependent var	13094157
Adjusted R-squared	0.457	S.D. dependent var	5491275.8
S.E. of regression	6397142.7	Akaike info criterion	39.654897
Sum squared resid	5.7E+014	Schwarz criterion	39.896471
Log likelihood	340.52789	F-statistic	4.202
Durbin-Watson stat	2.252	Prob(F-statistic)	0.015