OPERATIONAL RESEARCH DEVELOPMENT
IN A NEWLY INDUSTRIALISED COUNTRY:
A STUDY OF THE CURRENT STATUS AND DIFFUSION OF O.R.
IN THE UNITED ARAB EMIRATES WITH AN O.R. APPROACH
TO STRATEGIC PLANNING

by

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ABSTRACT

This thesis is concerned with the evaluation of the current status of Operational Research practice, training and education and the diffusion of O.R. in a newly industrialised and developing country, the United Arab Emirates (U.A.E.). The purpose of such evaluation is to explore the level of O.R. awareness, to discover the extent of acceptance and implementation of O.R. techniques and the adequacy of training and education in O.R. Further it attempts to identify the barriers to the wide adoption of O.R./M.S. techniques in the industrial and business organisations and companies in particular, and to determine the basic requirements for O.R. development. In the course of this exploration new information is revealed regarding the U.A.E. industrial and business organisations in relation to O.R. awareness, usage, and willingness of personnel to use O.R., as well as strategies of training in O.R., barriers to its wide acceptance and characteristics of O.R. suitable for decision makers' needs and the environment in the U.A.E.

As a means of demonstrating the advantages and values of O.R. techniques, the U.A.E. cement industry is taken as a case study. The aim of this case study is not to produce the best solution to the problem of the cement industry, rather it produces one possible way of approaching this problem, and to demonstrate the application of some O.R. techniques (e.g. scenario analysis, statistical analysis, multi-attribute decision model, and cost-benefit analysis.) on a macro-level in the hope that such application might motivate the wide use of O.R. in the future.

Two research techniques were adopted in this research. The first one is the survey method where personally administered questionnaires were used, and the second one is the case study method.

The thesis concluded that the level of O.R. awareness and usage in the U.A.E. industrial and business organisations in particular is very low, that O.R. education and training are inadequate, that many problems serve as barriers to the wide adoption of O.R. in the industrial and business organisations in the U.A.E., and that some basic requirements have to be met so that O.R. can develop further. It is also concluded that the most feasible solution to the problem of the U.A.E. cement industry is to cut the current level of capacity by 50 percent and suggested one possible way of implementing this solution.

In carrying out this research, some problems were encountered due to a lack of statistical and micro and macro data, insufficient materials and the like.

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List of Abbreviations

U.A.E.	:	The United Arab Emirates
DH	:	Dirham (The UAE currency)
GNP	:	Gross National Product
GDP	:	Gross Domestic Product
GFCF	:	Gross Fixed Capital Formation
DC	:	Demand for cement
GCC	:	Gulf Co-operation Council
AGCC	:	Arab Gulf Co-operation Council
OPEC	:	Organisation of Petroleum Exporting Countries
OECD	:	The Organisation for Economic Co-operation and Development
OR	:	Operational Research (Operations Research)
MS	:	Management Science
EEC	:	European Economic Council
EIU	:	The Economist Intelligence Unit
MEED	:	Middle East Economic Digest
BP	:	British Petroleum
macls	:	megacalories (10^{10} calories)
mtoe	:	million tons of oil equivalent
toe	:	tons of oil equivalent
UN	:	United Nations
sq.km.	:	square kilometer
CMF	:	Cement Makers Federation
GOIC	:	Gulf Organisation for Industrial Consulting

CHAPTER ONE INTRODUCTION

1.1 Motivation for the Study.

1.2 Statement of Research Problems.

1.3 Approach of the Study.

1.4 Organisation of the Study.

CHAPTER 1 INTRODUCTION

1.1 Motivation for the Study

Prior to discussing the motivation behind this study, it would be useful to outline its main objectives. These are:

(i) to establish the extent to which O.R. techniques have been adopted and implemented in the industrial and business organisations in the U.A.E.

(ii) to promote the wide adoption of O.R. in the U.A.E. This is carried out through investigating the needs of the decision makers and the characteristics of the environment in the country and in turn suggesting techniques which can be easily adopted.

(iii) to investigate the problems which hinder the wide adoption of O.R. in the U.A.E. in general and in the industrial and business organisations in particular.

(iv) to determine the main requirements necessary for securing internal and environmental conditions leading to O.R. development in the U.A.E.´s industrial and business organisations.

(v) to demonstrate where O.R./M.S. techniques can or can not be used. This is done through investigating the problem of the cement industry to see whether O.R. can be applied or not.

(vi) to direct the education of O.R. in the U.A.E. toward serving its practice through concentrating on the techniques that suit decision makers with little experience in O.R. techniques.

(vii) to develop a systematic and comprehensive procedure for capacity planning which can deal with problems of the nature "What happens if...?".

(viii) to suggest one way of solving a real life problem which will demonstrate where O.R. can be successful in the U.A.E.

Now attention is paid to the motivation behind this study.

(i) It is well known that most developing countries, and the U.A.E. in particular, have rushed toward industrialisation as a means of diversifying their economies, especially in the last few years. Such action has created many managerial as well as social and economic problems. These problems, especially the managerial ones, necessitate the use of scientific methods as opposed to the traditional ones (i.e. trial and error, common sense, subjective judgments ... etc.). An example of such a problem created by this rush toward industrialisation is the investment of a great deal of funds in a particular industry or sector at the expense of other industries or sectors, where the investment decision is typically based on short term market indicators.

(ii) Lack of previous published studies investigating the practice, education and training in O.R. in the U.A.E. has encouraged us to carry out such an investigation which might be the first of its type in the U.A.E., if not in the Gulf States.

(iii) As far as we know, there is no published use of O.R./M.S. techniques on a large scale or macro-level in the U.A.E. to solve managerial or other problems in the public and the private sectors, therefore it was decided to introduce the use of O.R. techniques to the U.A.E., since these techniques have been successful in the developed and some of the developing countries.

(iv) Western scholars have concentrated largely on developing sophisticated mathematical models, and algorithms for solving them which suit developed economies, while developing economies have been largely neglected. Consequently, we concentrated on developing a procedure which can be suited to the particular environments of developing countries and to decision makers' needs and experiences in O.R. techniques.

(v) Previous published work in the area of capacity planning concentrated largely on one aspect of the capacity problem: capacity expansion, or investment decisions, while other aspects such as divestment and rationalisation of capacity, have been given very little attention, although these latter ones are as important as the former. Therefore, here we are tackling this previously overlooked aspect of the problem.

(vi) An extensive survey of the published work in the area of capacity planning has revealed little evidence of implementation or management involvement. Almost all have been theoretical exercises with no proven application. Hence, this study is intended to be problem oriented, which is more appropriate for developing countries, in the sense that it deals with a problem which exists, rather than developing theoretical approaches which might or might not be applicable.

(vii) The traditional approach of O.R., (for example, mathematical models) has difficulty in handling strategic problems, and in turn there is a need for a less structured procedure to tackle the problem like that of the U.A.E. cement industry.

(viii) The U.A.E. cement industry is experiencing a crucial problem which threatens its future. It was decided that something had to be done to safeguard this vital industry.

Having examined briefly the main motivations behind this study, the next thing is to describe briefly the research problems.

1.2. Statement of Research Problems

In this section statement of research problems is given. Firstly, developing countries in general and the U.A.E. in particular look to industrialisation as a means of replacing the oil sector, especially after the dramatic fluctuation in the oil demand and in turn in its prices, and also as a means of national income diversification. Such a rush toward industrialisation is usually accompanied by several serious problems, examples of which might include, mis-allocating investment among competing projects, poor choices in production levels, transportation problems, quality control problems, plant location problems and the like. These types of problems necessitate the adoption of scientific methods which should include the use of O.R. techniques. Therefore, this study evaluates the current status of the practice, training and education of O.R. in the U.A.E. and demonstrates the application of some O.R. techniques in a real life problem in the U.A.E. in a systematic and comprehensive manner in the hope that such action might encourage the wide adoption of O.R. in the U.A.E.

Secondly, the obstacles which serve as impediments to the diffusion of O.R. in the industrial and business organisations and companies in the developing countries have been given little attention despite its enormous impact on O.R. development. Therefore in this research special attention is given to these obstacles, in particular in the industrial and business organisations and companies in the U.A.E.

Thirdly, the acceptance and implementation of O.R. techniques in the industrial and business organisations and companies in the U.A.E. in particular is subject to certain environmental and internal factors. These factors need to be investigated to see whether they have been met or not. Therefore, this study attempts to explore these factors and the level of their fulfilments in the industrial and business organisations in the U.A.E. context.

To sum up, this research is concerned with three main questions:

(i) To what extent is O.R. accepted and implemented in the U.A.E., particularly in the industrial and business organisations?

(ii) What are the main characteristics of O.R. techniques which are suitable for the U.A.E. environment and decision makers' needs and experience in O.R.?

(iii) What are the problems which have served as impediments to the widespsread use of O.R. in the industrial and business organisations in the U.A.E. and how can we convince industrialists and businessmen to accept and implement O.R.?

The Case Study

The problem which is used as a case study concerns excessive investment or overcapacity in the U.A.E. cement industry; which resulted from a great deal of investment being based on short term market indicators, and the motivation was a quick return on the investment.

Two decision making bodies exist on two separate levels. The first level consists of the authority in the Ministry of Industry which practices control over the whole industry, and the second level consists of the board of directors in each individual company. Decisions affecting the whole cement industry are taken by the authority in the Ministry of Industry through consultation with the board of directors in the individual companies. Decisions affecting individual companies are made either by the board of directors or senior managers depending on the significance of the decisions made about the future of the company.

The consequences of the problem of excess capacity are disastrous, especially in capital intensive industries like cement, and include among other things low capacity utilisation rate, and accordingly the waste of resources; excessive productions costs, and in turn low profitability, if any at all; and excessive inventories.

Alternative strategies or courses of action to tackle this problem will be discussed in chapter eight. The purpose of this case is to demonstrate the application of some O.R. techniques on a situation where there are self-evident problems as well as a number of possible solutions so that we can demonstrate the value of O.R. in a more convincing manner.

The next section summarises the approach of the study.

1.3 Approach of the Study

This section examines the approach used to achieve the objectives of this thesis.

The approach used is divided into two main parts. First, an exploratory part investigates O.R./M.S. techniques taught and more frequently used in the U.A.E., and also explores the problems hindering the widespread use of O.R. in the industrial and business organisations in particular. This aims to discover decision makers´ needs, their ability in and understanding of O.R./M.S. techniques and their willingness to use these techniques, and to find a way of promoting the wide use of O.R., especially in the industrial and business organisations. This was carried out through the use of questionnaires and personal interviews (survey method).

Secondly, an applied part demonstrates the application of a newly developed procedure to deal with capacity planning problems in the U.A.E. cement industry in a different way. This demonstration will show the application of some O.R./M.S. techniques in the U.A.E. in the light of decision makers´ needs, knowledge, and understanding of O.R./M.S. techniques and also the political, social and economic environment in the U.A.E. This was carried out through the investigation of procedures used to deal with such problems and the development and application of an appropriate procedure (case study method).

The procedure is based mainly on the concept of decision analysis or decision making under uncertainty. However the analytical tools within this procedure are somewhat different from that of decision analysis or decision making under uncertainty.

The application of the developed procedure consists of the following steps.

First, it investigates the environment of the system studied; this is done by utilising two types of analytical tools, namely, scenario analysis and econometric models. Secondly, alternative strategies are formulated with the help of the decision making body. Thirdly, scenario/strategy matrices are constructed utilising the outcomes of the previous two steps. Fourthly, strategies are evaluated against the chosen scenarios. Fifthly, the choice of an appropriate strategy is made based on quantitative and qualitative criteria. Finally, ways through which the chosen strategy is to be implemented are examined and the best methods of implementation are discussed.

This procedure tries to answer questions such as when to cut or expand capacity, where, by how much, and in what manner.

Its main features are summarised as follows.

(i) It is an integrated procedure, i.e. it consists of scenario analysis, statistical analysis, multiattribute decision making, and judgmental approach.

(ii) It requires less use of computing facilities and time than, for example, mathematical models and systems dynamic.

(iii) It is easy to understand and apply, and requires no specialists.

(iv) It deals with more than one future.

(v) It is appropriate for the decision makers' needs and knowledge of O.R.

(vi) It is based on 'soft O.R.' as opposed to technical or hard O.R.

(vii) It is flexible, i.e. it can deal with the problem of capacity expansion and capacity reduction and it is also less structured.

(viii) It is relevant to the problem at hand.

(ix) It is based on the concept of predictive methods which allow decision makers to explore the future and answer questions of the nature "what happens if ... ?"

(x) It gives more credit to forecasting which has been neglected by other research work which deals with capacity planning problems.

The reasons for not using mathematical programming and system dynamics modeling, the most favourable candidates for this sort of problem, are presented in chapter five, and are briefly summarised here.

(i) Mathematical models lack flexibility (i.e. they are well structured).

(ii) Mathematical models cannot cope with uncertainty which is greatly present in developing countries.

(iii) Mathematical models do not suit strategic problems due to the difficulty in formulating this sort of problem.

(iv) Mathematical models need a great deal of data which is either not available in developing countries or not reliable.

(v) The use of mathematical modeling requires a high degree of skill which is hardly available in Third World countries.

(vi) There is a chronic shortage of computing facilities and computer operators in developing countries in general and in the U.A.E. in particular, which are needed to run mathematical models.

In the same way, the use of systems dynamic modeling has been ruled out because of lack of skilled personnel, computing facilities, and the incapability of systems dynamic modeling to deal with uncertainty.

It should be noted here that a detailed discussion of the approach is given in chapter six.

Having outlined the approach of the study, next we highlight the organisation of the remaining chapters of this thesis.

1.4 Organisation of the Study

This section presents the organisation of the remaining chapters of the thesis.

Chapter two aims at providing the reader with a better understanding of the environment of the problem investigated.

This chapter examines the political and economic structure of the Federation as a whole and its member Emirates; the political, economic, and administrative unity of the Federation are also examined. Industrialisation and the industrial policy in the U.A.E. are examined, and finally, this chapter examines the ill-effects of the conflict of interests between the members of the Federation.

Chapter three investigates the practice and education of O.R. in the U.A.E. as well as the problems that hinder the wide adoption of O.R. in the U.A.E.

Chapter four aims at providing a historical review of the problems experienced by the system studied, the cement industry. First it outlines the technology of manufacturing cement used world-wide; then it discusses briefly the major economic characteristics of the cement industry in general. Some aspects of the U.A.E. cement industry in particular are also discussed in this chapter. Finally the problems experienced and the solutions adopted by this industry to resolve these problems are also discussed.

Chapter five examines the previous work in the area of capacity planning, it should be noted here that whilst this is not an exhaustive list of all previous work in this area, it does provide a reasonably extensive review of the published literature. The factors that affect the adoption of a particular capacity strategy are examined. It also examines the problem of excess capacity. Finally the negative consequences of misjudged capacity decisions are outlined.

Chapter six describes the approach used. It outlines the main characteristics of the developing economies and the characteristics of O.R. techniques suitable for them. The components of the approach used will be discussed in some detail.

Chapter seven examines the application of the procedure described in chapter six. The first step in the application of this procedure is examined in this chapter. It outlines forecasting techniques available and the methods of forecasting used to forecast cement demand world wide. Forecasting methods we tested and ruled out are also described. The forecasting of the home and export market are also discussed.

Chapter eight examines the remaining steps in the application of the developed procedure. It examines the application of the steps mentioned in chapter six. First, the application of some of the techniques of generating alternative strategies mentioned in chapter six will be discussed. Then it describes the process of constructing the scenario/strategy matrices and the evaluation of selected alternative strategies against the four chosen scenarios. Strategy choice and implementation have been given considerable attention in this chapter.

Chapter nine examines the problems encountered during the progress of this study and the ways in which these problems have been overcome; areas for further research are also outlined.

Chapter ten summarises the whole work, offers comments on the results and presents some recommendations.

CHAPTER TWO THE U.A.E.: POLITICAL AND ECONOMIC BACKGROUND

south-west by Saudi Arabia and on the west by Qatar (see map (2.1) on page 15). Its total area is 33 thousand sq. miles. The U.A.E. falls geographically into four areas: the mountain zone, the gravel plains west of the mountains, the coastal strip and the desert interior. According to the 1985 census, the total population is 1.6 million people with 41 percent in Abu Dhabi, 26 percent in Dubai, 17 percent in Sharjah, 7 percent in Ras al-Khaimah, 4 percent in Ajman, 2 percent in Um al-Qauwain and finally 3 percent in Fujairah. Approximately 60 percent or more of the total population are immigrant workers. Income per capita in the U.A.E. is one of the highest in the world (average $19600 per person per year). The official language is Arabic and the official religion is Islam. The U.A.E. is a member of the Arab Gulf Co-operation Council (AGCC) which includes also Saudi Arabia, Kuwait, Qatar, Bahrain and Oman.

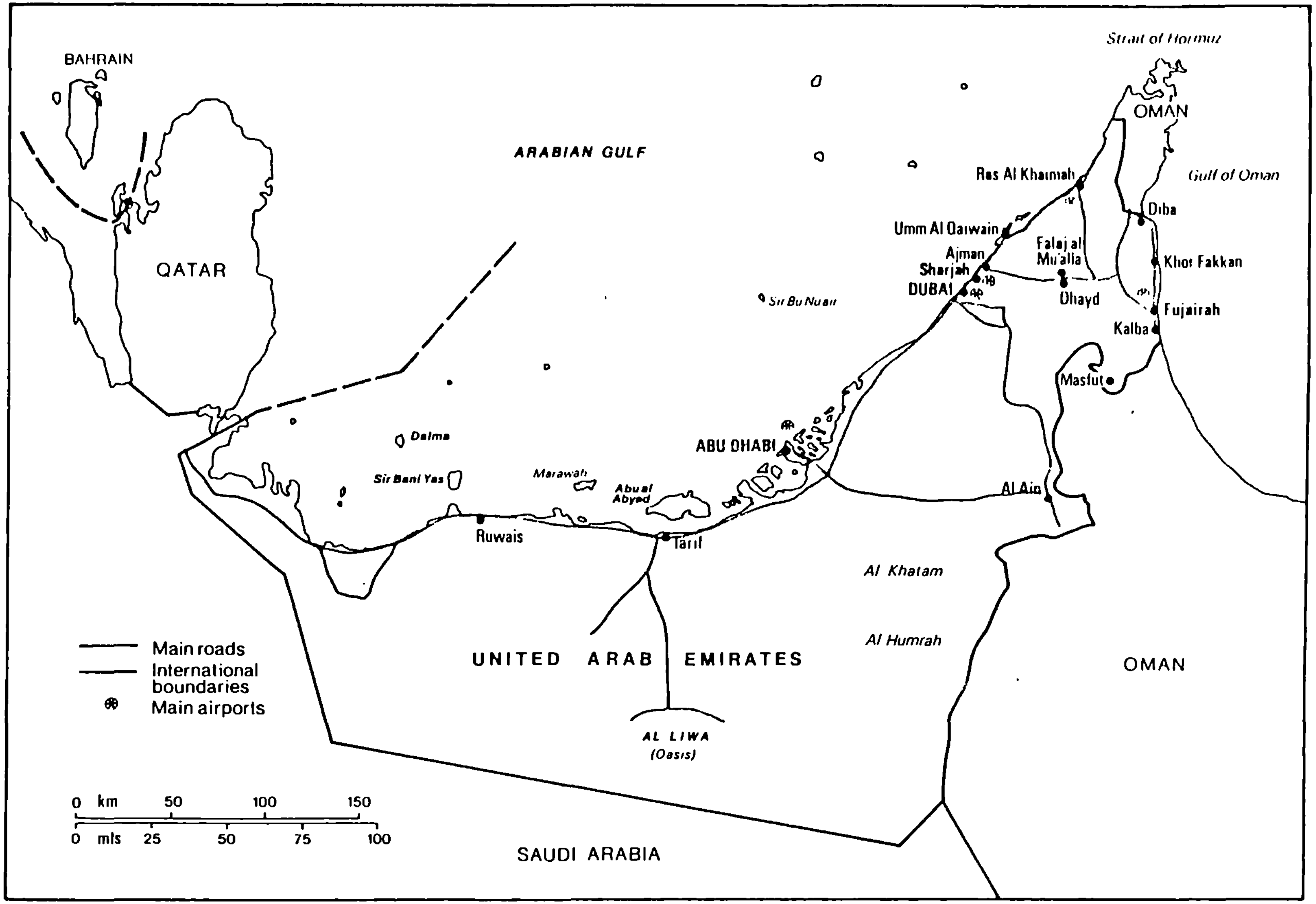
2.2.1 The Political Structure of the Federation

To understand the present it is necessary to highlight the past and the historical influences which have gone to shape the present.

First of all, in the 1820's the Sheiks of the seven entities signed a general treaty for the cessation of plunder and piracy by land and sea, and this treaty transformed what was previously known as the piracy coast into the Trucial coast; then the seven entities became known as the Trucial States;

Map (2.1)

United Arab Emirates



Source: E.I.U., Quarterly Economic Review of the U.A.E.

A Trucial States Council was formed in 1952 under British supervision, and this was presided over by the British political agent. E.I.U. (2, 1984);

In 1965 the British government set up a development office attached to the Trucial States Council. The aim of this office was to supervise agricultural, communication and health services in the northern Emirates which include Dubai, Sharjah, Ajman, Um al-Qauwain, Fujairah and Ras al-Khaimah;

In 1968 the labour government in Britain decided to pull out of the region and abandon the treaty with the sheiks. Al-Jamil (3, 1981);

Then, in 1971 the British pulled out of the region and on the 2nd of December of that year (1971), the U.A.E. proclaimed itself an independent state.

Now attention is directed to the political structure of the Federation. Two topics are examined; first the structure of the federal government; and second the structure of the local government.

The Federal Government structure

The structure of the federal government consists of five main authorities as stated in article (45) of the provisional constitution, with which the U.A.E. started out and under which it has operated ever since. These five authorities are: the Supreme Council, the President and his Deputy, the Council of Ministers, the National Assembly and finally, the Judiciary.

The Supreme Council

This is the highest authority, and consists of the seven rulers of the seven Emirates. Some of its responsibilities are: to plan policy, elect the President and his Deputy, admit new members to the Federation, appoint and dismiss the Prime Minister and the Judges of the federal Supreme Court.

The Presidency

The President and his Deputy are elected for five years and they can be re-elected for another term. The President also acts as the armed forces' commander. Article (54) of the provisional constitution lists the powers assumed to the President, some of which are: presiding over the Supreme Council, calling the Supreme Council into session, calling the Supreme Council and the Council of Ministers into joint sessions whenever necessity demands.

The Council of Ministers

The Council of Ministers consists of the Prime Minister, his deputy and a number of Ministers. Those are chosen from among citizens known for their competence and experience. Article (60) of the Constitution stated powers assumed to the Council of Ministers, of which a few are listed here: they follow up the implementation of government policy, initiate federal laws, draw up the annual budget and the final national accounts, and prepare drafts of decrees and make various other decisions.

The National Assembly (NA)

This is composed of forty members and seats are distributed to member Emirates as follows: eight seats to each of Abu Dhabi and Dubai, six to each of Sharjah and Ras-al-Khaimah, and four to each of Ajman, Um al-Qauwain and Fujairah. The (NA) performs a consultative rather than legislative function. The members of the (NA) are appointed by the rulers of each Emirate.

The Judiciary

This consists of five judges who, upon formal request, resolve disputes between the Federal Government and member Emirates or between member Emirates themselves. They are appointed by Presidential decree upon the approval of the Supreme Council.

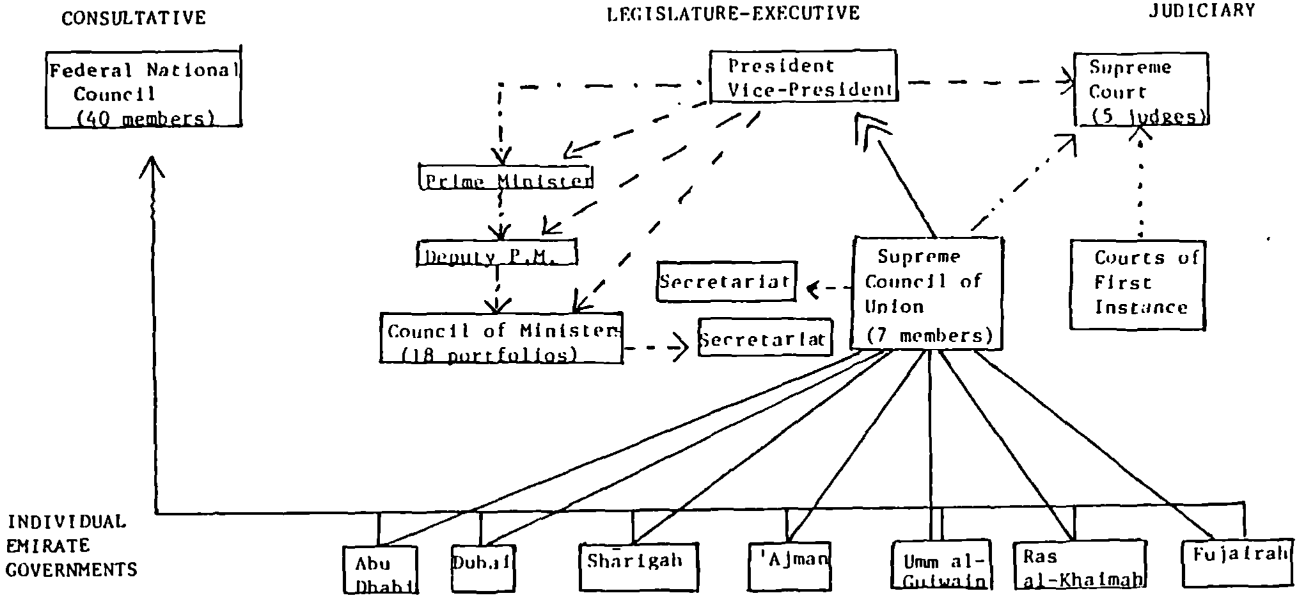
Figure (2.1) on page 19 shows the U.A.E. government structure in 1972 and this is valid up to the present time.

The Structure of the Local Governments

The structure of the local government in each of the seven Emirates is almost the same with one exception, the Emirate of Abu Dhabi. In all the Emirates the government structure consists of three authorities: the Ruler Office, Administration Departments and Judiciary. In the Emirate of Abu Dhabi, a fourth authority exists, which is the Consultant Council.

Figure (2.1)

U.A.E. GOVERNMENT STRUCTURE, 1972



Key to Symbols:

- elected
- control
- appointed
- ex-officio
- appellate route
- ratification required
- generally appointed by the individual rulers but specific modes of delegate selection is left to individual emirates

SOURCE: Based on a schema provided by John Duke Anthony in his *Arab States of the Lower Gulf: People, Politics, Petroleum*, Washington, D.C.: The Middle East Institute.

The role of the Ruler Office (Dewan) is similar to that of the President or Prime Minister in a formal state. The office holds the responsibility of supervising and controlling the administrative departments in the Emirate. It also issues the rules and regulations to be executed by those departments in each functional area.

The administrative departments, on the other hand, are equivalent to the Ministries in the formal state. These departments include: Municipality, Public Works, Culture, Accounts, Accounts Control, Water and Electricity, Police, Civil Service, Customs ... etc. The number and the name of these departments might slightly differ from one Emirate to another, but their functions are almost the same.

The Judiciary in each Emirate has a role similar to that of the U.A.E. but in this case its role is restricted to the Emirate territory.

In the Emirate of Abu Dhabi a fourth authority exists, which is the Consultant Council and its role is similar to that of the National Assembly of the U.A.E.

2.2.2 The Economic Structure of the Federation

Prior to the discovery of oil, the economy of the Emirates was based on four main activities: pearl diving, fishing, trade and agriculture. Since its discovery in the 1950´s oil has become the backbone of the U.A.E. economy. In the pages that follow the four main sectors of the economy are highlighted.

Oil and Gas

Oil was and will continue to be the source of prosperity not only for the U.A.E. but also for other Gulf States as well. The contribution of oil revenue accounted for 92 percent of the total revenue of the government in 1975. It was about 80 percent in 1984. The decline in the contribution of oil revenue in the total revenue of the Country is due to the decline in oil prices.

The contribution of this sector to the GDP accounted for 64 percent in 1980. This contribution declined to 45 percent in 1984. This decline is attributed mainly to the fall in oil demand and prices rather than the increase in the output of other economic sectors.

As a result of the fall in world demand for oil, oil production in the U.A.E. fell from 623.7 million barrels in 1980 to only 421.3 million barrels in 1984. Ministry of Planning (4, 1985). The Emirate of Abu Dhabi produced 79 percent of the total oil production in the U.A.E. in 1980, while the remaining 21 percent was produced by Dubai 20 percent, and Sharjah 1 percent. As a result of the decline in oil demand, the production in Abu Dhabi fell to 65 percent of the U.A.E. total production in 1984, while the production in Dubai increased to 30 percent and in Sharjah to 5 percent.

Oil dominates the exports of the country. In 1975, oil exports accounted for 91 percent of the total U.A.E. exports. In 1984 the share of the export of oil to the total export of the country decreased to 82 percent. This decline is due to the decline in the demand for oil on the one hand, and the increase in the contribution of the export of other commodities and the re-export activities on the other hand. Ministry of Planning. (4, 1985).

Industry

Before the discovery of oil, there were very simple industries which were usually associated with the main activities dominant at the time, namely, pearl diving, cultivation, fishing, and trading in general. Examples of these industries include: ship building, fish and date curing, handicrafts and the like. With the discovery of oil things have changed dramatically. More advanced industries have been introduced; these are either directly or indirectly oil related and are based mainly in the industrial zones of Abu Dhabi and Dubai. The contribution of the manufacturing sector in total non-oil gross domestic product (GDP) has risen from 3 percent in 1975 to 17.2 percent in 1984. Furthermore, the gross fixed capital formation in the manufacturing sector has risen in absolute value from DH 3348 million (in 1980 prices) in 1975 to DH 7005 million (in 1980 prices) in 1984. Ministry of planning (4, 1985).

The objectives of industrialisation, obstacles and key factors in its success are examined in section (2.3).

Another important sector in the U.A.E. economy is Trade.

Trade

The term "trade" is taken here to mean both internal and foreign trade. The U.A.E. in general and the Emirate of Dubai in particular was and still is known as a trading centre in the Arabian Gulf region, partly for its geographical setting and partly because of the availability of basic infrastructures especially in recent years.

The internal trade (retail and wholesale) plays an important role in the economy of the U.A.E. since it provides the Country with a continuous supply of goods and services at the appropriate time and at the quantity and quality required. The private sector has the upper hand in this sector.

In recent years the public sector started a serious participation in the trade sector through the introduction of consumer co-operatives and central markets. With regard to foreign trade (export and import) this is also very vital to the economy of the U.A.E., especially because the U.A.E. market depends heavily on imports due to the lack of locally produced commodities. Oil and gas have the lion's share of exports. The contribution of the trade sector to total non-oil gross domestic product has risen in absolute value from DH 4940 million in 1975 (in 1980 prices), to DH 8788 million in 1984 (in 1980 prices). The gross fixed capital formation in this sector has also risen in absolute value from DH 410 million (in 1980 prices) in 1975 to DH 736 million in 1984 (in 1980 prices). Ministry of Planning (4, 1985). It is worth pointing out that in 1985 total exports to GCC were DH 2000 million and imports from the GCC in the same year were DH 1652 million. U.A.E. Central Bank (5, 1986).

Another important sector in the U.A.E. economy is agriculture.

Agriculture

U.A.E. looks to the development of this sector on both strategic and economic grounds with the objectives of achieving self-sufficiency in food products. However, complete self-sufficiency is a far-off dream.

The total local production of fruit and vegetables accounts for 30 percent of the total domestic needs despite harsh weather conditions, poor soil quality and shortages in water supply. The U.A.E. government continues its effort to help develop this vital sector. This can be seen through the variety of services and assistance provided for the farmers in the Country. Such services and assistance include drilling new wells, free interest loans to buy machines and equipment, free seeds and fertilizer and the like. However, the contribution of this sector to the total non-oil GDP remains very low compared with the two previously mentioned sectors, namely, industry and trade.

Its contribution to total non-oil GDP accounts for 2.1 percent in 1975 and has risen to 2.4 percent in 1984. The gross fixed capital formation in this sector has risen in absolute value from DH 244 million (in 1980 prices) in 1975 to DH 536 million (in 1980 prices) in 1984. Ministry of Planning (4, 1985).

The discussion in this section leads to the conclusion that the oil sector continues to be the dominant sector in the economy of the U.A.E. despite the fact that other sectors have improved in terms of their contribution to the total gross domestic product (GDP).

The next section concerns itself with the discussion of the industrialisation and industrial policy in the U.A.E.

2.3 Industrialisation and Industrial Policy

In the last section the political and economic structures of the Federation were highlighted. This section places special emphasis on industrialisation as a more likely candidate to replace oil as the main section of the economy in the post oil era. The objectives of industrialisation, the key factors in its success, obstacles of industrialisation and examples of industries which exist in the U.A.E. are all examined in this section.

Objectives of Industrialisation

The following are the main objectives of industrialisation in the U.A.E.: Ministry of Finance and Industry (6, 1985) and (7, 1980).

1) to increase the participation of the industrial sector in the gross domestic product of the Country;
2) to reduce the dependence on one source of national income - oil;
3) to develop the export of industrial goods;
4) to achieve self-suffiency in industrial production;
5) to develop handicrafts and light industries for domestic market and export;
6) to develop agricultural industries;
7) to utilise mineral resources available in the Country.

Key Factors for the Success of Industrialisation

The path of industrialisation is long and in order for the industrial sector to progress or even to exist, a few key factors have to exist, these include:

1) the market;
2) the finance;
3) basic infrastructures;
4) skilled labour force;
5) production factors;
6) the use of scientific methods and techniques.

Gergus et al. (8, 1987).

These six factors are examined briefly in the pages that follow.

1) The Market

Generally speaking, two factors affect the market. The first one is the size of the population of the Country; and the second is the purchasing power of the individuals. In the case of the U.A.E., the population size is rather small and the U.A.E. is considered an under-populated country. On the other hand, the purchasing power of the individuals is reasonably high. In spite of this, the domestic market is fairly small, and in turn this does not encourage large scale industries to develop, and, if they do to continue in operation for a long period of time without bearing heavy losses. However, the availability of a large scale market is not the only factor in the success of industrialisation.

The market should be coupled with the funds or finance needed to make the industry exist in the first place and to keep it in operation thereafter.

2) The Finance

Another important factor which affects the process of industrialisation is availability of the finance needed. In the case of the U.A.E., there was an ample supply of funds available during the boom in the oil demand and prices between 1973 and 1981, but the emphasis during that period of time, especially during the first half of it was on construction activities. Emphasis on these is quite right, since all other activities within the economy depend in one way or another on the availability of basic infrastructures such as ports, airports, roads, water facilities, electricity facilities and the like. Toward the end of the 1970's and in the early 1980's, the emphasis was diverted to industrialisation, especially after the decline in oil demand and in turn oil prices.

Unfortunately, the availability of funds diminished over the period between 1981 and the present following the recession in oil demand and consequently oil prices. This, of course, led to cuts in investment carried out by the public sector, the main investor in the industrial sector as well as other sectors in the economy, this in turn delayed the progress of industrialisation in the Country. However, the availability of the market and finance are not the only factors for the success of industrialisation, other factors are equally important. This leads us to the discussion of another factor, namely, the availability of basic infrastructures.

3) <u>Basic Infrastructures</u>

As mentioned earlier, the emphasis during the 1970's and early 1980's was on construction, and this included the construction of airports, ports, road networks, water and electricity facilities, health and education facilities and the like. Undoubtedly, the presence of these basic infrastructures helps greatly in the progress of industrialisation as well as other activities in the economy.

4) <u>Skilled Labour Force</u>

Another important factor which contributes greatly to the success of industrialisation is the availability of a skilled labour force. All sorts of industries, light or heavy, capital intensive or not, require a considerable number of workers both skilled and unskilled. In the case of the U.A.E. there are acute shortages in labour supply of both types - partly because of the size of the population and partly because of the peoples' attitudes and values, i.e. people in the U.A.E. as well as in other Arab Gulf States look upon blue collar jobs as less prestigious occupations, and very few are willing to work in industry.

However, it is easy to import a skilled labour force from abroad especially from India, Pakistan and Korea, but this creates other political, economic and social problems.

5) <u>Production Factors</u>

In addition to the two production factors mentioned earlier, namely finance and labour force, there are two other production factors - availability of raw materials and energy. The availability of raw materials is limited to oil and very few mineral resources such as limestone, gypsum and iron ore. With regard to energy, natural gas is abundant in addition to the potentialities of solar energy.

6) <u>The Use of Scientific Methods and Techniques</u>

An important key factor in the success of industrialisation is the use of advanced technology which includes among other things the use of O.R. techniques as tools for decision making and problem solving. At the early stage of industrialisation and especially when there is a rush toward industrialisation, it is necessary to introduce such techniques as a means of problem solving.

The six mentioned factors are the most important ones which contribute largely to the success of the process of industrialisation in newly industrial nations.

However, the path of industrialisation is very long and full of obstacles. The U.A.E. has only begun to surmount these obstacles.

Some of these obstacles are examined in the pages that follow.

Obstacles to Industrialisation

Earlier, the key factors in the success of industrialisation were highlighted, now attention is directed at the main obstacles to the process of industrialisation.

These obstacles are summarized below.

1) small market size;
2) lack of skilled workers;
3) absence of comprehensive industrial planning;
4) high production costs;
5) absence of protective measures;
6) absence of the use of scientific methods for decision making.

These six obstacles are outlined individually below.

1) <u>Small Market Size</u>

As mentioned earlier the U.A.E. market is relatively small, and this is due mainly to the size of the population. Undoubtedly, this hinders the process of industrialisation since this prevents the introduction of high technology and large scale plants which benefit greatly from the presence of economies of scale in capital investment and reduce the cost of production which puts the industry in a highly competitive position. This obstacle can be overcome through co-operation between the Arab Gulf States.

2) <u>Lack of Skilled Labour Force</u>

Another obstacle to the progress of industrialisation is the lack of a skilled labour force. As mentioned previously, the U.A.E. experiences a lack of both a skilled and an unskilled labour force. Nonetheless, this obstacle has been overcome through the use of imported workers both skilled and unskilled, but such action has created other social and economic problems associated with the presence of a great number of foreign workers in the U.A.E. These problems can be resolved or reduced by the introduction of automated technology.

3) Absence of Comprehensive Industrial Planning

As mentioned in section (2.2), the U.A.E. is a Federation of seven Emirates and this means that seven authorities exist for granting industrial licences and preparing industrial plans, with very little co-ordination between these authorities. The situation is far from tolerable and the result is duplication in industrial projects and a waste of financial resources. The need for a unified industrial plan is more vital than ever especially with the decline in oil demand and prices, and the emergence of the need to search for other sources of national income to avoid the dependence on one.

4) High Production Costs

In newly industrialised countries, industries suffer from high production costs. This is attributed to rapid deterioration of fixed capital, high costs of buildings and of energy. This is true in the case of the U.A.E.. High production costs mean there is an inability to compete with cheaper imported products from advanced countries where high technologies are used and large scale production exists. Furthermore, local products would not be able to compete with foreign products in the export markets due to the high production cost disadvantages.

5) Absence of Protective Measures

At the early stages of industrialisation most countries take hard protective measures to protect their own newly developed industries against the invasion of foreign products. In the case of the U.A.E., the situation is totally different. There are no protective measures of any sort and this, of course, has a negative impact on the progress of industrialisation.

6) Absence of the Use of Scientific Methods for Decision Making

Another obstacle to industrialisation is the use of the traditional methods of decision making (e.g. trial and error) as opposed to more advanced and reliable methods of decision making and problem solving.

In the U.A.E., decisions are made arbitrarily most of the time, especially in publicly owned organisations. The adoption of scientific methods for decision making and problem solving is of great significance for the progress of industrialisation, (as has been shown in Europe and in the U.S.A.). Having highlighted the main obstacles to industrialisation, it seems useful to give a few examples of industries which exist in the U.A.E.

Examples of Industries which Exist in the U.A.E.

The industries in the U.A.E. can be classified into two main categories. The first category includes those which are oil based; and the second one includes those which are non-oil based.

Examples of the two types are given below.

Oil Based Industries

Industries of this type are usually capital intensive, heavy industries and include petrochemical and natural gas liquification. These are publicly owned, and are concentrated in the industrial zone in Jabel Ali (Dubai) and AL-Ruwais industrial complex (Abu Dhabi). The participation of the private sector in this type of industry is hardly noticed, due, in part, to the large amount of capital needed, and in part to the high risks associated with the investment in these industries.

Non-oil Based Industries

The second category of industries existing in the U.A.E. is non-oil based. This includes: aluminium, iron and steel, cement, food processing, construction materials, mineral water and soft drinks and many other small industries. These industries are mainly export oriented, i.e. 60 percent or more of their production is for the export market. These industries are publicly, privately or jointly owned and concentrated mainly in the four largest Emirates, namely, Abu Dhabi, Dubai, Sharjah and Ras al-Khaimah.

Industrial Policy

The process of industrialisation, its objectives key factors in its success and obstacles to industrialisation were examined in some detail. It makes no sense to discuss industrialisation without examining the industrial policy of the Country. One would expect that a newly industrialised country would have a well defined industrial policy which enables it to continue its way towards greater development. Unfortunately, in the U.A.E. there is no well defined and unified industrial policy at the federal level. However, some emirates like Abu Dhabi, and Dubai have their own industrial policies.

2.4 The Political, Economic and Administrative Unity of the Federation

This section is concerned with the political, economic and administrative unity of the Federation. These three aspects of unity are now examined.

Political Unity

Two dimensions of political unity, namely, the constitutional text and practice are examined below.

The Constitutional Text

A review of article (2) of the provisional constitution states "the Union shall exercise sovereignty in matters assigned by the constitution ...", and article (3) states that "the member Emirates shall exercise sovereignty over their own territories and territorial waters in all matters which are not within the jurisdiction of the Union as assigned in the constitution." The U.A.E. provisional constitution (9, 1971), reveals that these two articles have given sovereignty and independence to both the Union and the Emirates. The Union´s sovereignty is presented in its dealings with the outside world and in dealing with its people on its territories. The foreign affairs of the country are the responsibility of the Federation, this was expressed in article (120) item (1) of the said constitution. On the other hand, article (123) has given the Emirates the right to conclude limited agreements of a local and administrative nature with the neighbouring states or regions on condition that such agreements do not conflict with the interest and the laws of the Union and provided that the supreme Council of the Union is informed well in advance regarding such matters. Going back to article (120) of the constitution, this article states the affairs in which the Union has exclusive legislative and executive jurisdiction, while article (122) states that "the Emirates shall have jurisdiction in all matters not assigned to the exclusive jurisdiction of the Union ..."

A revision of these two articles (120) and (122) reveals that the power of the Union is restricted in some matters, while that of the Emirates is not or in other words, the legislative and executive jurisdiction power of the Union is the exception and that of the Emirates is the rule. With regard to foreign policy and international relations, the power of the Union is the rule and that of the Emirates is the exception.

A comparison between the provisional constitution of the U.A.E. with that of other federations like the U.S.A., Canada, Mexico and India reveals the weakness in the power granted to the Union in the U.A.E.. Al-Husory (10, 1981).

The Practice

The second dimension of the political unity is the practice. There are situations which support and strengthen the unity between the Union and its members, while other situations try to weaken this unity. First, one factor which supports the unity between the Union and its members is the size of the individual Emirates. Since they are rather small it would be impossible for any one Emirate to be a Country by itself. Furthermore, the existence of a more developed organisation at the federal level which cannot exist at the individual level either because of lack of finance or for any other reasons, has motivated the Emirates to work toward strong unity with the Union. On the other hand, the tendency toward having a weak unity between the Union and its member Emirates is due mainly to the presence of a large number of foreigners in the country and it is of interest to those people to see the Country loosely unified. Three examples are given here to show the gap between the constitutional text and its practice.

The first example is article (142) of the provisional constitution of the Federation which has given the individual Emirates the right to set up their own security forces. This article was omitted from the constitution in November 1976. Despite this fact the individual Emirates still practice the right granted to them by the article, and the division of the army forces to three districts according to the decree of May 1976 is still in action. The second example is interior security which is still in the hands of the individual Emirates although several decrees have been issued to transfer such responsibilities to the federal government. The third example is the conflict over borders between members of the Union. In 1980, there was a conflict over the borders between the Emirates of Ras al-Khaimah and Al-Fujairah. Ghibash (11, 1981).

The Economic Unity

The economic unity of the Federation is influenced more or less by the political unity, i.e. the more politically unified the Federation is, the stronger the economic unity and in turn the economy. A few facts regarding the economic unity of the Federation are outlined.

First, article (23) of the provisional constitution of the Federation has given the member Emirates the right to retain their natural resources and wealth; this of course creates imbalances between the member Emirates in terms of the economic and social development.

Second, although oil is a vital source of income for individual Emirates as well as for the Federation as a whole, and one would presume that a well defined and unified policy would be in existence, the reality proves the reverse to be true.

Third, the Federation depends largely on the contribution of the wealthiest Emirates into the federal budget besides taxes and duties collected by some Ministries. Until the present, the Federation has no independent and permanent source of national income. In 1978, for example, the total revenue in the federal budget was DH 6588.1 million, of which 97.4 percent was Emirate's contribution and the remaining 2.6 percent from other sources. U.A.E. Central Bank (12, 1978). In 1986 the contribution of the Emirates into the revenue of the U.A.E. was 90.1 percent. U.A.E. Central Bank (13, 1986).

Fourth, there is no comprehensive economic and social plan for the Federation as a whole or a unified comprehensive industrial policy.

Fifth, and finally, as will be seen later, there is no unified custom and foreign trade policy for the Federation as a whole.

The Administrative Unity

The administrative unity is defined here as managing and supervising the economic and social organisations by the federal authorities and this does not prevent having branches to these organisations in the member Emirates provided that these branches are controlled by the headquarters.

The discussion is concentrated on the administration of production as well as service activities with the object of finding out whether there is co-ordination and co-operation between the federal units providing these services in the individual Emirates or not.

Agriculture and Fishing

The administration of these activities was in the hands of the authorities of the individual Emirates until the foundation of the Federation and the setting up of the Ministry of Agriculture and Fisheries which took over the responsibilities of managing and supervising.

However, the Emirate of Abu Dhabi still keeps its own agriculture department which manages and supervises the activities of cultivation in its territories. This indeed leads to waste of both money and manpower, especially when lack of co-ordination and co-operation between the two administrations is at fault.

Industry

Industry is considered as a more likely candidate to replace oil, and the federal government has set up a special unit to manage and supervise the industrial activities in the Federation as a whole.

However, each member Emirate runs its own industrial programme with its own organisations, which grant industrial licences. Sometimes more than one organisation at the individual Emirate level holds the responsibilities over industrial activities.

For example, in the Emirate of Abu Dhabi, two organisations, namely the General Industrial Corporation (GIC) and Abu Dhabi National Oil Co. hold the responsibilities of managing and supervising the industrial activities in the Emirate of Abu Dhabi.

The lack of co-ordination and co-operation between the federal organisation and its counterparts in the individual Emirates, can and does lead to waste of resources which could be utilised elsewhere in the economy.

Oil and Gas

As mentioned earlier, oil was and still is the main source of income for oil producing Emirates and in turn for the Federation as a whole and one would presume that such a vital sector would be well managed and supervised. In reality the responsibilities of managing and supervising this sector are divided between several organisations and the Ministry of Petroleum and Mineral Resources which was set up to manage this sector. Its functions are limited for political as well as constitutional reasons. The absence of co-ordination and co-operation between the Ministry and the local organisations in charge of this vital sector led to the variation in oil policies from one Emirate to another, which led to a waste of financial resources.

Trade

Trade is a major sector (after oil of course) in the Federation. The private sector has the upper hand in the trading activities. The responsibility of granting trade licences is in the hands of the local authorities, usually the Chamber of Commerce and Industry and Municipality. Unfortunately, licences are usually granted without prior investigation of the need for the market for a particular business for which the licence is issued. Moreover, the laws and regulations which organise the trading activities differ from one Emirate to another. At the Federal level the Ministry of Commerce and Economics is responsible for managing and supervising this sector. This ministry has issued various laws and regulations which organise the trading activities in the Federation, but the implementation of these laws and regulations is hindered by lack of co-ordination and co-operation between the Ministry of Commerce and Economics and its counterparts in the Emirates and between the local organisations themselves.

Construction

Undoubtedly, the basic infrastructures are the cornerstone of the economic and social development of any nation. Without ports, airports, roads, telecommunications, trade centres, schools, hospitals and public offices, there would be no trade, agriculture or industry.

The responsibility of building those infrastructures lies on the the shoulders of the public works sector. There is almost one department of public works in each Emirate which holds the responsibility of carrying out its own construction projects such as roads, public buildings, and the maintenance of these projects.

At the Federal level, the Ministry of Public Works and Housing has been assigned the responsibility of carrying out building projects such as roads, highways, schools, hospitals, low income houses, and public buildings, and has been assigned responsibility to the maintenance of these projects. As can be seen, the responsibility of the Ministry overlaps with that of the local authorities and sometimes there is an overlap between the Department of Public Works and the Municipality in the same Emirate. This of course results from lack of co-operation and co-ordination between the local and federal authorities.

Other Services

Economic and social developments do not survive on physical infrastructures alone. They should be accompanied by social infrastructures as well. These latter ones include education and training, health services and other social services. Those services are in the hands of federal organisations such as the Ministry of Education and Youth, the Ministry of Public Health, and the Ministry of Social Affairs and Works.

As there are no local organisations sharing the responsibilities of providing the previously mentioned services with the federal organisations, there is no conflict of objectives, except in the health services, since the Emirate of Dubai has its own health department which manages the health services in the Emirate and there is no co-operation between this department and the Ministry of Public Health.

In conclusion, the administrative unity of the Federation is rather weak because of lack of co-ordination and duplication of efforts. This has led to a waste of resources which might otherwise be used more effectively. Table (2.1) summarises the administration of different activities in the U.A.E.

Table (2.1)

Administration of Production and

Services in the U.A.E.

Activities / Administration	Agriculture & Fisheries	Industry	Oil	Trade	Construction	Other Services
Federal	-	-	-	-	-	X*
Local	-	X	X	X	-	-
Federal & Local	X	X	-	-	X	-

* Except in the health services where local authorities share the responsibility with the Federal authority.

2.5 <u>The Ill-effects of the Conflict of Interest between the Members of the Federation</u>

The last section discussed the political, economic and administrative unity of the Federation and concluded that the unity of the Federation in those three areas is rather weak. This section outlines the consequences of such weak unity.

1) <u>Duplication in Basic Infrastructures, Industrial and Commercial Establishments</u>

This effect is the result of several factors, such as:

(i) the control of natural resources in each Emirate is by its own government;

(ii) the independence of each Emirate in its financial resources;

(iii) the existence of severe competition between the Emirates;

(iv) the independence in licensing of commercial and industrial projects. Al-Dean (14, 1981).

A few concrete examples are stated below which illustrate this effect.

Basic Infrastructures

(i) Airports

Five Emirates out of the seven have their own international airports, most of these airports are highly under utilised.

For example, Abu Dhabi international airport, which is one of the busiest, has not exceeded 77 percent of its designed capacity of three million passengers per annum. Similarly, Ras al-Khaimah international airport just handles about one tenth of its total capacity. By the same token, Sharjah international airport has never exceeded 25 percent of its capacity of two million passengers per annum. Despite this, there are plans to expand Dubai and Abu Dhabi international airports and build a new one. Apparently, excess capacity is the case in such circumstances and this means wasting a great deal of funds which could otherwise be used more effectively elsewhere in the economy.

(ii) Ports

There are seven ports in six of the seven Emirates with a total of 170 deep water berths. This capacity is far greater than needed, and once again this means a waste of resources. The main causes of such a situation is the competition between the Emirates and the absence of co-ordination between the planners in the different Emirates.

Industrial Establishments

Two obvious examples where duplication of industrial establishments has taken place, are the plastics industry and mineral water bottling and soft drinks industry.

(i) Plastics Industry

This industry has witnessed unplanned expansion over the last few years and this has led to it having more capacity than needed, and consequently bankruptcy for many establishments which could be avoided if there were some sort of co-ordination and co-operation between the planners in the individual Emirates on the one hand, and the planners in the Federation on the other.

(ii) Mineral Water Bottling and Soft Drinks

There are six mineral water bottling and seven soft drinks factories in the seven Emirates. Table (2.2a) presents the development in the installed capacity in the mineral water bottling industry between 1980 and 1985. Also annual production figures and capacity utilisation rates are presented in Table (2.2a).

Table (2.2a)

Installed Capacity, Production and

Capacity Utilisation in the Water Bottling

Industry, 1980-1985

Year	Installed Capacity (000) Cartons	Production (000)	Capacity Utilisation %
1980	5,300	3,374	64%
1981	7,778	4,644	60
1982	8,508	5,869	69
1983	8,958	6,668	74
1984	11,233	6,742	60
1985	11,233	6,129	55

Source: Ministry of Finance & Industry (15, 1986), p.(13).

From the data given in Table (2.2a) one can find that the maximum level of capacity utilisation was 74 percent (in 1983), which has since steadily declined. This resulted from the unplanned expansion in capacity and the import of mineral water from abroad. Similarly, Table (2.2b) shows the development in installed capacity, production and capacity utilisation in the soft drinks industry between 1980 and 1985.

Table (2.2b)

Installed Capacity, Production and

Capacity Utilisation in the Soft Drinks

Industry, 1980-1985

Year	Installed Capacity (000) cartons	Production (000)	Capacity Utilisation %
1980	17,735	7,663	43%
1981	17,735	7,559	42.6
1982	17,735	8,430	48
1983	24,235	9,523	39
1984	31,116	11,738	38
1985	31,116	13,023	42

Source: Ministry of finance & Industry (15, 1986), p.(13).

Table (2.2b) indicates that the highest level of capacity utilisation in the soft drinks industry over the period between 1980 and 1985, was 48 percent (in 1982), this of course is an uneconomic level of capacity utilisation. This low level of capacity utilisation is attributed to demand led expansion in the capacity of soft drinks industry and to the import of soft drinks from abroad, which of course affected capacity utilisation in the home industry.

Commercial Establishments

The duplication in commercial establishments is more obvious at the individual Emirate level. There are many small scale retail stores scattered in each Emirate as a result of the haphazard way of granting trade licences without pre-investigation of the need for the market. Consequently, many establishments have faced bankruptcy, and in turn loss of substantial amounts of money especially during the depression in the economy.

2) The Absence of Comprehensive and Unified Economic and Industrial Plans and Policies

As a result of the conflict of interest between the member Emirates, there is no economic planning in general and industrial planning in particular in the U.A.E.; this of course leads to an imbalance between different sectors of the economy. More emphasis is placed on oil and petro-chemicals, and very little is placed on other sectors. Since 1971, when the U.A.E. was proclaimed an independent state up to the present there has only been one five-year plan (1981-1985) and this plan has never been put into practice.

3) Differences in Customs and Foreign Trade Policies

Although article (11) of the provisional constitution of the Federation stated that "the Emirates of the Union shall form an economic and customs entity"; in reality there are differences in the customs policies of the seven member Emirates. For example tariffs imposed on imports and exports differ from one Emirate to another, Abu Dhabi and Ras Al-Khaimah impose a one percent tariff, while sharjah, Dubai and Ajman impose three percent. Likewise, foreign trade policies differ from one Emirate to another. For example, two Emirates import the same goods from the same source at two different prices. Al-Rafaei (16, 1981). Undoubtedly, such variation leads to a waste of funds which could otherwise be used more effectively.

4) Misdirection of Capital and Natural Resources

Although item (2) of article (11) of the provisional constitution of the Federation stated that "the free movement of all capital and goods between the Emirates of the Union is guaranteed ... ", in practice the movement of both capital and natural resources is not an easy task. For example, the exchange of natural resources such as natural gas and rocks between the member Emirates needs to be carried out through agreement between the governments of the Emirates concerned, and sometimes these (natural resources) might be exported abroad rather than transferred to other Emirates in need of them. Likewise, surplus capital in the wealthiest Emirates is usually invested abroad instead of investing it in those Emirates which are in need of it. Al-Rafaei (16, 1981).

5) Difficulty in enforcing Federal Laws and Regulations

Owing to the fact that the member Emirates give priority to their own interests over that of the Federation, this has led to resistance to federal laws and regulations. For example, the federal law no. (1) was issued in 1979 with the object of rationalising industrial development in the Country, but because of the independent-mindedness of the individual Emirates' governments, it was impossible to enforce this law. MEED (17, 1984).

Another example, is the taxation law on company profits, which has never been implemented for the reason mentioned above.

In conclusion, one would expect that if the loose political, economic and administrative unity of the Federation continues, these ill-effects will persist, draining financial resources and wasting human efforts.

2.6 Conclusion

This chapter was concerned with the political and economic background of the Federation. Its aim was to investigate the environment in which O.R. techniques and methods are to operate. Based on the discussion of this chapter one can draw the following conclusions:

(i) The political structure of the Federation is somewhat different from that of other Arab Gulf States and other Arab States.

(ii) The Federation economy depends heavily on one source of income, oil and of course this is a dangerous short-sighted policy.

(iii) The loose political unity of the Federation has weakened both the economic and administrative unity.

(iv) Because of the peculiar characteristics of the Federation, many economic problems have emerged which otherwise would not appear.

(v) The peculiar characteristics of the environment in the U.A.E. (market size, labour shortage, lack of natural resources, domestic competition, ... etc.) necessitate the use of advanced technology including the use of O.R. techniques and methods as problem solving and decision making tools.

The next chapter examines the O.R. techniques which are more commonly used in the U.A.E., also an investigation of decision makers awareness of O.R. techniques and willingness to use these techniques is carried out. This chapter also examines O.R. education and training in the U.A.E., and discusses whether it is relevant to practice it or not. The problems hindering the wide adoption of the practice of O.R. in the U.A.E. are outlined.

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CHAPTER THREE: O.R. PRACTICE AND EDUCATION IN THE U.A.E.

CHAPTER 3 O.R. Practice and Education in The U.A.E.

3.1 Introduction

In the last chapter the political and economic environment in the U.A.E. was examined. The purpose of that chapter was to explore the environment in which O.R. techniques have been and will be applied. This chapter deals with the practice, education and training in O.R. in the U.A.E. The main objectives of this chapter are:

(1) to evaluate O.R. practice in the U.A.E. This includes:

(a) finding out the extent to which O.R. techniques have been adopted and implemented in the industrial and business sectors in the U.A.E.

(b) determining the willingness of those who do not use any form of O.R. at the present, but have some knowledge of it, to adopt O.R. in the future.

(c) determining the aspects of the economy which use more O.R. techniques.

(2) to explore the problems which hinder the wide adoption of O.R. techniques in the U.A.E. industrial and business sectors.

(3) to evaluate O.R. training and education in the U.A.E.

The next section discusses and analyses the survey of O.R. practice in the U.A.E.

It should be made clear that for the purpose of the survey O.R. is defined as "a set of management techniques grounded on mathematics, statistics, computing, logic and judgment (objective and subjective) employed by an organisation to enhance the quality of decisions made."

3.2 Survey of O.R. Practice in The U.A.E.

The main objectives of the survey are as follows:

(i) to evaluate O.R. awareness among industrialists and businessmen in the U.A.E.

(ii) to evaluate O.R. usage in the industrial and business sectors in the U.A.E. in terms of types of techniques being used, the reasons for using them, and areas of application.

(iii) to determine the attitude toward O.R.

(iv) to determine the adequacy of O.R. education and training in the U.A.E.

(v) to find out what facilities are available for O.R. usage which include specialised personnel, computing facilities and packages.

The Questionnaires

Two types of questionnaires were employed in this study.

(i) Questionnaire for the evaluation of O.R. practice in the industrial and business sectors.

This questionnaire was distributed to people at the highest levels of decision making in organisations and companies in the industrial and business sectors in the U.A.E.

(ii) Questionnaire for the evaluation of O.R. education in the U.A.E.

This questionnaire was directed at students taking the O.R. course and at instructors teaching this course at the U.A.E. University, in the Department of Business Administration.

These two questionnaires are presented in Appendix (A-1) and (A-2) at the end of the thesis. The description of these questionnaires is given in the pages that follow.

(i) Questionnaire for The Evaluation of O.R. Practice in the U.A.E. industrial and business organisations and companies.

This questionnaire is divided into six parts. The first part is designed to collect information about the responding organisations and companies. The aim is to use the information to classify organisations and companies according to the nature of their businesses, and their sizes measured in numbers of employees; to classify respondents according to their academic backgrounds, educational levels, job positions and nationalities.

The second part is designed to measure O.R. awareness among industrialists and businessmen in the U.A.E. This part includes one main question and one sub-question. The main question asks about the awareness of O.R., while the sub-question identifies sources of acquiring knowledge in O.R.

The third part is aimed at measuring the usage of O.R. in terms of: the techniques being used, the reasons for adopting them and the management decision areas of application of these techniques. This part includes one main question and three sub-questions. The main question is a "yes/No" question and it examines the usage of O.R. in the responding organisations and companies. The first sub-question is concerned with the types of O.R. techniques being used, the second sub-question is designed to identify the reasons for adopting these techniques. The third sub-question is an attempt to determine decision areas of application for the adopted techniques.

Part four is designed to determine facilities available for the usage of O.R. which include: specialist personnel, computing facilities, packages and training. This part includes three main questions and four sub-questions. The first main question examines the availability of O.R. departments and specialised personnel in the responding organisations and companies. The second main question is concerned with the availability of computing facilities for the purpose of using O.R. techniques. The third main question in this part is concerned with the availability of training departments or centres in the responding organisations and companies.

The first sub-question in this part deals with the type of computer available whether main-frame or micro-computer.

The second sub-question is concerned with types of packages used, the third sub-question investigates whether training in O.R. is provided by the responding organisations and companies or not, and finally, the fourth sub-section in this part is concerned with the type of O.R. training provided.

The fifth part of the questionnaire is devoted to measure the attitude toward O.R. This includes: the examination of the willingness of those not adopting any form of O.R. at the present to adopt O.R. in the future, the aspect of the responding organisations and companies where

O.R. could be used, the reasons for not adopting any form of O.R. at the present time, and the management decision tools currently available for non-O.R. users.

This part includes three main questions and one sub-question. The first main question investigates the willingness to use O.R. techniques in the future. The second main question identifies the management decision tools available for those not adopting any form of O.R.. The third main question in this part is concerned with the reasons for not adopting O.R. techniques. The only sub-question in this part attempts to identify the aspects of the organisation or company where O.R. techniques could be applied.

Finally, part six of this questionnaire is devoted to the assessment of O.R. problems and characteristics in the U.A.E.

This part is divided into three main questions and one sub-question. The first main question in this part attempts to identify the possibility of facing any problems when using O.R. in the U.A.E. The second main question is concerned with identifying the reasons for not using O.R. This question is a repetition of a question given in part five and the aim is to double check the answer given by the respondent and at the same time to give him the chance to express his own choice and view since this question is open-ended. The third main question in this part is designed to identify the characteristics of O.R. techniques which would suit the U.A.E. environment and needs. The single sub-question in this part deals with types of problems which might be faced when using O.R. techniques in the U.A.E.

(ii) Questionnaire for The Evaluation of O.R. Education in The U.A.E.

This questionnaire is divided into two main parts. The first part is directed to the students taking the O.R. course, and the second part is directed to the instructors teaching this course. The first part consists of five main questions.

The first question in this part attempts to assess the usefulness of the O.R. course to the students taking this course. The sub-question to this question is concerned with the reasons for considering the course useful.

The second question in the first part attempts to identify the subjects to which the O.R. course should give more attention, and the reasons for choosing particular subject(s).

The third question attempts to assess the applicability of the subjects taught in the O.R. course to real life problems in the U.A.E. The first sub-question of question three is concerned with the identification of areas of application of the techniques taught in the O.R. course. The second sub-question of question three attempts to discover whether the students believe that what is taught in the O.R. course at the U.A.E. University is or is not applicable to real life situations.

Question four in this part assesses the attitude of the students taking the O.R. course toward the introduction of the practice of O.R. into the U.A.E. Students were asked to give the reasons behind their attitudes.

Finally, the fifth question in part one is concerned with the identification of the managerial problems in the U.A.E. which O.R. could be used to solve.

The second part of this questionnaire is directed to the instructors teaching the O.R. course. This part consists of five main questions in addition to questions two and four in part one.

The first main question in this part is concerned with the assessment of the comprehensiveness of the O.R. course currently taught at the U.A.E. University. The sub-question to this question identifies the subjects which should be included in the course if it is not comprehensive enough.

The second question in part two attempts to assess the suitability of the O.R. course taught to the clients' needs and the environment in the U.A.E. The sub-question to question two deals with the modifications required to make the course suitable for the clients' needs and the environment in the U.A.E. if it is not suitable at the present time.

Question three attempts to identify the purpose for which O.R. could be used in the U.A.E.

The fourth question is concerned with the identification of the characteristics which make O.R. more suitable in the U.A.E.

Finally, question five in part two is designed to find out whether or not another O.R. course is required, and if it is required what subjects should it include.

With reference to the types of question structure employed in this study, a combination of closed-ended and open-ended questions was employed. The majority of the questions used in the two questionnaires were the closed-ended type. The use of closed-ended type of questions was based on the fact that O.R. is not well-known in the U.A.E., and so respondents would not be able to adequately answer open-ended questions without considerable guidance. Although closed-ended questions were used more frequently in the two questionnaires mentioned above, the freedom of respondents to choose their own answers or words or express their views was not restricted since we usually provide space for respondents to write their own answers.

Sample Selection

It should be pointed out that the population of the study for the first questionnaire includes all organisations and companies in the industrial and business sectors in the U.A.E. For the second questionnaire, the population of the study includes all the students enrolled for the O.R. course in the Autumn of 1987 in the U.A.E. University.

The sample frame used for questionnaire no.(1) was based on the lists provided for us by the Chambers of Commerce and Industry and the Departments of Economy and Industry in the seven Emirates, while the sample frame for the second questionnaire was based on the list of enrolment provided by the U.A.E. University.

With reference to the type of sample used, it should be pointed out that no specific type was used. For the first questionnaire, the population of the study was divided into groups according to major activities, then a random sample from each strata was drawn. With regard to the sample type for the second questionnaire, the whole population was used, and no sample was drawn because the size of the population was small (80 students).

During the period between 22/9/87-10/10/87 a sample of 24 organisations and companies in the Emirate of Dubai, was drawn based on the list provided by the Dubai Chamber of Commerce and Industry. A questionnaire was distributed and interviews were carried out. Based on the comments provided by some of the 24 interviewees and ideas gained through reading published surveys in the field, the original questionnaire was re-formulated and new versions were added.

During the period between 7/11/87-31/12/87 a sample of 116 organisations and companies was drawn from all Emirates and personally administered questionnaires were distributed, and interviews were carried out. The reasons for adopting a personally administered questionnaire rather than, for example, a mail survey or a telephone survey were: first of all, the need to clarify some of the terms and questions which appear in the questionnaire, making a mail survey impractical, and a telephone survey costly. Secondly, a personally administered survey gives us the chance to assess the accuracy of the answers given by the interviewees through asking some further questions to cross-check written answers. Thirdly, the response of a mail survey proved to be very poor, for example, when we used the same questionnaire over the same period of time by means of a mail survey in the Emirate of Abu Dhabi, one out of the fifteen questionnaires which were sent out was completed and returned to us (about 7 percent response rate), while when a personally administered survey was used for the other Emirates and also for Abu Dhabi, (mainly oil and gas companies), 102 organisations and companies out of 116 returned the completed questionnaires, i.e. a response rate of about 88 percent was achieved.

It might be of interest to the reader and to those who might carry out similar studies in the U.A.E. in the future, to explain briefly how access to respondents was gained.

Therefore, the next topic discussed is regarding the access to respondents.

Gaining Access to Respondents

It was a difficult task for us to get in touch with interviewees especially in Jabel Ali industrial zone in Dubai where a special licence was required to enter this zone. The Dubai Chamber of Commerce and Industry provided us with a general letter urging industrialists and businessmen working in the Emirate of Dubai to provide us with all the information required and also arranged for us to enter the industrial zone.

In the Emirate of Abu Dhabi, the General Industrial Organisation (GIO) assisted us by distributing the questionnaires to the organisations and companies in the private sector in this Emirate.

With reference to oil and gas companies operating in Abu Dhabi, direct contact was established between the author and the people in these companies.

In the Emirate of Sharjah, the Sharjah Chamber of Commerce and Industry provided us with a list of the establishments operating there, and also with a general letter asking personnel to provide us with all the information needed. The only difficulty we faced in Sharjah was to locate the organisations and companies we were going to visit. This problem was also faced in Ajman and Umm al-Quwain.

In the Emirate of Ras Al-Khaimah, a direct contact was established with the concerned personnel, and no difficulties were encountered, mainly because our familiarity with the place enabled us to get access to the respondents.

In the Emirates of Ajman and Umm Al-Quwain, the Chamber of Commerce and Industry provided a list of organisations and companies working in their territories, using direct contact with no previous arrangements we collected the needed information. In the Emirate of Ajman we visited all the companies listed by the Ajman Chamber of Commerce and Industry, since the list was reasonably short.

Finally, in the Emirate of Al-Fujairah, the Department of the Economy and Industry assisted us in distributing the questionnaire to a sample of organisations and companies operating in this Emirate.

Classification of Responding Organisations

The organisations and companies which participated in the survey were of different sizes, geographical locations and are involved in different activities. They represent the public as well as the private sector. Table (3.1) presents the classification of the responding organisations and companies according to their major activity.

Table (3.1)

Classification of Responding

organisations and companies

According to their Major Activity

Code	Major Activity	No. of Organisations/ Companies	As % of the Total
1	Manufacturing	66	52.4
2	Trading	13	10.3
3	Banking, Finance and Business Services	13	10.3
4	Engineering & Construction	3	2.4
5	Petroleum & Energy	9	7.1
6	Distribution & Storage	4	3.2
7	Agribusiness	4	3.2
8	Industrial Services	12	9.5
9	Other	2	1.6
	Total	126	100.0

Source: Compiled from questionnaire given out by the author, November-December, 1987.

As indicated by Table (3.1), the number of organisations and companies engaged in manufacturing account for 52.4 percent of the total responding organisations and companies. This is not surprising in a country looking to industrialisation as a replacement for the oil sector and as a means of diversifying its national income. The majority of the responding organisations and companies in the manufacturing sector are from Dubai. Another comment on the data given in Table (3.1) is that, although the number of organisations and companies engaged in petroleum and energy business is small, might lead one to the conclusion that this sector is insignificant. In fact, these organisations and companies are large in terms of both numbers of employees and turnover, and their contributions to the U.A.E. economy are enormous.

The number of organisations and companies engaged in engineering and construction activities is very small, and this is of course unrepresentative. The reason for choosing such a small number of organisations in this sector is due mainly to the fact that after visiting the three companies mentioned, we discovered that organisations and companies in this sector are not well-organised and the use of O.R. techniques remains unlikely. The majority if not all the organisations and companies in this sector are ignorant of O.R. techniques. Hallouda and Mortagy (1, 1984) advocated "...... a well organized system will be prerequisite to applying operations research techniques." p.(288). Therefore, visiting large numbers of organisations and companies in this sector would have been counter-productive.

This is equally true in the case of agribusiness. The number of organisations and companies in the trading sector and in the banking, finance and business services is relatively small, and this by no means represents the total number of organisations and companies in these two sectors.

It should be pointed out that the majority of organisations and companies in these two sectors are small, and are branches of main offices which are usually situated in the Emirate of Dubai. Therefore, to avoid duplication only the main medium to large offices were selected.

As mentioned earlier, the responding companies and organisations differ in terms of size measured in number of employees, and also in terms of geographical locations. Tables (3.2) and (3.3) present the classification of the participants in terms of size and geographical locations respectively.

Table (3.2)

Classification of Responding organisations and companies in terms of Size (No. of Employees)

Size* (Employees)	No. of Organisations and Companies	As % of Total	Rank
1- 100	84	66.7%	1
101- 500	36	28.5	2
501-2000	6	4.8	3
Total	126	100	

Source: figures compiled from questionnaire distributed by the author, November-December 1987.

* organisations and companies with no. of employees less than 100 are small, those with no. of employees more than 100 but less than or equal to 500 are medium and those with no. of employees more than 500 but less than or equal to 2000 are large.

It is obvious from the information presented in Table (3.2) that the majority of the responding organisations and companies are small to medium in size (about 95 percent).

Those are engaged either in light industries or in trading and the service sector. While the larger ones (about 5 percent) are involved in oil and gas industries or are groups of companies under one management and engaged in manufacturing and trading or engaged in heavy industries like aluminium, steel and cement.

A further comment on the information given in Table (3.2) is that large organisations and companies are situated in the Emirates of Dubai and Abu Dhabi, whereas those of small and medium sizes are distributed all over the seven Emirates.

Table (3.3)

Geographical Locations of Responding organisations and companies

Emirate	No. of Organisations/ Companies	As % of Total	Rank
Abu Dhabi	11	8.7%	4
Dubai	49	38.9	1
Sharjah	24	19.0	2
Ras al-Khaimah	18	14.3	3
Ajman	10	7.9	5
Umm al-Quwain	6	4.8	7
Fujairah	8	6.3	6
Total	126	100.0	

Source: Compiled from questionnaire distributed by the author, November-December,1987.

Based on the information given in Table (3.3) one might draw the conclusion that there are fewer organisations and companies in Abu Dhabi than, for example, in Sharjah or Ras al-Khaimah. In fact, this is not true, and the number of responding organisations and companies in Abu Dhabi is unrepresentative of the total number of organisations and companies in this Emirate. We could not cover a large number of them for economic reasons and time limitations. It would be of interest to point out that organisations and companies in Abu Dhabi are predominantly engaged in the oil sector and heavy industries, those in Dubai are predominantly engaged in the light industries, trading and the service sector. Those in Sharjah are predominantly involved in light industries. Similarly, in the remaining four Emirates, organisations and companies are predominantly engaged in light industries.

O.R. Awareness

The survey conducted revealed that 81 of the responding organisations and companies are aware of O.R., while only 45 of the responding organisations and companies are totally ignorant of O.R.

The responding organisations and companies can be classified into four categories in terms of O.R. awareness and usage as follows:

(i) Those who are aware of O.R. and use it, 50 organisations and companies or 40 percent of the total responding organisations and companies.

(ii) Those who are aware of O.R., but do not use it, 31 organisations and companies or 25 percent of the total.

(iii) Those who are not aware of it, but use some O.R. techniques, 2 organisations and companies or about 2 percent.

(iv) Those who are totally ignorant of O.R., and of course, do not use any form of O.R., 43 responding organisations and companies, or about 34 percent of the total.

With reference to the relationship between O.R. awareness and usage, Table (3.4) indicates that 96 percent of those who use O.R. techniques are aware of it, while only 4 percent of those who use some O.R. techniques are not aware of O.R.

Table (3.4)

Cross-tabulation of O.R. Awareness versus Usage

O.R. Awareness		Yes	No	Total
O.R. Usage	Yes	50(96%)	2(4%)	52(100%)
	No	31(42%)	43(58%)	74(100%)
Total		81(64%)	45(36%)	126(100%)

O.R. Usage

As mentioned earlier, there is a positive relationship between O.R. awareness and usage. It was found that 96 percent of those who use some form of O.R. techniques, are aware of O.R. Here the discussion concentrates on O.R. usage in terms of techniques being used in the industrial and business organisations in the U.A.E., their users classified in terms of major activity, size and geographical location, areas of application of these techniques, the reasons for adoption of the O.R. techniques currently being used, and the degree of use of O.R. techniques measured by the number of techniques being used.

Techniques Used and the Users

The objective of this investigation is to find out the frequency of use of different O.R. techniques, and in turn to find out which of those techniques are more adoptable and why.

It is worth pointing out that 52 out of the 126 responding organisations and companies were using some form of O.R. techniques.

Table (3.4a) presents different O.R. techniques and the frequency of their use.

Table (3.4a)

O.R. Techniques Being Used

Technique	Frequency of use	As % of total users	Rank
Inventory Theory	31	60.0	1
Forecasting models	28	54.0	2
Cost benefit analysis	23	44.0	3
Statistical analysis	21	40.0	4
Linear Programming	17	33.0%	5
Decision Theory	14	30.0	6
Computer simulation	12	23.0	7
Financial modelling	12	23.0	7
Network analysis	11	21.0	9
Risk analysis	6	12.0	10
Scenario analysis	4	8.0	11
Queueing Theory	3	6.0	12
Transportation models	3	6.0	12
Dynamic Programming	2	4.0	14
Other	2	4.0	14
Multi-attribute Decision making models	1	2.0	16
Monte-carlo method	1	2.0	16

Source: Figures compiled from questionnaire distributed by the author, November-December, 1987.

As revealed by Table (3.4a) techniques like: Inventory Theory, Forecasting Models, Cost Benefit Analysis, Statistical Analysis, Linear Programming and decision Theory, in that order, are more frequently used than the remaining techniques. This is due, according to the respondents, mainly to the simplicity of these techniques, and probably because most of these techniques derive their data input directly from the accounting system.

It is worth pointing out that techniques like Linear Programming and Decision Theory are largely adopted by oil and gas companies and by those engaged in heavy industries like aluminium, cement, steel, ... etc. Inventory Theory and Forecasting Models are used by the majority of the organisations and companies currently using O.R. Statistical Analysis and Cost Benefit Analysis are mainly used by those in the manufacturing sector, especially those engaged in light industries.

Table (3.4b) shows major activities versus types of O.R. techniques used.

With reference to the relationship between the size of the users and the type of techniques being used, it is to be noted that techniques like Linear Programming and Decision Theory are mainly used by medium and large users (about 71 percent of the users of these two techniques are medium and large users). While the majority of the users of the remaining four most common techniques are small and medium users.

Table (3.4c) presents the relationship between the size of the users and the type of techniques being used.

Table (3.4b)

Major Activity Versus Types of O.R. Technique Used

O.R. Techniques Code * / Major Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Manufacturing	7	2	-	2	8	12	1	18	10	3	2	14	4	2	1	-	1	-	87
Trading	1	1	-	-	-	2	-	1	3	-	-	3	2	1	-	-	-	-	14
Banking, Finance & Business Service	2	4	-	-	1	3	1	3	1	-	3	2	3	1	1	-	-	-	25
Eng. & Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum & Energy	2	4	-	-	4	6	1	5	3	1	2	2	1	1	-	-	-	1	33
Distribution & Storage	2	1	-	-	1	2	-	2	1	-	2	-	2	-	-	1	-	-	14
Agribusiness	1	-	-	-	-	1	-	1	2	-	1	1	-	1	1	-	-	-	9
Industrial Service	2	-	-	-	-	2	-	1	1	-	1	1	-	-	-	-	-	-	8
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	17	12	-	2	14	28	3	31	21	4	11	23	12	6	3	1	1	2	191

Source: Figures compiled from questionnaire distributed by the author, November-December 1987.

* See table (3.4c).

Table (3.4c)

Cross-tabulation Between The Type of O.R. Techniques

Being Used Versus Users Size

Code	users size Type of technique	1-100	101-500	501-2000	Total raw
1	Linear Programming	5	8	4	17
2	Computer Simulation	5	4	3	12
3	Mixed Integer programming	-	-	-	-
4	Dynamic Programming	2	-	-	2
5	Decision Theory	4	7	3	14
6	Forecasting Models	11	13	4	28
7	Queueing Theory	2	1	-	3
8	Inventory Theory	12	15	4	31
9	Statistical Analysis	12	6	3	21
10	Scenario Analysis	1	2	1	4
11	Network Analysis	6	3	2	11
12	Cost benefit Analysis	14	6	3	23
13	Financial Modelling	6	4	2	12
14	Risk Analysis	5	-	1	6
15	Transportation Models	2	1	-	3
16	Monte Carlo Method	1	-	-	1
17	Multi-attribute Models	1	-	-	1
18	Other	1	1	-	2
	Total column	90	71	30	191

Source: Figures compiled from questionnaire distributed by the author, November-December 1987.

Comparing the most popular techniques in the U.A.E. with those in other developed and developing countries, it was found that in the U.S.A. as stated by Forgionne (2, 1983), the most widely used techniques are: Statistical analysis, Computer Simulation, PERT/CPM and Linear Programming. In Greece, as stated by Pappis (3,1978), the most widely used techniques are: Linear Programming, PERT/CPM and Inventory Control. Here one can argue that the environment plays a significant role in determining the types of O.R. techniques being adopted. Clayson (4, 1980), for example, stated that "It is the nature of the local-problem environment that determines what O.R. techniques are relevant ... " p.(294). Papoulias (5, 1984) also argued that "O.R. methodology and the O.R. techniques used must fit the needs of the society and the economy in the context of which they are going to be utilized" p.(584).

The Reasons for the Adoption of the O.R. Techniques Currently used by the Users

Table (3.4d) presents the reasons for adopting O.R. techniques currently being used by user organisations.

Table (3.4d)

Reasons for Adopting O.R. Techniques Being Used

Reasons	(1)	(2)	Rank
(a) Suitability for the problem examined	45	87%	1
(b) Simplicity of the technique	36	69	2
(c) Less need for computing time	25	48	3
(d) Less need for specialised personnel	25	48	3
(e) Less need for data	2	4	5
(f) Other	1	2	6
Total	52		

Column (1) shows no. of organisations and companies.

Column (2) shows this number as a percentage of the total.

Source: Figures compiled from questionnaire distributed by the author, November-December 1987.

Based on the information given in Table (3.4d) one can draw the conclusion that the most common reasons for the adoption of the O.R. techniques currently being used by the user organisations and companies are: suitability of the techniques being used to the problem examined (87 percent), the simplicity of the techniques being used (69 percent), less need for computer time (48 percent) and finally less need for specialised personnel (48 percent). This might lead us to assume that certain characteristics make some O.R. techniques more adoptable than others in the U.A.E. in general and in the industrial and business organisations and companies in particular. This assumption was confirmed by the answers given to questions (6.3) in questionnaire no.(1) regarding the characteristics of O.R. techniques suitable for the U.A.E. needs and environment. Further discussion of these characteristics is given in chapter ten.

Degree of use of O.R. Techniques

The degree of use of O.R. techniques used measured by the number of techniques being used is presented in Table (3.4e).

Table (3.4e)

Degree of Use of O.R. Techniques

No. of techniques techniques used	no. of organisations	As % of the total
1	3	5.8
2	8	15.4
3	13	25.0
4	6	11.5
5	14	26.9
6	3	5.8
7	4	7.7
8	1	1.9
Total	52	100

As can be seen from Table (3.4e), the majority of the user organisations and companies (85 percent) use between one and five techniques, whereas a handful (15 percent) use more than five techniques. This means that the vast majority use very few O.R. techniques.

An attempt was made to examine the relationship between no. of techniques being used and the size of user organisations and companies measured by no. of employees. Using correlation between the no. of techniques being used and the size of the users. It showed that there is a positive correlation between the two variables, though, it is not strong - about (0.18). Table (3.4f) shows cross-tabulation of no. of techniques being used versus the size of the user organisations and companies. This table indicates that 50 percent or more of those who use up to five techniques are small users (between 1-100 employees), while the majority of those who use more than five techniques are medium and large users (between 101-2000 employees).

Table (3.4f)

Cross-tabulation of No. of Techniques

Being Used Versus Users Size

size / no. of techniques	1-100	101-500	501-2000	Total row
1	2 66.6%*	1 33.3%	-	3
2	4 50.0	3 37.5	1 12.5	8
3	7 53.8	6 46.2	-	13
4	3 50.0	2 33.3	1 16.7	6
5	7 50.0	5 35.7	2 14.3	14
6	1 33.3	1 33.3	1 33.3	3
7	1 25	3 75	-	4
8	-	-	1 100%	1
Total column	25	21	6	52

* To be read: 2 (66.6%) of the responding organisations and companies which use one O.R. technique are of the size 1-100 employees.

From the previous discussion the following facts emerge:

Firstly, the vast majority of O.R. user industrial and business organisations in the U.A.E. use very few O.R. techniques, about 85 percent of the users use less than five O.R. techniques, only 15 percent use more than five techniques and less than nine techniques. This might be attributed to lack of awareness of the range of techniques available.

Secondly, there is a positive correlation between the no. of techniques being used and the size of O.R. users, though it is not a strong one (about 0.18).

Thirdly, the majority of those who use one to seven O.R. techniques are small to medium sized organisations (between 1-500 employees), while the one which uses more than seven O.R. techniques is large ($\geqq$500 - $\leqq$2000).

With respect to the geographical locations of the users of O.R. techniques in the U.A.E., Table (3.4g) shows that 9 out of the 11 organisations and companies which participated in the survey in Abu Dhabi use some form of O.R./M.S., in Dubai 19 out of the 49 companies use O.R./M.S., in Sharjah 9 out of the 24 companies use O.R./M.S., in Ras Al-Khaimah 6 out of the 18 companies use some form of O.R./M.S., in Ajman 1 out of the 10 use O.R./M.S., in Umm Al-Quwain 1 out of the 6 use O.R./M.S. and finally in Al-Fujairah 7 out of the 8 companies use some form of O.R./M.S.

Nonetheless, this should not lead to the conclusion that O.R. is more adopted in Al-Fujairah than in Dubai or Sharjah, rather it is due to the fact that the selected organisations and companies in Al-Fujairah might not be representative of the Emirate as a whole and further investigation is needed to find out what reasons caused this attitude. A further comment on the information given in Table (3.4g) is that O.R. users in Abu Dhabi are predominantly engaged in the oil and gas industries, in Dubai O.R. users are predominantly in the petroleum and energy sector and in the heavy industries. In

Sharjah, they are predominantly in the light industries. Similarly in Ras Al-Khaimah, Ajman and Fujairah, O.R. users are predominantly in the light industries. In Umm Al-Quwain, the one O.R. user is involved in the banking business.

Table (3.4g)

Geographical Location of O.R.

Users in the U.A.E.

Emirate	No. of responding organisations and companies (1)	No. of users (2)	(2) as % of (1)
Abu Dhabi	11	9	81.8%
Dubai	49	19	38.8
Sharjah	24	9	37.5
Ras Al-Khaimah	18	6	33.3
Ajman	10	1	10.0
Umm al-Quwain	6	1	16.7
Fujairah	8	7	87.5
Total	126	52	41.3

Source: Figures compiled from questionnaire distributed by the author, November-December,1987.

With regard to aspects of economy where O.R./M.S. techniques are used, Table (3.4h) shows the number of organisations and companies out of the total number of organisations and companies in each activity using some form of O.R. technique.

Table (3.4h)

Classification of User Organisations and

Companies By Major Activity

Activity	No. of organisations and companies (1)	No. of users (2)	(2) as % of (1)
Manufacturing	66	26	39.4%
Trading	13	3	23.1
Banking, finance and business services	13	6	46.2
Engineering & construction	3	0	0
Petroleum & energy	9	7	77.8
Distribution & storage	4	3	75.0
Agribusiness	4	2	50.0
Industrial services	12	4	33.3
Others	2	1	50.0
Total	126	52	41.3

Source: compiled from questionnaire distributed by the author, November-December 1987.

It is to be noted that the total number of organisations and companies in distribution and storage and in the agribusiness sectors is small, therefore the sample chosen from these two sectors is also small.

It should be pointed out that the high usage of O.R. in the petroleum and energy sector is due mainly to the availability of foreign experts with adequate knowledge in O.R. By the same token the high usage of O.R. in the distribution and storage sector is partly due to the fact that companies in this sector are run by foreign personnel who have some knowledge in O.R. and partly because of the need for it.

Table (3.4i) presents the classification of user organisations and companies according to their size measured by the number of employees. Although this measurement is not the best indicator of the size of the organisation or company it gives some indication of the size, especially when we realise the difficulty in obtaining information about turnover or sales volume. However, Table (3.4i) indicates that about 30 percent of the organisations and companies that range between one and one hundred employees use some form of O.R./M.S. technique; 58 percent of the organisations and companies with one hundred to five hundred employees apply some sort of O.R./M.S. technique. The percentage of users increases with the increase in the size of the user organisation or company. Furthermore, large users are predominantly engaged in the petroleum and energy sector or groups of companies under one management and engaged in manufacturing and trading.

Table (3.4i)

Classification of User Organisations and

Companies By Size (no. of employees)

Size	(1) No. of organisations companies	(2) No. of O.R. users	(2) as % of (1)
1-100	84	25	29.8%
101-500	36	21	58.3
501-2000	6	6	100.0
Total	126	52	41.3

Source: Figures compiled from questionnaire distributed by the author, November-December 1987.

From the previous facts one can argue that O.R. is used to some extent in small, medium and large industrial and business organisations and companies in the U.A.E.

This is a result of awareness of the benefits which can come from the application of these techniques.

It becomes clear from the figures that people tend to adopt those techniques which are not difficult, need less data, computing time and do not require highly specialised and trained personnel.

Application Areas

Table (3.5) lists areas of applications of O.R. techniques reported by the repondents. The most frequently used technique is demand forecasting and this is to be expected in the U.A.E. market which is subject to severe domestic and foreign competition.

In order to remain competitive and hence to survive, companies need to operate efficiently and this is shown by the five most frequently used techniques; demand forecasting, profitability analysis, resource allocation, product mix and stock control. All of these are used to improve the efficiency of operation of the companies concerned. The other techniques used also contribute to long and short term efficiency to a greater or lesser extent.

Table (3.5)

Area of Application of The Adopted O.R. Techniques

Area of application	Frequency of application	as % of total	rank
Forecasting demand	31	60.0	1
Profitability analysis	23	44.0	2
Allocating resources	22	42.0	3
Product mix problem	20	38.0	4
Stock control	20	38.0	4
Sales analysis	16	31.0	6
Investment appraisal	15	29.0	7
Accounting procedures	14	27.0	8
Production scheduling	13	25.0	9
Project control	13	25.0	9
Maintenance & repair	13	25.0	9
Capital budgeting	12	23.0	12
Quality control	11	21.0	13
Price setting	11	21.0	13
Project scheduling	10	19.0	15
Manpower planning	10	19.0	15
Capacity planning	8	15.0	17

Source: Figures compiled from questionnaires distributed by the author, November-December 1987.

It is worth noting here that the interviews revealed that O.R./M.S. techniques are not formally used as part of a company policy in any of the responding organisations and companies, they are only used by individuals in these organisations.

Willingness to use O.R.

An essential factor in the introduction and diffusion of O.R. is the willingness to use it. The willingness to use it depends on: applicability, availability of computers and specialised personnel, and the belief and confidence in its value and contribution.

The survey revealed that of the 31 respondents with knowledge in O.R. but not using any form of it at the present time, 45 percent are willing to use it in the future; of the 43 with no knowledge in O.R. and, of course, not using any form of it, only 23 percent are willing to use it in the future and about 26 percent are undecided. The willingness to use O.R. in the future is subject to the condition that the resulting benefits are greater than the costs of its usage.

It is interesting to notice that of the 31 responding organisations with adequate knowledge in O.R. but not using any form of it at the present time, and are willing to use it in the future, 80 percent are of small size (between 1-100 employees) while the remaining 20 percent are of medium size (between 101-500 employees). Similarly, 80 percent of those with no knowledge in O.R., but are willing to use it in the future are of small size (between 1-100 employees) while the remaining 20 percent are of medium size (between 101-500 employees). This might support our belief that the future of O.R. in the U.A.E. is encouraging since the majority of small sized organisations are willing to use this branch of technology in the future.

O.R. Personnel

Having examined O.R. techniques being used and their areas of application, now let us turn to those who use these techniques.

It is worth pointing out that no specialised personnel with a degree in O.R. or M.S. were employed in the 126 organisations and companies which participated in the survey. Furthermore, no O.R. department or group exists in those organisations and companies. Table (3.6a) presents the academic backgrounds for those who have some knowledge in O.R./M.S. techniques whether they apply these techniques in their organisations and companies or not.

Table (3.6a)

Academic Backgrounds of Respondents with knowledge in O.R.

Academic Backgrounds	No. of respondents	As % of the total	Rank
Computer Science	3	3.7%	6
Engineering	38	46.9	1
Accountancy	12	14.8	2
Business administration	12	14.8	2
Agriculture	3	3.7	6
Finance	4	4.9	4
Mathematics	2	2.5	9
Economics	4	4.9	4
Other	3	3.7	6
Total	81	100	

Source: Figures compiled from questionnaire distributed by the author, November-December 1987.

It can be inferred from Table (3.6a) that 46.9 percent of those who have some form of knowledge in O.R./M.S. have engineering backgrounds and those with backgrounds in accountancy and business administration account for 14.8 percent each; finance and economics come fourth and fifth respectively. On the whole about 57 percent have hard scientific backgrounds.

By comparison, Kwong's survey of O.R. practice in

Malaysia revealed that 18 percent of O.R. practitioners are from an engineering background, 14 percent have backgrounds in computer science, 9 percent economics, 8.6 percent mathematics, 6 percent business administration and 5.5 percent have backgrounds in accountancy. (6,1986).

Although both surveys revealed that an engineering background comes at the top of the list, business administration and accountancy ranked second in our survey, while they ranked sixth and seventh respectively in Kwong's survey. Those with a computer science background ranked second in Kwong's survey whereas they ranked sixth in ours. It is not obvious to us whether this happened by pure chance or there are systematic factors causing such differences.

Table (3.6b) presents the educational level of respondents.

Table (3.6b)

Educational Level of Respondents

Educational level	No. of respondents	As % of total	Rank
BSC	41	50.6	1
BA	13	16.0	2
B.Comm	5	6.2	3
MA	2	2.5	9
MSC	2	2.5	9
MBA	5	6.2	3
Diploma	3	3.7	6
Charter of accounting	4	4.9	5
PHD	3	3.7	6
Other	3	3.7	6
Total	81	100	

Source: Figures compiled from questionnaire distributed by the author, November-December 1987.

As can be seen from Table (3.6b) the majority of those who have knowledge in O.R./M.S. techniques hold BSC degrees (51 percent), while those with PHD's account for only 4 percent of the total.

With regard to the job positions, Table (3.6c) shows the job positions for the 81 respondents with some form of knowledge in O.R./M.S. techniques. As shown in Table (3.6c), 43 percent of the 81 respondents are general managers, 57 percent of the respondent general managers with knowledge in O.R. apply O.R./M.S. techniques in their organisations and companies while 43 percent do not apply any form of O.R./M.S.

in their organisations and companies at the present time; operation managers and regional managers each account for 7 percent of the total; 67 percent of the respondents operation managers apply some form of O.R./M.S. techniques in their organisations and companies while 33 percent do not use any form of O.R./M.S. techniques. Of the regional managers only 33 percent use some form of O.R./M.S. techniques while 67 percent do not use any form of O.R. The personnel managers account for 5 percent of the total, 50 percent of personnel managers with knowledge in O.R. apply some sort of O.R./M.S. techniques. Chief accountants, computer service managers and production managers each account for 4 percent of the total and all apply some form of O.R./M.S. techniques in their organisations and companies.

Table (3.6c)

Job Positions of Respondents

Job position	No. of respondents user of O.R.		No. of respondents Non-O.R.user		Total	
					No.	%
General Manager	20	57%	15	43%	35	43%
Chief Accountant	3	100.0		-	3	4
Personnel Manager	2	50.0	2	50.0	4	5
Operation Manager	4	67.0	2	33.0	6	7
Regional Manager	2	33.0	4	67.0	6	7
Computer Services Manager	3	100.0		-	3	4
Production Manager	3	100.0		-	3	4
Technical Manager	2	100.0		-	2	2.5
Management Analyst	1	50.0	1	50.0	2	2.5
Other	10	59	7	41.0	17	21
	50		31		81	

Source: figures compiled from questionnaire distributed by the author, November-December 1987.

With regard to the methods of acquiring knowledge in O.R./M.S. techniques, Table (3.6d) indicates that 34 percent of those who use O.R./M.S. and 45 percent of those who do not use O.R./M.S. acquired their knowledge in O.R./M.S. techniques through taking courses.

14 percent of those who have some knowledge in O.R./M.S. techniques and at the same time use them gained their knowledge from other sources which includes: literature, press and self studies, while a further 26 percent of those

who have some knowledge in O.R. but do not use it gained their knowledge from similar sources. This discussion leads to the conclusion that taking courses in O.R./M.S. is the main source of acquiring knowledge in O.R./M.S., and this means that a great emphasis should be placed on the quality and quantity of O.R. education in the U.A.E.

Table (3.6d)

Methods of Acquiring Knowledge in O.R./M.S.

Method of acquiring knowledge in O.R.	No. of respondent user of O.R.		No. of respondent non-user of O.R.		Total	
					No.	%
taking courses only	17	34%	14	45%	31	38%
training only	1	2	-		1	1.2
use only	4	8	-		4	4.9
other sources only	7	14	8	26	15	18.5
taking courses & training	4	8	1	3.2	5	6.2
taking courses and use	6	12	1	3.2	7	8.6
taking courses and other sources	1	2	1	3.2	2	2.5
taking courses, training and use	4	8	2	6.5	6	7.4
taking courses, training and other	1	2	-		1	1.2
training and use	4	8	1	3.2	5	6.2
training and other	-		1	3.2	1	1.2
use and other	1	2	1	3.2	2	2.5
taking courses, use and other	-		1	3.2	1	1.2
Total	50		31		81	

Source: compiled based on questionnaire distributed by the author, November-December, 1987.

The classification of respondents according to nationality is given in Table (3.6e).

Table (3.6e)

Classification of Respondents According to Their Nationality

Nationality	No. of respondent (user)		No. of respondent (non-user)		Total	As % of total
British	11	21%	3	10%	14	16.9
American	7	13	1	3	8	9.6
Indian	8	15	5	16	13	15.7
U.A.E.	5	10	1	3	6	7.2
Egyptian	5	10	3	10	8	9.6
Pakistani	3	6	2	6	5	6.0
Lebanese	1	2	3	10	4	4.8
Dutch	1	2	2	6	3	3.6
Jordanian	2	4	1	3	3	3.6
Sudanese	3	6	-		3	3.6
French	-		1	3	1	1.2
Bangladeshi	-		1	3	1	1.2
Sri Lankan	1	2	-		1	1.2
Syrian	-		1	3	1	1.2
Palestinian	1	2	1	3	2	2.4
Japanese	1	2	-		1	1.2
Swiss	2	4	-		2	2.4
German	1	2	1	3	2	2.4
Korean	-		1	3	1	1.2
Austrian	-		1	3	1	1.2
Yemen Arab Rep	-		1	3	1	1.2
Iranian	-		2	6	2	2.4
Total	52		31		83	

Source: Compiled from questionnaire distributed by the author, November-December 1987.

The discussion of this sub-heading can lead to the conclusion that very few U.A.E. nationals are aware of O.R./M.S., and the majority of users are foreigners. This is due partly to the fact that the majority of organisations and companies in the U.A.E. are run by foreign experts, and partly to lack of skilled personnel among U.A.E. citizens. It is worth pointing out that those few U.A.E. nationals aware of O.R. acquired their knowledge in O.R. abroad, mainly in Europe and the USA, and it is the U.A.E. government policy to replace foreigners by U.A.E. nationals. No doubt, lack of O.R. awareness among U.A.E. nationals is going to hinder the wide adoption of O.R. in enterprises run by U.A.E. nationals. Here O.R. education and adequate training in O.R. usage is essential to overcome such obstacles.

Another point worth noting is that 40 percent of O.R. users and 48 percent of the non-users who have some knowledge in O.R. are at the highest level of management. This is of course an essential factor which helps in the wide adoption of O.R. in the future. Another point worth noting is that 48 percent of O.R. users gained their knowledge in O.R. through taking courses and at the same time hold a first degree. This might suggest that university education in O.R. is an important source of knowledge in O.R., therefore the quality and quantity of O.R. education should be given special attention.

The Use of O.R. and the Availability of Computing Facilities

Having examined the academic backgrounds, educational level, methods of acquiring knowledge in O.R./M.S., and finally nationality of respondents, now attention is paid to the following question: "is there any relation between the availability of computing facilities and the use of O.R./M.S. techniques?"

The survey revealed that 90 percent of user organisations and companies have computing facilities whereas only 10 percent of the users do not have computing facilities and those usually use techniques which do not require the use of computers. Most of those organisations and companies which have computers, own micro-computers and use standard packages, and very few have large computers and develop their own programmes. Of those who do not use O.R. techniques at the present, 31 percent own computers, while 69 percent do not.

Undoubtedly, the availability of computing facilities is an important factor in the use of O.R. techniques, since the majority of these techniques require the use of computers to varying degrees. One of the main obstacles to the introduction and wide adoption of O.R. in developing countries is limited availability of computing facilities and inadequate maintenance services. This has turned out to be true in the case of the U.A.E.

Table (3.7) shows cross-tabulation of O.R. usage versus availability of computing facilities.

Table (3.7)

Cross-tabulation of O.R. Usage

Versus Availability of Computers

Availability of computers		Yes	No	Total
O.R. usage	Yes	47* 90%	5 10%	52 100%
	No	23 31%	51 69%	74 100%
Total		70	56	126

* to be read: 47 (90%) of those who use O.R. techniques, have computers.

3.3 Evaluation of O.R. Education and Training in the U.A.E.

This section concentrates on the evaluation of O.R. education and training with the aim of finding out whether there is a link between the education and practice of O.R./M.S. or not.

An O.R. course is taught at the U.A.E. university in the department of Business Administration for third year students studying Business and Public Administration and it is an elective course. In the Autumn of 1987 about 80 students registered for this course. The subjects taught include: Linear Programming (simplex method), Transportation Problems, Queuing Theory, Network Analysis (PERT-CPM), Decision Theory, and Inventory Theory.

The course is taught by means of lectures (two lectures per week of one and a half hours duration), no textbook is used and up to now computers have not been introduced also no projects are used. A survey was conducted on the 80 students registered for this course. 48 questionnaires were completed (a response rate of 60 percent). The two instructors of the course were asked to complete the second part of the questionnaire and both completed it. When asked whether the O.R. course taught at the U.A.E. University was useful in terms of knowledge gained from the course, 39 out of the 48 respondents answered "Yes" (about 81 percent) and only 9 answered "No", (about 19 percent). 5 out of the 9 who answered "No" to the above question did so because of the difficulty of the course, 2 out of the 9 thought that O.R. was not applicable to real-life situations in the U.A.E., 1 out of the 9 thought that the course was not suitable for his major (Public Administration), and 1 out of the 9 thought the course was not useful because there was no introductory course before the O.R. course currently taught.

With reference to the subject area where the O.R. course should give more attention, Table (3.8) indicates that 51 percent of the 39 who answered "Yes" when asked whether the O.R. course was useful, thought that it should give more attention to Linear Programming, Decision Theory, Queueing Theory and Transportation Problems. 18 percent of the 39 thought that the O.R. course did not give enough attention to the Decision Theory only, 10 percent thought that the O.R. course should give more attention to Transportation Problems and the Decision Theory, 8 percent thought that the Queueing Theory and Transportation Problems needed more attention. About 3 percent thought that more attention should be given to Linear programming only, the Queueing Theory only, the Transportation Problems only, and a combination of LP, DT and QT.

The same percentage (3%) thought that the O.R. course should give more attention to other areas: e.g. Network Analysis (PERT/CPM).

Out of the 9 students who gave negative answers for the first question, 22 percent felt that the O.R. course taught at the U.A.E. University should pay special attention to the following four subjects: Linear programming, Decision Theory, Queueing Theory and Transportation Problems, 22 percent did not answer the question, and 11 percent felt that the O.R. course should place more attention on Decision Theory. The same percentage thought that it should give more attention to both the Queueing Theory and the Transportation Problems.

Table (3.8)

Subjects to be Given More Attention in The O.R. Course

Taught at The U.A.E. University

No.	Subject	Q1 (yes) No. of respondent	%	Q1 (no) No. of respondent	%
(a)	LP	1	2.6%	-	-
(b)	DT	7	18.0	1	11.1%
(c)	QT	1	2.6	1	11.1
(d)	TP	1	2.6	1	11.1
(e)	All above	20	51.2	2	22.2
(f)	Other	1	2.6	-	-
(g)	a & b	-	-	1	11.1
(h)	b & d	4	10.3	1	11.1
(i)	c & d	3	7.7	-	-
(j)	a & b & c	1	2.6	-	-
(k)	undecided	-	-	2	22.2
	Total	39	100.0	9	100

Source: Figures compiled from questionnaire distributed to the O.R. students at the U.A.E. university, December 1987.

When students were asked if they could apply what they had learned in the O.R. course to real life situations, 42 students out of the 48 respondents (87.5 percent) answered "Yes", and 6 students out of the 48 (12.5 percent) answered "No", see Table (3.9a).

Table (3.9a)

Usefulness Versus Applicability of The O.R.

Course at The U.A.E. University

Useful / Can be applied	yes	no	Total row
yes	38	4	42 (87.5%)
no	1	5	6 (12.5%)
Total column	39 (81%)	9 (19%)	48 (100%)

Of those with the positive answer, 27.7 percent selected the public sector as the area of application of what they had learned in the O.R. course, 35.5 percent said that they could apply what they had learned in the O.R. course in the private sector, 34.4 percent in the industrial sector, and 2.2 percent in other sectors such as agriculture. With regard to the possibility of introducing O.R. into the U.A.E., about 24 percent of the 42 students, strongly agreed, about 67 percent agreed, 7 percent were undecided and 2.4 percent disagreed, see table (3.9b).

Table (3.9b)

Students Attitude Toward The Introduction

of O.R. Into The U.A.E.

Attitude	No. of students	As % of total
agree	28	66.7%
strongly agree	10	23.8
disagree	1	2.4
strongly disagree	0	0
undecided	3	7.1
Total	42	100

With reference to the second part of the questionnaire which was completed by the two instructors, both thought that the O.R. course should give more attention to Linear Programming and one of them thought it should give more attention to both Linear Programming and Decision Theory. Both instructors strongly agreed that the practice of O.R. could be introduced into the U.A.E. to help decision makers make more effective and efficient decisions.

Regarding the comprehensiveness of the O.R. course currently taught at the U.A.E. University, there was disagreement between the two instructors; while one thought it was sufficiently comprehensive, the other thought that two more subjects, namely Game Theory and Markov Chains should be included in the course. With regard to the suitability of the O.R. course taught at the U.A.E. University to the decision makers' needs and the environment in the U.A.E., both instructors answered positively.

With regard to the need for additional O.R. courses, both instructors answered positively. The areas of application of O.R. in the U.A.E. suggested by the instructors include Product Mix problems, Capital Budgeting and Allocation of Resources.

We should point out here that the majority of students who participated in the survey have no real life experience in the use of O.R. in particular. Consequently, no perfect judgment can be based directly on their views.

Based on the previous discussion one can argue that the O.R. course taught at the U.A.E. University is insufficient to provide adequate knowledge in O.R. Partly because it is theoretically orientated, partly because of the wide gap between what is taught in the course and what is really needed in the U.A.E., and partly because less attention is paid to this course, this is evident from the absence of textbooks, computers and qualified instructors.

Regarding the training of O.R. in the U.A.E., it was found that no formal or informal training in O.R. techniques is available either at the company or the national levels. No private or public organisations which provide training in O.R./M.S. techniques are in existence in the U.A.E. The only training available is in the use of computing facilities and software. There is one centre which provides training in marketing, sales skills, communication skills, computer system analysis, but not in O.R. techniques.

Based on the previous discussion we can conclude that the supply side is totally inadequate and this has to be resolved first so that the O.R./M.S. can flourish. The supply side includes both O.R. education and training.

In chapter ten of this thesis we discuss the type of O.R. education and training required at this stage, so that O.R. can be widely adopted in the U.A.E.

3.4 Problems Hindering the Diffusion of O.R. in The U.A.E.

This section examines the problems hindering the wide adoption of O.R. techniques in the U.A.E. As mentioned earlier in this chapter 31 organisations and companies out of 126 organisations and companies have some knowledge in O.R./M.S. techniques but do not apply O.R./M.S. techniques at the present time. The reasons for not adopting O.R./M.S. techniques are presented in Table (3.10a). This table indicates that 12 organisations and companies out of 31 organisations and companies with knowledge in O.R./M.S. techniques but not applying these techniques at the present, think that O.R./M.S. techniques are not applicable to their activities. 7 out of the 31 or about 23 percent have not adopted any form of O.R./M.S. because of the lack of specialised personnel. 19 percent have not adopted O.R./M.S. techniques because the major decisions are made by the parent company overseas. 13 percent have not adopted them because of other reasons mainly the small size of the organisation or company. About 10 percent have not adopted any form of O.R./M.S. because they believe that the use of O.R./M.S. techniques is too costly. The same percentage again have not adopted them because of lack of computing facilities.

Table (3.10a)

Reasons for Not Adopting O.R./M.S.

Techniques in Organisations and Companies with

Knowledge in O.R.

No.	Reasons	No. of organisations and companies	As % of total	Rank
(a)	Not applicable	12	38.7%	1
(b)	Lack of computing facilities	3	9.7	5
(c)	Lack of specialised personnel	7	22.6	2
(d)	Management has no interest in O.R.	2	6.5	7
(e)	Too costly	3	9.7	5
(f)	Major decisions are made by parent company overseas	6	19.4	3
(g)	No particular reason	1	3.2	8
(h)	Other e.g. too small	4	12.9	4
	Total	31		

Source: Figures compiled from questionnaire distributed by the author, November-December, 1987.

With reference to those organisations and companies with no knowledge in O.R./M.S. techniques and, of course, not applying any form of these techniques, this group accounts for 34 percent of the total responding organisations and companies. The reasons for not adopting O.R./M.S. techniques for this group are presented in Table (3.10b). This table indicates that the most common reasons for not adopting O.R./M.S. techniques are:

Lack of knowledge in O.R./M.S. techniques (30 percent); no particular reason (24 percent); lack of specialised personnel (24 percent); management has no interest in these techniques (12 percent); major decisions are made by the parent company overseas (9 percent) and lack of computing facilities (9 percent).

Table (3.10b)

Reasons for Not Adopting O.R./M.S.

in Organisations and Companies with

No Knowledge in O.R./M.S.

No.	Reason	No. of organisations and companies	As % of total	Rank
(a)	Not applicable	6	14.0%	4
(b)	Lack of computing facilities	4	9.3	6
(c)	Lack of specialised personnel	10	23.6	2
(d)	Management has no interest in O.R.	5	11.6	5
(e)	Too costly	3	7.0	8
(f)	Major decisions are made by parent company overseas	4	9.3	6
(g)	No particular reason	10	23.6	2
(h)	Other (lack of knowledge in O.R./M.S.)	13	30.2	1
	Total	43		

Source: Figures compiled from questionnaire distributed by the author, November-December, 1987.

It is noteworthy that about 30 percent of non-users respondents do not use O.R. in their organisations and companies because of lack of knowledge in O.R., this is not surprising, but it is surprising to find that 24 percent of pespondents with no knowledge in O.R. said that there was no particular reason for not using O.R. in their organisations and companies. This may result from lack of knowledge in O.R., so they do not know whether it is applicable in their organisations and companies or not and they tick this answer to avoid embarassment.

It is also worth pointing out that the majority of respondents with no knowledge in O.R. are working in small scale organisations and companies in trading, banking and business services, and light industries.

Based on the previous discussions one can argue that the main obstacles to the wide adoption of O.R. in the U.A.E., particularly in the industrial and business organisations and companies are:

(i) Lack of O.R. awareness;

(ii) Lack of specialised personnel;

(iii) Applicability;

(iv) The small size of the organisation or company;

(v) High costs of O.R. usage;

(vi) Lack of management interest in O.R.

In this thesis, we do not consider "applicability" as a problem to the wide adoption of O.R. since nothing can be done regarding this matter. Furthermore, problems (iv) and (v) are related to each other. Since the small size of an organisation or company makes the adoption of O.R. either unnecessary or unaffordable. Therefore, problems (i), (ii) and (vi) are examined in chapter ten and these are considered as internal factors within the organisation. While problems like: lack of training schemes, inadequate O.R. education and lack of computing facilities and maintenance services are considered as environmental factors. Comparing the information given in Table (3.10a) with the information given in Table (10) p.339 in Kwong (6, 1986) the reasons for not using O.R. techniques in Malaysian companies, we found that in Malaysia the main reasons for not using O.R. techniques are: computer resources devoted to higher priority users (47 percent); not applicable (28 percent); lack of sufficiently competent personnel (27 percent); lack of interest amongst executives (11 percent); and finally, other reasons e.g. newly computerising (2.0 percent). While in Hongkong the main reasons for not using O.R. techniques as mentioned in Leung (7, 1983), Table (2) p.471, are: there is no need for such techniques (30.4 percent): lack of O.R. personnel (21.7 percent): too costly (13.0 percent): Business environment too volatile (8.7 percent): lack of data processing (8.7 percent): major decisions are made by parent company (4.3 percent).

In Greece, as reported by Pappis et al (8,1988) the main reasons for not adopting O.R. techniques are: O.R. application is not considered necessary (20 percent); the administration is not familiar with O.R. (18 percent); lack of qualified personnel (14 percent); and the bad organisational and operational conditions of the firms do not favor the utilization of O.R. (13 percent). Similarly, Bartholdi III (9,1986) concluded that the slow application of O.R. techniques in China is attributed to shortage of trained personnel, severe shortage of computing facilities, shortage of data and finally rigid social organisation.

From the previous comparison one can argue that there are common reasons for not adopting O.R. techniques in the third world countries. These are: lack of awareness and knowledge in O.R.; lack of trained and qualified personnel; lack of management interest and belief in O.R. and finally, lack of computing facilities.

To sum up, despite the fact that there are some problems which hinder the wide adoption of O.R. techniques in business and industry at large, 81 percent of the 52 user organisations and companies currently using O.R. see no problems in using O.R./M.S. techniques in the U.A.E. in general, only 15 percent see some problems in using O.R./M.S. techniques in the U.A.E., and 4 percent do not know.

The Future of O.R. in the U.A.E.

Having examined the current status of O.R. in the U.A.E. it would be of interest to evaluate its future. We strongly believe that the future for O.R. is encouraging, this belief is based on three main facts:

First, the survey revealed that 45 percent of the 31 non-users with knowledge in O.R. are willing to use some form of O.R. in the future provided that the cost of its usage is justified by the resulting benefits. 23.2 percent of the 43 non-users with no knowledge in O.R. are willing to use O.R. in the future.

Second, as revealed by the survey, 48 percent of non-user respondents with knowledge in O.R. hold the top management positions (general managers or senior managers); this of course is a promising sign of a bright O.R. future, since an essential factor in the succesful introduction and adoption of O.R. rests in the belief of decision makers in the value of these techniques.

Third, the U.A.E. follows an open door economy policy and this tends to make market forces encourage productivity rises and cost reduction. This in turn necessitates the use of aids, tools and methods of science for the improvement of productivity and reduction of cost. Here O.R. can help.

3.5 The Value of O.R. to its Users

So far we have discussed the status of O.R. practice in the U.A.E., evaluated the education and training in O.R. in the U.A.E. and outlined the problems which have served as impediments to the diffusing of O.R. in the industrial and business organisations and companies in the U.A.E. The question which might be raised here, is "why should O.R. be used more widely in the U.A.E., especially in the industrial and business organisations and companies?"

To answer this question accurately, a great deal of information is needed, so that we can justify the value of O.R. to its users, or in other words, the role of O.R. in improving the productivity and profitability of its users. Since no such information is readily available at this moment, to justify O.R. values to its user, examples from the literature are used to demonstrate the value of O.R. to some developing countries where some form of O.R. has already been implemented.

First, let us start with the survey we have conducted. This survey revealed that 41 percent of the responding organisations and companies (52 organisations and companies out of 126) use some form of O.R. Logically, those users would not use O.R. techniques if they would not yield the benefits which justify their usage.

Now let us turn to the examples from other developing countries where O.R. has already been used.

Cook and Wright (10, 1981), for example, reviewed the literature relating to the application of O.R. in developing countries. Table (1), p.1209 in the Cook and Wright paper summarised the number of cases and areas of application of O.R. in developing countries in Asia, Africa and South America. Perfect judgment regarding the value of O.R. to developing countries cannot be based largely on the information given in this table in particular and the review in general. Partly because their review has been restricted to the English language literature, and therefore studies published in native languages have been overlooked, and partly because this review is now out of date. However, it still can give some indications that O.R. has justified its usage in the developing countries stated in the Cook and Wright paper, otherwise they would not use it.

As another example, Sagasti (11, 1974) examined several case studies on the use of O.R./M.S. in Peru. One of the successful uses of O.R./M.S. in Peru was the study of the distribution system of a dairy firm in Lima where a sophisticated mathematical model was employed. As a result of the application of this model a cut in the distribution cost per unit of 25 percent was achieved. Similarly, Bhuleskar (12, 1972) discussed the application of a linear programming model to determine the best oil buying plan for

Hindustan Lever Ltd of India. The use of this model has benefited the management of the company, though no monetary value of saving was reported in the paper probably for the reason of commercial security.

Muir et al. (13, 1962) reported an application of simple system analysis and basic data collection in a steel company in Chile. The application of this procedure resulted in a 17 percent increase in the production rate of the company.

As another example, Roy et al. (14, 1982) reported the application of a mathematical model to solve the problem of locations and capacities of LPG bottling plants in India. The solution of the model was accepted by the organisation sponsoring the study.

Finally, Kwong (6, 1986) reported the results of a survey of the practice of O.R. in Malaysia and Singapore. The survey showed that O.R. is widely used in the energy and petroleum industry in the two nations; it is also used to a large extent in the manufacturing sector and to some extent in the business and finance sector of both nations. This suggests that the use of O.R. was stimulated by its value to the users in Malaysia and Singapore.

The examples mentioned earlier are merely for the purpose of demonstrating the value and significance of O.R. to the users in the industrial and business organisations in some developing countries, and it is by no means an exhaustive list of all the applications of O.R. in the developing countries. We concentrated on the actual implementation of O.R. in the industrial and business organisations rather than on theoretical papers or the application of O.R. in the civil service and government sector. The previously mentioned examples might give indication of the values of O.R. to the industrial and business organisations and companies in the developing countries. This might justify why we believe that O.R. is an essential branch of technology which should be adopted widely whenever possible especially in the industrial and business organisations in newly industrialised countries.

3.6 Conclusion

This chapter discussed in some details the outcomes of the surveys regarding the practice of O.R./M.S. techniques and also the education and training in O.R. in the U.A.E..

The main findings of this chapter are as follows:

(1) techniques like: Inventory control, Forecasting Models, Statistical Analysis, Cost benefit Analysis, decision Theory and Linear Programming are widely used in the U.A.E. This is due in part to the simplicity of these techniques and in part to the environment in the U.A.E. which necessitates the adoption of specific techniques.

(2) forecasting demand, profitability analysis, allocating resources, product mix problems, and stock control are the most popular areas of application of O.R. techniques. This is also attributed to the environment in the U.A.E., where severe competition takes place, and uncertainty is presented greatly.

(3) more O.R. techniques are adopted in the petroleum and energy sector than any other sector. This is due largely to the complexity of the problems faced by this sector, and also

to the availability of highly skilled personnel with knowledge in O.R. techniques.

(4) the vast majority of O.R. users in the U.A.E. use very few techniques (one to five), while very few users use more than five and less than nine techniques. This is attributed largely to lack of awareness of the values of these techniques on the one hand, and to the lack of experience and knowledge in all O.R. techniques available and their areas of application on the other.

(5) factors like: suitability of the techniques being used for the problem examined, simplicity of the techniques, less need for computing time, and less need for specialised personnel are collectively responsible for the adoption of O.R. techniques being used in the users organisations and companies. This points to the fact that O.R. techniques which could be used in the U.A.E. in particular and in the developing countries in general should have special characteristics.

(6) there are a few problems which serve as impediments to the diffusing of O.R. techniques in the industrial and business organisations in the U.A.E. These are: lack of O.R. awareness, lack of specialised personnel, lack of computing facilities and computers maintenance services, and lack of training schemes.

(7) O.R. users personnel are generalists rather than specialists i.e. those practicing O.R. in the responding organisations and companies are not specialised in O.R./M.S. but have some knowledge in O.R., mainly through taking O.R. courses or training in O.R. The majority of them are of

engineering backgrounds and hold first degree.

(8) O.R. education in the U.A.E. is inadequate and theoretically oriented and does not fulfil the needs of the society.

(9) training in O.R. does not exist either at the company level or at the national level although it is an important source of knowledge in O.R.

(10) no formal O.R. group or department has been identified in any of the user organisations and companies, but O.R. usage appears to have been an informal process, spread throughout various functional areas in the user organisations and companies.

(11) on the whole O.R. is not a well-established and widely used activity in the industrial and business organisations and companies in the U.A.E. O.R. contribution to U.A.E. development is not up to expectations. This is due in part to lack of awareness of its value and in part to other environmental factors.

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CHAPTER FOUR

THE U.A.E. CEMENT INDUSTRY: HISTORY AND PROBLEMS

CHAPTER 4

THE U.A.E. CEMENT INDUSTRY: HISTORY AND PROBLEMS

4.1 Introduction

The previous chapter examined the current status of O.R. in the U.A.E. in general and in the industrial and business organisations in particular. It also examined the problems which serve as impediments to the widespread use of O.R. in the U.A.E., in particular in the industrial and business organisations. Furthermore, the main characteristics of O.R. which suited the U.A.E. were outlined.

This chapter gives an overview of the history and the current situation in the U.A.E. cement industry. It examines how cement is made and what processes of manufacturing cement are used world-wide. Furthermore, it outlines the general economic characteristics of the industry. Four main economic characteristics are examined, these are: capital intensity, energy intensity, economies of scale and transportation costs. Moreover, it discusses briefly some aspects of the U.A.E. cement industry, namely, the structure of the industry, location and plant size, production, the market, labour force, labour productivity, finance, and finally administration. It also outlines the problems currently facing the U.A.E. cement industry and examines what has been done to overcome some or all of these problems.

4.2 Technology of Cement Manufacturing

This section deals with two aspects of the technology of cement manufacturing. The first aspect is the processes of cement manufacturing and the second one is methods of manufacturing cement. These are dealt with in the next two sub-sections.

4.2.1 Manufacturing Processes:

The principle processes in manufacturing cement consist of: crushing, grinding, mixing, burning raw materials, grinding the resultant clinker and finally adding gypsum. These processes are discussed below as follows. (See Figure 4.1).

(i) Crushing:

Limestone is transported from the quarry to the crushers where it is crushed and screened. The crushed limestone is then transported to the grinding mills.

(ii) Grinding:

The crushed limestone is fine ground and then it is transported to the mixing mills.

(iii) Mixing:

Here, the ground limestone is mixed and other raw materials like clay, shale and iron ore are added. Then the mixture is transported to the kilns.

(iv) Raw materials burning:

This process is the most important operation in manufacturing cement because: (a) fuel consumption is a major expense; (b) the capacity of a plant is measured by the capacity of the kiln; and (c) the strength and other properties of cement depend on the quality of clinker produced. In this process the mixture is burned in kilns.

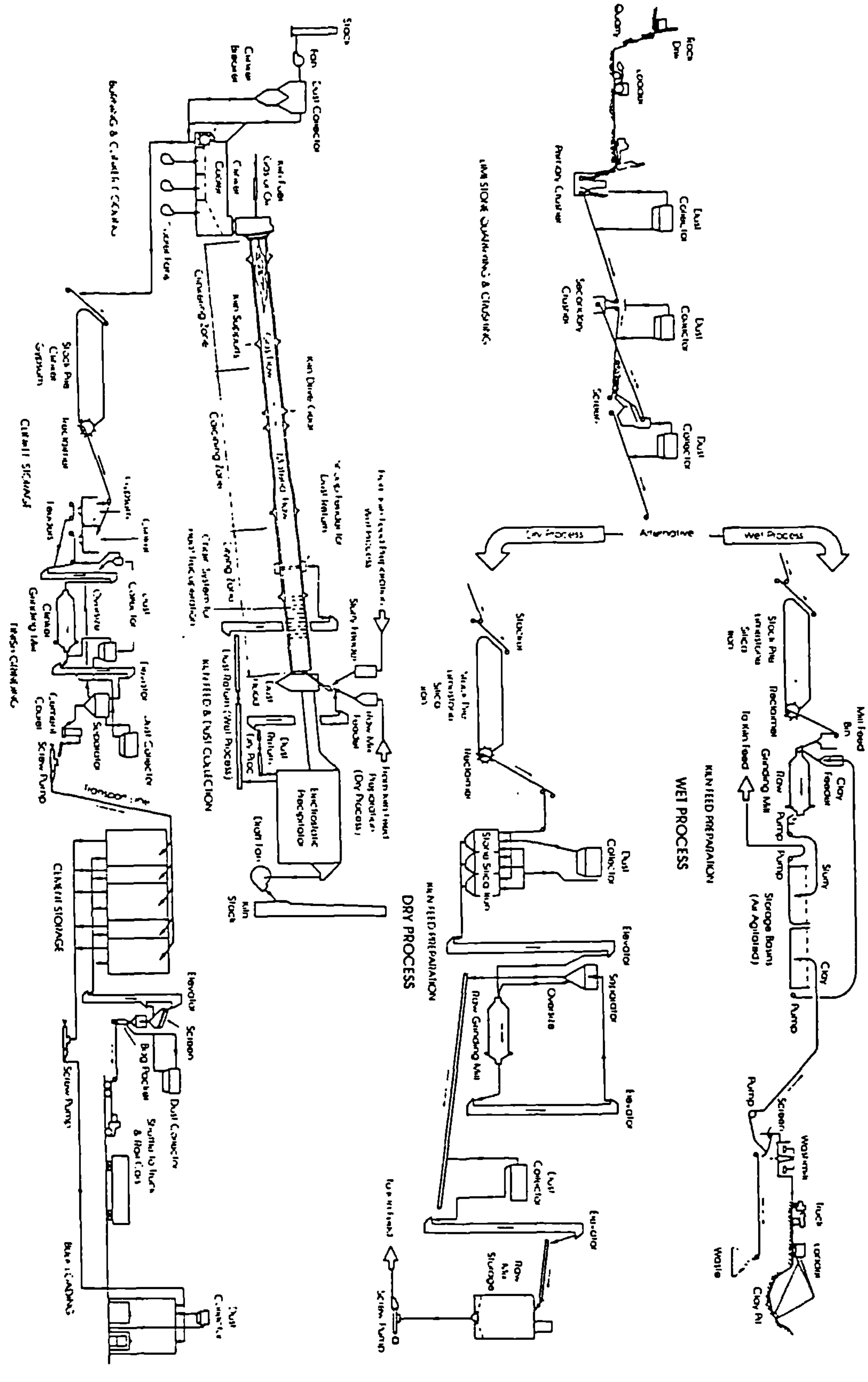

Figure (4.1)
Dry and Wet Process Flows

Source: Fog and Nadkarni (1, 1983) p.(55)

Two types of kilns are in common use: vertical and shaft kilns, and rotary kilns. The resultant clinker is transported to clinker grinding mills.

(v) Clinker grinding:

In this process, clinker is fine ground and gypsum is added to form cement. Fog and Nadkarni (1, 1983), and U.S. Dept. of Interior (2, 1985)

Having highlighted the principle production processes, attention is directed toward the methods of manufacturing cement used world-wide.

4.2.2 Manufacturing Methods:

There are four manufacturing methods: dry, wet, semi-dry and semi-wet. The first two are most common these days. Therefore we are going to examine very briefly those two methods only.

(i) Dry method:

In this method, raw materials are air-dried utilising exhaust gases from the kiln while they are being ground in the raw mill and then fed into the kiln as dry powder for calcination.

(ii) Wet method:

By contrast, water is added to raw materials while being mixed in the raw mill and the outcome, which is called slurry, is fed to the kiln. Fog and Nadkarni (1, 1983).

The choice between these two methods is determined mainly by the type of raw materials available and the cost of energy.

Figure (4.1) shows the manufacturing processes for the two basic methods mentioned above.

4.3 The Economic Characteristic of The Cement Industry

This section examines the four main economic characteristics of the industry: capital intensity, energy intensity, economies of scale and transportation costs. These characteristics are dealt with over the next four sub-sections.

4.3.1 Capital Intensity

There are several ways of measuring capital intensity. Shepherde (3, 1979), for example, mentioned three ways of measuring capital intensity. One is capital-sale ratio; the second is capital-labour ratio; and the third is capital-value added ratio. The numerator in the three mentioned ratios is the capital. It (capital) can be measured by either net total assets or net fixed assets.*

The second measurement of the three mentioned earlier is used here for the purpose of comparison between different industries to demonstrate the point that the cement industry is capital intensive rather than labour intensive. See Table (4.1)

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*Net total assets = net current assets + net fixed assets.
net current assets = total current assets - creditors (one year or less).

Table (4.1)

Capital Intensity In Different Industries

Industry	Firm	Net fixed asset (million £)	Labours	Capital intensity (£/worker)
Oil	British Petroleum (group)	22,000.00	131,600	167,173.25
cement	Blue circle (group)	929.40	11,622	79,969.02
aluminium	British ALcun Ltd	54.20	10,838	5,000.92
steel	British Steel (group)	1428.00	71,100	20,084.39

Source: Figures compiled from data presented in the annual reports (1984) of the firms mentioned in the table.

Judging from the data given in Table (4.1), one can argue that the cement industry has one of the highest capital intensity (after oil) among the industries presented in the table. Another example which demonstrates the capital intensity in the cement industry is calculated on the basis of data presented in Table (ii) of McBride (4) and presented in Table (4.2) of this chapter. It indicates that capital costs account for 37-42 percent of average total costs per unit of output, depending on capacity size, while labour costs account for 21-26 percent of average total costs per unit of output depending also on capacity size.

Table (4.2)

Average Costs per Unit of Output

at Different Levels of Capacity

Capacity (000 barrels) / Costs $ 1960 price	704	1990	2990	5863
Direct labour	.361	.397	.300	.153
Raw materials	.114	.114	.114	.114
Power	.358	.358	.358	.358
Fuel	.404	.404	.404	.404
Indirect labour	.575	.481	.392	.275
Depreciation on fixed capital	.841	.691	.592	.431
Interest on fixed capital	.663	.546	.467	.341
Average total costs	3.586	2.991	2.627	2.076

Source: Table (II) M.E. McBride (4, 1981), p.(109).

A third example which demonstrates the fact that the cement industry is a capital intensive one is taken from Saudi Arabia. Table (4.3) presents capital intensity in different industries in Saudi Arabia in 1970. It is obvious from this table that the cement industry ranked second after steel and iron in terms of capital intensity.

Table (4.3)

Capital Intensity In Different Industries

In Saudi Arabia In 1970

Industry	Capital (000) Saudi Riyals	Labour	Capital intensity (SR/Worker)
Electricity generation	241,193	1698	142,045.35
Cement industry	960,000	981	978,593.27
Chemical	102,700	439	233,940.77
Steel & iron	303,800	200	1,519,000.00
Oil refinery	70,000	500	140,000.00
Food processing	23,073	1128	20,454.79
Mineral products	14,280	441	32,380.95
Printing industry	13,161	614	21,434.85
Bricks & tiles	12,185	942	12,935.24

Source: Compiled from data presented in (p.39) in "KAFELAT AL-ZAYIT", Vol.18, No.7, September/October 1970 (in Arabic).

The previous discussion has demonstrated that the cement industry is a capital intensive one. The next sub-section examines another economic characteristic of the industry, namely, energy intensity.

4.3.2 Energy Intensity

It was concluded from the previous sub-section that the cement industry is a capital intensive industry. This sub-section examines another economic characteristic of the industry, namely, energy intensity. We defined energy intensity as the total energy consumption by the industry over a period of time, say, a year. Despite the fact that the consumption of energy per ton of cement is less than other industrial products, for example, a metric ton of cement consumes between 1000 to 2000 mcals/ton, steel 7000 mcals/ton, plastic 20000 mcals/ton, aluminium 42000 mcals/ton, the total consumption of energy in the cement industry on a world-wide basis is higher than other industries (with the exception of steel and chemicals). This is because of high tonnage of cement production. Fog and Nadkarni (1, 1983). For example, in 1982 world production of cement was 886.3 million tons, of steel was 643 million tons, and of aluminium was 16.7 million tons. UN (5, 1986). In the United States, portland cement manufacturing is one of the most energy intensive of all the industries in the Country. US Dept. of Interior (2, 1985). The report stated that "portland cement manufacturing is one of the most energy intensive of all U.S. industries." (p.9).

As another example which illustrates the consumption of energy in the cement industry compared with other industries, we took Tunisia, due to availability of data, and also to demonstrate the energy consumption in the cement industry in a less developed economy. In 1980/81 the total energy consumption by the industrial sector was 1,047,000 tons of oil equivalent (toe), of which, 242,000 toe is used by the cement industry alone. This accounts for 23 percent of the total consumption of the industrial sector. Other industries are: steel 13 percent, textiles 5.1 percent, paper 4.3 percent and bricks 10.4 percent. Ahmed (6, 1985).

Although these figures might differ from one country to another due to the difference in technology used in addition to other factors, they still give an indication of energy intensity in the cement industry. Energy intensity within the cement industry varies from one manufacturing process to another and also from one manufacturing method to another.

With respect to manufacturing processes, raw materials burning is the most energy intensive among all manufacturing processes. It uses about 82 percent of total energy (fuel and electricity) used by all processes. With regard to manufacturing methods, the wet method consumes more fuel than the dry method. It consumes about 20 to 25 percent more fuel than the dry method, while the dry method consumes 4 to 8 percent more electricity than the wet method. UN (7, 1963).

In summary, cement is an energy intensive product. In the next sub-section the third economic characteristic of the industry is discussed.

4.3.3 Economies of Scale

The previous sub-section concluded that cement is an energy intensive product.

This sub-section examines another economic characteristic of the industry, the economies of scale. Several comparative studies of economies of scale in manufacturing provide evidence on economies of scale that exist in cement production. Table (4.4) presents the results of eight independent studies which estimate the minimum efficient size necessary for a cement plant to obtain all available economies of scale. McBride (4, 1981).

Table (4.4)

Estimates of Efficient Cement Plant Size

Study	Time period	Annual production capacity (million barrels)
Loesher	1949	1.5-2.0
Weiss	1939-1953	1.4
Bain	1956	2.0-2.5
Weiss	1953-1961	2.3
Allen	1965	3.25
Scherer	1965	7.0
Weiss	1966	6.0-8.0
Pratten	1971	12.0

Source: McBride (4,1981), p.(108).

As another example which demonstrates the existence of economies of scale in the cement industry, the information presented in Table (4.5), was calculated on the basis of the data given in Table (A.1) page 335 in Norman, (8, 1979). It indicates that economies of scale exist in the cement industry. For example, if the capacity of a plant were increased from 100 thousand tons p.a. to 200 thousand tons p.a., capital costs per unit of output would have declined by 17 percent. By the the same token, if capacity were increased from 100 thousand tons p.a. to 1000 thousand tons p.a., capital costs per unit would have declined by 54 percent.

Table (4.5)

Capacity, Capital Costs and Capital Cost

per Unit of Capacity

Capacity (000) ton p.a.	Capital cost $ (000) 1960 price	Capital cost per unit of capacity $	% reduction in Capital cost per unit of capacity
100	$ 6,500	$ 65	-
200	10,800	54	17%
340	16,000	47	28
400	18,000	45	31
500	21,500	43	34
1000	30,000	30	54

Source: calculation based on Table (A.1), Norman (8, 1979), p.(335).

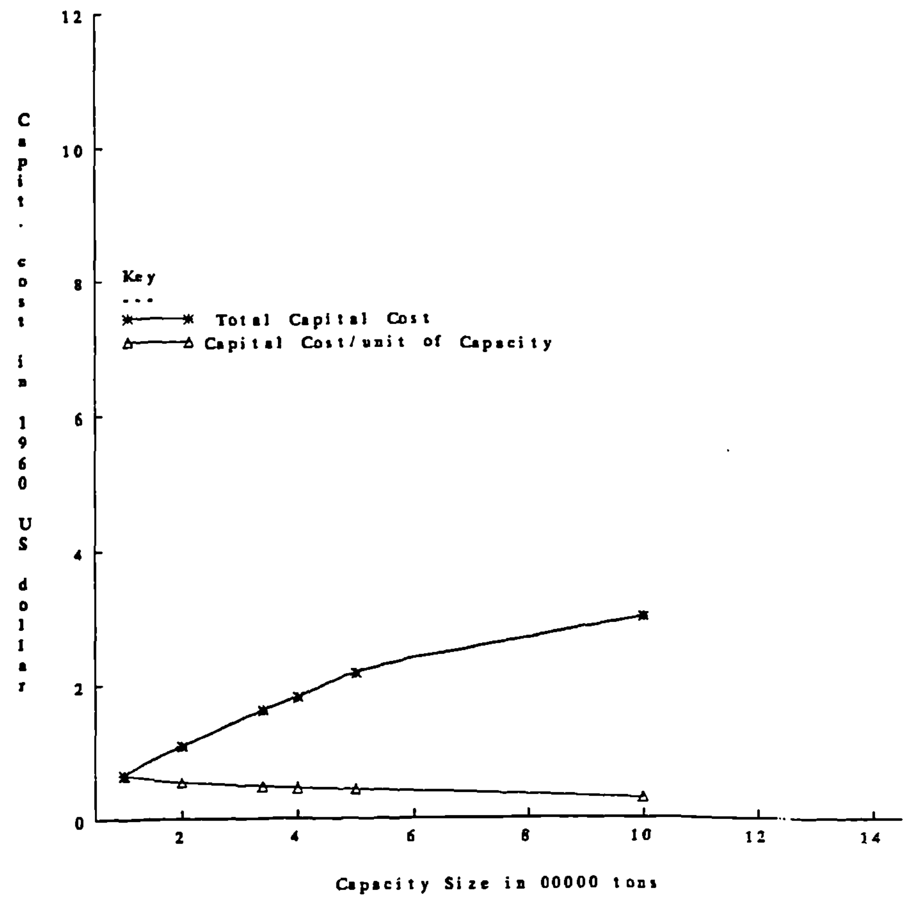
Table (4.2) also shows that economies of scale exist in the cement industry. The larger the capacity is, the lower the average cost per unit of output.

Figure (4.2) presents the relationship between capital cost, capital cost per unit of capacity and capacity size.

Based on the previous discussion it can be concluded that economies of scale exist in the cement industry. The next sub-section discusses the fourth economic characteristic of the industry, transportation costs.

Figure (4.2)

Relationship between Capital Cost, Capital Cost per Unit and Capacity Size



4.4 High Transportation Costs

Cement is a high weight low value product. The cost of transportation accounts for a high proportion of the total cost per unit of the output. Table (4.6) presents the average cost for cement manufacturers in the U.K. in 1966. Due to the difficulty in obtaining more recent data regarding the cost of delivery as a percentage of total maufacturing costs, the data shown in Table (4.6), which is quite old, is used to show the significance of the transportation costs.

Based on the data given in this table, one can see that delivery expenses account for 17 percent of the total cost per unit of output. It is reasonably high and ranks second after the cost of energy which is 25 percent. Silberston (9, 1972). Transportation costs influence both location and plant size, i.e. to trade-off between having one plant of large size in one region or having several plants in different regions. The cost of transporting raw materials is as high as that of the cement and it also has a great influence on the location of the plant.

Table (4.6)

Average Costs for Cement

Manufacturers in The U.K. 1966

Manufacturing costs (£)	Average cost per tonne	As % of manufacturing costs	As % of total cost
kiln fuel 1.01 electric power .45	1.46	32%	25%
Wages & salaries	0.65	14	11
Maintenance materials	0.48	11	8
Works overhead	0.34	8	6
Depreciation	0.30	7	5
Interest at 10% on Capital employed	0.70	16	12
Other cost (including raw materials)	0.58	13	10
Total	4.51	100%	76%
Delivery expenses	1.01	-	17%
Sales expenses	0.40	-	7%
Total	5.95	100%	100%

Source: A. Silberston, (9, 1972)

Having examined the four main characteristics of the cement industry in general, the next step is to examine the main aspects of the U.A.E. cement industry in particular. This is the subject of the next section.

4.4 Aspects of the U.A.E. Cement Industry

The previous section and its sub-sections examined the four economic characteristics of the cement industry in general. These were: capital intensity, energy intensity, economies of scale and finally transportation costs. It was concluded that the cement industry is a capital intensive one, and that cement is a highly energy intensive product. It was also concluded that economies of scale exist in this industry and that transportation costs account for a high proportion of the total cost per unit of the delivered product.

It is worth noting that the choice of the cement industry as a case study is based on two main facts:

First, the problems of this industry are self-evident as are a number of possible solutions which makes it an excellent example for demonstrating the value of O.R. as a problem-solving tool.

Second, this industry is considered to be an important one as far as the economy is concerned. As indicated by Table (4.7), the cement industry ranks first among the industries mentioned in this table in terms of the value of the output. The value of its output in 1985 accounts for 11 percent of the value of the output of the manufacturing sector as a whole. With respect to net added value, its net added value accounts for 1.3 percent of that of the manufacturing sector. In terms of labour force, the total employees in this industry is equal to 6 percent of the total number of employees working in the manufacturing sector as a whole. Furthermore, the net capital formation in the cement industry accounts for 16 percent of the net capital formation in the manufacturing sector.

Table (4.7)

Comparison Between The Cement Industry And Other Industries In The U.A.E., 1985

Industry	No. of establishments	value of output (000)DH	%	net added value (000)DH	%	labour force	%	net capital formation (000)DH	%	investment (000)DH	%
Soft drinks & mineral water	13	261,662	4.0	57,065	3.0	1472	4.0	109,445	1.1	213,138	15.0
Spinning & weaving	47	40,287	0.6	22,250	1.2	808	2.0	6,067	0.06	28,327	2.0
Furniture	22	84,190	1.0	33,664	1.8	964	2.0	14,282	0.14	37,572	2.6
Chemicals	7	142,293	2.0	60,330	3.0	543	1.4	94,933	1.0	235,048	16.0
Fertilizers	1	102,549	2.0	35,310	1.8	500	1.3	58,336	0.6	98,697	7.0
Pharmaceutical	1	26,226	0.4	(4,720)	(0.3)	220	0.6	119,007	1.2	145,878	10.0
Glass & glass products	1	1,868	0.3	719	0.04	43	0.1	2,455	0.02	1,985	1.4
Building materials	1	10,871	2.0	2,098	0.11	103	0.3	21,930	0.2	34,279	2.4
Cement	9	695,081	11.0	24,714	1.3	2326	6.0	1,551,498	16.0	280,297	20.0
Iron & steel	2	49,303	0.8	14,831	0.8	218	0.6	11,424	0.1	27,443	2.0
Total manufacturing sector		6,423,404		1,911,457		39044		9,859,511		1,436,556	

Source: Ministry of Finance & Industry, U.A.E. Industrial Survey - 1985, December, 1987.

Twenty percent of the total investment in the manufacturing sector in 1985 was investd in the cement industry only. The previous discussion might give some indication of the significance of this industry to the U.A.E. economy. This might justify its choice as a case study.

Now let us turn to the subject of this section and its sub-sections.

This section and its sub-sections discuss briefly the main aspects of the U.A.E. cement industry in particular. These aspects are discussed over the eight sub-sections that follow.

4.4.1 Structure

The U.A.E. cement industry began in 1975, when a 250 thousand tons plant was set up in the Emirate of Ras Al-Khaimah. Now there are seven plants in six of the seven Emirates.

Generally speaking, in order to establish a new plant three conditions are to be met, these are; Hoffmeyer (10, 1982):

(i) availability of raw materials both in terms of quantity and quality;

(ii) availability of the market;

(iii) availability of financial resources.

Both conditions (i) and (iii) are true in most of the U.A.E. cement plants, while condition (ii) was true at the time when these plants were established, but in recent years, the demand has been very low both at home and abroad.

Table (4.8) presents the total output of each plant in

1984, its share in the total production of the Country in that year and its ownership.

Table (4.8)

Total Output of Cement Manufacturers

in The U.A.E., 1984

plant	total output (000) tons (1984)	as % of total output	ownership
Al-Ain Cement	555	14	local government
National Cement	494	13	private sector
Sharjah Cement	506	13	private and local government
Union Cement	1023	27	private and local government
Gulf Cement	714	19	private sector
Ajman Cement	111	3	private sector
Fujarah Cement	413	11	private and local government
Total	3814	100%	

Source: Author (11, 1985)

From the data given in Table (4.8), one can see that two plants produced about 46 percent of total cement production in the U.A.E. in 1984, whereas the remaining five plants produced 54 percent of the total cement production in the Country in the same year. This indicates that this industry is highly concentrated (i.e., few plants produce a high proportion of the total production of the industry.)

4.4.2 Location and Plant Size:

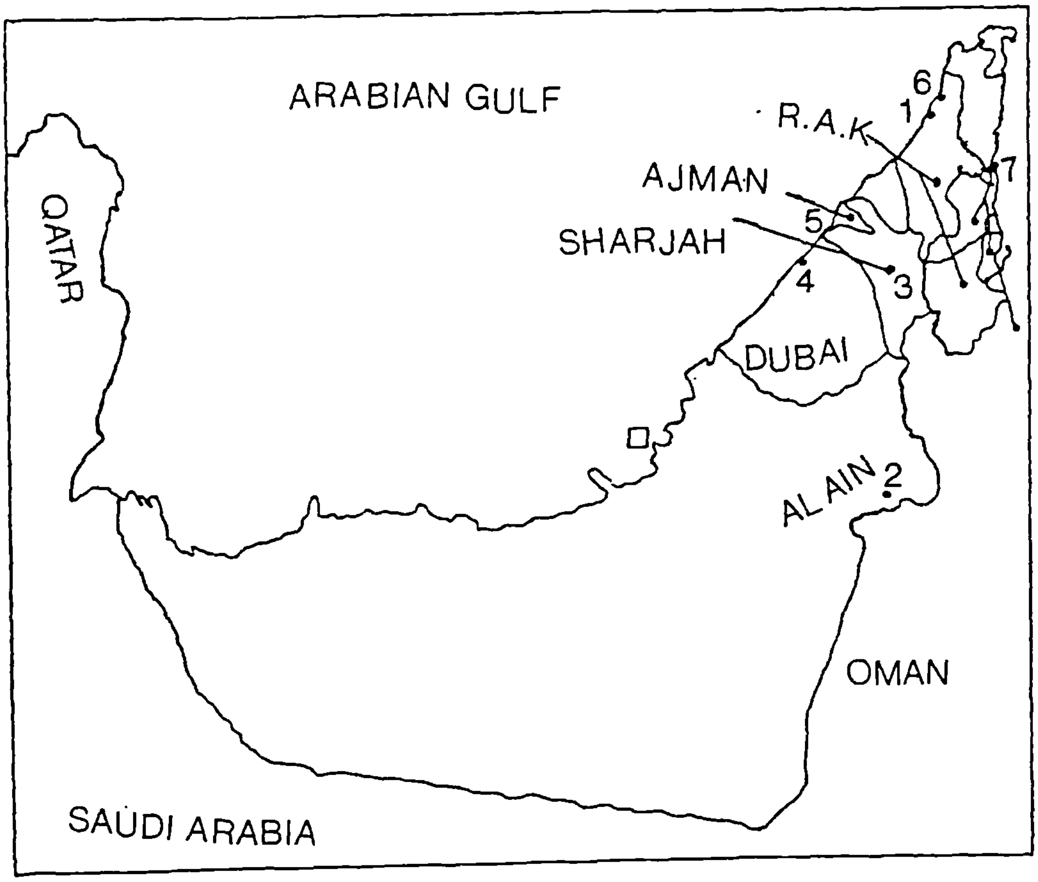
The current sub-section, gives attention to the location and the size of different plants. The purpose of this discussion is to find out whether cement plants in the U.A.E. are located in the right place or not, whether their sizes are of the ones which qualify them for obtaining all economies of scale available for a plant or not, and also whether their sizes are appropriate for the current market conditions or not.

As mentioned earlier in the chapter, transportation costs of cement accounts for about 17 percent of the total cost per unit of the product. Consequently, transportation cost has great influence on the location of a plant and its size as well. In the case of the U.A.E. cement plants, all of them are located near limestone stock, except Ajman plant which is a grinding plant. Union cement plant and Gulf cement plant in Ras Al-Khaimah are both located fairly close to the port. The remaining five plants are located some distance from the port. What is common about the location of the seven plants is that they are all located some distance from the local market. Map (4.1) shows the location of the seven plants.

With regard to plant size, the plant size of the U.A.E. cement plants range between 500 thousand tons p.a. and 2000 thousand tons p.a. Table (4.9) presents the size of the seven plants in thousand metric tons p.a.

Map (4.1)

Location of Cement Plants in The U.A.E.



1. Union Cement Co. in Ras al-Khaimah.
2. Al-Ain Cement Co. in Abu Dhabi.
3. Sharjah Cement Co. in Sharjah.
4. National Cement Co. in Dubai.
5. Ajman Cement Co. in Ajman.
6. Gulf Cement Co. in Ras al- Khaimah.
7. Fujairah Cement Co. in Al-Fujairah.

Table (4.9)

Capacity Size of Cement Plants

In The U.A.E., 1985

Plant	capacity (000) tons
Union Cement plant	1200
Gulf Cement plant	1200
Sharjah Cement plant	1300
Ajman Cement plant	750
Fujarah Cement plant	520
National Cement plant	2000
Al-Ain Cement plant	750
Total	7720

Source: Author (11, 1985)

In the light of the information given in Table (4.9) one can find that when comparing capacity size of the U.A.E. cement plants with "minimum efficient size" which is necessary for a plant to obtain all available economies of scale, one can find that most of the U.A.E. cement plants fall short of the minimum efficient size which was mentioned earlier in the chapter, specifically when talking about economies of scale in the cement industry.

The next sub-section discusses the production of cement in the U.A.E.

4.4.3 Production

In 1981, the total world cement production was about 883 million tons, of which 353 million tons were produced by the developing countries, 10 million tons were produced by high-income oil exporting countries and the remaining 520 million tons were produced by industrial countries and centrally planned economies. Fog and Nadkarni (1, 1983).

In the same year the production of the U.A.E. was 2825 thousand tons or about 28.25% of the total production of high-income oil exporting countries. In 1975, the total cement production in the U.A.E. was just 50 thousand tons. The rapid increase in cement production between 1975 and 1981 is ascribed to the boom in the construction industry, the main consumer of cement. Cement production in the U.A.E. reached its peak in 1983 when about 4141 thousand tons were produced, then it declined and reached 3160 thousand tons in 1985.

The development of cement production in the U.A.E. is presented in Table (4.10), also Figure (4.3) depicts the development in the production of cement in the U.A.E. between 1975 and 1985.

4.4.4 Market

Generally speaking, the market of any product can be divided into two sectors, the first sector is the home market and the second one is the export or foreign market. This is true for U.A.E. cement. In 1975, the U.A.E. market consumed about 839 thousand tons of which 10 thousand tons were locally produced and the remaining 829 thousand tons were imported from abroad.

Table (4.10)

Cement Production In The U.A.E.

1975-1985

(000 tons)

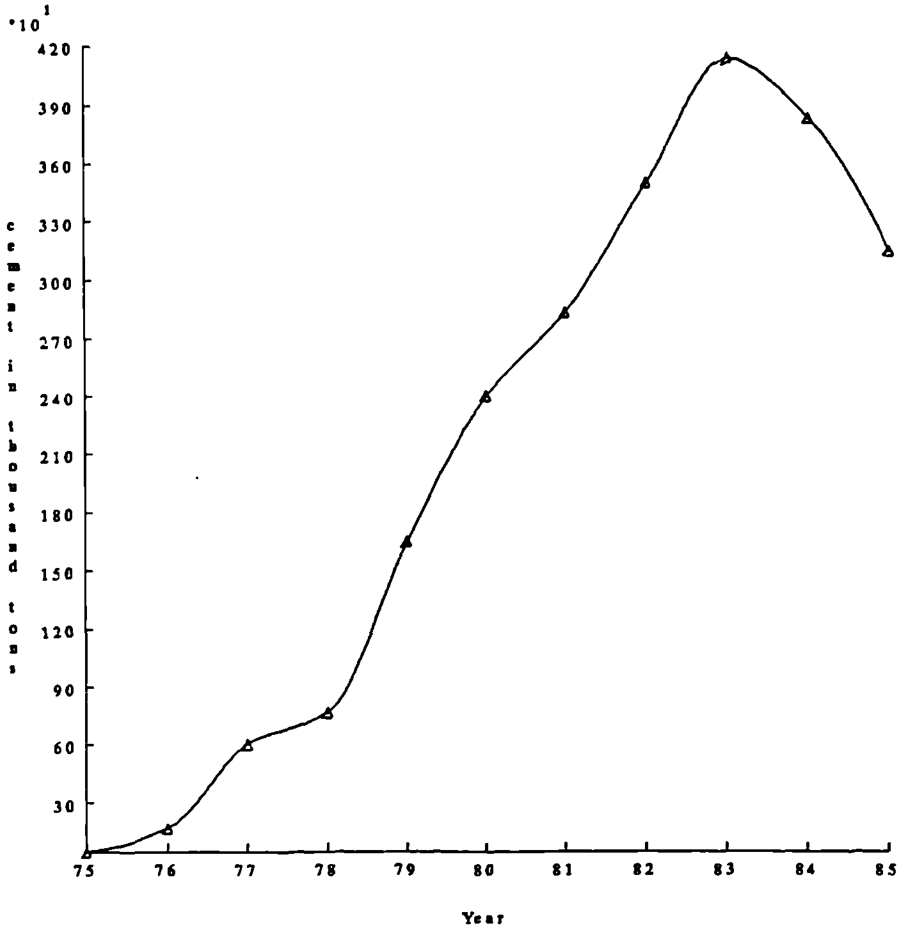
Year	1975	76	77	78	79	1980	81	82	83	84	85
Production	50	170	603	768	1649	2401	2835	3498	4141	3814	3160*

Source: Author (11, 1985).

*. 1985 figure from World Statistical Review, No.8, December 1986.

Figure (4.3)

Cement Production in The U.A.E. 1975-1985



In 1984, total consumption of cement in the U.A.E. was 2205 thousand tons of which 1928 thousand tons were locally produced and the remaining 277 thousand tons were imported.

Table (4.11a) presents the consumption of cement in the U.A.E.

Figure (4.4) also shows the development in cement consumption between 1975 and 1985.

Table (4.11a)

Cement Consumption in The U.A.E. 1975-1985.

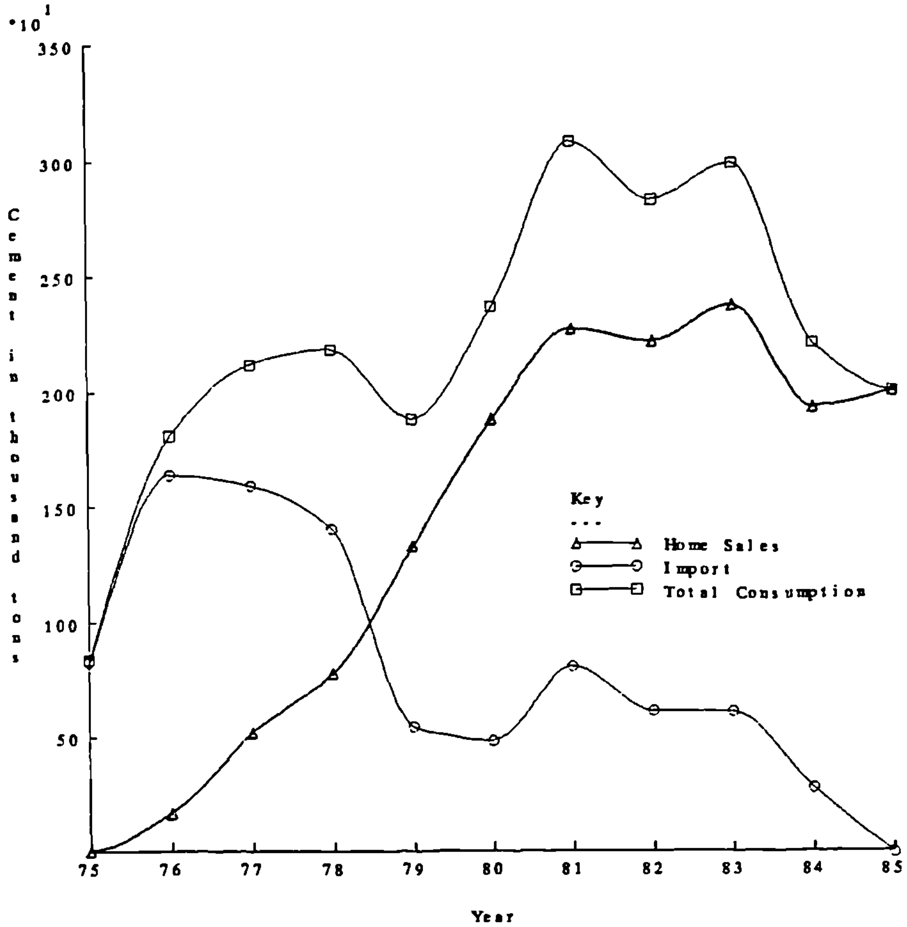
Quantity: (000) tons

Description \ year	1975	76	77	78	79	1980	81	82	83	84	85
Home sales (1)	10	172	522	776	1331	1876	2266	2210	2371	1928	2000
Import (2)	829	1638	1589	1401	546	482	4807	611	8611	277	-
Total (3)	839	1810	2111	2177	1877	2358	3073	2821	2982	2205	2000
1:3%	1%	10	25	36	71	80	74	78	80	87	100%

Source: Author (11, 1985) and GOIC (12, 1983).

Figure (4.4)

Total Consumption of Cement in The U.A.E., 1975-1985



With regard to the export or foreign market, it is of substantial importance to the U.A.E. cement industry, especially after the decline in the local demand since 1981. In general, one might argue that the size of the export market depends on four factors. These are: product design, market efforts,production cost and transportation costs. The latter three are applicable to cement. In the case of the U.A.E. cement industry, production cost is relatively high due to the high cost of energy and capital. Therefore, its chances of invading the export markets without incurring great losses is very low. Furthermore, the marketing efforts of U.A.E. cement industry are very poor. This can be seen from the absence of advertising campaigns, and factories waiting for customers to come to them and buy cement rather than going to the customers and sell cement to them. However, the export market for U.A.E. cement has witnessed a progress between 1979 and 1984 as shown by Table (4.11b).

Table (4.11b)

Export Sales Development

1979-1985

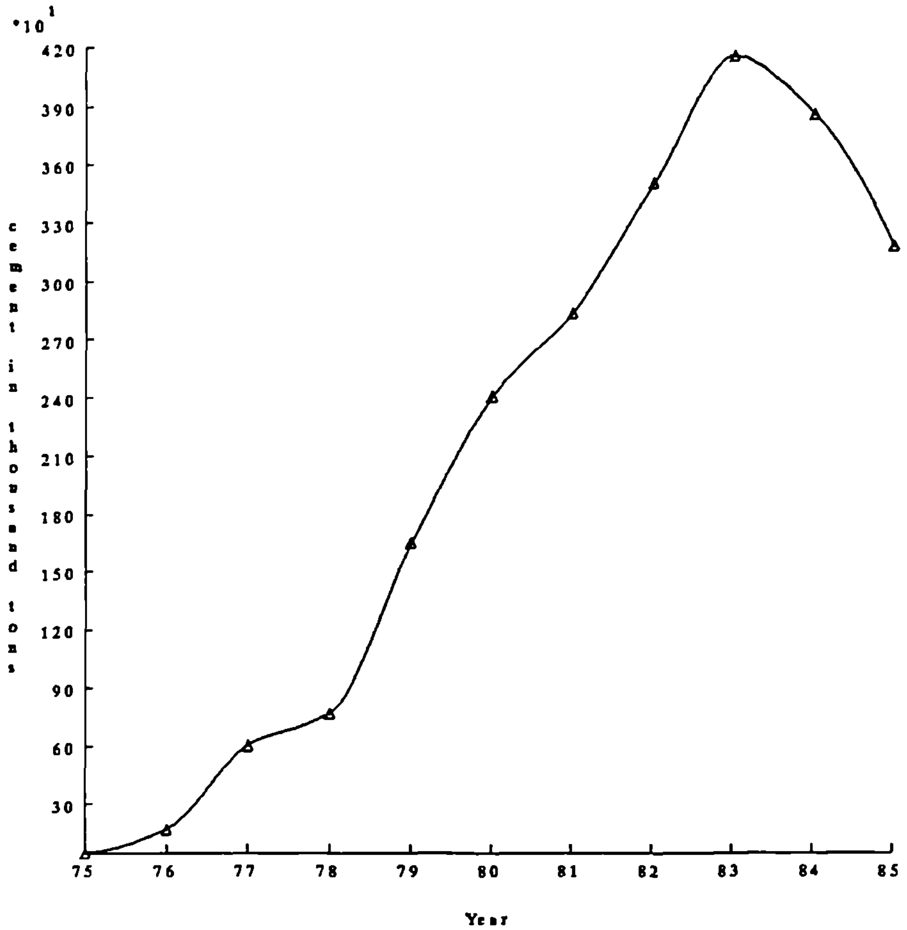
year / Description	Quantity: (000) tons						
	1979	1980	1981	1982	1983	1984	1985
Production (1)	1649	2401	2835	3498	4141	3814	3160*
Export (2)	296	498	537	1282	1845	2007	1160*
% increase in export over 1979	-	68%	81	333	523	578	292
(2) as % of (1)	18%	21	19	37	45	52	37

Source: Author (11, 1985)
* Figures for 1985 are from World Statistical Review, No.8, December 1986.

A point worth noting is that the U.A.E. is the main exporter of cement in the gulf region, and U.A.E. exports cement to all other gulf states, in addition to India, Pakistan, Yemens and Somalia. Figure (4.5) depicts the development of the export. Per capita consumption of cement in the U.A.E. is one of the highest around the world. In 1981, per capita consumption in the U.A.E. was 3900 Kg. whereas in Japan 659 Kg., in the UK 221 Kg. and in the USA 292 Kg. Cembureau (13, 1982). This is attributed to the fact that cement is the main building material used in the U.A.E., while in those countries other building materials are used.

Figure (4.5)

Cement Export Sales in The U.A.E., 1979-1985



The stage of economic development might also have an effect on the amount of cement consumed, since at the early stage of development more GFCF spent on construction than on machinery and equipment.

Labour:

This sub-section gives attention to the labour force in the cement industry. Despite the fact that the cement industry is a capital intensive one, it still employs a considerable number of labourers. For example, in 1975 the U.A.E. cement industry employed 343 persons in the one factory which was operating at that time, but in 1984 the total figure reached 2202 persons. Only 23 percent of the total employees in the cement industry in 1975 were U.A.E. nationals. In 1985 only 6 percent of total employees in the industry in that year were U.A.E. nationals. Table (4.12) presents the development of labour forces in the U.A.E. cement industry and the number of U.A.E. nationals in the industry over the period between 1975 and 1985.

Figure (4.6) also depicts the development in the labour force in the U.A.E. cement industry between 1975 and 1985.

As mentioned previously, the number of nationals employed in the cement industry is very small. It is generally considered that several factors caused such a situation to emerge, of which three are mentioned here. First, lack of skilled personnel among the nationals. Second, nationals prefer to work for the government rather than to work for the industry, because salaries in the government are higher than that in the industry and because they consider the work with the government to be of more prestige than with the industry. Third, as will be seen later, most cement firms in the U.A.E. are managed by foreign experts, and they prefer people from their own nationality because it is easier for them to communicate with those who speak their own language.

In the next sub-section, the discussion concentrates on the productivity of labour force in the U.A.E. cement industry.

Table (4.12)

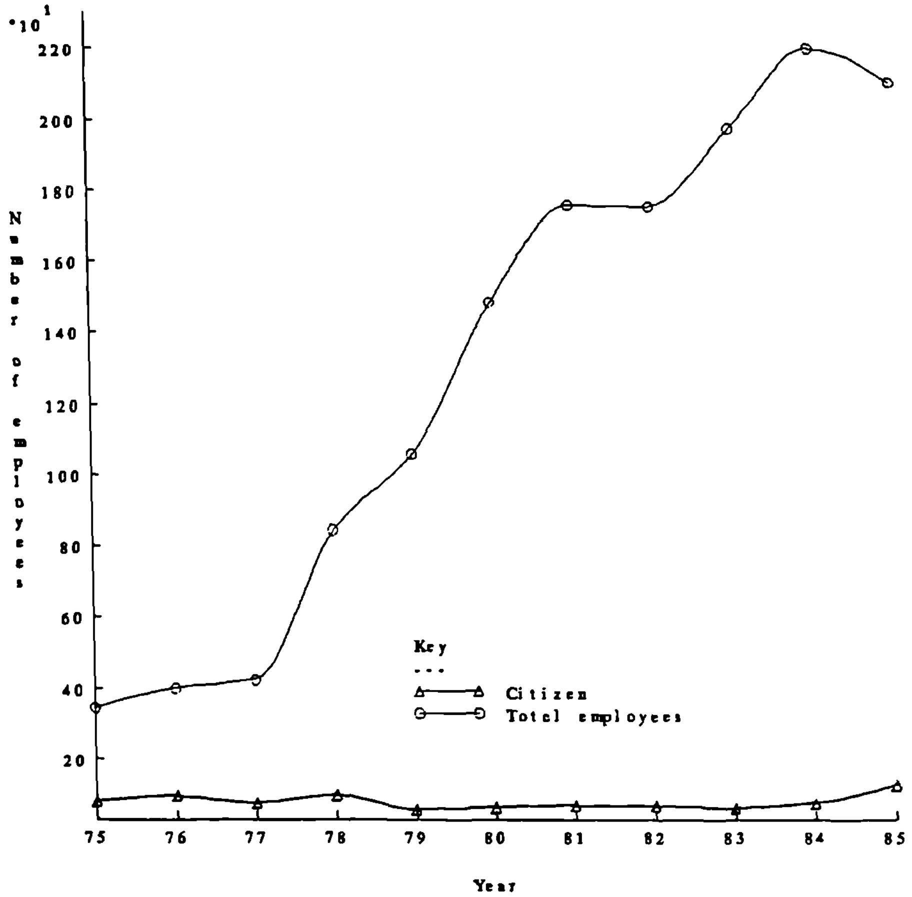
Development of the Labour Force in The U.A.E. Cement Industry

year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
No. of nationals (1)	80	95	75	97	58	63	68	68	62	76	129
Total no. of employees (2)	343	399	423	841	1058	1484	1759	1755	1976	2202	2015
(1) as % of (2)	23%	24	18	12	5	4	4	4	3	3	6

Source: Author (11, 1985).

Figure (4.6)

Labour Force in The U.A.E. Cement Industry, 1975-1985



4.4.6 Labour Productivity

To start with, let us define what is meant by labour productivity. It is generally defined as the ratio between total production of the firm in a specific time period and the size of the labour force in that period. In 1977, the productivity per man was at its lowest level, it was 143 tons per man. It reached its highest level in 1983, it was 2096 tons per man. Table (4.13) illustrates labour productivity in the U.A.E. cement industry for the period between 1975 and 1985, see also figure (4.7).

Table (4.13)

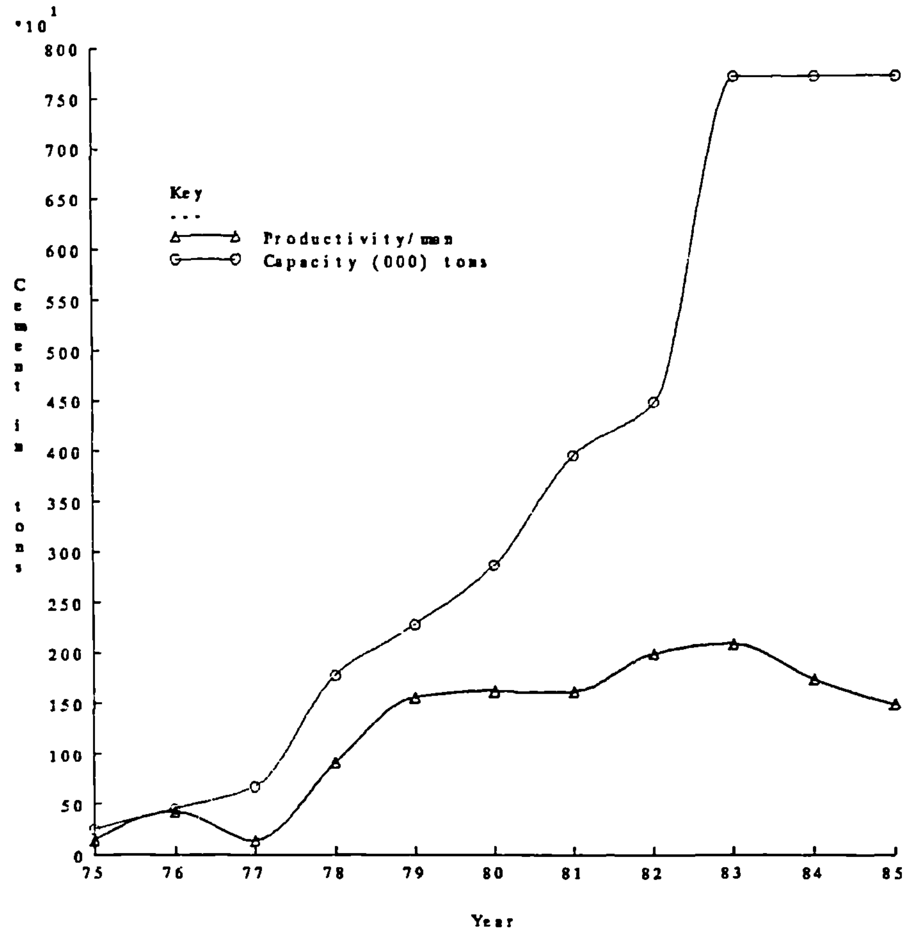
Labour Productivity in The U.A.E. Cement Industry

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Productivity per man	146	426	143	913	1559	1918	1912	1992	2096	1740	1501
Plant size (000) tons	250	448	672	1772	2272	2867	3956	4484	7720	7720	7720

Source: compiled from the data given in Tables (4.10) & (4.12).

Figure (4.7)

Labour Productivity in The U.A.E. Cement Industry 1975-1985



It has to be noticed that labour productivity differs from one plant to another within the U.A.E. cement industry. This is ascribed to the difference in total production and the size of the labour force. This is due mainly to fluctuations in capacity utilisation rates which is affected by market conditions.

The next sub-section examines another aspect of the U.A.E. cement industry, namely, finance.

4.4.7 Finance

The current sub-section tackles an important aspect of the industry. In general, capital is as important to the firm as blood is to the human being. Without capital the firms cannot function, and without blood human beings cannot function either. As mentioned earlier, finance is one of the three conditions to be met in order for a new plant to be established. This is particularly true for the U.A.E. cement industry which found no difficulty in obtaining the finance needed. The main source of finance for the cement companies in the U.A.E. was shareholders. It is estimated that DH 2829 million was invested by shareholders or about 90.7 percent of total investment. Shareholders include, local governments, U.A.E. nationals, and other Gulf states' nationals. Loans from local and foreign banks amounted to DH 289 million or about 9.3 percent of the total investment in the cement industry. Author (11, 1985). It is estimated by other sources, Khalej Times, (14, 1984) and CMA, (15, 1984), that the total amount invested in the cement industry was DH 7000 million. The total investment in the cement industry accounts for 20 percent of the total investment in the manufacturing sector in the U.A.E. in 1985. Ministry of Industry and Finance (19, 1987).

Another important aspect of the cement industry is administration. This is the subject of the next sub-section.

4.4.8 Administration:

The previous sub-section examined one of the most important aspects of the cement industry, namely finance.

However, the success of any business does not depend only on finance, it should be coupled with a capable administration. Therefore, this sub-section examines the administration of the industry. As already mentioned, a great deal of money has been invested in the industry. So one might expect that great caution has been taken by the representatives of the owners in selecting the personnel to manage the plants within the industry. The survey showed that three plants, namely Union Cement Co., Fujairah Cement Co., Sharjah Cement Co., are managed by foreign experts. While the remaining four plants are managed by U.A.E. nationals or experts from Arab states. It is greatly considered that different people have different managing styles. This is true in the case of U.A.E. cement industry since different firms are managed by different groups with different experiences, background and cultures.

Figure (4.8) presents a simplified organisational structure of one of the plants in the U.A.E. cement industry.

4.5 Problems Facing The U.A.E. Cement Industry

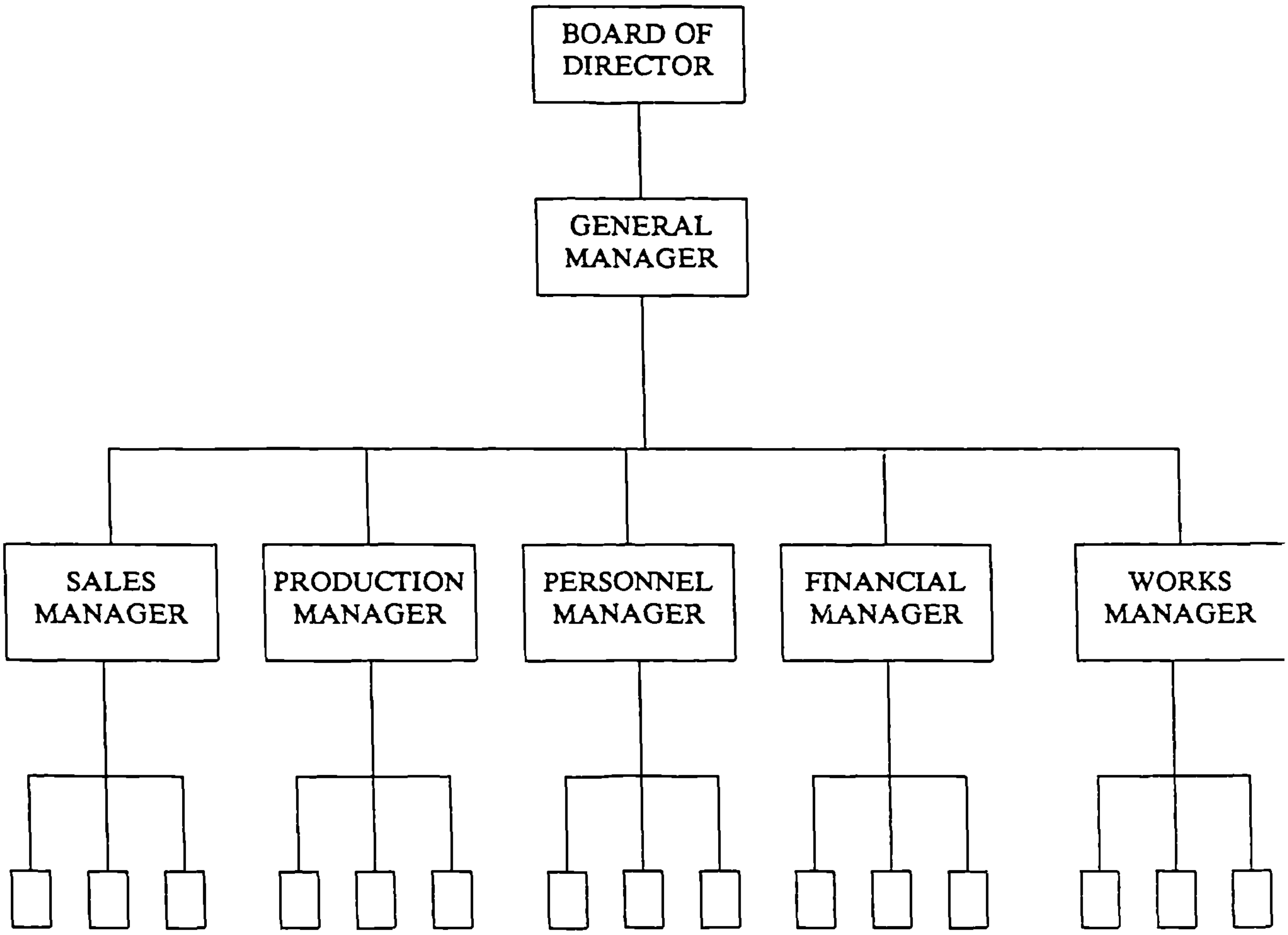
This section and its sub-sections discuss the crucial problems the industry is currently facing and their causes.

4.5.1 Over capacity:

It is meant by over-capacity that the installed capacity exceeds the total sales (home and export). In the case of the U.A.E., the total installed capacity reached 7720 thousand tons while the total demand in recent years is around 2500 thousand tons.

Figure (4.8)

Simplified Organisational Structure of One of The Plants in The U.A.E. Cement Industry



In such a situation excess capacity cannot be avoided. Generally speaking, the cause of this problem is twofold. First, poor forecasting and in the case of the U.A.E. the absence of forecasting and planning; and second the ill timing of investment and this is particularly true in the case of U.A.E. cement industry.

The expansion in the capacity in the U.A.E. cement industry was demand led i.e. the expansion in capacity was as a result of the increase in the demand for cement without paying attention to whether this behaviour would continue for a long time in the future or not.

Table (4.14) presents the excess capacity in the U.A.E. cement industry during the first half of the 1980´s.

Table (4.14)

Excess Capacity in The U.A.E.

Cement Industry 1980-1985

(000) tons

Year	Installed capacity	Production	Capacity utilisation	Total Sales	Over-capacity
1980	2867	2401	84%	2,374	493
1981	3956	2835	72	2,803	1,153
1982	4484	3498	78	3,392	1,092
1983	7720	4141	54	4,216	3,504
1984	7720	3833	50	3,935	3,785
1985	7720	3160	40	3,000	4,720

Source: Author (11, 1985).

4.5.2 High Production Costs

The current sub-section examines another crucial problem, which is high production cost. A high portion of cement manufacturing cost is due to energy cost, which means that if the cost of energy is high, then the overall production cost is going to be high. World-wide the cost of energy accounts for about 40 percent of the total production cost per ton of cement. US Dept. of the Interior (2, 1985) and CMF (16, 1984). In the case of the U.A.E. cement industry, fuel oil is widely used to power the kilns, and the cost of fuel oil is relatively high in the U.A.E. Consequently, the cost of production per ton was high. Table (4.15) presents a comparison between the cost of energy and electricity for cement manufacturing in the U.A.E. with that of other Gulf states, Far East and Europe. Another factor which has contributed to high production cost is under utilisation of capacity.

Table (4.15)

Cost of energy per ton of cement

in the U.A.E. and other countries

Country	Cost per ton of cement		Energy source
	Energy	Electricity	
U.A.E.	DH 75+	0.08	Fuel oil/gas
Europe/Far East	28	-	Coal/gas
Saudi Arabia	12	0.05	Fuel oil/gas
Oman	12	-	Fuel oil/gas
Qatar	4	0.04	Gas
Kuwait*	-	0.01	-
Bahrain*	-	0.16	-

Source: CMA (15, 1984)

* Grinding only.

\+ U.A.E. Dirhams.

4.5.3 Foreign Competition

This sub-section, examines another serious problem currently facing the cement industry. The U.A.E. is a free economy, i.e. no restriction on export or import. This foreign trade policy has encouraged some cement producing countries like S. Korea, Japan and Spain to dump the local market with their cheap cement. These nations usually subsidise their cement industries to encourage the export of the surplus to other nations especially to the U.A.E. and other Arab Gulf states.

In 1977 total import of cement reached 1,594 thousand tons but it started to decline, as can be seen from Table (4.16) and reached 296 thousand tons in 1983.

Foreign competition not only affects the home sales, but also affects the export sales. For example, Saudi consumers prefer to buy Korean and Japanese cement because of its low price and this, of course, affects the export of U.A.E. cement to Saudi Arabia.

Table (4.16)

Import of cement into the U.A.E. 1977-1984

Year	Dubai	Abu Dhabi	Total (000) tons
1977	1,272	322	1,594
1978	999	355	1,354
1979	401	13	413
1980	387	80	468
1981	701	76	777
1982	382	30	412
1983	293	3	296
1984	277	-	-

Source: Statistical office of central Account Section, Dubai (17) and Public Custom Department Abu Dhabi (18).

4.5.4 Unhealthy Domestic Competition:

This sub-section gives attention to the competition between local manufacturers of cement. This problem started after the recession in the economy and consequently in the construction industry which led to the decline in the demand for cement.

The cause of this problem lies not only in the decline in the demand but also in the unplanned expansion in the industry during the boom. It is unhealthy competition in the sense that too many firms fight for a small market. One might argue that seven firms with seven plants are not too many. This is not true especially for a tiny country like the U.A.E. with a population of about 500 thousand (nationals only).

Another cause of this problem is a lack of coordination between the decision makers in the seven Emirates which worsen the situation further.

Having examined the most crucial problems currently facing the industry, it would be desirable to discuss what has been done so far to resolve some or all of these problems. Thus, the subject of the next section is to highlight solutions adopted by the industry to overcome some or all of the mentioned problems.

4.6 Methods Adopted by The U.A.E. Cement Industry to Overcome its Problems

This section highlights the ways in which the previously mentioned problems have been handled.

In an attempt to overcome the problem of unhealthy local competition, the cement manufacturers have formed an association which is called "Cement Manufacturers' Association". This association was formed in 1982 as an amalgamation of six firms. The purpose of this association was to achieve the following objectives:

(i) evaluate the size of the market;

(ii) fix the price of cement;

(iii) reduce production to the level of equilibrium with local demand;

(iv) divide the local market between manufacturers;

(v) stabilize and increase the price to reach a profitable level taking into consideration production costs and location of the plants;

(vi) obtain political support to secure Gulf market for gulf manufacturers;

(vii) discourage the protective tendencies within the U.A.E.

Unfortunately the Cement Manufacturers' Associations (CMA) failed to achieve its objectives because of the conflict of interests between the manufacturers. Every member of the CMA wants to increase his market share at the expense of the others. Furthermore, although they agreed to fix the prices they usually cheat each other. This was concluded from discussion with more than one general manager in the U.A.E. cement industry. With regard to the other problems, they have not been tackled yet.

4.7 Conclusion

This chapter examined the main economic characteristics of the cement industry in general, and the past and the current situation of the U.A.E. cement industry in particular.

From the discussion of this chapter one would draw a few conclusions. These are summarized below.

(i) technology of making cement is not highly sophisticated;

(ii) cement industry is capital and energy intensive;

(iii) economies of scale exist in this industry;

(iv) transportation costs account for a high portion of the total cost per unit of output and it is an important factor in determining plant size and location;

(v) the U.A.E. cement industry is currently facing serious problems and action needs to be taken fairly soon;

(vi) solutions proposed by the industry are short term and against public interest.

In the next chapter an investigation of previous work in the area of capacity planning is carried out. The problem of excess capacity in particular is also examined. Furthermore, factors affecting strategies for capacity planning and the consequences of wrong capacity decisions are examined.

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CHAPTER FIVE

CAPACITY PLANNING: AN OVERVIEW

CHAPTER 5 CAPACITY PLANNING: AN OVERVIEW

5.1 Introduction

The previous chapter highlighted the history and the current situation in the U.A.E. cement industry. It examined briefly the technology of cement manufacturing, the main economic characteristics of the cement industry in general, it also examined some aspects of the U.A.E. cement industry in particular and the problems currently facing it, and finally the methods which have been adopted by the U.A.E. cement industry to overcome some or all of its problems were also examined in that chapter.

This chapter is concerned with reviewing what has been published in the field of capacity planning, the factors affecting the selection of strategies for capacity planning, the problem of excess capacity and the negative consequences of misjudged capacity planning decisions.

5.2 Survey of Previous Published Work in Capacity Planning

Before proceeding to the main issue of this section, the terms "capacity" and "capacity planning" are defined. Capacity has different meanings for different users. For example, technologists define it as the maximum output of a plant or a factory over a time period, while economists define it as the level of output at which average costs are at the minimum level. From the national industrial planning point of view it means the maximum output achieved by an industry under "normal" conditions. Hillebrandt (1, 1975).

For the purpose of this study, the first definition of the three mentioned is used. The term "capacity planning" is defined as the process of forecasting the demand for capacity; determining the capacity required; choosing between different capacity plans based on cost-benefit analysis; and finally deciding on the appropriate plan. Buffa (2, 1981). Having defined those two terms, now attention is directed toward the main issue of this chapter, approaches used to tackle the problem of capacity planning. The aim of this section is to give a general concept of these approaches with examples, illustrating their usage and it should be stressed here that although the literature survey was wide ranging and comprehensive, it was by no means exhaustive. The approaches examined are classified into three main categories. These are: the mathematical approach, systems dynamics approach, and other selected approaches which include: economic analysis, computer approach, and cartel and government intervention method.

Let us start with the first type, the mathematical approach.

5.2.1 The Mathematical Approach

This approach has been widely used to tackle capacity planning problems, where different mathematical techniques have been used. In the pages to follow, examples are given; also the drawback of these techniques are highlighted.

Linear Programming (LP)

LP is defined as a mathematical tool of limited resources allocation. Thierauf, et al. (3, 1985). It assumes that the relationship between variables are directly proportional. The objective function and constraints must be linear. As an example which illustrates the use of this technique to the problem of capacity planning, Fetter (4, 1961), developed a linear programming model to tackle capacity planning problem where the demand for capacity can be met by several alternatives: ownership; lease for various terms; and spot contracts. His model is applied for any type of capacity, for which the market characteristics are as follows:

(i) ownership implies a long term capital investment;

(ii) leasing is an available alternative and implies a different capital commitment than ownership;

(iii) capacity is available on a short term or spot basis;

(iv) capacity prices are variable overtime.

This work has several drawbacks such as the following:

(i) it is applied only to the types of capacity, for which the market characteristics are as those mentioned above. In real life these characteristics are not all applicable to all industries. For example, in the cement industry, leasing is not an available alternative. Capacity is also not available for short term. This is true for many other process industries;

(ii) the use of linear model is another drawback of this work. Since linearity assumes that the relationship which exists is linear over the planning horizon. This cannot hold for a long term which is one characteristic of capacity planning problems;

(iii) another disadvantage associated with the use of linear programming is certainty. This is also not a long term solution.

As another example of the application of linear programming models to capacity planning problems, McNamara, (5, 1976) employed a linear model to tackle the problem of capacity expansion in electric utility. He justified his usage of linear programming to handle this problem by claiming that (LP) has great computational power. Furthermore, an electric utility can be approximated to a useful degree of accuracy by linear or piece wise linear function.

The solution is based on the minimization of the present value of investment cost.

Like Fetter´s model, McNamara´s model suffers from the drawbacks associated with the use of linear programming.

<u>Non-linear Programming (NLP)</u>

Non-linear programming is an extension of linear programming. It can accomodate non-linearity which exists in most situations.

Rao and Rutenberg (6, 1977) incorporated continuous time into a non-linear programming formulation to tackle a dynamic multi-location capacity expansion problem. The assumptions underlying their model were the following:

(i) continuous time;

(ii) demand growing at varying rates in different markets and at different times;

(iii) the existence of economies of scale in building plant capacity.

The solution was based on the minimization of the present value of construction, production and transportation costs over the time horizon. They used a transportation algorithm to solve their model. The flow chart of the algorithm can be found in Figure (3), (p.1194), (Roa and Rutenberg), (6, 1977). The procedure developed by Rao and Rutenberg has not been implemented in a real-life situation but it has been applied using data in real-life situations. More specifically using data compiled on the Indian fertilizer industry.

This work handles non-linearity in the demand which is more realistic than the assumption that there is a constantly growing demand. However, we cannot use this work to handle the problem investigated in this thesis for the following reasons.

(i) it does not treat the excess capacity cost, i.e. it deals with sizing an expansion of a capacity which is not the case in our problem;

(ii) it deals with the shipment from (n) plant to (m) market, which is also not the case we are dealing with;

(iii) it is based on mathematical modelling which suffers from the shortcomings which we are going to examine later in this chapter.

<u>Dynamic Programming (DP)</u>

Dynamic programming is an extension of linear programming. It was developed by Richard Bellman and G.B.Dantzig. It is used to solve problems which are concerned with variations that occur over time or through some sequence of events. Thierauf et al. (3, 1985). A dynamic programming technique has been widely used by researchers to deal with the problem of capacity planning. Fong and Rao, (7, 1975) for example, developed a dynamic programming algorithm to choose a schedule of capacity expansion in each of the two regions and a schedule of shipment between the two regions which minimize the total costs over a time horizon. The assumptions underlying their model were:

(i) demand is a non-decreasing function of time;

(ii) capacity expansion and shipment costs are concave;

(iii) time horizon is finite;

(iv) no inventory and backlogging is allowed;

(v) demand in a region in a time period must be satisfied, either by the current production capacity there or by a shipment from the other region.

This work has several drawbacks such as the following:

(i) The assumptions underlying the model are oversimplified. For example, assumption (i) cannot hold for a long-time, at least not for all products. Furthermore, assumption (iv) is not realistic in the sense that no inventory cannot be true for all industries, and no backlogging is ensured in only a few industries, such as electricity and telecommunications;

(ii) another drawback of this work is associated with the use of dynamic programming techniques. Despite the fact that dynamic programming is superior to linear programming, because it can handle both linear and non-linear problems, and, it takes time into consideration, it still suffers from some drawbacks, such as its limited ability to handle large problems, and its lack of a standard mathematical formulation. Hillier & Lieberman, (8, 1980). We cannot use this work to handle the problem which we are investigating because of its simplified assumptions, and also because of its use of mathematical models.

Another example of the application of dynamic programming techniques to capacity planning problems can be found in Erlenkotter (9, 1967). He developed a dynamic programming algorithm to choose a plant construction policy without the restriction of constant cycle length which was used by Manne (10, 1967). Erlenkotter's model was based on the following assumptions:

(i) demands grow at a constant annual rate;

(ii) infinite plant life;

(iii) discount rate, plant investment function, and penalty rate for manufacturing one unit in one region and shipping it to another region are all to be stationary;

(iv) total discounted costs of plant investment and inter-regional transport penalties are to be minimized over an infinite time horizon subject to the constraint that overall excess capacity for both areas be non-negative.

Apart from the drawbacks associated with the use of dynamic programming, this work suffers from shortcomings like:

(i) over simplicity of assumption. For example, assumption (i) cannot be accepted in real-life. Assumption (ii) is also far from reality. This makes this model unrealistic;

(ii) this work is more or less a theoretical exercise.

Erlenkotter (11, 1975) used "incomplete dynamic programming", which consists of an approximation of the first cycle of the dynamic programming policy iteration approach in addition to an approximate approach. These two approaches have been used to deal with the problem of multi-location dynamic capacity expansion. Another example of the application of a dynamic programming technique to the problem of capacity planning can be found in Luss (12, 1984).

He developed a dynamic programming algorithm to find an optimal capacity expansion policy. Idle capacity holding cost, capacity expansion cost and shortage capacity cost are all incorporated into the objective function.

The assumptions underlying the model were:

(i) finite number of discrete time periods;

(ii) demands and expansions occur instantaneously and simultaneously immediately after the beginning of each period;

(iii) each capacity unit simultaneously serves a specified number of demand units of each product;

(iv) all cost functions are non-decreasing and concave.

In addition to the drawbacks introduced by the use of dynamic programming mentioned earlier, this work suffers from the following shortcomings:

(i) it ignores the lead time between the demand and the expansion of the capacity;

(ii) it is a theoretical exercise with no proven application;

(iii) it gives no credit to the intangible factors which can affect the choice of strategy for capacity, and which cannot be formulated mathematically. For example, technical or political factors which prevent the adoption of particular strategy cannot be taken into consideration because such factors cannot be modelled. This is equally applicable to other mathematical programming models.

The model developed by Luss, cannot be applied on the problem investigated in this thesis because this work is based on the use of mathematical modelling which we believe is not appropriate for strategic problems. Furthermore, this work cannot accomodate the factors which affect the choice of strategy for capacity planning.

Integer Programming (IP)

Integer linear programming like linear programming is a tool for allocating limited resources to competing demands for maximizing or minimizing a specific objective. It differs from linear programming in that the solution of (ILP) is whole numbers. (ILP) has been employed by some researchers to study the problem of capacity planning. Manne (10, 1967), for example, formulated an integer programming model. The assumptions underlying his model were:

(i) demands in region (i) are growing at a constant annual arithmetic rate;

(ii) infinite plant life;

(iii) discount rate, constructions costs and penalty costs for inter-regional transport are all to be constant over an indefinite future;

(iv) discrete time periods;

(v,vi) at time zero excess capacity is zero and at time (T) excess capacity returns to zero.

Manne developed a heuristic algorithm for two producing areas based on the principle that constant cycle time policies are the only class of plant construction sequences to be considered.

By a constant cycle time policy for a producing region (i), he meant that there were two decision variables to be chosen: (Yi) the on-stream date for the first plant to be built in the region, and (Xi) the length of time elapsing between the on-stream dates of the first plant and the second one. Manne suggested the use of a heuristic integer programming routine for more than two producing regions. The main drawback of Manne´s work is that the assumptions underlying his model are not realistic. For example, assumption (iii) cannot be accepted in real-world cases because these factors cannot be controlled for a long time. Assumptions (v, vi) are also not realistic. Furthermore, this work deals with the problem of capacity expansion. This, of course, differs from the situation we are investigating.

As another example, Fong and Srinivasan (13, 1981) formulated the problem of multi-regional dynamic capacity expansion as a discrete time mixed integer programming model. The formulation of the model allows for non stationary capacity expansion cost and does not have upper bound limitation or discretization on the sizes of capacities. The assumptions underlying their model were:

(i) the unit of capacity added in any period has a unit production capability at least until the end of the time horizon;

(ii) any shipment out of a region in a period occurs after capacity expansion;

(iii) demand can be satisfied by production and shipment from any of the regions or by importing from an exogenous source with a penalty cost;

(iv) costs are linear.

The solution was based on minimization of the discounted capacity expansion and shipment costs over the planning horizon. They developed a heuristic algorithm to solve the model, but prior to the application of this algorithm, an initial feasible solution to the problem must be obtained. The heuristic algorithm is based on the idea of exchanging capacities between a chosen pair of regions. The shortcomings of this work are as follows:

(i) the assumption that costs are linear is not realistic, the authors themselves admitted that linear cost is realistic only for firms which rent or sub-contract their production capacities from others, or when the fixed components in the capacity costs are relatively small.

Fong and Srinivasan stated that "all the cost expressions in problem (P1) have been assumed to be linear. This assumption is realistic in the case of firms which rent or sub-contract their production capacities from other firms, or when the fixed components in the capacity expansion costs are relatively small" p.(790).

This means that in other cases this assumption is not realistic.

(ii) as mentioned above, the application of heuristic algorithms requires that an initial feasible solution is obtained and this requires that the problem is solved for the first period and the value of capacity expansion size obtained is added to the initial capacity of the second period and then the problem is solved for second period and so on. This makes the situation troublesome especially when tackling a large problem;

(iii) this work like the previous ones ignores the fact that there are factors which affect the adoption of a particular strategy for capacity planning.

We cannot use the model developed in this paper despite the fact that it treats idle capacity cost in the objective function because it deals with the problem of capacity expansion or investment decision whereas the problem investigated in this thesis is capacity reduction or divestment decision and rationalization of capacity. Another example where integer programming is used can be found in Fong and Srinivason (14, 1981). They extended the heuristic approach developed in Fong and Srinivason (13, 1981) to handle the case of a multi-regional dynamic capacity expansion problem with capacity expansion cost in the form of a fixed charge plus a cost proportional to the size of the expansion. They developed a branch and bound procedure for deriving an improved solution, based on the capacity exchange heuristic.

<u>To sum up this section:</u>

The drawbacks associated with the use of mathematical modelling as tools for dealing with capacity planning problems are that its ability to convey the change in the structure and behaviour of the system is poor; there is no one standard form that can be applied for all problems, this means that each problem should have its own model and this, of course, is time consuming and costly;

it (mathematical model) ignores many important factors which affect the capacity planning problem and cannot be quantified;

it is a "data hungry" technique. This means that a lot of data is needed and in turn more time and cost;

uncertainty is an important factor inherent in long-range planning, mathematical models ignore this fact, due to the cost associated with running complex models for many options;

finally, mathematical modelling has proved to be inadequate for handling strategic problems. For example, Naylor and Thomas (15, 1984) have outlined six methodological problems which serve as obstacles to the use of optimization as tools for strategic planning. These are summarized below:

(i) ill-defined problems;

(ii) the economics of interdependence;

(iii) degree of resolution and aggregation;

(iv) inadequate theory of strategic planning;

(v) computational problems;

(vi) inadequate decision support system.

Moreover, some scholars argue that traditional O.R./M.S.

techniques are not wholly applicable to strategic problems.

Ansoff (16, 1985), for example, argued that "the scientific method of operational research and management science is not wholly applicable to the strategic problems".

Likewise, Sagasti (17, 1972) said that "... most of the operations research techniques that are available are best suited to short- and medium-range tactical problems, whereas the problems of underdeveloped countries involve primarily strategic and long-range planning considerations." (p.130).

Because of the mentioned shortcomings of mathematical modelling, some used other tools to tackle the problem of capacity planning. In the next sub-section systems dynamics is examined and examples of previous work using this technique as a tool for dealing with capacity planning problems are given.

5.2.2 Systems Dynamics Approach

Because mathematical modelling proved to be inefficient as a tool for dealing with capacity planning problems a system dynamic approach has been adopted by certain researchers. Let us first understand what is meant by systems dynamics. Coyle (18, 1977) for example, defines system dynamics as the branch of control theory and that of management science, where the former deals with socio-economic systems while the latter deals with the problems of controllability.

The use of systems dynamics is intended to accomplish two main objectives:

(i) to explain system's behaviour measured by its structure and policies;

(ii) to recommend modification of such structure, policies or both to enhance system's behaviour. Coyle (18, 1977).

According to Meadows and Robinson (19, 1985) system dynamics technique is most applicable to systems which have the following characteristics:

(i) distinctive dynamic pattern;

(ii) long-time horizon;

(iii) broad inter-disciplinary boundaries;

(iv) involvement of aggregate quantities.

System dynamics approach has been widely used to tackle the problem of capacity planning. The most recent published work which we are aware of, and which employed system dynamics approach to tackle the problem of capacity acquisition, was carried out by Thillainthan (20, 1983).

Thillainthan supported system dynamics techniques by various mathematical techniques; his method of approach was based on system dynamics modelling techniques developed by Forrester.

Thillainthan developed a systematic procedure to analyse problems concerned with the management of capacity in manufacturing industries. He applied his procedure in the UK paper and board industry.

Thillainthan examined previous works which used system dynamics to deal with the problem of capacity planning, therefore, readers interested in a more detailed discussion of previous works utilising system dynamics are referred to Thillainthan (20, 1983), pp.(47-52).

However, despite the fact that systems dynamics could overcome some of the mathematical modelling drawbacks, it (systems dynamics approach) has a few shortcomings such as the following:

(i) inability to perform sensitivity analysis;

(ii) the reliability of the system dynamics model depends on satisfying a few conditions such as:

(a) parameters which are sensitive to numerical change in the model are also sensitive to similar changes in a real system;

(b) every part of the relationship of the model should have a real-world meaning and cope with the measurement and observations available;

(c) every variable of the model should express the quantitative and qualitative behaviour of real-life systems when simulating a historical period.

However, most of the time these three conditions cannot be met and also are difficult to evaluate.

(iii) elements within the system are to respond to each other in a non-linear pattern;

(iv) dynamo, the software package associated with system dynamics has several disadvantages, some are outlined below.

(a) because of its ease it might drive beginners to rely heavily on their skills and models despite the fact that their knowledge of system dynamics might be poor;

(b) because alterations can be done very easily, this might cause beginners as well as advanced to concentrate on model variation rather than analyzing the essence of the process;

(c) the simplicity of adding new elements and relationships to the model improves the existing tendency of modellers to create an over-complex and incomprehensible structure. Meadows and Robinson (19, 1985).

The next sub-section examines various approaches which have been used to tackle the problems of capacity planning and have been classified under other selected approaches.

5.2.3 Other Selected Approaches:

This sub-section examines three types of approaches. These are: economic analysis; computer approach, and cartel and government intervention method.

Let us start with the economic analysis approach. This approach has been used by Cameron, (21, 1974) to determine the optimum plant capacity. He outlined three steps to determine the optimum plants size for new ventures. These steps are summarized below.

(i) evaluate scaling factors for various types of process plant;

(ii) the cost of alternative building strategies to be related to the forecast of production requirements;

(iii) plot graphically discounted capital and fixed costs of investment strategies against plant size to find the plant size associated with the minimum cost strategy.

In order to carry out these steps, the cost of capital and production growth rates are to be determined.

The major shortcoming of this approach is its simplicity and its inability to handle large and complicated real-life problems. It is also unable to accomodate the interactions between different variables in the system.

Having examined the economic approach, let us turn our attention to another simple approach which has been used to tackle the problem of capacity planning. It is a simplified computer approach. Aley and Zimmer, (22, 1974) described a simplified computer approach with manual review, that can identify short- and long-term capacity problems. Five steps for long-term capacity analysis were identified. These were:

(i) develop sales forecast;

(ii) explode the sales forecast;

(iii) convert standard machine hours to expected actual machine hours;

(iv) analyze the capacity projection;

(v) consider methods of increasing capacity.

This method has been adopted by Tobbins and Myers´ Mayno Pump Division (Springfield, Ohio, USA). It is designed to answer questions such as: do we have the capacity to produce this year´s sales forecast? Do we have the capacity to produce next year´s sales forecast? What is our manufacturing capacity?

Apparently, this approach is easy to understand and to apply but it is unable to accomodate more complex long-term situations, and it does not take into account the effect of the intangible factors which affect capacity planning strategy and which have to be taken into account when choosing the appropriate strategy.

Another method which we discuss in this sub-section is cartel and government intervention. The word cartel means a union of manufactures to fix prices and restrict sales ... etc. A cartel was formed between the manufacturers in the Japanese cement industry, to cut down the excess capacity of cement. The Japan Economic Journal (23, 1986). With regard to government intervention, the French government, for example, adopted this procedure both to cut excess capacity and to expand capacity. McArthur and Scott (24, 1969). These two procedures are discussed in some detail when discussing the factors affecting the choice of strategy for capacity planning.

These two procedures, namely, cartel and government intervention cannot be adopted in all economic systems. For example, in a free economy where an anti-trust law is enforced, a cartel cannot be instituted. Similarly, government intervention is unlikely to take place in such an economy unless the decision to expand capacity is going to affect the environment such as causing pollution in a heavily populated region.

To sum up this section (5.2) one can argue that the majority of the previous published work in the area of capacity planning has been a series of theoretical exercises on the micro-level. Furthermore, more emphasis was placed on mathematical techniques based on unrealistic and simplified assumptions. Moreover, forecasting was neglected and also uncertainty which is associated with capacity planning has been ignored. Furthermore, there was very little evidence of implementation or management involvement in these studies.

The next section examines the problem of excess capacity.

5.3 <u>The Problem of Excess Capacity</u>

This section briefly examines the problem of excess capacity. A few examples of previous work in the area of excess capacity are stated below.

Chares (25, 1972) in his Ph.D thesis discussed the factors which cause the under-utilisation or prevent the full utilisation of capacity in some privately-owned industries in Indonesia between 1954-1961 and in 1965. He concluded that no single factor determined the level of utilisation of capacity of production every year during the 1955-1961 period. However, some factors such as shortages in imported materials are found to have more effects on industries heavily dependent on imported materials. A change in the local price-cost was also found to be an important factor in causing variation in the utilisation of capacity; the size of enterprise has no effect on the utilisation of capacity.

Shortages in electricity supply was found to have little effect on the utilisation of capacity in smaller enterprises.

To sum up, this study concentrated on investigating the causes of under-utilisation of capacity in different industries and over different periods of time. Similarly, Pekarun (26, 1973) utilising verbal analysis with supporting statistical information examined the causes of excess capacity in leading branches of Turkish manufacturing. He stated several causes for the problem of excess capacity in Turkish manufacturing. These were: the negative effects of competing imports; bottlenecks in capital and raw material imports; capacity expansion in export-oriented activities; unbalanced capacity expansion with regard to inter-industry relations; and others, such as foreign exchange problems, strikes, and increase in labour migration or firm scale. This study concluded that planning practice, rather than demand deficiency, was responsible for the existence of excess capacity in Turkish manufacturing.

Another example where the problem of excess capacity investigated can be found in Winston (27, 1971). He investigated the causes of excess capacity in West Pakistan; utilising statistical analysis (regression analysis) he examined the effect of four major factors and two secondary factors on the utilisation of capacity in industries in west Pakistan. He found that competing imports negatively correlated with the utilisation of capacity, i.e. the higher the competing imports are the lower is the utilisation of capacity. On the other hand, the other three major factors which include: capital-income ratio, export sales and average firm size were positively correlated with the utilisation of capacity. The two secondary factors, namely market structure and labour productivity have different correlation with the utilisation of capacity.

The former has positive correlation, while the latter has negative correlation. The fourth and the final example which illustrates the causes of the excess capacity problem can be found in UN (28, 1970). This publication discussed in several articles the problem of measuring industrial capacity and capacity utilisation in less developed countries, excess capacity - measurement, causes and uses in Israel, case studies of the causes of excess capacity in industry and finally industrial excess capacity and its utilisation for export.

As can be seen from the previous examples, the concentration was on the investigation of the causes of the problem of excess capacity and suggesting solutions for the problem. The analysis which was used either verbal with supporting statistical information or statistical analysis (e.g. regression analysis).

Moreover, all the examples mentioned are from an economist point of view. However, in this thesis the problem of excess capacity is treated as a strategic problem and its cause is known to us therefore we are not going to investigate its causes in any detail.

Further, it is dealt with in a systematic and comprehensive manner.

In the next section the discussion concentrates on the factors affecting capacity planning strategy.

5.4 Factors Affecting Strategies Adopted For Capacity Planning

This section and its sub-sections examine the factors which affect the adoption of strategies for capacity planning.

5.4.1 Econo-political Systems As An Environment:

Economic system operates in a socio-political environment. Thus its rules and institutions are influenced vigorously by this environment. Vazsongi and Spiver (29, 1984).

There is also a great overlap between the political and economic system. Ecksten (30, 1970). Furthermore, every economic system experiences a form of governmental influence. Maunder, (31, 1979). Even the free economy of the USA experiences governmental presence of this kind. This influence differs depending on the political bias of the party in power. In the USA, for example, Republicans are against the idea of government intervention in the economy while Democrats are in favour of such intervention. In the light of the foregoing discussion, the focus is now on the influence of the economic system, which is more or less affected by the political system, on capacity planning. Before proceeding to examine the influence of the economic system on the process of capacity planning it would be desirable to outline the most important characteristics of the four selected economic systems. Thus next we are going to outline these characteristics, then the influence of these systems is examined.

Characteristics of Selected Economic Systems

Before examining the main characteristics of the four economic systems of interest, we are going to use economic systems to mean "a network of institutions and arrangements directed toward using scarce resources of a certain organization." Vazsongi and Spiver, (29, 1984).

Four major economic systems are of interest, these are: market economy; centrally planned economy; mixed economy; and loosely unified economy. The main characteristics of these four systems are as follows:

Market Economy

The USA provides an excellent example of this sort of economic system. The general characteristics of this type of economic system are well demonstrated by Grossman (32, 1974), Shitzer and Nordyke (33, 1971), and Neuberger and Duffy (34, 1976) who stated that: market mechanism allocates resources among different lines of activity, adjusts production and consumption, and distributes incomes;

means of productions are privately owned, but do not prevent government's ownership;

consumer preferences determine what and how much is to be produced;

profit functions as an incentive for enterprises and prices operate as channels of communication.

Centrally Planned Economy

This type of economic system represents the other extreme of the four economic systems mentioned. The USSR gives an obvious example of a centrally planned economy. The main characteristics of this type of economic system as stated by (32, 1974); (33, 1971); and (34, 1976) are:

in contrast to the market economy, in a centrally planned economy the command principle allocates resources to different lines of activity, and distributes incomes;

firms are ordered by governments, what, when, how and how much to produce and consume; this is also contrary to a market economy, where consumer preferences determine what and how much is to be produced;

means of production (or productive assets) are publicly owned; and finally, government planners determine prices and costs.

Mixed Economy

A mixed economy as its name suggests is a combination of the two previously mentioned types of economic system. The UK, other west European countries and Japan are good examples of this kind of economic system. Presented below are the most important features of this type of system.

(i) substantial emphasis is placed on indicative planning;

(ii) there is primary dependence on free enterprise and market mechanism;

(iii) full employment is the most important economic objective while price stability is a secondary objective.

Having outlined briefly the main characteristics of the most common economic systems, let us now examine the main features of a less common type of economic system, which we call "loosely unified" economic system.

Loosely Unified Economy

UAE, EEC and GCC are prototypes of this sort of economic system. It should be noticed that there is no such term, i.e. "loosely unified economy", which we are aware of, which exists in the literature. We used this term to assist us in examining the influence of the economic system like that of the UAE and which cannot be classified perfectly as a free economy, centrally planned economy or mixed economy, on capacity planning strategy.

The main characteristics of this class of economic system are outlined below.

(i) means of production (production assets) are privately owned in some political units, publicly owned in others, and mixed in other units;

(ii) the existence of independent decision makers with regard to economic decision making in particular;

(iii) the absence of a unified economic policy in general and an industrial policy in particular.

The aim of the previous discussion was to provide a brief outline of the main characteristics of the four economic systems of interest without elaborating, so the reader can better understand the influence of these systems on the selection of strategies for capacity planning.

We now investigate the influence of these systems on the selection of strategies for capacity planning.

<u>The Influence of The Four Economic Systems on The Selection of Strategies For Capacity Planning</u>

This sub-section examines the influence of the four economic systems of interest on the selection of strategies for capacity planning. It should be borne in mind that "capacity planning" is taken here to mean two things. First, planning the expansion of capacity; and second, planning the reduction in capacity.

<u>Capacity Expansion Decision</u>

One of the most important decisions which faces capacity management is the decision which is related to productive capacity expansion. Since such decisions will cost the firm or the industry substantial financial expenses, therefore planning should take place a long time before such decisions are taken. It is strongly believed that different economic systems affect the decision to expand the productive capacity differently, for example, in a free economy or market economy where great emphasis is placed on the market mechanism, and prices play a significant role in the economy, the market mechanism determines the size of the production and in turn the size of capacity needed for the firm or the industry as a whole. On the other hand, in a centrally planned economy, as mentioned earlier, the government planners determine the quantity to be produced and the prices to be charged; consequently, government planners decide the capacity needed for the firm or industry as a whole, and whether there is a need for expansion or not. In a mixed economy, where government intervention can occur, capacity expansion is differently affected. Governments intervene to expand the capacity to meet the shortage in supply of a particular product, for example, the French government during the post war period intervened in the cement industry to eliminate the shortages in the supply of cement. Its intervention took different forms which included allocating industrial output; controlling investment in the industry; and monitoring the prices. McArthur and Scott (24, 1969). In a loosely unified economy the situation is slightly different; here each political unit within the loosely unified economy affects the process of capacity expansion differently. In those units where capital is publicly owned, the government planners determine the size, the time and the location of expansion, while in units where capital is privately owned the individuals or more accurately their representatives take such decisions. Let us take the UAE as an example of a loosely unified economy to illustrate the influence of this type of economic system on capacity expansion decisions. In some Emirates in the UAE, capital is predominantly publicly owned (e.g. Abu Dhabi, Fujairah) while, in others capital is predominantly privately owned. In the first case, government organisations take the decisions to expand capacity, whereas, in the second case such decisions are made by the representatives of the capital owners.

In summary, different economic systems affect the decisions of capacity expansion differently.

Capacity Reduction Decision

The decision to cut capacity is as important as the decision to expand capacity, especially in capital intensive industries where a great deal of money has been invested in equipment and machinery and the decision to cut capacity means to put on ice some equipment and machinery either for a short or long term. Once again such a decision is influenced by an economic environment in which the firm or industry is operating. For example, in a market economy where an anti-trust law is enforced and government intervention is very rare, the market mechanism, through competition, force capacity cuts either by withdrawing some firms from the market or by cutting the operation level of others. On the other hand, in a centrally planned economy, the government planner takes the decision to cut the capacity of some plants. In a mixed economy such a decision is made either through collaboration between rivals or through government intervention. As an example of the first case (collaboration), in Japan, where an anti-monopoly law is enforced, the Ministry of Internal Trade and Industry (MITI) is permitted to supervise cartels which operate through industrial associations to serve certain purposes such as the reduction of excess capacity. Magaziner and Horet (35, 1980). In recent years, and due to excess capacity in the Japanese cement industry, cooperation between cement manufacturers is taking place to reduce the productive capacity which has in turn improved operating rates. The Japan Economic Journal (23, 1986).

In a loosely unified economy, the situation is somewhat vague. Generally speaking free competition might exist, and an anti-trust law either does not exist or is not strictly enforced.

However, the decision to cut capacity in such an environment is likely to be affected by the intervention of the government of the individual political units (Emirates) within the loosely unified economy. For example, the Western European synthetic fibres industry which includes EEC and non EEC producers experienced excess capacity, price wars and heavy losses during the period between 1974 and 1980, such a situation necessitated the rationalization of the productive capacity, but this action was countered by government intervention and state assistance to extend the fibre producing capacity (e.g. Italian government). Shaw and Shaw (36, 1983).

The aim of the previous discussion was to examine the influence of different economic systems on capacity reduction decisions.

The next sub-section examines another factor which can affect the selection of strategies for capacity planning, namely, the market.

5.4.2 The Market

This sub-section examines another factor which affects the capacity planning strategy. The market is looked at from two dimensions. Firstly demand pattern (i.e. constantly increasing, stagnating etc.); and secondly competition. These two dimensions are examined below.

Demand Pattern

The demand pattern, is gleaned from the behaviour of the demand, i.e. whether it is constantly growing, whether its growth rate is rapid or slow or whether the demand is in decline. The demand pattern affects the capacity planning strategy, it affects the determination of the capacity required. It is easier to determine the capacity required in the system when the demand is growing constantly and when growing slowly, but it is more difficult when the demand is growing rapidly. The success of the strategy chosen for capacity planning depends more or less on the accuracy of the forecast of the demand. The pattern of demand affects indirectly the strategy adopted for capacity planning, for example, if the demand is growing constantly, then one possible strategy is to expand capacity through adding a new capacity unit.

Competition

The second dimension of the market is competition. It affects the first stage of capacity planning i.e. the stage of forecasting the demand for the capacity of the system. When a firm is in a monopolistic situation it is easier for it to forecast the demand for its capacity, since the demand for the industry will be its demand.

On the other hand, when it is in competition, demand is divided among other firms in the industry as well, the forecast of the demand for a single firm is a very difficult task. Competition usually creates excess capacity. Sheshinski and Preze (37, 1976). When there is competition in the market, with more firms entering the market, this leads to supply exceeding demand (especially in capital intensive industries). Furthermore, competition makes the reduction in capacity more difficult than the case when there is monopolistic control. In short, competition affects the choice of capacity planning strategy, for example, in a competitive market the decision to expand the capacity is usually taken after careful consideration of competitors reaction to such decisions.

5.4.3 System Structure

This sub-section examines another factor which affects capacity planning, namely, the structure of the system. Wild (38, 1979) argues that the structure of the system influences or limits the strategies adopted for capacity planning, for example, systems which are capable of operating with stock can accommodate the fluctuation in the demand very easily, through the use of stock during peak demand, whereas, systems which are unable to operate with output stock will have difficulty in coping with the fluctuation in the demand.

Similarly, whether the system operates on continuous production or batch production also affects the strategy chosen.

For example, the cement industry has the first type of system, and it operates around the clock, in this case the strategy of shutdown of kilns during low demand and turn on kilns when there is demand cannot be adopted, while it could easily be adopted in the second type.

In summary, the system structure affects the choice of strategy for capacity planning. In the next section the concentration is on the consequences of misjudged capacity decision.

5.5 Consequences of Misjudged Capacity Decision

This section examines the consequences of misjudged capacity decisions. Large financial penalties can be incurred if the capacity of a plant is undersized or oversized. Having more capacity than required results in having excess capacity and in turn under-utilisation of capacity which means high production costs and probably heavy losses. Furthermore, having more capacity than needed results in putting capital on ice and in turn a waste of resources.

On the other hand, having less capacity than needed results in backlogging of customers' orders and eventually trade loss, especially in a competitive market. The problem of undersizing or oversizing the capacity is as serious to the industry as a whole as to the firm itself. As an illustrative example which demonstrates the seriousness of the wrong capacity decision at the industry level, let us take the U.A.E. cement industry. As mentioned in chapter four, this industry is having excess capacity; it is due, among other things, to misjudged capacity decisions. In the seventies, when the demand for cement was growing rapidly because of the boom in the economy and in the construction industry in particular, the cement industry expanded very rapidly either by adding new facilities to the existing plants or adding new plants. Since in 1982 and until the present time, the U.A.E. cement industry has suffered from the problem of excess capacity because of the decline in the demand for cement due to the recession in the economy in general and the construction industry in particular; as a result of the excess capacity the industry is incurring heavy losses. On the other hand, if the U.A.E. cement industry were experiencing shortages in capacity rather than excess capacity, the situation would be as serious as having excess capacity, because other industries depend on the output of the cement industry. Therefore; the shortage in the supply of cement means that the activities of these industries, mainly the construction industry, might be disturbed and in turn this might cause delays in the progress of vital projects, possibly affecting the economy as a whole. Anyway, the problem of having excess capacity or shortages in capacity is more serious in the process industries like cement, steel, ... etc., because the facilities of such industries are less flexible to cope with the fluctuation in the demand for capacity.

5.6 Conclusion

This chapter concerned itself with various issues. The literature survey of previously published work in the area of capacity planning, the problem of excess capacity, the factors which affect the choice of strategies for capacity planning, and finally the consequences of the wrong capacity decision. Based on the discussion of this chapter, one might draw the following conclusions:

(i) the majority of the previously published work in the area of capacity planning concentrated on capacity expansion, while very little attention has been paid to the problem of excess capacity or under-utilisation of capacity. Furthermore, there was little evidence of implementation or management involvement in these studies;

(ii) mathematical models have been widely used to deal with capacity planning problems;

(iii) those who dealt with the problem of excess capacity concentrated on the investigation of the causes of this problem by means of economic and statistical analysis;

(iv) a number of significant factors have been identified, which affect the choice of strategy for capacity planning, and these are to be taken into consideration;

(v) misjudged capacity decisions have serious effects both at the industry and the firm level.

The next chapter examines the approach of the study.

First it outlines the main characteristics of O.R. techniques suitable for developing countries; then the two main components of the approach are examined. Finally, the potential applications for the developed procedure are briefly discussed.

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CHAPTER SIX: APPROACH USED

CHAPTER 6 APPROACH USED

6.1 Introduction:

The previous chapter addressed the survey of published literature in the area of capacity planning in addition to other issues, such as the factors affecting capacity planning strategies, the problem of excess capacity, and the negative consequences of misjudged capacity decisions. This chapter addresses the approach used to accomplish the objectives of the study. It outlines the characteristics of O.R. techniques suitable for developing countries in particular. Furthermore, it addresses the two main components of the approach, namely, the exploratory and the applied parts. It also highlights the areas where the developed procedure can be applied. Finally, the research techniques adopted were briefly discussed.

6.2 Characteristics of O.R. Techniques Suitable for Developing Countries

Prior to outlining the main features of O.R. techniques suitable for developing countries, the criteria for choosing a particular procedure, and the characteristics of Third World countries need examining. Firstly, the criteria for choosing a particular procedure will be identified through a series of questions.

Coyle (1, 1977), for example, suggested fourteen criteria for applying system dynamics modelling; many of which seem equally applicable to other techniques. These will address the following problems:

(i) availability of data and information;

(ii) the ability to define the variables;

(iii) the danger of oversimplification;

(iv) the level of aggregation needed;

(v) facilities needed;

(vi) training needed;

(vii) time needed.

One can add a few more to Coyle's list: the relevance of the technique or the procedure chosen to the problem investigated, its suitability to the clients' needs and whether it takes into consideration the environment in which it is to be applied. Having set out the criteria for choosing a particular technique or procedure, how can these be applied to the Third World?

Third World countries have special features differentiating them from developed countries.

Cook and Wright (2, 1981) have summarised some of these features:

(i) centralized planning systems;

(ii) the importance of political factors in making decisions;

(iii) a large cultural and communication gap between decision makers and those affected by the decisions;

(iv) uncertainty in the planning environment;

(v) low levels of infrastructures;

(vi) significance of capital investment projects as a proportion of total public expenditure;

(vii) shortage of financial resources;

(viii) shortage of reliable information for making decisions;

(ix) shortage of skilled supervision and management.

We strongly believe that features (ii), (iii), (iv), (vi), (viii) and (ix) of the nine mentioned above are more pronounced in the U.A.E. in particular. Undoubtedly, economies with these features require techniques with special characteristics to suit their needs. Once again Cook and Wright (2, 1981) summarised the features of O.R. approaches needed to suit Third World economies. They state that the approach should:

(i) have built-in flexibility;

(ii) build up the capacity within an organisation for data collection, so that the organisation can carry out self-studies;

(iii) encourage 'grass roots' participation in defining problems, collecting data, and implementing solutions.

Having outlined the main features of Third World economies and features of O.R. techniques suited to them, now attention is paid to the main features of the analytical procedure developed in this chapter.

These features are summarised below.

(i) flexibility in the sense that it can be applied to both reduction and expansion in capacity, and it is less structured than, for example, mathematical modeling and system dynamics.

(ii) it is easy to understand and apply, i.e. no need for specialists;

(iii) it does not require a great deal of data and information;

(iv) it requires less use of computing facilities and time than, for example, mathematical models or system dynamics;

(v) it can cope with more than one future;

(vi) it can accommodate uncertainty;

(vii) it is an integrated procedure.

These features are consistent with those proposed by Cook and Wright, which were outlined earlier. Furthermore, the analytical procedure described in this chapter does not require the conditions set by El Shafei (3, 1982) for a successful application of O.R. in developing countries, which might be necessary when applying the traditional O.R. techniques such as mathematical programming. The conditions set by El Shafei for a successful application of O.R. in developing countries are:

(i) the availability of O.R. specialists;

(ii) the existence of an efficient data collection system;

(iii) the existence of a sufficient data processing system;

(iv) the prevalence of good relations between the O.R. team and the organisational units.

Furthermore, Smith (4, 1987) stated three conditions for successful O.R. application: that O.R. must be appropriate to the problem, the decision makers, and the environment including the culture. The proposed analytical procedure complies with these conditions.

The criteria for choosing a particular technique, the features of Third World economies and the features of O.R. techniques suitable for developing countries have now been outlined. The features of the procedure developed in this chapter have also been outlined.

Now we wish to describe the two main parts of the approach of this study.

6.3 The components of The Approach Used

This section concentrates on the two main parts of the approach of the study. The exploratory and the applied parts. These two parts are examined as follows.

6.3.1 Exploration of O.R. Techniques Taught and Used in The U.A.E.

This part of the approach concentrates on the investigation of O.R. techniques taught and practiced in the U.A.E. This was carried out through the use of questionnaires and personal interviews. The purpose of such investigation was to get the feeling of O.R. techniques which are common and which are not, also to gain insight into the level of awareness, understanding and knowledge among decision makers regarding O.R. techniques. Furthermore, to find out what problems serve as impediments to the widespread use of the O.R. techniques in the U.A.E. in general and in the industrial and business organisations in particular. Furthermore, to identify the main requirements necessary for the O.R. development in these organisations.

Chapter two and three cover the investigation of the environment, and the decision makers' needs, awareness and understanding of O.R. techniques respectively.

6.3.2 Steps In The Application of The Developed Procedure

This part of the approach describes a procedure which has been applied on the capacity planning problem of the U.A.E. cement industry. The purpose of this part is to demonstrate how O.R. techniques and methodologies can be used on a macro-level in the U.A.E., a country which is not very familiar with such techniques. The application of this procedure is discussed in chapter seven and eight following its description which is given in this chapter. The developed procedure is based largely on the concept of decision analysis. It is designed so that it can cope with strategic problems, the decision makers' needs and experience in O.R.; and also the environment of the U.A.E.

It utilises scenario analysis, statistical analysis, multi-attribute decision making, corporate planning and the judgmental approach as analytical tools. Table (6.1) gives an overview of the steps and the analytical tools of the procedure, and the text that follows describes these steps and tools in detail.

Table (6.1)

The steps and analytical tools

of the developed procedure

No.	Steps	Analytical tools
1	States of the environment evaluation	Scenario analysis Econometrics modelling
2	Strategies formulation	Brainstorming Logical method and thorough discussion
3	Scenario/strategy matrices building	
4	Strategies evaluation	Quantitative criteria Qualitative criteria
5	Strategies choice	Cost/benefit analysis
6	Strategy implementation	Multi-attribute decision making Bargaining theory

6.3.1 <u>States of The Environment Evaluation</u>:

It should be noted that market levels are regarded here as the environment for the system under study. This environment is influenced by several, internal, within the country, and external, from outside the country, variables. Moreover, some of these variables are controllable and predictable, whereas others are not. The objective of this step is to investigate these variables (internal and external) and study their evolution over the planning horizon, then evaluate their effects quantitatively. At this stage two analytical tools are used, namely, scenario analysis and econometric modelling. Let us start with scenarios analysis.

Scenario Analysis:

It seems desirable to define the term ´scenario´ before going any further. The term ´scenario´ has different meanings to different authors, though, some sort of similarities between different definitions exist. Khan and Wiener (5, 1967) defined the term ´scenario´ as "hypothesis sequences of events constructed for the purpose of focussing attention on causal process and decision points." Another definition of the term ´scenario´ is given by Armstrong (6, 1985). He defined it as a story about the future. Parker (7, 1986) defined ´scenario´ as "a self consistent picture of a future state, or evolution of the world ...". Moreover, Aryes (8, 1969) defined scenario as "a logical and plausible set of events, both serial and simultaneous, with careful attention to timing and correlations whenever the latter are salient." From these definitions of the term it can be concluded that a scenario is a comprehensive picture of future events. Having defined the term ´scenario´ it would be useful to examine types of scenarios before proceeding to examine the ways in which scenarios are constructed, and the method which we used to construct the scenarios mentioned in this thesis. There are several types of scenarios which exist, a few of which are mentioned here. Van Doorn (9, 1986) classified scenarios into four sets. The first set includes: projective and prospective scenarios; projective in the sense that it starts from the past and the present and looks into the future; on the other hand, prospective scenarios look back to the present on the basis of one or more images in the future. The second set includes: normative and descriptive scenarios. The former are constructed based on wishes, choices and interests of the designers or users, whereas the latter are constructed on the basis of available facts. The third set includes: dominant and limits-identifying scenarios. Finally, the fourth set includes: preferential and prioristic scenarios. As another example of scenario types, Godet (10, 1979) classified scenarios into two types: trend-based scenarios and contrasted scenarios.

However, it should be stressed that for the purpose of this study projective and at the same time contrastive scenarios are adopted.

Having outlined the type of common scenarios, the next thing is to outline different methods used by different authors to construct scenarios and summarise the method we used to construct the scenarios mentioned in this thesis.

There is no one way of constructing scenarios, different people use different methods of approach to construct their scenarios, a few are summarised here. Norse (11, 1979) described the five main stages used by Interfutures to construct their scenarios.

(i) definition of the concept model;

(ii) selection of specification of the key assumptions;

(iii) production of qualitative framework;

(iv) enrichment with material from complementary studies;

(v) analysis of the dynamic path leading to the end state.

Another method of constructing scenarios can be found in Durperrin and Godet (12, 1975). They discussed a method of scenario construction called SMIC-74 and based on cross impact analysis which has the advantage of both taking into account the opinions which are expressed, and the inderdependence between the factors to which those opinions relate. Zentner (13, 1982) also outlined three methods of scenario construction. These are: the consequences technique; the cross impact technique and the iteration through synopsis technique.

Another example of methods of scenario construction can be found in Godet (10, 1979). He outlined two methods of approach of constructing scenarios. They are: the literary approach by which he meant the use of a method which depends on thought and reasoning, while the second approach is a "formalised approach", by which he meant the use of a method based totally on mathematical or computer processes.

These are the most commonly used methods of approach for constructing scenarios. The following list summarises the steps we used to construct our own scenarios:

(i) define the objective of the scenarios;
(ii) select scenario elements;
(iii) examine historical evolution of the elements elected;
(iv) formulate assumptions about the selected scenario elements;
(v) assess the consistency of the assumption;
(vi) formulate the scenarios;
(vii) choose the most plausible and consistent scenario;
(viii) write down the chosen scenarios.

The descriptions of the above steps with their application is given in chapter seven. Other aspects of scenarios are also examined in that chapter.

Having briefly highlighted the definitions of the term "scenario", common types of scenarios, and methods of approach of constructing scenarios used by other authors and those we used in this thesis, we turn to the second analytical tool of evaluating the states of the environment, namely, econometric model building.

Econometric Model Building:

As mentioned elsewhere, scenarios are not forecasts, therefore we shall look for a method to translate these scenarios into forecasts which can be used for the purpose of planning. Many methods have been used as a means of translating scenarios into quantitative forecast, (e.g. simulation models, global modelling and system dynamics).

We choose regression models for this purpose. The reasons for choosing this technique and the construction of the regression models are discussed in the next chapter. Having examined the first step in applying the analytical procedure proposed, the next thing is to move toward examining the second step, formulating alternative strategies.

6.3.2 Strategy Formulation

It would be useful to define the term ′strategy′ and ′strategy formulation′ prior to discussing the objective of this step. Different authors have used different terminologies to define the term strategy. Hofer and Schendel (14, 1978) defined ′strategy′ as statement of means to achieve goals and objectives. Similarly, Hussey (15, 1979) defined it as a means by which the organisation or the company intends to reach its objective. Wheelen and Hunger (16, 1987) defined it as an extensive master plan expressing how the organisation will accomplish its missions and objectives. Ansoff (17, 1971) defined it as a set of decision making rules for the guidance of organisational behaviour.

Although different terminologies have been used by different authors to define the term 'strategy', they all lead to one meaning which is a means of achieving the ultimate objectives of a firm or organisation.

Here, the term 'strategy' is taken to mean a course of action followed by the decision makers to achieve the ultimate objective of his organisation. Strategy formulation is used in this thesis to mean the process of shaping the course of actions which are to be taken to achieve the ultimate objective. The discussion in this section concentrates on different techniques of strategy formulation, while the application of some or all of these techniques is discussed in chapter eight.

There are many techniques of formulating strategies. They differ in terms of complexity, detail and formality. Argenti (18, 1985), for example, suggested five methods of enriching a short list of alternative strategies. These include: brainstorming, logical method, imitation, opinion survey, and finally, 'what business' question. Wedley (19, 1977) suggested the use of the Delphi method as a means of strategy formulation. Decision analysis approach has been applied as a means of strategy formulation, Bunn and Thomas, (20, 1977). Churchman et al. (21, 1957) suggested a way of deriving a list of alternative courses of action. Their methodology depends on asking and answering the following questions. For each phase of the system would change:

(i) in personnel, affecting the efficiency of the system relative to the sponsor´s objectives;

(ii) in operations and/or machines, affecting the efficiency of the system;

(iii) in the materials, affecting the efficiency of the system;

(iv) in the environment, affecting the efficiency of the system.

Some more complex, detailed and systematic techniques of strategy formulation have been presented by some authors. Hofer and Schendle (14, 1978), Wheelen and Hunger (16, 1987) and Sutton (22, 1980).

However, it should be stressed that an integrated technique has been adopted in this thesis. This technique is based largely on Argenti´s five methods. First, by means of brainstorming, a list of alternative strategies is developed, then, by means of a logical method, this list is enriched. Finally, the enriched list is presented to the clients accompanied with long discussions, a final list is reached. The application of this procedure is presented in chapter eight.

The reason for adopting such methodology of strategy formulation is that this methodology is more suitable for the business environment in the U.A.E. and it is easy to apply. It is worthwhile mentioning that some people might argue that there will be an infinite number of alternative strategies. Although this might be true in some situations, several ways of handling such problems have been suggested. Pearman et al. (23, 1986) mentioned a procedure by which the number of alternative strategies can be narrowed down to a manageable size. This procedure is based on the concept of identifying the objective of the decision making body and the constraints under which the strategy can be seen as operating.

Johnson and Scholes (24, 1984) suggested ranking, and decision trees as a means of narrowing alternative strategies down. Logic can also be utilised to narrow down the number of alternative strategies. For example, many alternative strategies will be ruled out from the start simply because they are not suitable, acceptable and applicable on technical administrative, economic and political grounds. This latter approach has been adopted, in addition to decision makers' judgment to narrow down the number of strategies.

In the next section the discussion is centred on developing scenarios/strategies matrices based on the outcomes of the previous two sub-sections.

6.3.3 Scenario/strategy Matrices Building

This sub-section explains how a scenario/strategy matrix is constructed utilising the scenarios chosen and the alternative strategies agreed on with the decision makers. Such a matrix is given in Table (6.2).

Table (6.2)

Scenario/strategy matrix

scenarios / strategies	scenario no.1	scenario no.2	scenario no.3	scenario no.4
strategy (1)	X	X	X	X
strategy (2)	X	X	X	X
strategy (3)	X	X	X	X
strategy (n)	X	X	X	X

N.B. (X´s) represent cost, profit, present value or any other quantitative criteria.

From the above matrix one can evaluate different strategies under various scenarios and choose the strategy with the highest or lowest expected value of (X´s) depending on the criteria used. Nonetheless some people, for example, Leemhuis (25, 1985) are opposed to such links between scenarios and strategies and his justification is that some questions like the following are left unanswered:

(i) do the scenarios describe all possible futures as seen by the decision makers?

(ii) what are the probabilities of the various scenarios as perceived by the decision makers?

(iii) what is the trade-off between criteria?

(iv) what is the risk-taking attitude of the decision makers?

In our case the previously stated questions would be answered through discussion with the decision makers and the participation of the decision makers in evaluating the probabilities of the various scenarios and the formulation of alternative strategies. Having constructed a scenario/strategy matrix, the next step is to evaluate various strategies, after, of course, assigning the probability to each state of the environment.

6.3.4 Strategies Evaluation

This sub-section concentrates on evaluating the strategies in the matrix against the four chosen scenarios. Different techniques for evaluating strategies have been discussed by different authors. Rowe et al. (26, 1986), for example, discussed various techniques for evaluating alternative strategies. These include: heuristic problem solving, cost benefit analysis, multi-attribute decision making and simulation.

Furthermore, Johnson and Scholes (24, 1984) outlined a framework for evaluating different strategies. This framework consists of eight steps:

(i) do strategic analysis;

(ii) produce a range of strategic options;

(iii) develop a basis for comparison;

(iv) establish the underlying rationale for each strategy;

(v) narrow down the number of alternatives strategies by means of ranking;

(vi) test the suitability of each alternative;

(vii) assess the feasibility and acceptability of suitable strategies;

(viii) select the appropriate future strategies.

Tilles (27, 1963) discussed six criteria for evaluating alternative strategies, which were:

(i) internal consistency;

(ii) consistency with the environment;

(iii) appropriateness in the light of available resources;

(iv) satisfactory degree of risk;

(v) appropriate time horizon;

(vi) workability.

In the same way, Argenti (18, 1985) suggested a few hints for the purpose of evaluating different strategies prior to deciding which one or ones should be adopted. These hints include asking the following questions: does the firm or organisation have the resources to carry it out in practice? Will it overstretch the management or the finance? Will it achieve the target? What could go wrong, and, if anything did, what would happen?

It is clear from the preceding discussion that no unique technique for evaluating strategies exists, and different people use different techniques for the purpose of evaluating strategies.

A review of the previously mentioned strategy evaluation procedures reveals that these are either theoretical and cannot be met in practice, or are too time consuming and costly. Therefore, we adopted two types of criteria. First, alternative strategies are evaluated quantitatively, in terms of their reduction in the idle capacity holding cost and shortage capacity cost; then the consequences of strategies evaluated quantitatively, are evaluated, these consequences might include the effect of alternative strategies on employment, economy, shareholders, customers and the well-being of the industry. These two criteria are applied in chapter eight.

In the next section we examine the fourth step in the application of the proposed analytical procedure.

6.3.5 Strategies Choice:

This sub-section examines another step towards applying the analytical procedure.

Like strategy evaluation, there are several techniques of strategy choices. Johnson and Scholes (24, 1984) presented different ways of choosing the appropriate strategy, These include: selection against objectives; referral to a higher authority; incrementalism; and using outside agencies.

Rowe et al. (26, 1986) outlined two models for the purpose of strategy choice. The first model is called a four-factor model and is used to examine what forces influence the decision makers' choice and action, while the second is called a decision-style model and is used to show how the decision maker thinks and in turn how his thinking affects his choice.

Generally speaking, the choices between alternative strategies are based on quantitative criteria i.e. the strategy which yields better profits, or demands less expenditures is chosen; sometimes qualitative criteria are used as a means of choosing between alternative strategies, for example, the risk associated with different strategies might be used as a means of choosing between them.

It is apparent from the previous discussion that the techniques mentioned earlier are either costly in terms of money, time or difficult to apply to our case.

It should be stressed here that the choice between alternative strategies is not as straightforward as it might look and a great deal of time and effort is required in order to make a successful choice. In this thesis the choice between alternative strategies is largely based on the quantitative and qualitative criteria used to evaluate these strategies.

For example, if Strategy (A) incurs less idle capacity holding and capacity shortage cost and yields less negative consequences than the others, then it will be chosen. In chapter eight we discuss the application of this methodology of strategy choice.

The line which we are taking is in some way less costly in terms of funds needed to finance specialists to carry out the choice and in terms of time needed to carry out the choice.

The final and the most important step is the implementation of the chosen strategy. This is the subject of the next sub-section.

6.3.6 Strategies Implementation:

Wheelen and Hunger (16, 1987) argue that prior to implementing a particular strategy, some questions must be answered. These questions often but (not exhaustively) are: who are the people who will carry out the strategic plan? What must be done? How are they going to do what is needed?

Moreover, Rowe et al. (26, 1986) argue that social change is the key factor in implementing strategies and should be identified prior to implementation. They proposed that a social change model should be used to assist strategic managers in making changes in the social system. This model consists of: preliminary analysis which has three main steps: preparing a systems description of the social system needed to carry out the new strategy; assessing the level of social resources the manager has available for implementing the strategy; and forming an overall appreciation of the problem of social change. Then three principles are applied: changeability, which means selecting the easiest change within the organisation based on the two variables, introducibility and acceptability; separability which means selecting a target area that is sufficiently independent from its context to be susceptible to a separate implementation while protected from outside pressures; and finally, the growth principle, which is "begin a change in such a way that extension of the change is possible".

The path to implementation of strategies is full of obstacles and these must be overcome in order for a strategy to be implemented successfully. Wheelen and Hunger (16, 1987), for example, listed ten problems associated with strategy implementation. This list was based on Alexanders'* survey of ninety three company presidents and divisional managers. The most frequent five are listed below.

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* L.D.Alexander, Towards an understanding of strategy implementation problems, proceedings, Southern Management Association, November 1982, p.147.

(i) more time is needed for implementation than originally planned;

(ii) unanticipated major problems;

(iii) in effective co-ordination of activities was evident;

(iv) crises that distracted attention away from implementation;

(v) insufficient capabilities of the involved employees.

Generally speaking the implementation of a strategy usually requires changes in the organisation structure, resource allocation and the like and such changes usually lead to objections either from inside or outside the organisation or both, and this makes the task of implementing a new strategy not an easy one.

However, the question left unanswered is "how to go about implementing the chosen strategy to tackle the problem at hand?" or in other words, "what techniques are to be used to implement the chosen strategy?"

Three techniques might be used for this purpose. Multi-attribute decision making, cost benefit analysis and the Bargaining Theory. The application of these techniques is discussed in chapter eight. The reason for using multi-attribute decision making here while it was used by others for the purpose of evaluating strategies is that, there is a need to choose between plants within the industry based on several criteria when implementing the chosen strategy.

Having examined the six steps in applying the proposed analytical procedure; attention is now directed toward the potential areas of application for this procedure.

6.4 Application Areas

This section examines briefly other potential applications for this procedure; at the company level, at the industry level and at a group of similar industries level; either for investment or divestment decisions.

Let us start with the company level. The same six steps mentioned earlier can be applied here with one exception, which is to evaluate the environment of the company rather than the industry. It can be applied for investment, divestment and rationalization decisions.

With regard to the industry level, two potential candidates are available at the time being. The first is the plastics industry where excessive investment is experienced; and the second is the tile industry where a similar problem is taking place. These two areas of application are from the U.A.E.

With respect to a group of similar industries, the oil refinery industry at the GCC level is a potential candidate where this procedure can be applied. Another potential area of application at the GCC level is the cement industry.

6.5 The Research Techniques Adopted

Two types of research techniques have been adopted. The first type is the survey method which is used to execute the first part of the approach, namely, the exploratory part; and the second technique is the case study method which is used to execute the second part of the approach, namely the application part.

6.6 Conclusion

This chapter addressed the main characteristics of O.R. techniques suitable for the developing countries in particular. In this respect the main features of these economies were outlined and the main features of the analytical procedure we developed were also outlined.

In another part of the chapter the two main parts of the approach used, namely, the exploratory and the applied parts were very briefly examined.

From the discussion of this chapter it can be concluded that because of the special features which characterise the developing countries, O.R. techniques with special features are needed to handle problems in these countries.

Both the decision makers' needs, awareness, and knowledge of O.R. and also the environment must be taken into account. The proposed analytical procedure takes into consideration the features of developing countries in general and the U.A.E. in particular.

The next chapter discusses the first step toward the application of the analytical procedure we developed in this chapter, and chapter eight discusses the remaining steps.

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CHAPTER SEVEN

APPLICATION OF THE APPROACH: STATES OF THE ENVIRONMENT EVALUATION

CHAPTER 7

APPLICATION OF THE APPROACH:

STATES OF THE ENVIRONMENT EVALUATION

7.1 Introduction

The previous chapter examined the approach of the study. It described its two main parts, the exploratory and the applied.

This chapter addresses the first step in the application of the developed procedure. It is the evaluation of the states of the environment.

In this case, the states of environment are market levels for the capacity of the U.A.E. cement industry. A hybrid forecasting approach has been used consisting of a qualitative technique using scenario analysis and a quantitative technique using regression models.

7.2 Problem Formulation

The most difficult task of any analyst is to formulate the problem to be solved. More time and attention is given to this task. Three main topics are examined. These are: the nature of the problem; the decision making body; and the objectives of this body.

The nature of the problem

A great deal of industrial investment by the private and the public sectors, in the Gulf States in general, and in the U.A.E. in particular, has been based on short term market indicators. This kind of investment planning resulted in an excessive investment, thus lowering productivity in many industrial activities.

This is true in the cement industry where a great deal of investment has been put into this industry during the boom in construction, the main customer of the cement industry; then when the demand for cement declined, the problem of excessive investment emerged. The consequences of such problems include: high amount of investment per unit of output, low capacity utilisation rate, and high production costs.

The decision making body

In the case of the problem under investigation two levels of decision making bodies exist. The first level consists of the authority at the Ministry of Industry. This level has greatly influential effects on the second level which consists of the board of directors of each company. Decisions concerning the whole industry are made by the first level, while decisions concerning an individual company are made by its board of directors or its senior manager depending on the nature of the decision. For example, decisions regarding capacity are made by the board of directors, while less important decisions are made by the senior manager.

The objectives of the decision making body

The main objective of the first level is the continuation of an efficient industry which contributes to the gross national product of the country. On the other hand, the objective of the second level is to survive in the short run and make a profit over the long run.

7.3 Data Collection

Having formulated the problem to be investigated, the next task is to collect data. This section discusses how data was collected. Almost all the data needed was collected through personal interviews and the use of questionnaires. The data needed for the application of econometric modelling was collected from materials published by the governments of the countries concerned and international organisations. An example of the questionnaires used is presented in Appendix (A) at the end of the thesis. The problems encountered in collecting the data are outlined in section two of chapter nine.

The data collected through the interviews and the questionnaires fall into two main groups. The first group is of a general type and this includes: production per year by type of product, sales, home and export; number of employees classified according to nationality and occupation and total investment in the industry while the second group is of a specific type and it includes: cost of production per ton, cost of raw materials, and cost of kilns and mills, capacity of kilns and mills and the like.

7.4 Forecasting Techniques:

It seems desirable to define the term 'forecasting' prior to examining the forecasting techniques available. Archer (1, 1985) defined forecasting as the art of predicting the occurrence of events before they actually take place. Similarly, Firth (2, 1977) defined forecasting as an assessment of the future. Other authors may have used different expressions to define the term 'forecasting'. However, they will all agree that forecasting is nothing more than estimating what will happen in the future. Having defined the term 'forecasting' we must examine briefly the forecasting techniques available.

Different people classify forecasting techniques differently. Archer (1, 1985) classified forecasting techniques as either mathematical, econometric and statistical models or pooled opinions of groups of experts. On the other hand, Firth (2, 1977) classified them into three types according to their underlying concepts. These three types are: time series analysis, causal models and qualitative forecasting. Vazsongi, et al. (3, 1984) classified forecasting techniques into two classes: judgmental and statistical. By the same token, Wheelwright et al. (4, 1980) classified them into two classes: qualitative and quantitative techniques. This latter classification is a general one, and can include under the first techniques such as: causal models, time series, Box-Jenkins and other mathematical models, whereas under the second, techniques such as: the Delphi method, the Scenario approach and other qualitative methods can be included.

Each forecasting technique has its advantages and disadvantages and is applicable in particular situations. Take for example, the regression model. Some of its advantages are: it is easy to handle, its results are easy to interpret and its cost in terms of time and money is low. On the other hand, it has several disadvantages some of which are: it is based on assumptions and the validity of these assumptions cannot be guaranteed in the future; there are some difficulties in choosing the appropriate explanatory variables; it does not take into account the effect of other variables which are not included in the model but might have an effect on the dependent variable, and finally, the accuracy of the results depends on the accuracy of the values of the input variables. This latter disadvantage is applicable to other forecasting techniques as well. Having examined the forecasting techniques available, now we are to examine the possible choices between the different techniques mentioned earlier. Archer (1, 1985) mentioned three factors which affect the choice between the different types of forecasting techniques. These three factors are summarised below:

(i) the purpose of the forecast;

(ii) the quantity and quality of the data;

(iii) time allowed.

One can also add the benefit of the forecast as another factor affecting the choice of forecasting techniques.

Furthermore, Wheelwright et al. (4, 1980) stated two sets of the appropriate forecasting technique. The first set relates to the characteristics of the decision making situation and includes: the time horizon, level of detail, number of items, control versus planning and finally, stability and existing planning procedures. The second set relates to the characteristics of forecasting methods. This consists of the following: the time horizon, the pattern of data, type of model, cost, accuracy and ease of application.

Based on the foregoing discussion one can argue that the choice between different techniques depends mainly on the availability of accurate data on the one hand and the time horizon on the other, at least from an academic point of view. Some forecasting techniques might look attractive, but because of the lack of accurate data or because of their applicability for short term forecasting they cannot be utilized. In the next section, forecasting methods used to forecast cement demand in particular are discussed.

7.5 Methods Used to Forecast Cement Demand:

This section discusses methods of forecasting used to forecast cement demand world-wide. These methods can be categorised into two main groups: group one is regression models, and group two is trend-extrapolation method. These two groups are discussed below one at a time.

7.5.1 Regression Models

It was found from the search of literature that regression models have been widely used as tools to forecast demand for cement both in developing and developed countries. UN (5, 1969), for example, has developed polynomial regression models to forecast cement demand in some developing countries. The consumption of cement in kilograms per capita was regressed against GNP per capita in fixed dollars. GOIC (6, 1983), to mention another example, developed regression models for some of the GCC nations. Non-oil GDP, GDP, fixed investment and population have been used as explanatory variables.

A close look at the regression models developed by GOIC indicated that these models are far from being reliable. As can be seen from Table (7.1), the difference between actual and predicted demand, reached about 7575 thousand tons in the case of S. Arabia in 1983, when actual demand exceeded the predicted by this amount.

Table (7.1)

Actual & Predicted Cement Demand in Some GCC Nations

Quantity: (000) tons

year	U.A.E.		S. Arabia		Kuwait		Oman	
	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted
1982	2,626	2,992	17,696	16,061	2,330	2,313	-	-
1983	2,670	3,044	23,889	16,314	2,385	2,330	988	952
1984	2,500	3,387	20,688	16,440	1,199	2,384	1000	1,031
1985	2,000	3,668	14,933	17,041	1,200	2,563	800	1,169

Source: Actual figures national statistics.
Predicted figures, GOIC, (6, 1983) Table (5.1) p.120.

Although the difference between the two is smaller in other cases it still indicates the weakness of these models.

Al-Turki (7, 1978), discussed in his Ph.D thesis a third degree polynomial regression model to forecast cement demand in Saudi Arabia. He tried four explanatory variables. These are: the contribution of the construction sector to the GDP, the oil revenue, public and private sectors construction activities and finally actual government expenditure. He used four statistical criteria to choose the appropriate model. These criteria are: the coefficient of determination (R^2), standard error of the estimate (SEE), the F-statistic, and degree of freedom (df). The actual government expenditure was chosen as an explanatory variable and the model was:

$$Y = 2.4785185 + 0.1471891X - 0.38213174(10^{-3})X^2 + 0.34659125(10^{-6})X^3$$

A test has been conducted for this model by comparing actual demand with the predicted, using the said model and the difference between the two is shown in Table (7.2). It should be stressed that statistical tests can be carried out for the purpose of testing the reliability of the model, but since the difference between actual and predicted demand is obvious therefore, there is no need for such tests.

Table (7.2)

Actual and Predicted Cement Demand in Saudi Arabia, 1979-1981

(000) tons

Year	Case (A)		Case (B)	
	Actual	Predicted	Actual	Predicted
1979	8,928	6,579	8,928	9,078
1980	12,913	7,793	12,913	12,886
1981	14,254	9,227	14,254	18,498

Sources: Actual figures, Saudi Arabian Monetary Agency, Annual report, 1984
Predicted figures, Al-Turki (7, 1978).

As indicated by Table (7.2) and in case (A), the actual demand exceeded the predicted by 36 percent in 1979, by 66 percent in 1980 and by 54 percent in 1981. In case (B), predicted demand exceeded actual by 2.0 percent in 1979, and by 30 percent in 1981. Actual demand exceeded the predicted by 0.2 percent in 1980. Based on the foregoing facts, we can conclude that this model is not reliable. One can argue that this is due to ill-chosen explanatory variable, the actual government expenditure; poor model; inaccurate estimation of the value of this explanatory variable; and the rapid change in economy structure over that period of time, which is not captured by the regression model.

Actual government expenditure includes not only the expenditure on building and construction but also other expenditures such as: expenditure on education, health services, welfare and so on. Hence, assuming that the past relationship between the demand for cement and actual government expenditure will continue in the future is unwise. The fourth example which illustrates the use of a causal model to forecast cement demand is taken from Msc thesis, Tuwfik (8, 1977) who presented five log. regression models to forecast demand for cement in Iraq for the period between 1976 and 1980. The five models are presented here:

1. <u>Public sector</u>:

$$\log.C_t = -5.017 + 0.291 \log.G_t + 1.832 \log.N_t$$

2. <u>Private sector</u>:

$$\log.C_t = -1.158 + +.268 \log.Y_t - 0.204 \log.P_t - 0.287 \log.M_t + 1.059 \log.F_t$$

3. <u>Industrial sector</u>:

(a) <u>The tile and mosaic industry</u>:

$$\log.C_t = 1.292 + 0.329 \log.V_t - 0.602 \log.P_t$$

(b) <u>The concrete products industry</u>:

$$\log.C_t = 1.909 + 0.141 \log.\ V_t - 1.121 \log.\ P_t$$

(c) <u>The asbestos products industry</u>:

$\log.C_t = 0.071 + 0.798 \log.V_t - 1.324 \log.P_t$

where: C_t = Quantity of cement consumed in thousand tons.

Y_t = Disposable income at 1969 prices in million Iraqi dinars.

P_t = Prices of cement in Iraqi dinars per ton.

M_t = Wholesale price index of construction materials other than cement.

F_t = number of families in urban areas in thousands.

G_t = Government investment expenditure in million dinars at 1969 prices.

N_t = population in thousand.

V_t = Net output at 1969 prices in thousand Iraqi dinars.

The values of the independent (explanatory) variables in the models mentioned earlier were estimated based on government estimation or by means of simple time trend equations. We tested the reliability of these five models by means of comparing actual and predicted demand and the results are presented in Table (7.3).

Table (7.3)

Actual and Predicted Cement Demand in Iraq, 1978-1980

(000) tons

year	actual	predicted
1978	6,196	2,815
1979	6,747	3,032
1980	7,009	3,257

Sources: Actual figures, GOIC, Doha, Qatar, 1983.
Predicted figures, Tuwfik, (8, 1977).

Based on the figures presented in Table (7.3), one can find that actual demand for the years 1978, 1979 and 1980 exceeded the predicted for these years by 120 percent, 123 percent and 115 percent respectively. Again, one can argue regarding the reliability of these models. Without doubt, decisions taken based on those models are misleading. Once again, such unreliable forecasts can be attributed to three factors: first, the use of inappropriate explanatory variables; second is inaccurate estimation of the values of these variables; and third these models were based on the assumption that the market would continue to behave in the future much as it had done in the past. In fact, demand doubled from 1977 to 1978 (see Table (B-5) p.490).

It is not known what economic factors led to this doubling. However, the use of scenario analysis or other technological methods of forecasting might have warned of this potential large increase in demand.

The fifth and final example where a regression model has been used as a tool to forecast cement demand is taken from OECD study, (9, 1973), here the consumption of cement in all member states, was regressed against GNP in all member states, to calculate the aggregate demand for cement for all member states. Because data is not available, we cannot examine the reliability of this model in any detail.

From the foregoing discussion, one can conclude that regression models have severe limitations as forecasting tools when used by themselves. It should be recognized that regression models are extensions of trends extrapolation.

Having discussed in some detail the first group of methods used world-wide to forecast cement demand, let us now examine the second group, trends extrapolation.

7.5.2 Trends Extrapolation:

This method of forecasting has been widely used by both developing and developed nations for the purpose of forecasting cement demand.

In Pakistan, for example, the Investment Advisory Centre of Pakistan (IACP), (10, 1965) used cement consumption historical time-series to forecast the future demand for cement by means of extrapolation. Another example, is taken from Nepal where Nepal Bureau of Mines, (11, 1969) has forecast the Country´s future demand for cement by plotting historical cement consumption figures versus time and then a trend line of consumption of cement was extended to forecast the future demand. This method was also used in the USA for the purpose of forecasting cement demand. Reuss (12, 1981) presented a trend extrapolation future forecast for cement consumption in the USA. According to his forecast, cement consumption in the USA is expected to be around 102 million tons in the year 2000. Speaking of the USA, another method of forecasting cement consumption has been used. Roy (13, 1985) discussed thoroughly, the use of a forecasting method which is based on market and economic analysis, and used in the USA for forecasting cement consumption. Due to the fact that actual and predicted demand for the countries using this method of forecasting to forecast cement demand is not avilable, we cannot test the reliability of this method. However, one can argue that trends extrapolation relies on the concept that the past trends are going to continue into the future, which is not always true. Thus, the reliance on trends extrapolation as a sole tool of demand forecasting is an unwise decision and when this technique is used it should be supplemented by brainstorming, scenarios, and similar devices for the deliberate investigation of the more remote possibilities as Rescher (14, 1981) suggested.

In the following section, we are going to examine forecasting approaches that we actually tried to use, but which proved to be inappropriate for one reason or another.

7.6 Forecasting Approaches Tested

This section concentrates on forecasting approaches that we have tested and the reasons for not using them.

Two approaches have been tested. The first one is called intensity of use method whereas, the second one is regression models. Let us start with intensity of use method. The term intensity of use means e.g. apparent steel or cement consumption per dollar of output (GNP), IISI (15, 1972). Apparent consumption is production plus imports minus exports. This method is a combination of time series and cross section. It has been used to forecast steel consumption world-wide. Its application requires that the intensity level of, say, steel is calculated by utilizing historical data about GNP, population, and steel consumption, then a theoretical average curve which traces the development of steel intensity at progressive per-capita income levels is to be developed. (A detailed discussion of this method is given in IISI (15, 1972) pp.7-10 and pp.103-113). It seems attractive to use this approach for long-range forecasting, but unfortunately after collecting the data and calculating the cement intensity, we found that a gap between the income per capita in U.A.E., Kuwait and the rest of the world exists, and this made it almost impossible for us to develop the theoretical average curve. Hence we ruled out the use of that method as a tool to forecast the demand for cement in the U.A.E. and other Gulf States. Prior to testing the foregoing approach, we tested regression models using different combinations of macro-economic variables such as: GDP, non-oil GDP, GFCF and also population as explanatory variables. When using macro-economic variables one can experience the problem of multi-collinearity which means a high correlation between the independent variables.

This problem can be eliminated either by eliminating some of the independent or explanatory variables after, of course, using factor analysis to see which is the important explanatory variable and which is not, or by assuming that this multi-collinearity will continue in the future over the forecasting period or by means of transforming the data or by other means.

There is another problem which is inherent in regression models: that is, the regression model cannot be used for long-term, by itself due to the difficulty in estimating the value of the explanatory variables. Furthermore, assuming that the past relationship between the dependent variable and the explanatory variables will continue for a long time in the future, this assumption cannot hold in all situations.

For all the above reasons we ruled out the use of regression model by itself. In the next section the concentration is on the approach of forecasting to be used to forecast the demand at home.

7.7 Forecasting Cement Demand in The U.A.E.

The task of this section and the next one is to address the main theme of this chapter. Here the demand in the home market is to be estimated. As indicated in the introductory section of this chapter, a hybrid forecasting approach is to be used which is more appropriate than the classical forecasting techniques.

This approach comprises scenario analysis; and econometric models. The latter are to estimate the demand associated with the former. However, it may seem inappropriate that we ruled out the use of regression models in the first place and now we are re-using them. It should be noted that we ruled out the use of regression models as a sole tool of forecasting or in other words, in their own rights. The approach used comprises three main stages: multiple scenarios construction; econometric models building; and the linkage between the scenario analysis and econometric modelling.

It would be useful to state briefly the objectives of the forecasting prior to examining the two tools used. These objectives are outlined as follows:

(i) it helps decide the level of investment needed in the industry in the future;

(ii) it helps decision makers draw their future plans;

(iii) it reduces the effect of being in the over-capacity or under-capacity trap;

(iv) assists decision makers in timing the investment and divestment decisions.

7.7.1 Scenario Analysis

Let us start with the first stage which is multiple scenarios constructing. Prior to addressing scenario analysis exercise, we would like to draw the reader's attention to the fact that there is no published application of scenarios analysis in the cement industry in general and the U.A.E. cement industry in particular. This fact is based on the search of literature in three journals where scenarios and their application appear. The three journals are: Futures; Technological Forecasting and Changes; and Long Range Planning. Keeping this in mind now attention is paid to four main issues: first, a brief definition of the term "scenario" is given; second the differences between scenarios and forecasts are outlined; third, the objectives of scenario and the characteristics of a successful scenario are outlined; and finally, a description of the methodology we used to construct the scenarios mentioned in this thesis is presented. As mentioned in the previous chapter, scenario can be defined as a comprehensive picture of future events.

Having defined the term "scenario", let us examine another aspect of scenarios, namely the difference between scenarios and forecasts or in other words, 'is a scenario a forecast?'. Some people mix up scenarios and forecasts. For example, Armstrong (16, 1985) stated that scenarios can integrate a number of different forecasts about a situation and present them in a comprehensive manner. Others including myself would disagree with such a statement. Pearman (17, 1986) is of the opinion that scenarios do not compose a forecast either collectively or individually.

Similarly, Durnad (18, 1972) has the opinion that a scenario cannot be the sum of different forecasts of its elements. Becker (19, 1983) also stressed that scenarios should not be considered as a forecast of what will happen. Furthermore, Beck (20 1981) outlined the difference between scenarios and forecasts, of which, a few are mentioned here. Firstly, a forecast is fundamentally quantitative, whereas the multi-scenario approach is essentially qualitative. Secondly, a forecast is based on the belief that the future can be measured and controlled, while a scenario is based on the belief that the future cannot be controlled and measured.

Thirdly, a forecast is intended to be regarded as an authoritative statement. On the other hand, a scenario is intended to be regarded as a tool to assist understanding. One can add to the three mentioned differences the fact that, scenario is less structured and allows one to consider possibilities in the future, whereas, forecast is well structured and usually one model built on a set of assumptions. It is worthwhile pointing out here that probability is to be assigned to the scenarios later in the chapter. By now we should be aware of the differences between scenarios and forecasts and that scenarios are not and should not be regarded as forecasts. Having clarified the differences between the two, let us now turn attention toward another issue concerning scenarios; ′what is the objective of using scenarios?′ or in other words, ′why do people use scenarios?′

One main objective of using scenarios is to clarify uncertainty but not to reduce it as Hanna (21, 1985) stated. Other objectives include: to act as a background against which strategic decisions can be made, Pearman, (17, 1986). To help an organisation to map out its environment and to sort out its priorities and options, Wilson (22, 1978). Scenarios can treat elements evolution when past extrapolation cannot be used, Lapillome and Chateau (23, 1980). In order for the readers to better understand the reasons why scenarios are used, let us take a concrete example. As stated by Norse (24, 1979), Interfutures' scenarios have four main functions, these are: "to provide coherent macro-economic and geopolitical frameworks of the world economy over the next quarter century; to assess the overlap and interaction of policy issues arising from changes in relation between OECD countries and from differing patterns of north-south relations; to explore the consequences of broad strategies that might be adopted by OECD governments; and to integrate the complementary studies". Scenario is used here as a tool of strategic analysis or in other words, what changes are going in the environment and how they will affect the cement industry and its activities. Nonetheless, it should be noted that the objective(s) of scenarios should be defined prior to constructing them.

So far we have outlined the differences between scenarios and forecasts, and the objectives of constructing scenarios.

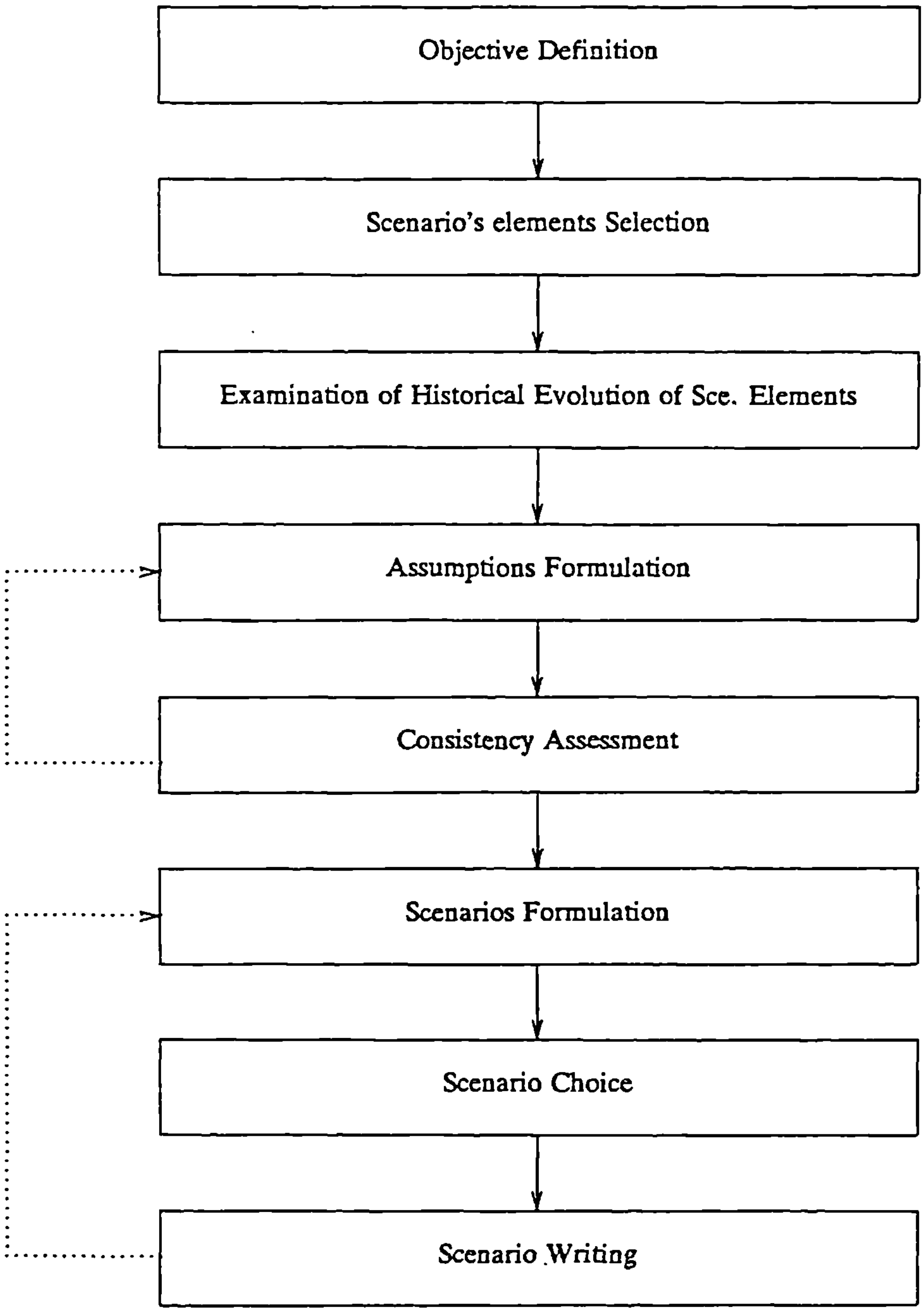
Questions like: 'what characteristics should a successful scenario have?', 'how can we evaluate the outcomes of scenarios?', and above all, 'how can we construct scenarios?', have not been answered yet. Shortly, these questions are to be answered.

In order for a scenario to be successful, it should have particular characteristics. The most important characteristic is the internal consistency of the scenario. By internal consistency we mean the elimination of the conflict between the assumptions or hypotheses about scenario's elements. For example, there is inconsistency in the assumptions that OPEC economics growth is high and at the same time we assume that oil demand is declining. It is unlikely that high growth in OPEC economies' activities would be coupled with declining demand for oil. The second characteristic of a scenario is that it should be understandable, Wilson (22, 1978). The third characteristic is that it should be credible i.e. a scenariologist should make it acceptable and believable. Finally, it should be useful, consisting of data and facts relevant to the problem discussed. Having highlighted the most important characteristics of a successful scenario, let us examine the method we used to construct the scenarios mentioned in this thesis.

We used an approach to scenario constructing somewhat similar to that of Interfutures' five stages mentioned earlier. Figure (7.1) illustrates the stages we followed to construct our six scenarios, and the text that follows describes each stage in some detail. It should be stressed here that the probabilities are to be assigned to levels of the market after, of course, converting the chosen scenarios into numerical values.

Figure (7.1)

Scenarios Construction Stages



Objective identification

Prior to constructing scenarios, we should ask ourselves a question such as the following: ′what is the objective of the scenarios we are going to build′ or ′why are we constructing scenarios?′. It is very important to define the objectives of the scenarios you are going to construct. For example, if your scenarios are to be used to evaluate the long-term demand for energy in the UK for the next twenty years, they would not be the same as if they were to be used to evaluate the development of the tourism industry in France. Having defined the objectives of the scenarios to be constructed, next scenarios′ elements are to be selected.

Scenario′s elements selection

Based on the objectives of the scenarios, their elements are selected. The scenarios′ elements should be relevant to their objectives, i.e. scenarios developed to evaluate demand for energy should not include anything about fashion or women′s liberation. Having selected scenarios′ elements, then the historical evolution of these elements is to be examined.

Examination of historical evolution of scenarios′ elements

Having identified the most relevant elements of the scenarios to be constructed, the next thing is to look back into the past and the present to trace the development of these elements over that span of time. For example, if one of the scenario elements was oil prices development, then we have to trace the development of oil prices, say, from 1970 up to 1986 and analyse the forces which affected the changes in oil prices over that span of time. Having analysed the

(iv) technological development (development of other sources of energy);

(v) OPEC unity.

II <u>Socio-economic scenario elements (internal variables)</u>

A. <u>Qualitative descriptors</u>

(i) level of economic growth;

(ii) urbanisation;

(iii) industrial development;

(iv) human settlement;

(v) protectionism;

(vi) agricultural growth.

B. <u>Quantitative variables</u>

(vii) GDP or GNP growth;

(viii) GFCF spent on building and construction as percentage of GNP;

(ix) we added an extra qualitative descriptor namely, the Gulf war when dealing with Iraq and Iran as export markets.

These elements have been examined during the panel meetings to see whether they are relevant and sufficient or not. After a general agreement regarding the relevancy and the sufficiency of the elements chosen, the historical evolution of these elements was examined. In the next few pages an examination of the historical evolution of these elements is presented and tables are used to illustrate the evolution of these elements whenever possible.

our case two ways have been utilised to check the consistency of the assumptions. These are: panel judgment and structural analysis matrix, presented in Table (7.4) which illustrates the relationship between scenario's elements, and determines the driver and dependent variables, and in turn arranging hypotheses in a way which eliminates inconsistency.

Having assessed the consistency of the hypotheses, the next step centres on formulating a set of consistent scenarios.

Scenario formulation

After assessing the assumptions, attention is to be paid to formulating the scenarios. This is done through combining consistent assumptions about the future evolution of the scenario's elements to form a complete picture of the future. Having done that, the next thing is to choose the plausible scenarios.

Scenario choice

The choice of scenarios is based on: consistency and plausibility. Zentner, (25, 1975) suggested three principal criteria to test scenarios: credibility, utility, and intelligibility. By 'credibility' he meant that the scenario should be believable, by 'utility' he meant that the scenario should be useful, contains fact and data relevant to the problems of those who are going to use it, and finally by 'intelligibility' he meant that the scenario should be presented in a manner easy to understand and use. When formulating scenarios, one is likely to be faced with numerous numbers of scenarios and one should select a limited number of them.

Table (7.4)

Structural Analysis Matrix

External Variables International Variables — Internal Variables National Variables

On \ Influence of	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1		- S	+ W	+ VW	- A		+ W		- W	+ W		+ A	+ A	+ W
2	+ VS		+ S		+ S	- W	+ W						+ W	
3	+ S	- S		+ VW	- W									
4	+ W	U	U											
5	+ W	+ S	+ A			- W								
6		+ W	+ W	+ W										
7	+ S	+ VS	+ S	+ S	+ S	- VS		+ A	- A	+ S	+ W	+ W	+ VS	+ S
8						- VS	+ A			+ W		- W	+ A	+ S
9	U						- A			U	- A		- A	
10	+ S	+ S	+ A	+ S	+ W	- VS	+ S	+ W	- A			+ W	+ S	+ S
11				+ W		- VS	+ W			+ W		+ A	+ W	+ W
12	+ A			+ S		- VS	+ W	+ VW	- A	+ VW	+ W		+ W	+ W
13	+ S	+ VS	+ S	+ S	+ W	- VS	+ S	+ A	- A	+ S	+ W	+ W		+ S
14	+ A	+ VS	+ S	+ S	+ W	- VS	+ S	+ S	- A	+ S	+ S	+ W	+ S	

Key:

1 World economy growth
2 Oil prices
3 Use of oil (Technological development)
4 Aid
5 OPEC Unity
6 Gulf war
7 National economy growth
8 Urbanisation
9 Protectionism
10 Industrial growth
11 Human settlement
12 Agricultural growth
13 GNP growth
14 GFCF/GNP

\+ Positive relationship
\- Negative relationship

VS Very strong
S Strong
W Weak
VW Very weak
U Unclear
A Average
Blanks - No relationship

Scenario writing

Having chosen the most plausible scenarios, the next thing is to write them down to form a comprehensive picture of future events, bearing in mind that the interrelation between scenarios' assumptions is explicitly described. The written scenarios are to be checked to see if there is any inconsistency. If there is any inconsistency, then assumptions are to be changed to eliminate it.

Having shed light on the theoretical framework which is to be used to construct the six scenarios of interest, the next step is to apply this framework. Thus, in the following pages, the concentration is centred on the application of this framework to construct the scenarios which will be used later, through of course, models to evaluate the demand for cement at home and abroad.

Application of Scenario Construction Stages

As pointed out earlier, the first stage in scenario construction exercise is to determine its objective. Our objective of constructing scenarios is to evaluate the size of the U.A.E. cement market at home and abroad. The reason why scenarios are used is because cement demand is closely linked to construction, a heavy cyclical industry that is very dependent on the level of economic activity which is affected by internal and external factors, and because of the high degree of uncertainty associated with long-term planning. Having identified the objectives of constructing scenarios, the next step is to identify the scenario elements.

For the purpose of constructing the scenarios a panel of four members of staff in addition to the author was formed. Those four were: an economist, a political scientist (an expert in the study of conflict), a management scientist, and an expert in transportation. The roles of the panel were:

(i) To help in identifying scenarios´ elements and choosing the appropriate ones.

(ii) To help in formulating the assumptions about the evolution of the chosen elements.

(iii) To help in checking the consistency of the assumptions.

(iv) To help in choosing the appropiate scenarios.

The first task of the panel was to identify scenarios´ elements.

The panel identified, five elements at the international level, and seven at the national level. Five of them are scenario descriptors and the remaining two are quantitative variables. In the second attempt we found that life-style does not affect the demand for cement seriously, therefore, it has to be eliminated.

Then we added two elements at the national level, namely, protectionism and agricultural development. The elements which are to be used to develop the scenarios are listed below.

I <u>World scenario elements (external variables)</u>

(i) the rate of world economy activities growth;

(ii) oil prices;

(iii) aid;

(iv) technological development (development of other sources of energy);

(v) OPEC unity.

II Socio-economic scenario elements (internal variables)

A. Qualitative descriptors

(i) level of economic growth;

(ii) urbanisation;

(iii) industrial development;

(iv) human settlement;

(v) protectionism;

(vi) agricultural growth.

B. Quantitative variables

(vii) GDP or GNP growth;

(viii) GFCF spent on building and construction as percentage of GNP;

(ix) we added an extra qualitative descriptor namely, the Gulf war when dealing with Iraq and Iran as export markets.

These elements have been examined during the panel meetings to see whether they are relevant and sufficient or not. After a general agreement regarding the relevancy and the sufficiency of the elements chosen, the historical evolution of these elements was examined. In the next few pages an examination of the historical evolution of these elements is presented and tables are used to illustrate the evolution of these elements whenever possible.

Analysis of historical evolution of world (international) scenario elements

Having agreed on the elements or variables to be used for the scenarios to be developed, the next task is to analyse the historical evolution of these elements. We begin the process by analysing the historical evolution of world or (external) scenarios′ elements as follows.

(1) The growth rate of world economic activity between 1971 and 1986:

Table (7.5) presents the annual growth rate of GDP for the world and for groups of countries.

Judging from this table, the growth rate of the world GDP reached its highest level in 1973 (6.6%) and it reached its lowest level in 1982 (0.7%). Probably, the decline in world GDP after 1973 was due to the rapid growth in oil prices between 1973 and 1980.

In the same way, the decline in world GDP growth over the period between 1981 and 1982 is because of the boom in oil prices. Between 1973 and 1980, the annual growth of developing countries GDP was higher than that of the developed market economies. This was due mainly to the rise in oil prices over that span of time.

(2) Oil prices

Table (7.6) shows the development in oil prices between 1972 and 1986.

As can be seen from Table (7.6), oil prices increased from about $3 per barrel in 1973 to $35 per barrel in 1981 and declined thereafter.

Table (7.5)

Growth rates of world output, 1971-1986

year / Country	1971	72	73	74	75	76	77	78	79	1980	81	82	83	84	85	86
World	4.4	5.4	6.6	2.0	0.6	5.4	4.5	4.4	3.4	2.0	1.7	0.7	2.7	4.6	3.6	3.2
Developing countries	5.5	6.0	7.1	5.8	3.6	7.1	5.6	4.4	5.0	3.2	1.3	-0.4	0.2	2.9	3.3	3.6
Developed market economies	3.7	5.4	5.9	0.2	-1.2	5.3	3.8	3.9	3.1	1.2	1.5	-0.2	2.4	4.6	3.2	2.5
Centrally planned economies	6.1	5.0	8.7	6.3	5.4	4.5	5.8	5.8	3.0	3.4	2.3	3.9	5.2	5.5	4.9	4.7

Source: Department of International Economic and Social Affairs of the United Nations Secretariat.

Table (7.6)

Oil Prices, 1972-1986

(Price per barrel in US$)

1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3.0	3.0	11.0	12.0	12.8	13.0	13.0	19.0	32.0	35.0	32.5	30.0	28.98	27.45	15.0

Sources: (1) U.A.E. central bank, annual report, different issues.

(2) BP Statistical Review of World Energy, June 1986.

(3) OECD, Economic outlook, December 1986.

It is believed that the rapid growth in oil prices is to be blamed for the world recession of 1977 and 1979, and that of 1980 and 1982.

The growth in oil prices between 1973 and 1981 is due partly to the growth in the demand for oil and partly to OPEC unity which was initiated by Arab-Israel war of 1973. The Gulf war also affects oil prices in one way or another.

(3) Aid

Table (7.7) presents the development of aid provided by OPEC and non-OPEC between 1970 and 1985.

Table (7.7)

Aid in Million US$

	1970	1975	1978	1979	1980	1981	1982	1983	1984	1985
OPEC	-	6239	8131	7652	9590	8524	5891	5399	4545	3530*
As % of GNP	-	2.92	2.48	1.83	2.41	1.94	1.37	0.95	1.16	0.65*
non-OPEC										
OECD	6968	13847	19992	22820	27267	25542	27730	27555	28707	29518
As % of GNP	0.34	0.35	0.35	0.35	0.38	0.35	0.38	0.36	0.36	0.36
CMEA	...	1512	...	...	2699	2991	3026	3167	3033	3520*
As % of GNP	...	0.17	...	...	0.17	0.21	0.21	0.21	0.21	0.23*

Sources:
(1) World bank development Report 1986, Table (20), pp.218-219.
(2) OECD development co-operation, 1985 Report Table III-8 p.(115).
* OECD development co-operation, 1986 Report Table V-1, P.77.
(...) Not available.

As can be seen from Table (7.7), aid provided by OPEC has declined between 1980 and 1984. This is due mainly to the decline in oil prices on the one hand, and the increase in government expenditure on the other. Aid provided by OECD and CMEA was almost stable both in absolute values and as a percentage of GNP over the same period of time. The aid of concern to us here is that provided to Egypt, Oman, Iraq and Iran.

(4) <u>Technological development</u>

We are concerned here with the development of other sources of energy, and the development of more efficient machines which use less oil. The western world is considering seriously the reduction of oil's share in total energy demand. For example, EC programme for 1990 established five targets, one of which, is the reduction of demand for petroleum to no more than 40 percent of total energy demand. Table (7.8) shows the decline in the consumption of oil in North America, Europe and Japan. It also shows the increase in the consumption of other sources of energy over the period between 1980 and 1985.

Table (7.8)

Consumption of Oil and Other Fuels

1980-1985

	1980	1981	1982	1983	1984	1985
N. America						
Nuclear energy	78.2	85.1	88.0	92.3	101.3	119.2
Oil (mill. tonnes)	881.7	827.7	778.4	733.1	793.5	791.8
Coal	415.8	429.2	421.9	428.5	462.6	469.8
Natural gas	556.4	542.9	508.1	482.8	574.2	494.6
Hydro-electricity	136.0	136.3	146.4	154.2	154.4	149.5
W. Europe						
Nuclear energy	48.3	66.0	73.0	85.2	107.1	128.4
Oil	665.0	617.8	589.2	571.5	575.7	566.8
Coal	251.2	297.9	249.7	248.6	239.3	255.9
Natural gas	181.0	178.9	173.3	175.0	185.6	191.9
Hydro-electricity	101.0	102.5	104.8	107.5	104.9	104.0
Japan						
Nuclear energy	20.1	21.5	27.0	27.5	33.3	37.8
Oil	237.7	223.9	207.8	207.2	251.1	201.3
Coal	57.6	63.6	62.0	63.0	69.9	73.7
Natural gas	23.4	24.2	24.7	25.2	33.6	35.9
Hydro-electricity	20.8	20.3	19.5	19.5	17.7	20.6
World						
Nuclear energy	171.2	201.7	223.9	248.5	295.3	348.1
Oil	2998.4	2899.5	2823.7	2803.7	2831.4	2809.0
Coal	2002.4	2005.3	2045.9	2100.4	2175.4	2272.7
Natural gas	1308.1	1331.9	1329.6	1345.5	1444.7	1494.1
Hydro-electricity	433.8	443.9	464.6	485.8	498.7	510.8

Source: BP statistical review of world energy, June 1987.
N.B. Consumption of other fuels are in million tonnes of oil equivalent.

(5) OPEC Unity

Table (7.9) presents OPEC share in world oil production between 1975 and 1985.

OPEC share in total world oil production declined from 52.0 percent in 1976 to only 30.0 percent in 1985. Clearly, this decline in OPEC share affected its ability to influence oil prices. OPEC unity is also affected by political events such as Arab-Israeli conflict and the Gulf war. The loose unity of OPEC can be seen through the violation of member countries of quotas allocated and selling prices. For example, in 1982, Iran's actual production exceeded its quota by 91.3 percent. The same is applicable to other members in varying degrees.

After examining the historical evolution of the world scenarios' elements, or the external variables, the assumptions about the future evolution of these elements have been formulated with the help of the panel members. In each case, three alternative values have been considered.

(I) Assumptions about world scenarios' elements

(a) The growth rate of world economy activities

(i) 4.0% annual growth in world economy activities over the next twenty years;

(ii) 3.0% annual growth in world economy activities over the next twenty years;

(iii) 2.0% annual growth in world economy activities over the next twenty years.

Table (7.9)

OPEC Share in World Oil Production

1975-1985

million tons

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
(1) World	2733.6	2955.1	3066.9	3092.9	3225.4	3081.9	2903.7	2787.3	2766.5	2839.0	2789.5
(2) OPEC	1361.7	1540.3	1564.5	1494.7	1552.7	1357.6	1150.4	977.3	903.0	904.0	839.6
(2) As % of (1)	49.8%	52.0	51.0	48.0	48.0	44.0	39.6	35.0	32.6	31.8	30.0

Source: BP Statistical Review of World Energy, June 1986.

(b) Oil prices

(i) 3.0% annual growth in oil prices over the next twenty years;

(ii) 2.0% annual growth in oil prices over the next twenty years;

(iii) 0.0% annual growth in oil prices over the next twenty years.

(c) Aid

(i) OPEC and non-OPEC aid increase.

(ii) current pattern (1986/87) of OPEC and non-OPEC aid.

(iii) declining OPEC aid and increasing non-OPEC aid.

(d) Technological development (in terms of the development of other energy sources).

(i) favour the use of oil (little efforts to develop other sources of energy);

(ii) average use of oil (moderate efforts to develop other sources of energy);

(iii) less use of oil (strong efforts to develop other sources of energy).

(e) OPEC unity

(i) 1973-style OPEC unity;

(ii) fragmented OPEC unity;

(iii) weak OPEC unity.

It should be realised that the hypotheses regarding world economy growth and that concerning oil prices' development were formulated in the light of published studies, and after tracing the growth of these two elements over the past fifteen years and the factors affecting their evolution. After formulating a set of hypotheses regarding the future evolution of the world scenarios' elements (external elements), attention is to be directed toward examining the historical evolution of socio-economic scenarios' elements (internal elements). A brief analysis of these elements is given in the next pages.

Examination of historical evolution of socio-economic scenarios' elements

Seven countries are of interest, these are: U.A.E. (home market), Saudi Arabia, Kuwait, Oman, Iraq, Iran and Egypt. The latter six countries compose the export market for the U.A.E. cement industry. These seven countries are classified into three groups:

1. Gulf cooperation council countries, except Bahrain and Qatar;
2. Iraq and Iran,
3. Egypt.

A brief description of the economic structure, development stage, urbanisation, industrial growth, agricultural development, human settlement, protectionism, GNP growth and the effect of the war will be presented with illustrative tables whenever applicable and possible.

1. Gulf Cooperation Council Countries (GCC)

(i) Economic structure

GCC countries' economies are based largely on oil revenue, and although the contribution of oil revenue to the total revenue of these countries has declined over the last few years, it has still and will continue to have a lion's share in the total revenue of each country. Table (7.10) presents oil revenue as a percentage of total government revenue and also the contribution of the oil sector to the GDP and in the total export of the four GCC countries.

Table (7.10)

Oil Revenues, Contribution of The Oil Sector to Total GDP and Oil Export as a Percentage of Total Export for Four GCC Countries

Country	Oil revenue as % of total revenue	Contribution of oil sector in total GDP	Oil exports as % of total export (1985)
U.A.E.	84.0% (1983)	46% (1984)	87.6%
S. Arabia	76.0% (1983)	39.0% "	94.8
Kuwait	89.0% (1984)	52.0 "	95.6
Oman	94.0% (1979)	45.0 (1983)	100.0 [a)]

NB: Different years were used because of lack of data.
Source: National accounts of the individual countries; OPEC annual statistical bulletin, 1985.
a) 1979.

It is obvious from Table (7.10) that the contribution of oil revenue in the total governments revenue and also the contribution of the oil sector in the total GDP and the contribution of oil export to the total exports of the four countries included in the table are reasonably high, with of course, varying degrees from one country to another. The significance of oil to the economies of these countries is expected to continue for decades to come.

(ii) <u>development stage</u>

The development stage here means physical development in terms of buildings, roads, bridges, highways, and the like. The four countries are almost at different stages of development. Hence, the need for more development is also varying from one country to another. Two factors affect the need for more development. One is the size of the population and the other, is the area. Table (7.11) presents, the size of the population, area, and the development stage for the four GCC countries included in the study.

Table (7.11)

Population, Area and Development Stage of Four GCC Countries

Country	population (000)		Area sq Km	Development stage
	1980	1985		
U.A.E.	1042	1600	77700	moderate
S. Arabia	9370	10823	2240000	moderate
Kuwait	1358	1911	17818	high
Oman	980	1240*	300000	low

Source: Gulf cooperation council, Facts and Figures, September 1985.

* IMF, International Financial Statistics, Vol.XL, No.4, April 1987, p.384 and p.412.

(iii) Urbanisation

Two main factors affect urbanisation growth. First the growth in national population through natural growth. The second is the growth in population through immigration. The latter is affected by the economic growth of the country. During the 1970's and early 1980's and because of the boom in the economies of the GCC countries, there was a huge inflow of immigrants into these countries, and this forced them to expand their social and economic facilities to cope with this new situation. Table (7.12) presents actual, projected growth in the population, and urban population as a percentage of the total population.

Table (7.12)

Population Growth; Urban Population as Percentage of Total Population and Average Annual Growth in Urban Population of Four GCC Countries

Country	Population growth		Urban population as % of total		
	1973-1983	1980-2000	1965	1983	Ave annual growth 1973-1983
U.A.E.	11.3%	3.7%	56%	79%	11.2%
S.Arabia	4.7%	3.6%	39%	71%	7.4%
Kuwait	6.4%	3.5%	75%	92%	7.8%
Oman	4.8%	2.9%	4%	25%	17.6%

Source: World bank development report, 1985.

As can be seen from the table, the period between 1973 and 1983 witnessed a high average annual growth rate in the population as a whole and in urban population as well. This can be attributed to the boom of the economies of these countries during that span of time and in turn the inflow of immigrants from abroad.

(iv) Industrial development

The GCC countries are in the process of developing their economic bases through the diversification of their national incomes, mainly through industrialisation. Therefore, the trend of industrial expansion is expected to continue to grow over the next ten years or so.

Table (7.13) shows the contribution of manufacturing to the GDP between 1980 and 1985, and also number of industrial establishments in four GCC countries for the same period. It should be noticed that the type of industrial development is of significance as far as the demand for cement is concerned. In this respect we can say that GCC nations are more likely to concentrate on capital intensive industries because of lack of labour forces, and these require a great deal of construction and in turn cement.

Table (7.13)

Contribution of Manufacturing to GDP and

No. of Industrial Establishments in Four GCC Countries

Country	(a) Contribution of manufacturing to GDP		(b) No. of industrial establishments	
	1980	1985	1980	1984
U.A.E.	3.8	10.0	*	515
S. Arabia	5.0	8.2	*	1997
Kuwait	5.9	8.0	*	773
Oman	0.7	3.3	195	501

Source: a) Al-Riyadh (newspaper), No.6895, year 23, 10.5.87, p.13.
b) Gulf organisation for industrial consulting.
* Not available.

(v) Agricultural development

The scope for cultivation differs from one GCC state to another due to the difference in availability of fresh water, and the quality of the soil. Table (7.14) indicates that there is more scope for cultivation in S.Arabia and Oman but on a lesser scale in the U.A.E., while in Kuwait there is very little scope.

Table (7.14)

Area Suitable for Cultivation, Utilisation Rate and Contribution of Agriculture to GDP

Country	Area suitable for cultivation (sq. km.)	Utilisation of area suitable for cultivation	Contribution of agriculture to total GDP (1983)
U.A.E.	2331	11.5%	1.2%
S.Arabia	29120	28.1	2.1
Kuwait	196	22.2	0.5
Oman	83400	49.2	2.0

Source: GCC, Secretary General, Economic section, Economic statistics No.1, 1986, Table (42.1), p.150.

(vi) Human Settlement

There is scope for human settlement in the GCC countries but with varying degree. In Saudi Arabia and Oman, because of their large size, the scope for human settlement is greater than in other GCC states. The U.A.E. comes third, and there is less scope in Kuwait.

(vii) Protectionism

GCC countries follow a free trade policy, i.e. there is no restriction on exports or imports. Some GCC countries impose protectionist measures against goods imported from outside the GCC region. For example, S. Arabia, and Oman impose a 20 percent protective tariff on goods imported from outside the GCC countries, when these goods are avilable in one of GCC members. Kuwait imposes a 10-30 percent protective tariff for the same purpose. While the U.A.E. imposes no protective tariff of any kind. The GCC intends to impose unified protectionist measures against imported goods whenever such goods can be found in any of the member states.

(viii) Growth in GNP

Table (7.15) presents average annual growth in GNP between 1973 and 1981 and between 1982 and 1984.

Table (7.15)

Average Annual Growth in Real GNP

Country	1973-1981	1982-1984
U.A.E.	12.1%	-0.79%
S.Arabia	11.7	-3.90
Kuwait	7.8	-0.68
Oman	11.9	19.86

Source: Calculated based on the information given in IMF publication, World Tables, and National Accounts of the concerned countries.

It is obvious from the above table, that GNP witnessed a high growth rate over the period between 1973 and 1981, this is due to the high oil price and, in turn, oil revenue. Then between 1982 and 1984 because of a sharp decline in oil prices, GNP witnessed a negative average annual growth.

The forecast of GNP for the four GCC countries and the remaining countries included in this study was based on the following:

(i) The past average annual growth rate in GNP for each country.

(ii) The World Bank prediction for the period between 1985 and 1990.

(iii) The panel opinions, adjusted by the opinion of two economists who have long experience in Middle-Eastern economics.

(iv) For GCC countries, the forecast of GNP was also based on a report published by International Gulf Bank based in Bahrain.

(ix) <u>The effect of Gulf War between Iran and Iraq</u>

Of the four GCC states mentioned earlier, Kuwait and Oman are greatly affected by this war because of their geographical location, while Saudi Arabia is slightly affected. The U.A.E. is moderately affected. The effects of the war can be seen on the trade movement between these countries and the outside world, and on the allocation of funds for defence rather than for developments. Therefore, the continuation of the war, will cause the continuation of the cut in spending on development projects.

(x) <u>Percentage of GNP spent on GFCF for building and construction</u>

The forecasts of this percentage for the four GCC countries and the remaining three countries included in this study were based on:

(i) The past average annual percentage of GNP spent on GFCF for each country.

(ii) The development stage of the country and the need for more development.

(iii) The urbanisation process, human settlement process and the pattern of industrial and agricultural developments.

2. <u>Iraq and Iran</u>

(i) <u>Economic structure</u>:

Like the economies of GCC countries, the economies of those two countries depend largely on oil revenue. Table (7.16) presents the percentage of oil revenue to the total government revenue, the contribution of the oil sector to total GDP and oil export as a percentage of total export.

Table (7.16)

Oil Revenue, Contribution of Oil Sector to Total GDP and Oil Export as Percentage of Total Export for Iraq and Iran

Country	(a) Oil revenue as % of total revenue	(b) Contribution of oil sector in total GDP	(c) Oil export as % of total export (1985)
Iraq	96%	80.0	98.9%
Iran	95%	75.0	97.7

Sources:

a) the world today, Vol.41, No.11, November 1985, p.198.

b) estimated

c) OPEC, annual statistical bulletin, 1985, Table (7) p.8.

(ii) <u>Development stage</u>:

The six years war has affected both countries greatly. Many cities and towns have been damaged by the war. Thus, re-building that which has been damaged is a definite requirement after the war comes to an end and a great deal of cement will be required for the rebuilding.

(iii) <u>Urbanisation</u>:

The war also has affected seriously the urbanisation process in both countries. Urbanisation expansion either through building new facilities or replacing existing ones is tied to the end of the war and availability of funds. The latter depends on oil prices and revenue and also on aid provided by other countries.

(iv) Industrial development:

This also is affected dramatically by the war and also by the availability of funds for investment. Like the GCC, these two countries are of the opinion that it would be wise to reduce their dependence on one source of national income.

(v) Agricultural development:

There is scope for agricultural activities in both countries, but the expansion is hindered by the war on the one hand and the availability of funds on the other.

(vi) Human settlement:

Thousands of citizens of both countries have fled to avoid being caught in the war, in addition to the people who were wandering in the desert, before the war started. So there is scope for human re-settlement in both countries.

(vii) Protectionism:

Both countries follow a free trade policy, although some sorts of protectionist measures are taken against products where similar ones can be produced locally. It is unlikely in the years to come that these countries would follow aggressive protective measures against imported products.

(viii) GNP growth:

Table (7.17) exhibits the growth in GNP in Iraq and Iran between 1973 and 1981 and between 1982 and 1985.

Table (7.17)

Average Annual Growth in Real GNP*

Country	1970-1981	1982-1985
Iraq	13.6%	-29.9%
Iran	4.18	2.01

Source: Calculated on the basis of International Financial Statistics and World Tables.

* GDP in the case of Iraq.

3. Egypt

(i) Economic structure

Unlike GCC countries, Iraq and Iran, Egypt's economy is based largely on the contribution of the agricultural sector; petroleum comes second in terms of its significance to the economy, then trade, industry and finally the Suez Canal revenue.

Table (7.18) presents the contribution of the mentioned four sectors to the GDP of the country in different years.

Table (7.18)

Contribution of Agriculture, Petroleum, Trade and the Suez Canal to Total GDP in Egypt (percentage)

Description / year	1980/81	81/82	82/83	83/84
Agriculture	17.0%	15.0	17.0	16.5
Petroleum	15.0	15.0	14.9	15.4
Trade	11.0	10.6	11.6	11.3
Suez Canal	3.0	4.0	3.0	2.9

Source: Ministry of Planning, Egypt.

(ii) Development stage:

Egypt has developed dramatically over the last few decades, but because of its area, population size, and above all, lack of funds, a great deal of physical development is needed especially in the rural regions.

(iii) Urbanisation:

As mentioned earlier, the growth of urbanisation is affected by natural growth in the population and through the growth in immigrants, in the case of Egypt, internal immigration from rural regions to the cities. Table (7.19) shows the average annual growth in population; urban population as a percentage of total population and average annual growth in urban population between 1973 and 1983.

Table (7.19)

Average Annual Growth in the Total and Urban Population and the Percentage of Urban Population in the Total Population in 1983

Country	Population annual growth 1973-1984	Urban population As % of total population	1973-1983
Egypt	2.5	45% (1983)	2.9% (growth)

Source: World development report, 1986.

(iv) Agricultural development:

As can be seen from Table (7.18), agriculture contributes generously to the total GDP of the country. The agricultural sector experienced an average annual growth rate of 2.5 percent over the period between 1973 and 1983.

(v) Protectionism:

Egypt follows an open door policy, and there are very limited protectionist measures against a limited number of products. This policy is likely to continue over the next decade or so.

(vi) Human settlement:

Over the last few decades, the process of human settlement has progressed rapidly. However, this phenomenon is still far from disappearing, and the scope for it, is still great. Therefore, the next ten years or so are expected to witness more human settlement, assuming that money would be available, and there would no more wars taking place in the Middle East.

(vii) GNP growth:

The average annual growth in real GNP between 1970 and 1981 was 4.64 percent, and between 1982 and 1985 the average annual growth rate in real GNP was -0.93 percent.

(viii) Industrial development:

As mentioned previously, the Egyptian economy is based on agriculture, but this does not mean that industry plays no role in the economy. Over the period between 1973 and 1983, the average annual growth in the industrial sector was about 10.3 percent.

Having examined the historical evolution of the socio-economic scenarios' elements, next the assumptions about future evolution of these elements are developed and listed below.

(II) Assumptions about socio-economic scenarios

A. Qualitative descriptors:

(a) Level of economic growth:

(i) High economic growth;

(ii) Moderate economic growth;

(iii) Low economic growth.

(b) Urbanisation:

(i) High urbanisation growth;

(ii) Moderate urbanisation growth;

(iii) Low urbanisation growth.

(c) Protectionism:

(i) High protectionist measures;

(ii) Moderate protectionist measures;

(iii) Low protectionist measures.

(d) Industrial development:

(i) High industrial growth;

(ii) Moderate industrial growth;

(iii) Low industrial growth.

(e) Human settlement:

(i) High pattern of human settlement;

(ii) Moderate pattern of human settlement;

(iii) Low pattern of human settlement.

(f) Agricultural development:

(i) High agricultural growth;

(ii) Moderate agricultural growth;

(iii) Low agricultural growth.

(g) GNP growth: [it is a numerical representative of (a)]

(i) High GNP growth;

(ii) Moderate GNP growth;

(iii) Low GNP growth.

(h) GFCF/GNP:

(i) High percentage of GNP allocated to GFCF for building and construction;

(ii) Moderate percentage of GNP allocated to GFCF for building and construction;

(iii) Low percentage of GNP allocated to GFCF for building and construction.

An extra qualitative variable was added in the case of Iraq and Iran. It is the Gulf war. The assumptions about this element are:

(i) Cease 1988;

(ii) cease 1990;

(iii) Cease 1995.

Figure (7.2) presents the relationship between the external and internal variables. Based on the sets of assumptions or hypotheses about future evolution of both world scenarios´ elements and socio-economic scenarios´ elements, scenarios were formulated utilising different consistent combinations of the previously stated hypotheses. The number of scenarios were limited to three: high, base and low. The choice of these scenarios was as a result of panel judgment and the test of consistency and plausibility.

These three scenarios are presented in Tables (7.20), (7.21) and (7.22) respectively. As mentioned earlier the panel consisted of four members of staff from different departments at this University.

Due to lack of financial resources and a time limit it was difficult for us to invite professional people to participate in the panel. As mentioned earlier, the panel helped a great deal in choosing the scenarios´ elements; formulating the hypotheses; and selecting the appropriate scenarios. The number of participants in the panel was kept small, because as Jefferson (26, 1983) suggested, a small number of participants is better, because effective communication and interaction can be achieved.

Going back to three scenarios developed and judging qualitatively, it was found that scenario No.(3), the Low Scenario, yields Low or poor outcomes to the cement industry. A set of sub-scenarios was developed around this scenario, the Low scenario, which is thought to be the least likely since this scenario is very pessimistic. This is done

Figure (7.2)

World and Socio-economic Flow Chart

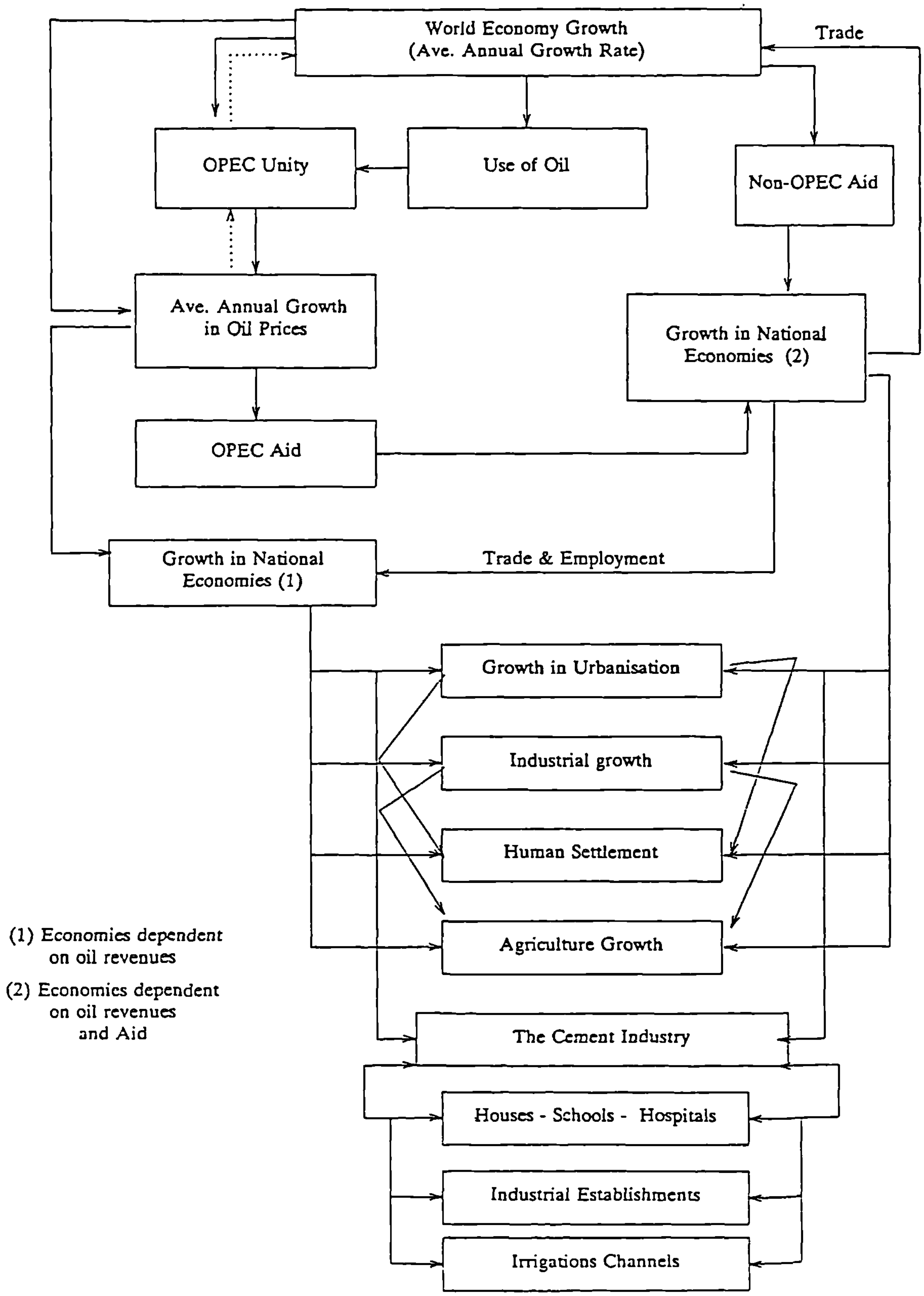


Table (7.20)

World Scenario No. (1): High Scenario (optimistic)

(1) 4.0 percent annual growth in world economy activity over the next twenty years.

(2) Favour the use of oil (little efforts to develop other sources of energy).

(3) 3.0 percent annual growth in oil prices.

(4) OPEC and non-OPEC aid increase.

(5) Fragmented OPEC unity.

Socio-economic Scenario No.(1): High Scenario (optimistic)

Variables (elements)	U.A.E.	Kuwait	S. Arabia	Oman	Iraq	Iran	Egypt
1) Gulf war	-	-	-	-	Cease 1988	Cease 1988	-
2) National economy growth	High growth	High growth	High growth	High growth	High growth	High growth	High growth
3) Urbanisation	Mod. growth	Low growth	Mod. growth	High growth	High growth	High growth	Cur. growth
4) Protectionism	High*	Low	Low	Low	Low	Low	Low
5) Industrial development	High growth	High growth	High growth	High growth	High growth	High growth	Cur. growth
6) Human settlement	Moderate	Low	Moderate	Moderate	High growth	High growth	Cur. growth
7) Agricultural development	Moderate	Low	Moderate	Moderate	Moderate	Moderate	High growth
8) GNP growth	3.5%	3.1%	3.9%	3.2%	3.5%	2.9%	2.9%
9) GFCF/GNP (building & construction)	5.0%	2.9%	5.0%	10.0%	14.0%	17.0%	4.0%

* High against the imported goods from outside GCC region.
Mod - moderate
Cur - current

Table (7.21)

World Scenario No. (2): Base Scenario

(1) 3.0 percent annual growth in world economy activity over the next twenty years.

(2) Average use of oil (moderate efforts to develop other sources of energy).

(3) 2.0 percent annual growth in oil prices.

(4) Current (1985/1986) OPEC and non-OPEC aid.

(5) Fragmented OPEC unity.

Socio-economic Scenario No.(2): Base Scenario

Variables (elements)	U.A.E.	Kuwait	S. Arabia	Oman	Iraq	Iran	Egypt
1) Gulf war	-	-	-	-	Cease 1988	Cease 1988	-
2) National economy growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth
3) Urbanisation	Low growth	Low growth	Low growth	High growth	High growth	High growth	Low growth
4) Protectionism	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
5) Industrial development	Cur.pattern	Cur.pattern	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Cur.pattern
6) Human settlement	Cur.pattern	Low growth	Cur.pattern	Cur.pattern	Mod. growth	High growth	Mod. growth
7) Agricultural development	Cur.pattern	Cur.pattern	Mod. growth	Mod. growth	High growth	Mod. growth	Mod. growth
8) GNP growth	3.0%	2.7%	2.9%	2.8%	2.9%	2.7%	2.7%
9) GFCF/GNP (building & construction)	3.8%	1.9%	3.8%	7.0%	9.0%	10.0%	2.4%

Table (7.22)

World Scenario No. (3): Low Scenario (pessimistic)

(1) 2.0 percent annual growth in world economy activity over the next twenty years.

(2) Less use of oil (more efforts to develop other sources of energy).

(3) 0.0 percent annual growth in oil prices.

(4) Declining OPEC aid and increasing non OPEC aid.

(5) Weak OPEC unity.

Socio-economic Scenario No.(3): Low Scenario (pessimistic)

Variables (elements)	U.A.E.	Kuwait	S. Arabia	Oman	Iraq	Iran	Egypt
1) Gulf war	-	-	-	-	Cease 1995	Cease 1995	-
2) National economy growth	Low growth	Low growth	Low growth	Low growth	Low growth	Low growth	Low growth
3) Urbanisation	Low growth	Low growth	Low growth	Low growth	Low growth	Low growth	Low growth
4) Protectionism	Low	Low	Low	Low	Low	Low	Low
5) Industrial development	Low growth	Low growth	Low growth	Low growth	Low growth	Low growth	Low growth
6) Human settlement	Cur.pattern	Cur.pattern	Cur.pattern	Low growth	Low growth	Low growth	Cur.pattern
7) Agricultural development	Low growth	Low growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth
8) GNP growth	2.4%	1.9%	2.2%	2.1%	1.8%	1.6%	1.7%
9) GFCF/GNP (building & construction)	2.0%	0.8%	1.9%	4.0%	5.0%	7.0%	1.5%

by trying different levels of the elements' values. Three new scenarios were developed around scenario No.(3). These are: sub-scenario No.(1), sub-scenario No.(2), and sub-scenario No.(3); they are presented in Tables (7.23), (7.24) and (7.25) respectively.

The next step is to write down the six scenarios developed in a descriptive manner to paint a complete picture about future events, bearing in mind the interrelations between the assumptions.

Scenario No.(1): Optimistic

It is assumed that 4.0 percent average annual growth in the world economy activities would stimulate the oil prices to grow at about 3.0 percent average annual growth rate. The growth in the world economy would result in increasing the demand for oil and in turn oil prices. The increase in the demand for oil would result in fragmented unity of OPEC since it is not expected that OPEC can reclaim its 1973 unity due to the decline in its share in the world oil market on one hand and the hostility between two of its members on the other.

The boom in world economic activities would also increase the ability of non-OPEC wealthy nations to provide more aid to poor nations in the Middle East. The growth in the world economy activities coupled with the growth in oil demand and prices, and also the growth in the aid provided by OPEC and non-OPEC nations, would lead to the growth in the Gulf States economies and Egypt. Egypt's economy depends on trade, the net income from abroad (Egyptians who work in the Gulf states) and the boom in world trade and the demand for

Table (7.23)

World Sub-scenario No. (1): High Sub-scenario (optimistic)

(1) 2.8 percent annual growth in world economy activity over the next twenty years.

(2) Average use of oil (moderate efforts to develop other sources of energy).

(3) 2.2 percent annual growth in oil prices.

(4) OPEC aid and non-OPEC aid are increasing.

(5) Fragmented OPEC unity.

Socio-economic Sub-scenario No.(1): High Sub-scenario (optimistic)

Variables (elements)	U.A.E.	Kuwait	S. Arabia	Oman	Iraq	Iran	Egypt
1) Gulf war	-	-	-	-	Cease 1992	Cease 1992	-
2) National economy growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Low growth	Low growth	Mod. growth
3) Urbanisation	Mod. growth	Low growth	Mod. growth	High growth	Low growth	Low growth	Low growth
4) Protectionism	High	Low	Low	Low	Low	Low	Low
5) Industrial development	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Low growth	Low growth	Mod. growth
6) Human settlement	Low growth	Low growth	Mod. growth	Mod. growth	Low growth	Low growth	Low growth
7) Agricultural development	Low growth	Low growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	High growth
8) GNP growth	2.8%	2.3%	2.6%	2.8%	2.4%	2.3%	2.5%
9) GFCF/GNP (building & construction)	3.5%	1.3%	3.8%	7.0%	7.0%	9.0%	2.0%

Table (7.24)

World Sub-scenario No. (2): Base Sub-scenario

(1) 2.5 percent annual growth in world economy activity over the next twenty years.

(2) Average use of oil (moderate efforts to develop other sources of energy).

(3) 1.0 percent annual growth in oil prices.

(4) Increase in OPEC and non-OPEC aid.

(5) Fragmented OPEC unity.

Socio-economic Sub-scenario No.(2): Base Sub-scenario

Variables (elements)	U.A.E.	Kuwait	S. Arabia	Oman	Iraq	Iran	Egypt
1) Gulf war	-	-	-	-	Cease 1994	Cease 1994	-
2) National economy growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth
3) Urbanisation	Low growth	Low growth	Mod. growth	High growth	Low growth	Low growth	Low growth
4) Protectionism	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
5) Industrial development	Mod. growth	Mod. growth	Mod. growth	High growth	Low growth	Low growth	Mod. growth
6) Human settlement	Low growth	Low growth	High growth	Mod. growth	Low growth	Low growth	High growth
7) Agricultural development	Low growth	Low growth	Mod. growth	Mod. growth	Low growth	Low growth	Cur.pattern
8) GNP growth	2.6%	2.1%	2.4%	2.6%	2.2%	2.0%	2.3%
9) GFCF/GNP (building & construction)	2.9%	1.0%	3.0%	5.0%	5.0%	7.0%	1.7%

Table (7.25)

World Sub-scenario No. (3): Low Scenario (pessimistic)

(1) 1.0 percent annual growth in world economy activity over the next twenty years.

(2) Less use of oil (more effort to develop other sources of energy).

(3) 1.5 percent annual growth in oil prices.

(4) Current (1985/1986) OPEC and increasing non-OPEC aid.

(5) Weak OPEC unity.

Socio-economic Sub-scenario No.(3): Low Scenario (pessimistic)

Variables (elements)	U.A.E.	Kuwait	S. Arabia	Oman	Iraq	Iran	Egypt
1) Gulf war	-	-	-	-	Cease 1995	Cease 1995	-
2) National economy growth	Mod. growth	Mod. growth	Mod. growth	Mod. growth	Low growth	Low growth	Mod. growth
3) Urbanisation	Low growth	Low growth	Low growth	Mod. growth	Low growth	Low growth	Low growth
4) Protectionism	Moderate	Moderate	Moderate	Moderate	Low	Low	High
5) Industrial development	Low growth	Low growth	Mod. growth	Mod. growth	Low growth	Low growth	Low growth
6) Human settlement	Low growth	Low growth	Mod. growth	Mod. growth	Low growth	Low growth	Low growth
7) Agricultural development	Low growth	Low growth	Mod. growth	Mod. growth	Low growth	Low growth	High growth
8) GNP growth	2.6%	2.0%	2.4%	2.3%	1.9%	1.6%	1.8%
9) GFCF/GNP (building & construction)	2.2%	0.9%	2.0%	4.2%	4.0%	6.0%	1.6%

oil would increase the revenue from the Suez Canal.

Assuming that the Gulf war would end by 1988, this would lead to a moderate growth in Iraqi and Iranian economies. Despite the fact that all Gulf States' economies witness growth, the average annual growth in GNP varies from one country to another but with a small degree of variation. This variation is attributed to the structure of the economy and the size of the country.

The average annual growth in the GNP in the U.A.E. is expected to be around 3.5 percent, Kuwait 3.1 percent, Saudi Arabia 3.4 percent, Oman 3.2 percent, Iraq 3.5 percent, Iran 2.9 percent, and Egypt 2.9 percent. The growth in the wealth of these nations would lead to the availability of funds to spend on urbanisation and industrial development. Since these nations look upon industrialisation as a means of diversification of their economic bases, a great deal of their revenues would be spent on building industrial establishments. More money would also be available to spend on housing for those who fled because of the war in Iraq and Iran and for those wandering in the desert in other Gulf States especially, U.A.E., Saudi Arabia and Oman. Apart from Kuwait where there is no scope for agricultural activities, a considerable amount of funds would be spent on irrigation channels especially in Egypt where agriculture accounts for about 17.0 percent of its GDP. In Iraq and Iran more money would be spent on urbanisation and industrial establishment and re-housing war refugees, than on agricultural activities. A large amount of annual GNP would be spent in GFCF in, of course, varying degrees. A very high percentage of GNP would be allocated for GFCF in Iraq and Iran to repair the damage of the war. Oman would also allocate a considerable percentage of GNP to GFCF; U.A.E. and Saudi Arabia would allocate 5.0 and 7.0 percent of GNP respectively to GFCF in building and construction. Kuwait would allocate 2.9 percent of GNP to GFCF in building and construction. This is due to the size of the country and its development stage. Egypt would allocate around 4.0 percent of the GNP on GFCF in building and construction because other aspects of the economy need to be fixed (e.g. transportation) rather than spending on construction. GCC countries would impose a unified tariff against imported goods when similar goods are available in these nations. This would encourage imports from the U.A.E. and reduce imports from abroad. Egypt is following an open door economic policy, therefore no protectionist measures would take place. Iraq and Iran would not impose any protectionist tariff on imports because of the damage done to their own industries and the need for imported goods. The demand for cement under these circumstances would be high.

Scenario No.(2): Base scenario

An average annual growth rate of 3.0 percent in the world economy activities, would lead to an average use of oil in oil importing nations. This would cause the oil prices to grow at slightly lower rate than in scenario (1), about 2.0 percent average annual growth rate. Aid provided by OPEC and non-OPEC is expected to continue at its current level. OPEC unity is not expected to be similar to that of 1973. Low growth in oil demand and prices would lead to moderate growth in the Gulf States economies and in Egypt's economy as well. Moderate growth in the home economy would not be enough to stimulate high growth in urbanisation.

Therefore the growth rate of urbanisation is expected to be low in the U.A.E., the same is applicable to other states like Kuwait and Saudi Arabia. Moderate growth in urbanisation in Oman is due to the need for some projects such as houses, schools, hospitals and the like. In Iraq and Iran because of the need to rebuild what has been damaged by the war, the growth in urbanisation would be high. By means of contrast, low growth in urbanisation is expected to be experienced in Egypt. Moderate protectionist measures would take place both at home and in other Gulf States and Egypt. At home against the imports from outside GCC region, GCC countries would impose a unified tariff policy against the imports from outside the member countries when similar goods can be found in any of the six members of the GCC. Moderate protectionist measures taken by Iraq and Iran are good and bad for the U.A.E. cement industry. It is good because the U.A.E. cement industry can secure a reasonable share of the market in those two nations, and it is bad because other exporters in Asia like Korea and Japan would be able to compete with the U.A.E. in those markets. Most developing countries, and those under consideration are no exception, are considering seriously the diversification of their economic bases through industrialisation. Therefore, whenever funds are available, a great deal of them would be spent on building industrial establishments. The current pattern of industrial growth is expected to continue in the

U.A.E. and Kuwait and to moderate in Saudi Arabia, Iraq, Iran and Egypt.

Agricultural development in the U.A.E., Saudi Arabia and Oman would continue at its current level. There would be a low level of agricultural growth in Kuwait because there is little scope for agriculture. Iraq and Iran are expected to experience a high growth in agricultural activities partly because there is more scope for agriculture in these countries than in other Gulf states and partly because less money is needed to fund this sector than for example, the industrial sector or urbanisation. The current pattern of human settlement is expected to continue in the U.A.E. and Kuwait and should moderate in the remaining nations under investigation. Despite the fact that all nations under consideration would experience moderate growth in the national economies. The average annual growth in GNP would vary slightly from one country to another because of the variation in the effect of world economy growth, their economies′ structure, and their sizes. The GNP growth in the U.A.E. would be about 3.0 percent average annual, 2.7 percent in Kuwait, 2.9 percent in Saudi Arabia, 2.8 percent in Oman, 2.9 percent in Iraq and 2.7 percent in Iran and Egypt. The percentage of GNP spent on GFCF for building and construction would also vary with the variation in the development stage, growth in urbanisation, industrial growth and agricultural growth and human settlement. A high percentage of GNP would be spent on GFCF in both Iraq and Iran assuming that the war would cease as early as 1990. It is estimated that 9.0 percent and 10.0 percent of GNP would be spent on GFCF in

Iraq and Iran respectively. Oman is expected to allocate about 7.0 percent of its GNP to GFCF in building and construction due to its staged development. U.A.E. and Saudi Arabia would allocate the same percentage of GNP to GFCF - about 3.8 percent of GNP would be allocated to GFCF. About 1.9 percent of GNP would be allocated to GFCF in Kuwait because of low growth in urbanisation.

Egypt would allocate about 2.4 percent of its GNP to GFCF because of low growth in urbanisation. The demand for cement is likely to be moderate. The demand for the U.A.E. cement depends among other things, on the capacity of the cement industries in the nations considered, and the ability of the U.A.E. cement to compete with Korean and Japanese cement, especially in Iraqi, Iranian and Egyptian markets, where there is no discrimination between the U.A.E. cement and cement from other countries in terms of protective tariffs applied.

Scenario No.(3), Pessimistic Scenario:

An average annual growth rate of 2.0 percent in the world economy activities would not be strong enough to stimulate more use of oil. Therefore, stagnation in oil prices is expected. Such stagnation would restrict the ability of OPEC to donate money to poor nations such as Egypt. The ability of non-OPEC nations would not be affected seriously. Hence, a country like Egypt could still get some aid and this would ease the pressure on its economy due to the shortages in its own resources. 2 percent growth in world economy and stagnation in oil prices would lead to a weak OPEC unity, because every member wants to sell as much oil as possible to get more money to finance his economy. The growth at the national level in the Gulf states and Egypt would be at a lower level. The low growth in these economies due to what is going on at the international level, would restrict the availability of funds and in turn the expenditure. This would lead to low growth in urbanisation in all the countries under consideration. Due to lack of finance, the growth in the industrial establishment would be low. Protectionist measures in the U.A.E. against imports from outside GCC countries would be at its lowest level. Other GCC countries would impose low protective measures against imports from the U.A.E. and high measures against imports from foreign countries whenever similar goods are available in one of the member states. Iraq and Iran are unlikely to follow tighter protectionist measures against the imports from abroad, because of the need to re-build their cities and because their own capacities would not be enough. Egypt, because of its open door economic policy, would not impose hard protectionist measures. Of course, such soft protectionist measures taken by Iran, Iraq and Egypt would have positive and negative effects on the U.A.E. cement industry. The positive effect is that the exports from the U.A.E. could go through easily, and the negative effect is that other exporters in Asia are likely to flood these markets with their cheap cement and compete with U.A.E. cement in these markets. Agricultural activities would experience low growth rate in the countries where the scope for agriculture is limited. Such countries are the U.A.E. and Kuwait.

Other countries like Iraq, Iran and Egypt where there is more scope for agriculture, would be able to finance such projects despite the lack of money available, as the construction of irrigation channels require low levels of financing.

Human settlement would vary between countries under consideration. The current pattern of human settlement would continue over the next twenty years in countries like the U.A.E., Kuwait, Saudi Arabia and Egypt. A low pattern of human settlement would be experienced by Iraq and Iran because of the continuation of the war for a long time and not too many people would rush for settlement.

Because of the low growth in the economies under consideration GNP growth would be low. In the U.A.E. it is expected to be around 2.4 percent, 1.9 percent in Kuwait, in Saudi Arabia about 2.2 percent, 2.1 percent in Oman, 1.8 percent in Iraq, 1.6 percent in Iran and 1.7 percent in Egypt.

Because of the lack of funds available, the percentage of GNP spent on GFCF would be low, but with a small degree of variation between the countries under consideration. For example, the percentage of GNP spent on GFCF in the U.A.E. would be about 2.0 percent, about 0.8 percent in Kuwait, around 1.9 percent in Saudi Arabia, about 4.0 percent in Oman, about 5.0 percent in Iraq, about 7.0 percent in Iran and about 1.5 percent in Egypt.

Generally speaking, the demand for cement under the circumstances mentioned earlier would be low. Such low demand at home and abroad would have a bad effect on the U.A.E. cement industry.

Sub-scenario No.(1). Optimistic

This sub-scenario has been developed around scenario (3) pessimistic scenario.

An average annual growth in the world economy activities is expected to be about 2.8 percent. This growth in the world economy activity would stimulate an average use of oil and the latter would lead to growth in the oil price. It is expected that the average annual growth in oil prices would be slightly above 2.0 percent.

Growth in world economy activity and in oil prices would lead to an increase in aid provided by OPEC and non-OPEC to poor nations such as Egypt and other nations like Iraq, Iran and Oman where funds are needed for executing development projects. OPEC unity is expected to be fragmented, since the 1973-style of unity would be far from reality. A moderate growth in the economies of the countries under consideration is expected, except Iraq and Iran, where low growth is expected because of the continuation of the war for a long time. Such a growth pattern in the countries under investigation would lead to variation in spending on different aspects of the economy. Urbanisation growth would be moderate in countries like the U.A.E. and Saudi Arabia, high in Oman because of its development stage and the need for more development, low in Iraq, Iran and Egypt. Iraq and Iran, because of the war and Egypt because there is less scope for more urbanisation. Industrial expansion would also vary. A moderate growth rate would be experienced by all the countries under investigation except Iraq and Iran. This is because of the war.

Agricultural growth is subject to variation between the countries under consideration. A low growth rate would be experienced by the U.A.E. and Kuwait, a moderate growth rate would be experienced by Saudi Arabia, Oman, Iraq and Iran. A high growth rate would be experienced by Egypt. A low growth rate because the scope of cultivation is limited, and a high growth rate because there is more scope for cultivation in a country like Egypt. Because the growth in the economy and availability of funds are restricted, the growth in human settlement would be affected. Low growth in human settlement would be expected in the U.A.E., Kuwait, Iraq, Iran and Egypt, and moderate growth in Saudi Arabia and Oman.

The moderate growth in the U.A.E. economy might lead to tighter protectionist measures against the imports from outside the gulf region. Other GCC members would impose soft protectionist measures against the imports from the member states and hard protectionist measures against the imports from outside the region. Iraq and Iran are unlikely to impose any protectionist measures and also Egypt, because of its open door policy. There would be moderate growth in GNP associated with the growth in the economy. About 2.8 percent average annual growth in GNP in the U.A.E., 2.3 percent in Kuwait and Iran, 2.6 percent in Saudi Arabia, 2.8 percent in Oman, 2.4 percent in Iraq and finally, 2.5 percent in Egypt.

The percentage of GNP allocated to GFCF for building and construction would vary from one country to another due to the variation in the development stage, the need for construction projects and the like. The percentage of GNP allocated to GFCF in the U.A.E. would be about 3.5 percent, about 1.3 percent in Kuwait, about 3.8 percent in Saudi Arabia, 7.0 percent in Oman, 7.0 percent in Iraq, 9.0 percent in Iran and finally about 2.0 percent in Egypt. Under this scenario the demand for cement would be much better than under the pessimistic scenario. The difference between the two is attributable to the pattern of growth of the economy, the growth pattern of urbanisation, industrial and agricultural activities, and the percentage of GNP allocated to GFCF. However, the demand for the U.A.E. cement depends on the size of the capacities of the export markets and the ability to compete with Korean and Japanese cement in Iraq, Iran and Egypt.

Sub-scenario No.(2) - Base Scenario

A lower growth in the world economy activity is expected, (about 2.5 percent an average annual growth rate). This pattern of growth would not be strong enough to stimulate high use of oil. Therefore, an average use of oil is expected to take place over the next twenty years.

Low growth in world economy coupled with average use of oil would lead to very low growth in oil prices, about 1.0 percent average annual growth rate in oil prices. OPEC unity is not expected to be better than the current style - fragmented. Such circumstances at the international level are not expected to lead to satisfactory results at the national levels. A moderate growth in the economies under investigation is expected. Such a pattern of growth would lead to low and moderate growth in other aspects of the economies considered with some exceptions. Urbanisation growth is expected to be low everywhere except in Saudi Arabia, Oman and Egypt.

Moderate urbanisation in Saudi Arabia and Egypt and high pattern in Oman. Industrial growth would also vary between the nations of interest. Low industrial growth would be experienced by Iraq and Iran. Moderate growth in the U.A.E., Kuwait, Saudi Arabia and Egypt. High growth in Oman. The variation in the industrial growth is due to the differrence in the scope of industrialisation and the effect of the war in the case of Iraq and Iran. Agricultural growth would vary between the countries considered. A low growth rate would be experienced in the U.A.E., Kuwait, Iraq and Iran. A moderate growth rate is expected in Saudi Arabia and Oman, and a high growth rate is expected in Egypt. Human settlement pattern would vary from one country to another. High pattern of human settlement in the U.A.E., Saudi Arabia, low in Kuwait, Iraq and Iran, moderate in Oman, and the current pattern of human settlement would continue in Egypt. As we mentioned earlier, moderate growth in the economy would be experienced by the countries considered in the study. Such a moderate growth would be associated with moderate growth in GNP. A 2.6 percent average annual growth in GNP is expected in the U.A.E., about 2.1 percent in Kuwait, 2.4 percent in Saudi Arabia, 2.6 percent in Oman, 2.2 percent in Iraq, 2.0 percent in Iran and finally 2.3 percent in Egypt. The variation in GNP growth is attributed to the economic structure, country's size and the like. Because of the moderate growth in GNP and low spending on construction projects, the percentage of GNP allocated to GFCF of building and construction would be low.

About 2.9 percent of GNP is expected to be allocated to GFCF in the U.A.E., 1.0 percent in Kuwait, around 3.0 percent in Saudi Arabia, 5.0 percent in Oman, 5.0 percent in Iraq, 7.0 percent in Iran and about 1.7 percent in Egypt. Protectionist measures taken by the countries under investigation is expected to be moderate. Such action would benefit the U.A.E. cement industry at home, but it might affect its export markets negatively.

Sub-scenario No.(3) - Pessimistic

A very low growth in the world economy activity - about 1.0 percent average annual growth - in addition to the tendency toward the development of other sources of energy would lead to less use of oil.

The latter would lead to a decline in oil prices of about 1.5 percent average annual rate. Decline in oil prices would restrict OPEC ability to donate money to poor middle eastern nations like, for example, Egypt.

Thus the current pattern of OPEC aid is expected to continue in the future. Non-OPEC aid would not be affected seriously but it might benefit from the decline of oil prices, therefore, non-OPEC aid is expected to increase over the next twenty years. A very low growth in world economy activity coupled with decline in oil prices would lead to weak OPEC unity. Under such circumstances at the international level, the situation at the national level for the countries of interest is expected to be worse. Despite the fact that this scenario is better than the pessimistic scenario in terms of its effect on the cement industry it is still far from being a good one. A moderate growth in the economies of the countries under investigation is expected, though this moderate growth would be slightly lower than the average scenario. A low growth is expected in the economies of the two nations involved in the war, namely Iraq and Iran. Urbanisation growth is expected to be low everywhere except in Oman where there is a need for development.

Industrial growth is unlikely to be better off. A low industrial growth is expected to be the dominant, except in Saudi Arabia and Oman where moderate growth is expected. Apart from Oman and Saudi Arabia where moderate agricultural growth is expected, low growth would be the dominant. Human settlement which is affected more or less by the availability of funds to the government so that it can build houses and other facilities and this in turn would encourage people wandering in the desert to settle down in one region.

Human settlement would be low everywhere either because of the lack of availability of funds, the continuation of the war in the case of Iraq and Iran or the limited scope of human settlement i.e. not too many people still wandering. Moderate human settlement is expected in Saudi Arabia and Oman for one reason or another.

As mentioned earlier, moderate growth is expected in the economies of interest, except in Iraq and Iran where low growth is expected. Such a pattern of growth in the national economies would lead to low growth in the GNP. About 2.6 percent average annual growth in the GNP in the U.A.E. is expected over the next twenty years. 2.0 percent in Kuwait, 2.4 percent in Saudi Arabia, 2.3 percent in Oman, 1.9 percent in Iraq, 1.6 percent in Iran and 1.8 percent in Egypt. A variation in the percentage of GNP allocated to GFCF for building and construction is expected, partly because of variation in GNP growth and partly because of the need for construction projects.

Slightly above 2.0 percent of GNP would be allocated to GFCF for building and construction in the U.A.E. Below 1.0 percent of GNP is likely to be allocated to GFCF for building and construction in Kuwait. 2.0 percent of GNP is expected to be allocated to GFCF in Saudi Arabia. About 4.2 percent of GNP is likely to be allocated to GFCF in Oman, 4.0 percent in Iraq, 6.0 percent in Iran and 1.6 percent in Egypt. The protectionist measures taken by the countries under investigation would range between low and high; low in the countries where the need for imported goods is high and high in the countries where the protection of locally produced goods is required. Moderate protectionist measures would be taken by the U.A.E. and other members of the GCC against the import of cement since a surplus of cement is available in the U.A.E. Low protectionist measures would be taken by Iraq and Iran and high measures would be taken by Egypt. Such measures taken by Egypt would make it difficult for U.A.E. cement to enter Egypt. The effect of this scenario on the cement industry is slightly better than the pessimistic scenario but the demand under this sub-scenario would still be very low.

Having written down the six scenarios the next step is to check the consistency of the scenarios, and whenever there is an indication of inconsistency, hypotheses are to be re-formulated to eliminate it.

The consistency of the scenarios has been justified, and four scenarios of the six mentioned were chosen. The four scenarios chosen are: scenario No.(1); scenario No.(2); sub-scenario No.(1); and sub-scenario No.(2). The reasons for the elimination of the remaining two scenarios are: first of all, it is strongly believed that the number of scenarios should not exceed four, since the fewer scenarios are better and more than four may cause confusion. Secondly, the eliminated two scenarios are least likely. We shall point out that the figures of GNP growth rates in the four scenarios have been discussed with two economists with a long experience in the economies of middle eastern countries, and these figures are adjusted based on their recommendations. The adjusted GNP growth rates are presented in Table (7.26). It is worth noting that these scenarios are to be updated to cope with the changes in the conditions under which they were constructed.

Table (7.26)
Adjusted GNP Annual Growth Rate (in Real Terms)

Country \ scenario	No.(1)	No.(2)	Sub-No.(1)	Sub-No.(2)
U.A.E.	5.0	4.5	4.3	4.1
S. Arabia	4.9	4.3	4.1	3.9
Kuwait	4.6	4.2	3.8	3.6
Oman	4.7	4.2	4.0	3.8
Iraq	-	-	-	-
Egypt	2.6	2.3	2.1	1.9
Iran	-	-	-	-

7.7.2 Econometric Models:

Having agreed on the scenarios to be used, the next step is to convert these scenarios into quantitative terms. Godet (27, 1986) stated that "standard forecasting techniques can be used within the framework defined by the scenario, in order to convert this scenario into quantitative terms." We utilised econometric models as a means of converting scenarios into quantitative terms. Furthermore, Godet (28, 1987) said that "the statistics (mathematical, econometric) contained in forecasting models are essential to an assessment of the consequences of scenarios". The construction of these models comprises the second stage of the three-stage hybrid forecasting approach used. At this stage, seven econometric models are to be built, one for each of the seven countries which comprise the home and the export markets. However, prior to discussing these models, it would be beneficial to remind ourselves of the two main shortcomings of regression models examined at the beginning of this chapter. These two shortcomings are: first, ill-chosen explanatory variables; and second, inaccurate estimation of the values of these variables, and the reliance on single value as opposed to multiple values. In order to avoid being caught in the same trap as the previous work, we have reversed these shortcomings in two ways: first, through the careful choice of the explanatory variables. The explanatory variable chosen, namely, the amount of GFCF spent on building and construction which is believed to have a physical relationship with the consumption of cement, subject to the condition that a minor or no serious fluctuation in the prices of cement is expected, and this condition is assumed to hold for a commodity like cement because there is a world-wide surplus in cement which can satisfy any increase in demand; and second, through the careful estimation of the values of this explanatory variables, by using scenarios and in turn multiple values of these variables. It should be stressed that due to unavailability of data, it was impossible for us to break down GFCF according to sectors. Moreover, the structure of the economies under study is not expected to change rapidly over the next twenty years and, of course, this will eliminate the effect of the change in economy structure on the demand for cement which cannot be captured by regression models. It should be pointed out that some of the econometrics models presented below were calculated by the ordinary least squares method (OLS), but whenever the Durbin-Watson statistic was found to be significant, a maximum likelihood method (ML) was used. The reason for this is that the ordinary least squares (OLS) estimates are inefficient and the t-statistic and F-statistic are biased upwards with the presence of significant serial autocorrelation. Because of the autocorrelation we fit a model which includes a first order autogressive process for the error term. The model is fitted by maximum likelihood method (ML). The F-statistic as output by (AR1) in TSP package is not equivalent to the t-statistic used to test the hypothesis that $\beta=0$.

Unlike estimation methods for (AR1) models based on least squares, such as the Cochrane-Orcutt method, which preserves the algebraic equality of F and the square of t, there is no reason why the maximum likelihood estimator used in some of the models should do so (for detailed discussion of (ML) see Beach & Mackinnon (28a, 1978)).

Keeping these facts in mind, let us now turn our attention to the discussion of the regression models for the seven markets, starting with the home market, the U.A.E. market.

<u>The U.A.E. Market</u>

The regression model developed for the U.A.E. is presented below:

$$\text{Ln } DC_t = -4.76914 + 1.50137 \text{ Ln } GFCF_t$$

where:

DC = The demand for cement in thousand metric tons.

GFCF = The amount of the Gross Fixed Capital Formation which is spent on building and construction in million US$(1980 prices).

As can be seen from the above model, the coefficient of the independent variable is high. This is due to the economic development stage on the one hand, and to the nature of GFCF on the other.

Some statistical parameters of the U.A.E. regression model are presented in Table (7.27); and Figure (7.3) depicts the relationship between actual and predicted demand for cement in the U.A.E. between 1972 and 1985.

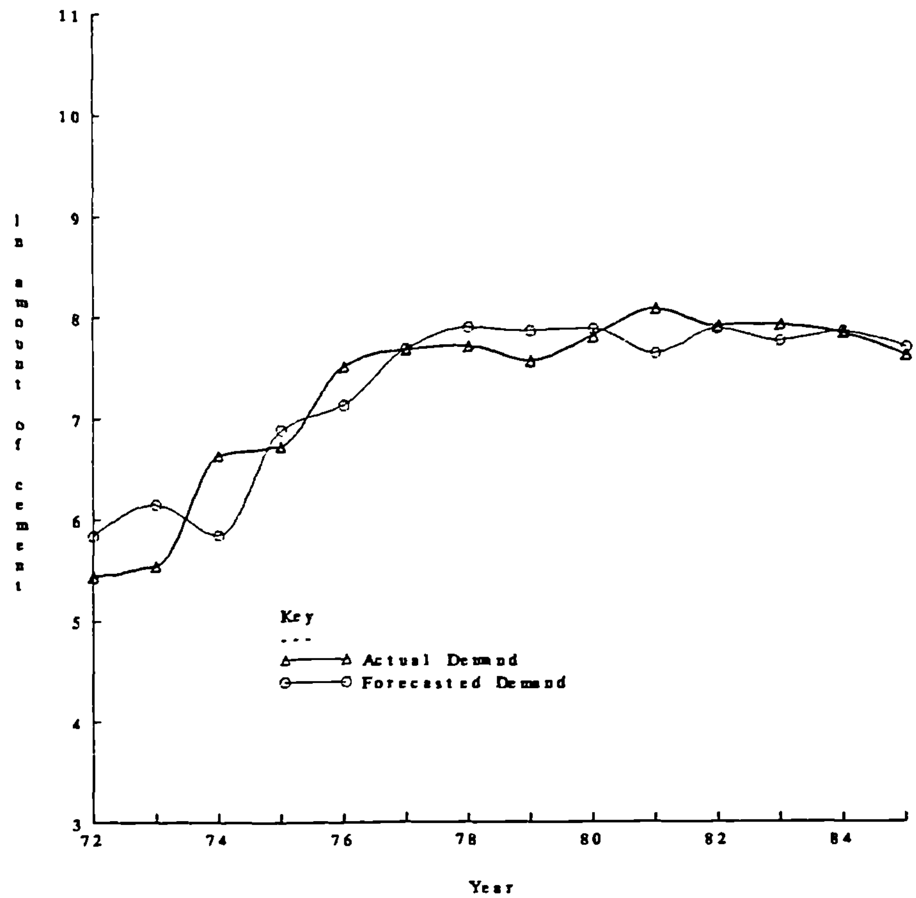
Table (7.27)

Statistical Parameters of The U.A.E. Regression Model

Parameters	Value
R-squared	0.82
T-test	7.51 ($GFCF_t$)
F-statistical	56.43
DW-statistic	2.34
Standard error	0.1999 ($GFCF_t$)
r	0.91
df	11
n	14

Figure (7.3)

Actual and Forecasted Demand for Cement in The U.A.E., 1972-1985



Prior to using the previously mentioned model for the purpose of forecasting; clarification of some points seems necessary at this stage.

These points are categorised into three main groups:

(i) those which relate to the simplicity of the model;

(ii) those which relate to the number of data points;

(iii) overall, those which relate to the technique used.

Let us examine the first group; some might argue that simple regression models are being used as opposed to multiple regression, and this means that we overlooked many variables which affect the demand for cement, as already mentioned. A response to such argument is based on the fact that the variables which affect the demand for cement can be categorised into three types: unquantifiable variables, for example, urbanisation, human settlement, life-style etc., quantifiable variables for which reliable data are not available, for example, prices of locally-produced and imported cement; and quantifiable variables for which data are available. The unquantifiable variables are affected by many variables such as: availability of funds, the development stage of the country, population growth etc.

This type of variable (unquantifiable) has been dealt with through the use of the scenario approach, and the effect of those variables on the demand has been investigated thoroughly. The second type of variable, was difficult for us to do anything about. With respect to the third type, careful attention has been given to the choice of variables which have a strong physical relationship with the demand for cement, and where such relationship is expected to last for a very long time. A second justification for the use of a single exogeneous variable model stems from the fact that whenever fewer data points are used, as in our case, it is preferable that very few explanatory variables are used, this is due to the fact that more explanatory variables with few data points might lead to R-squared being one and this, of course, will give unrealistic models and in turn unrealistic results. This should not be interpreted to mean that whenever there are few data points, only one explanatory variable is used, but very few can be used. Another justification for the use of simple regression is that the percentage of error when estimating the value of one explanatory variable, is smaller than when more than one explanatory variable is used. With regard to the second group, namely, few data points being used, it should be noted that most middle-eastern economies, if not all, are oil-based economies either directly or indirectly. As it is known, the boom in oil prices in 1973 and 1974 has changed these economies dramatically, therefore, it is unwise to go back too far beyone 1973. Thus, we limited the starting point to 1970, and due to unavailability of data about 1986 and 1987, we limited the end point to 1985. Consequently, the number of data points used was small. With regard to the third group, namely, the techniques used, we can argue that using other quantitative techniques like, for example, Box-Jenkins and systems dynamic modelling has been prevented by one or more obstacles. The Box-Jenkins method is a powerful tool of forecasting and gives good results. Its use was prevented by the lack of a historical data base, since its application requires at least twenty five data points, whereas, sixteen data points are available (fourteen in the case of the U.A.E.). Systems dynamic modelling is also a powerful tool of forecasting and it is considered appropriate for long term forecasting. Unfortunately, it has a few shortcomings as already mentioned in chapter five. Moreover, it has been used for long-term forecasting of some of the monetary and non-monetary variables of Saudi Arabia´s economy, Al-Sabaan (29, 1985). Its results suggested that it cannot be a useful forecasting tool when dealing with the behaviour of monetary variables and especially in oil-based economies. Al-Sabaan admitted that it is not expected that the systems dynamic model gives correct forecasts for monetary variables such as GDP for the economy of Saudi Arabia. The foregoing discussion raises some doubts regarding the use of a systems dynamic model as a means of forecasting the demand for cement. In summary, there is no unique forecasting technique which can be used in conjunction with the scenario approach and can produce very accurate results, but one should seek for a technique which can produce results with a minimum degree of errors. One should also keep in mind that sophisticated methods do not necessarily yield better outcomes than less sophisticated ones.

Furthermore, one should apply techniques where data are available rather than trying to use more sophisticated techniques that offer potentially greater accuracy but require non-existent or costly data.

Having clarified the three groups of points, let us now go back to the regression model developed to forecast the demand for cement in the U.A.E. The evolution of the exogenous variable in the model has been estimated through the use of scenario approach, and then the demand is to be calculated using these estimates. The forecast of the demand in the U.A.E. under the four chosen scenarios are presented in Table (7.28).

Table (7.28)

Forecasted* Cement Demand in The U.A.E.

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	1949.0	1089.0	922.0	654.0
87	2094.0	1165.0	1057.0	695.0
88	2254.0	1245.0	1126.0	738.0
89	2426.0	1331.0	1199.0	783.0
1990	2611.0	1419.0	1277.0	833.0
91	2806.0	1516.0	1359.0	885.0
92	3021.0	1620.0	1450.0	940.0
93	3252.0	1731.0	1545.0	998.0
94	3499.0	1849.0	1646.0	1060.0
1995	3767.0	1975.0	1752.0	1125.0
96	4048.0	2110.0	1866.0	1197.0
97	4159.0	2254.0	1988.0	1271.0
98	4690.0	2408.0	2118.0	1313.0
99	5048.0	2572.0	2255.0	1433.0
2000	5434.0	2748.0	2402.0	1522.0
01	5839.0	2936.0	2558.0	1618.0
02	6285.0	3136.0	2729.0	1719.0
03	6765.0	3350.0	2907.0	1825.0
04	7282.0	3580.0	3096.0	1938.0
2005	7837.0	3824.0	3298.0	2057.0

* Excluding the imported cement into the U.A.E.

Source: Calculated using the econometric model and the values of the exogenous variable generated by the scenarios.

The values of the exogenous variable (GFCF) and other data used to construct the U.A.E. econometric models as well as the export market's models are presented in Appendix B, while the graphs exhibiting the relationship between the dependent and independent variables (actual raw data) for the seven econometric models are presented in Appendix C.

It is important to point out that the figures appearing in the previous table by no means represent a perfect forecast of the demand for cement in the U.A.E. over the next two decades; it is meant to give the decision maker a guide against which plans can be drawn up; or as the proverb says "a bad ride is better than a walk". Since at the present, decisions are made arbitrarily with no estimate of future demand, in either the short or the long term. Furthermore, the forecasted demand was carefully monitored so that the actual most of the time exceeds the predicted one and this is slightly better than when the actual falls short of the predicted demand, and in turn bearing the cost of carrying excess capacity. The shortage in capacity is better, especially for a commodity like cement because a world-wide surplus exists. Thus, it will be of no difficulty to obtain what is needed, but one must make sure that this attitude does not continue for a long time, otherwise customers will get used to the habit of buying from abroad rather than buying the locally produced commodity. Another comment about our forecasts is that it is multiple as opposed to single point forecasting and this makes it more realistic especially when dealing with long-term futures and in turn the degree of certainty is almost nil. Moreover, when using monetary variables as explanatory variables, the estimation of their values is questionable regardless of the techniques used. This leads to the conclusion that multiple forecasts are superior to single point forecasts, especially under the two circumstances stated earlier; long-term futures and the use of monetary variables as explanatory variables, especially in oil based economies. Baets (30, 1987) argued that "high degrees of accuracy in forecasting for strategic planning are both unlikely to be obtained and unnecessary to achieve. What matters is that the broad thrust of forecast is in the right direction, ...strategic forecasting should focus on the development of average of possible outcomes ......" (p.172). A final word about the figures presented in the previous table is that these figures are possible and attainable but not assured.

Having described the procedures to go about forecasting the demand in the home market, the next thing to do is to forecast the demand in the export market.

7.8 Forecasting Export Demand for U.A.E. Cement

This section, however, examines the forecast of the export demand for U.A.E. cement.

Nonetheless, prior to beginning the business of forecasting utilising the same procedure followed for the home market, the significance of the export market to the U.A.E. cement industry is examined. This is done through the examination of the export of U.A.E. cement to the individual export markets as a percentage of total cement imported by each market. Table (7.29) presents these percentages over the period between 1980 and 1985.

Table (7.29)

Import of U.A.E. Cement as a Percentage

of Total Cement Imported, 1980-1985

Country / Year	Kuwait	S.Arabia	Oman	Iraq	Egypt	Iran
1980	11.0%	...	...	-	-	-
1981	17.0	...	...	-	-	-
1982	4.0	...	...	-	-	-
1983	2.0	11.5%	18.0	-	-	-
1984	10.0	12.0	25.0	-	-	-
1985	15.0	10.5	30.0	-	-	-

It should be noted that Iraq, Egypt and Iran comprise the potential export market for U.A.E. cement. Other current small export markets like Bahrain, India, Pakistan, Yemen and Somalia have been omitted from the study since their significance to the U.A.E. cement industry does not encourage further investigation. Qatar, despite its significance to U.A.E. cement, was omitted because of a lack of data. It should be pointed out that the forecast of the percentage of imports by each country comprising the current and potential export market for U.A.E. cement is based on the following factors:

(i) past import by each country.

(ii) level of demand in each country.

(iii) protection measures taken by each country.

(iv) capacity available in each country.

(v) whether the export market is potential or current.

(vi) ability of U.A.E. cement to compete with foreign cement in the export market.

Having examined the significance of the export market to the U.A.E. cement industry and also the factors on which the percentages of the imports by the countries comprising the export market were based, let us turn our attention to the exercise of forecasting the export markets one at a time as follows:

Kuwait market:

As can be seen from the previous table, a significant portion of the imported cement into Kuwait comes from the U.A.E., partly because Kuwaitis invest in the U.A.E. cement industry and therefore they favour the use of U.A.E. cement, partly because of the short distance between Kuwait and the U.A.E. and partly because there is no scope for capacity expansion in Kuwait, due to the fact that no raw materials exist in Kuwait. Anyway, the econometric model for Kuwait demand is presented below.

$$\text{Ln } DC_t = 4.329496 + 0.4144859 \text{ Ln } GFCF_{t-1}$$

Table (7.30) presents some statistical parameters of the model, and figure (7.4) shows the relationship between the actual and the predicted, utilizing the model, over the period between 1971 and 1985.

It might be useful to point out here that the reason why a smaller proportion of $GFCF_t$ in Kuwait, as indicated by the coefficient of Ln $GFCF_{t-1}$ in the model of Kuwait contributes to cement demand, compared with that of the U.A.E. is because of the economic structure of Kuwait where more emphasis is placed on financial investment abroad as opposed to industrial investment in the country on the one hand, and because of the development stage of Kuwait on the other hand.

Table (7.30)

Statistical Parameters of Kuwait's Econometric Model

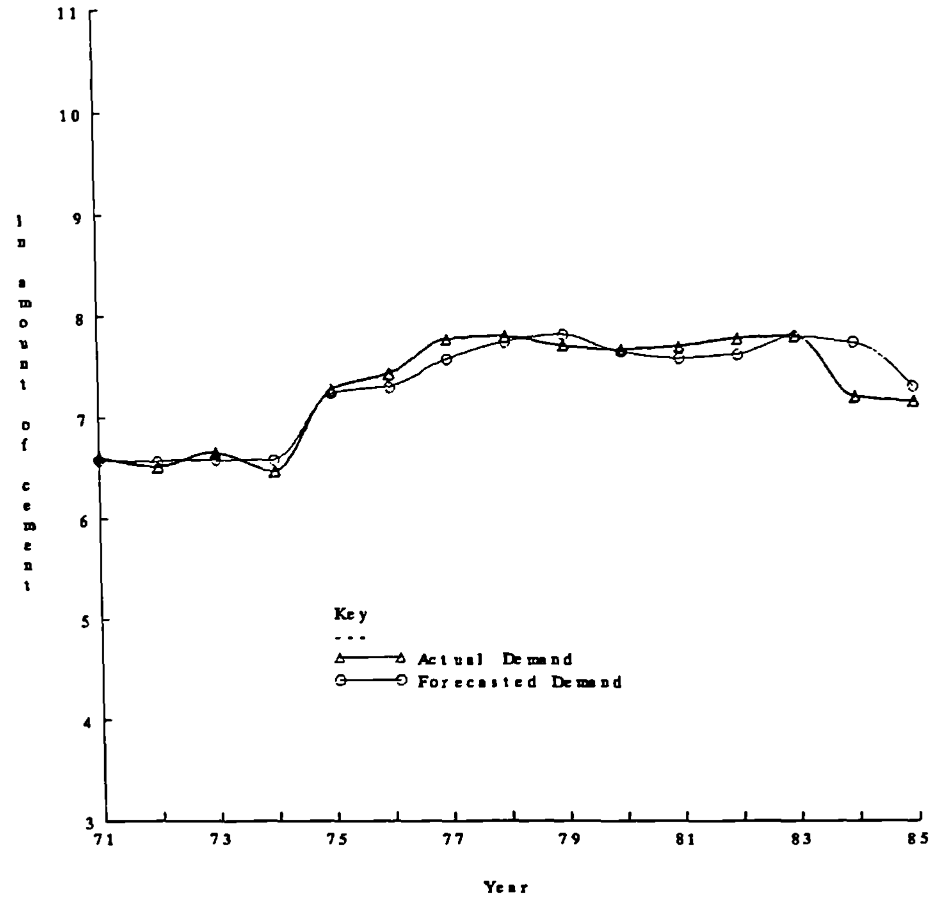
Parameter	Value	Value
	$GFCF_{t-1}$	$GFCF_t$
R-squared	0.93	0.86
F-statistical	167.94	85.34
T-test	5.58($GFCF_{t-1}$)	7.64($GFCF_t$)
DW-statistic	1.45	1.90
Standard error	0.0743($GFCF_{t-1}$)	0.0606($GFCF_t$)
r	0.91	0.88
df	13	14
n	15	16

Source: computer print out, Tsp package.

With respect to using lag independent variable in the case of Kuwait, and also in the case of Egypt as will be seen later, apart from a better fit being obtained when using lag independent variable compared with not using lag independent variables, there is no other justifications for the use of lagged independent variable.

Figure (7.4)

Actual and Forecasted Demand for Cement in Kuwait, 1971-1985



Utilising the previous model and the value of the explanatory variables, using the scenario approach, the demand for cement in Kuwait is presented in Table (7.31). As far as the U.A.E. cement industry is concerned, the imported cement from the U.A.E. by Kuwaiti market is of great significance. The import is calculated as a percentage of total demand under the four chosen scenarios. Table (7.32) presents the import of cement from the U.A.E. by Kuwaiti market.

Table (7.31)

Forecasted Cement Demand in Kuwait

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	1624.0	1624.0	1624.0	1624.0
87	1509.0	1300.0	1250.0	1216.0
88	1537.0	1322.0	1270.0	1235.0
89	1566.0	1345.0	1290.0	1265.0
1990	1596.0	1367.0	1310.0	1271.0
91	1626.0	1392.0	1330.0	1290.0
92	1656.0	1416.0	1349.0	1309.0
93	1688.0	1440.0	1370.0	1328.0
94	1719.0	1464.0	1392.0	1348.0
1995	1721.0	1490.0	1413.0	1367.0
96	1785.0	1515.0	1435.0	1388.0
97	1818.0	1541.0	1457.0	1409.0
98	1853.0	1568.0	1482.0	1429.0
99	1887.0	1595.0	1503.0	1450.0
2000	1923.0	1622.0	1527.0	1472.0
01	1959.0	1650.0	1551.0	1493.0
02	1980.0	1679.0	1575.0	1515.0
03	2018.0	1707.0	1599.0	1538.0
04	2056.0	1737.0	1625.0	1560.0
2005	2094.0	1766.0	1650.0	1584.0

Source: Calculated using the econometric model and the values of the exogenous variable generated by the scenarios.

Table (7.32)

Import from the U.A.E. by Kuwait Market, 1986-2005

(000) tons

Year	15.0% scenario (1)	13.5% scenario (2)	12.5% scenario (3)	12.0% scenario (4)
1986	244.0	219.0	203.0	195.0
87	226.0	176.0	156.0	146.0
88	231.0	178.0	159.0	148.0
89	235.0	182.0	161.0	152.0
1990	239.0	185.0	164.0	153.0
91	244.0	188.0	166.0	155.0
92	248.0	191.0	169.0	157.0
93	253.0	194.0	171.0	159.0
94	258.0	198.0	147.0	165.0
1995	258.0	201.0	177.0	164.0
96	268.0	205.0	179.0	167.0
97	273.0	208.0	182.0	169.0
98	278.0	212.0	185.0	171.0
99	283.0	215.0	188.0	174.0
2000	288.0	219.0	191.0	177.0
01	294.0	223.0	194.0	179.0
02	297.0	227.0	197.0	182.0
03	303.0	230.0	200.0	185.0
04	308.0	234.0	203.0	187.0
2005	314.0	238.0	206.0	190.0

Source: Calculated as a percentage of total demand presented in Table (7.31)

Saudi Market

The Saudi market accounts for a significant portion of the total U.A.E. export market. This is due mainly to the fact that it is better for those areas which are close to the U.A.E. borders to get their cement from the U.A.E. rather than from Saudi Arabia because of road access. The second reason, and this applies to other GCC countries as well, is the imposing of protective tariffs against imported cement from outside the GCC region. However, the econometric model to predict the demand for cement in Saudi Arabia is presented below.

$$\text{Ln } DC_t = -5.087835 + 1.452165 \text{ Ln } GFCF_t$$

Table (7.33) presents the main statistical parameters of the model and figure (7.5) exhibits the relationship between the actual and the predicted demand, using the previous model, between 1970 and 1985.

Table (7.33)
Statistical Parameters of the Saudi´s Econometric Model

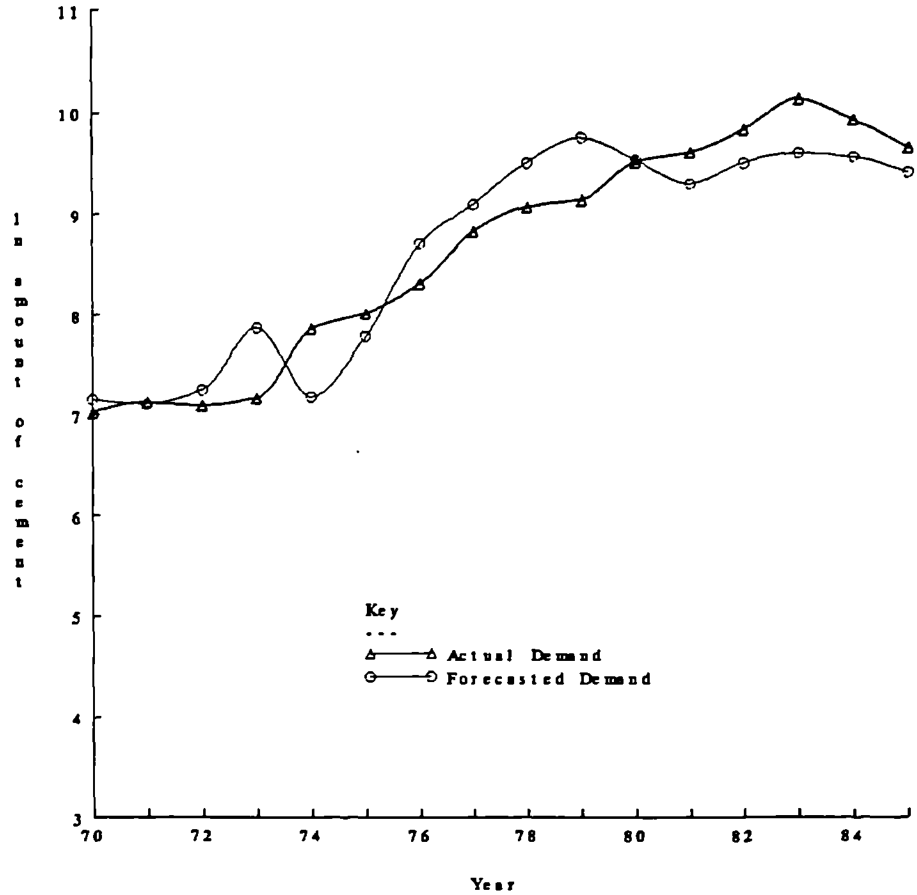
Parameter	Value
R-squared	0.86
F-statistical	87.90
T-test	9.38($GFCF_t$)
DW-statistic	1.38*
Standard error	0.1549
r	0.93
df	14
n	16

Source: Computer print out, Tsp package.
* DW-statistic at (.05 level) is d_L=1.10 and d_U=1.37

Figure (7.5)

Actual and Forecasted Demand for Cement in Saudi Arabia

1970-1985



The parameters presented in Table (7.33), and Figure (7.5) show that the econometric model for Saudi Arabia is adequate. It is to be noted that the coefficient of the independent variable is as high as that of the U.A.E., and this is due to the economic development stage and the nature of GFCF.

This model is used to forecast the demand for cement in Saudi Arabia over the next two decades; utilising the values of the exogenous variable generated by means of scenario analysis. The forecasted demand for cement in Saudi Arabia is presented in Table (7.34), and the import of cement from the U.A.E. by the Saudi market is presented in Table (7.35).

Table (7.34)

Forecasted Cement Demand in Saudi Arabia

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	4499.0	3226.0	2120.0	1172.0
87	4823.0	3429.0	2247.0	1239.0
88	5172.0	3644.0	2381.0	1311.0
89	5537.0	3874.0	2524.0	1386.0
1990	5937.0	4123.0	2675.0	1464.0
91	6365.0	4383.0	2835.0	1547.0
92	6825.0	4658.0	3009.0	1637.0
93	7317.0	5263.0	3189.0	1730.0
94	7846.0	5593.0	3379.0	1828.0
1995	8400.0	6945.0	3582.0	1932.0
96	9006.0	6319.0	3796.0	2045.0
97	9656.0	6717.0	4023.0	2160.0
98	10581.0	7139.0	4270.0	2283.0
99	11345.0	7599.0	4525.0	2416.0
2000	12164.0	8077.0	4795.0	2553.0
01	13043.0	8585.0	5082.0	2698.0
02	13984.0	9125.0	5386.0	2851.0
03	14994.0	9699.0	5708.0	3018.0
04	16060.0	10308.0	6059.0	3189.0
2005	17212.0	10308.0	6421.0	3370.0

Source: Calculated using the econometric model and the values of the exogenous variable generated by the scenarios.

Table (7.35)

Import from The U.A.E. by Saudi Market, 1986-2005

(000) tons

Year	12.0% scenario (1)	9.0% scenario (2)	8.5% scenario (3)	8.0% scenario (4)
1986	540.0	290.0	180.0	94.0
87	579.0	309.0	191.0	99.0
88	621.0	328.0	202.0	105.0
89	664.0	349.0	215.0	111.0
1990	712.0	371.0	227.0	117.0
91	764.0	394.0	241.0	124.0
92	819.0	419.0	256.0	131.0
93	878.0	446.0	271.0	138.0
94	942.0	474.0	287.0	146.0
1995	1008.0	503.0	304.0	155.0
96	1081.0	535.0	323.0	164.0
97	1159.0	569.0	342.0	173.0
98	1270.0	605.0	363.0	182.0
99	1361.0	643.0	385.0	193.0
2000	1460.0	684.0	408.0	204.0
01	1565.0	727.0	432.0	216.0
02	1678.0	773.0	458.0	228.0
03	1799.0	821.0	485.0	241.0
04	1927.0	873.0	515.0	255.0
2005	2065.0	928.0	546.0	270.0

Source: Calculated as a percentage of total demand presented in Table (7.34).

Iraqi market

This market counts as a potential market for the U.A.E. cement industry. The econometric model for Iraqi demand is presented below.

$$\text{Ln } DC_t = 5.308355 + 0.3882287 \text{ Ln } GFCF_t$$

Table (7.36) presents the main parameters of the said model and Figure (7.6) shows the relationship between the actual and the predicted demand over the period between 1970 and 1985. As can be seen from the above model, the coefficient of the independent variable is very low, this is not surprising in a country involved in a war for a long period of time.

Table (7.36)

Statistical Parameters of Iraqi

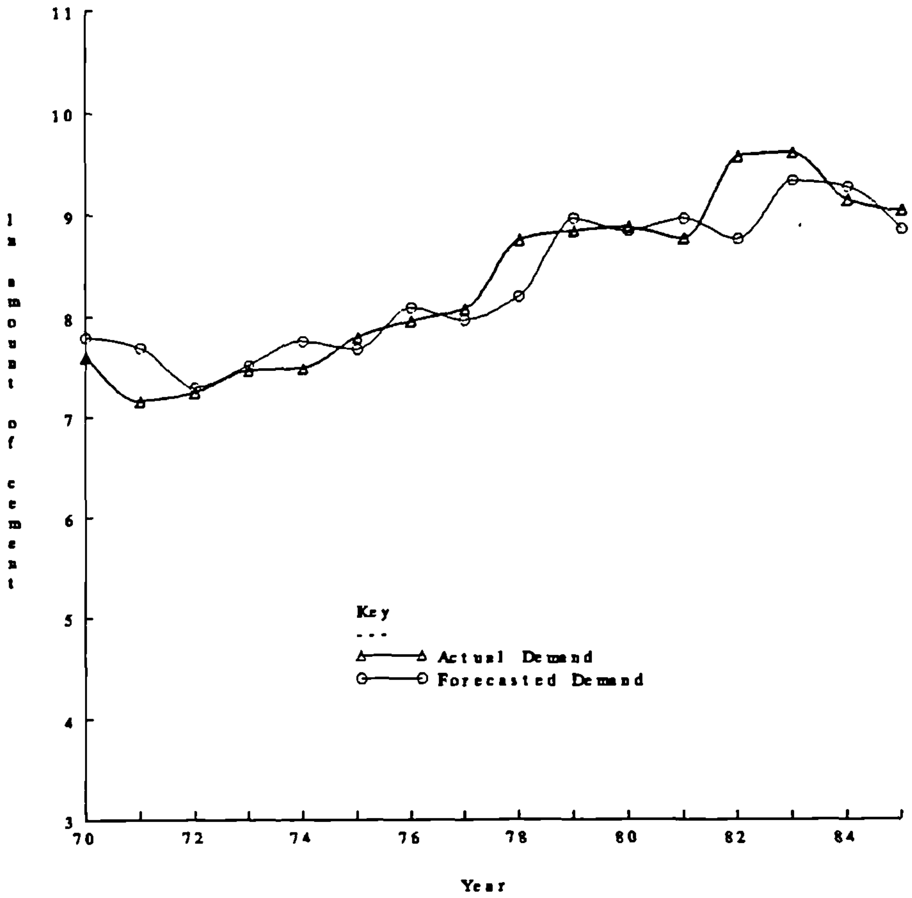
Econometric Model

Parameter	Value
R-squared	0.82
F-statistical	60.75
T-Test	1.59($GFCF_t$)
DW-statistic	1.85
Standard error	0.2447 ($GFCF_t$)
r	0.80
df	14
n	16

Source: Computer print out, Tsp package.

Figure (7.6)

Actual and Forecasted Demand for Cement in Iraq, 1970-1985



Clearly, the fitness of the Iraqi econometric model is adequate compared with other attempts, which are presented in Appendix (D-2). This model is used to predict the demand for cement in Iraq over the next two decades; utilising the values of the exogenous variable generated by means of scenario analysis. Table (7.37) presents the forecasts of cement demand in Iraq, and Table (7.38) presents the import of U.A.E. cement by the Iraqi market calculated as a percentage of the total demand presented in Table (7.37).

Table (7.37)

Forecasted Cement Demand in Iraq, 1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	3239.0	2919.0	2607.0	2387.0
87	3280.0	2953.0	2632.0	2407.0
88	3326.0	2987.0	2720.0	2427.0
89	3371.0	3022.0	2745.0	2448.0
1990	3416.0	3057.0	2774.0	2468.0
91	3463.0	3195.0	2800.0	2489.0
92	3509.0	3233.0	2826.0	2510.0
93	3557.0	3271.0	2854.0	2531.0
94	3605.0	3306.0	2882.0	2551.0
1995	3652.0	3345.0	2910.0	2574.0
96	3700.0	3384.0	2938.0	2595.0
97	3751.0	3424.0	2966.0	2618.0
98	3802.0	3463.0	2995.0	2640.0
99	3853.0	3503.0	3024.0	2661.0
2000	3904.0	3543.0	3052.0	2684.0
01	3956.0	3584.0	3081.0	2707.0
02	4010.0	3625.0	3111.0	2730.0
03	4063.0	3667.0	3141.0	2754.0
04	4119.0	3710.0	3172.0	2776.0
2005	4174.0	3752.0	3202.0	2800.0

Source: Calculated using the econometric model and the values of the exogenous variable generated by the scenarios.

Table (7.38)

Import from The U.A.E. by Iraqi Market, 1986-2005

(000) tons

	10.0%	8.5%	8.0%	7.0%
Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	324.0	248.0	209.0	167.0
87	328.0	251.0	210.0	168.0
88	332.0	254.0	218.0	170.0
89	337.0	257.0	220.0	171.0
1990	342.0	260.0	222.0	173.0
91	346.0	272.0	224.0	174.0
92	351.0	275.0	226.0	176.0
93	356.0	278.0	228.0	177.0
94	361.0	281.0	231.0	179.0
1995	365.0	284.0	233.0	180.0
96	370.0	288.0	235.0	182.0
97	375.0	291.0	237.0	183.0
98	380.0	294.0	240.0	185.0
99	385.0	298.0	242.0	186.0
2000	390.0	301.0	244.0	188.0
01	396.0	305.0	246.0	189.0
02	401.0	308.0	249.0	191.0
03	406.0	312.0	251.0	193.0
04	412.0	315.0	254.0	194.0
2005	417.0	319.0	256.0	196.0

Source: Calculated as a percentage of the total demand presented in Table (7.37).

Egyptian Market:

Another potential market for the U.A.E. cement industry is the Egyptian market. The econometric model for Egypt is presented below.

$$\text{Ln } DC_t = 3.699518 + 0.6834088 \text{ Ln } GFCF_{t-1}$$

Table (7.39) presents the main statistical parameters of this model and figure (7.7) exhibits the relationship between the actual and forecast demand over the period between 1971 and 1985 in Egypt.

Table (7.39)

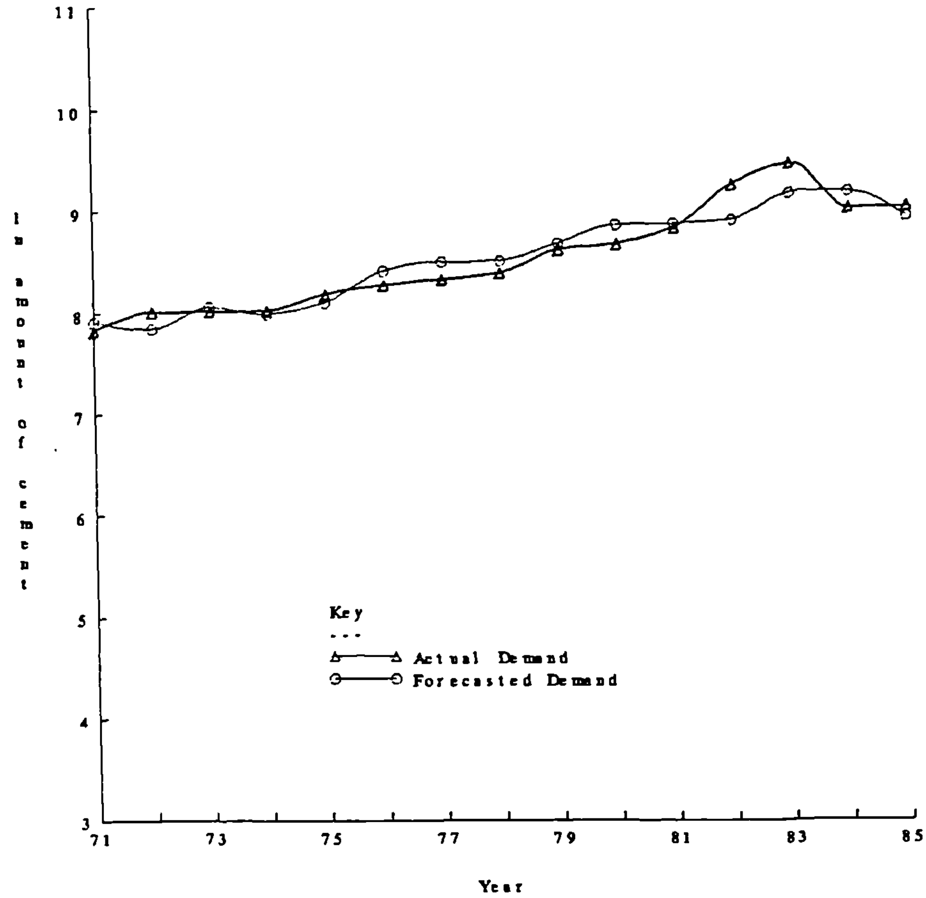
Statistical parameters of Egypt's econometric model

Parameter	Value	Value
	$GFCF_{t-1}$	$(GFCF_t)$
R-squared	0.94	0.95
F-statistical	210.97	289.24
T-Test	5.38 $(GFCF_{t-1})$	3.29 $(GFCF_t)$
DW-statistic	1.62	1.56
Standard error	0.1270 $(GFCF_{t-1})$	0.1809 $(GFCF_t)$
r	0.92	0.85
df	13	14
n	15	16

Source: Computer print out, Tsp package.

Figure (7.7)

Actual and Forecasted Demand for Cement in Egypt, 1971-1985



It is clear, based on the parameters presented in Table (7.38) and Figure (7.7) that the fitness of the Egyptian model is of good quality. This model is used to forecast the demand for cement in Egypt over the next two decades utilising the values of the exogenous variable generated by means of scenario analysis. Table (7.40) presents the forecasts of cement demand in Egypt, and Table (7.41) presents the import of U.A.E. cement by the Egyptian market as a percentage of total demand presented in Table (7.40).

Table (7.40)

Forecasted Cement Demand in Egypt,

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	6810.0	6810.0	6810.0	6810.0
87	5812.0	4610.0	3953.0	3602.0
88	5916.0	4683.0	4009.0	3650.0
89	6020.0	4756.0	4065.0	3698.0
1990	6126.0	4829.0	4123.0	3745.0
91	6236.0	4904.0	4185.0	3793.0
92	6346.0	4993.0	4242.0	3843.0
93	6459.0	5070.0	4303.0	3893.0
94	6572.0	5150.0	4366.0	3943.0
1995	6689.0	5231.0	4429.0	3992.0
96	6808.0	5312.0	4492.0	4045.0
97	6928.0	5395.0	4554.0	4097.0
98	7050.0	5489.0	4622.0	4149.0
99	7176.0	5577.0	4686.0	4204.0
2000	7301.0	5664.0	4753.0	4258.0
01	7432.0	5754.0	4823.0	4312.0
02	7562.0	5842.0	4892.0	4369.0
03	7696.0	5936.0	4961.0	4427.0
04	7832.0	6029.0	5031.0	4482.0
2005	7895.0	6121.0	5103.0	4542.0

Source: Calculated using the econometric model and the values of the exogenous variable generated by the scenarios.

Table (7.41)

Import from The U.A.E. by Egyptian Market, 1986-2005

(000) tons

	4.0%	3.5%	3.0%	2.5%
Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	272.0	238.0	204.0	136.0
87	232.0	161.0	119.0	72.0
88	237.0	164.0	120.0	73 0
89	241.0	166.0	122.0	74.0
1990	245.0	169.0	124.0	75.0
91	249.0	172.0	126.0	76.0
92	253.0	175.0	127.0	77.0
93	258.0	177.0	129.0	78.0
94	263.0	180.0	131.0	79.0
1995	268.0	183.0	133.0	80.0
96	272.0	186.0	135.0	81.0
97	277.0	189.0	137.0	82.0
98	282.0	192.0	139.0	83.0
99	287.0	195.0	141.0	84.0
2000	292.0	198.0	143.0	85.0
01	297.0	201.0	145.0	86.0
02	302.0	204.0	147.0	87.0
03	308.0	208.0	149.0	89.0
04	313.0	211.0	151.0	90.0
2005	316.0	214.0	153.0	91.0

Source: Calculated as a percentage of the total demand presented in Table (7.40).

Iran Market

Another potential market for the U.A.E. cement industry is the Iranian market, but two main factors affect the transfer of this market, and this equally applies to the Iraqi market, from the state of being potential to an actual market. These two factors are; the cessation of the Gulf war on the one hand, and the availability of funds on the other.

The econometric model which is to be used shortly to forecast the demand for cement in Iran is shown below.

$$\text{Ln } DC_t = 4.413308 + 0.4516351 \text{ Ln } GFCF_t$$

Table (7.42) presents the main parameters of the model and Figure (7.8) shows the relationship between actual and predicted demand over the period between 1970 and 1985. It is obvious from the above model that the coefficient of independent variable is low. This is attributed mainly to the war which undoubtedly affected the amount spent on GFCF for building and construction, and also to the development stage of the country.

Table (7.42)

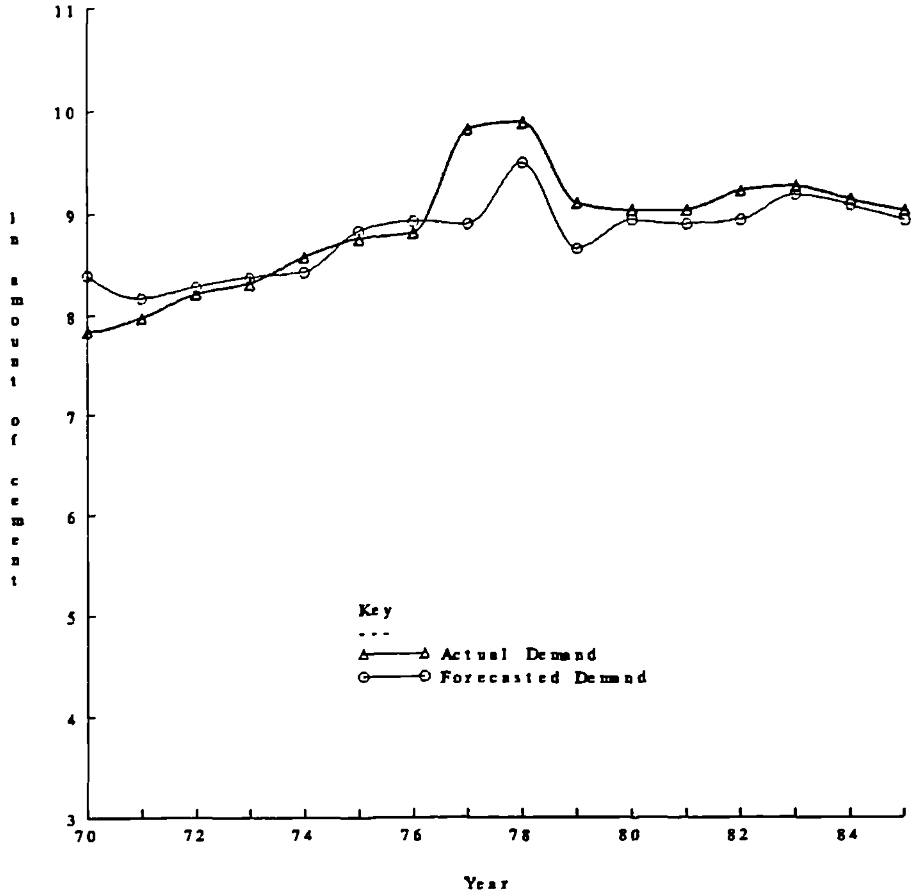
Statistical Parameters of Iran's Econometric Model

Parameter	Value
R-squared	0.83
F-statistical	51.31
T-Test	1.07($GFCF_t$)
DW-statistic	2.53
Standard error	0.4210 ($GFCF_t$)
r	0.44
df	14
n	16

Source: Computer print out, Tsp package.

Figure (7.8)

Actual and Forecasted Demand for Cement in Iran, 1970-1985



Unlike the previously stated models, the Iranian model shows low correlation between the demand for cement and the Gross Fixed Capital Formation in construction and building. Moreover, the value of t-test for both the constant and the independent variable is somewhat low. Several attempts have been conducted to improve the quality of the model, but all have failed to produce better results. The model presented previously is the best of all attempts. This model is used to forecast the demand for cement in Iran for the next two decades. The forecast of the demand for cement in Iran is presented in Table (7.43) and the import of the U.A.E. cement by the Iranian market is presented in Table (7.44).

Table (7.43)

Forecasted Cement Demand in Iran

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	6927.0	6346.0	5834.0	5414.0
87	7026.0	6423.0	5894.0	5463.0
88	7127.0	6500.0	5955.0	5512.0
89	7229.0	6579.0	6019.0	5561.0
1990	7333.0	6659.0	6078.0	5611.0
91	7438.0	6739.0	6141.0	5662.0
92	7544.0	6821.0	6205.0	5713.0
93	7653.0	6903.0	6269.0	5764.0
94	7762.0	6987.0	6397.0	5814.0
1995	7873.0	7072.0	6464.0	5868.0
96	7986.0	7157.0	6530.0	5921.0
97	8101.0	7244.0	6597.0	5974.0
98	8215.0	7332.0	6666.0	6027.0
99	8335.0	7420.0	6734.0	6081.0
2000	8454.0	7510.0	6803.0	6136.0
01	8575.0	7601.0	6874.0	6191.0
02	8698.0	7693.0	6945.0	6247.0
03	8823.0	7786.0	7017.0	6303.0
04	8949.0	7881.0	7089.0	6360.0
2005	9077.0	7976.0	7163.0	6417.0

Source: Calculated using the econometric model and the values of the exogenous variable generated by the scenarios.

Table (7.44)

Import from The U.A.E. by Iranian Market,

1986-2005

(000) tons

Year	8.0% scenario (1)	6.5% scenario (2)	6.0% scenario (3)	5.0% scenario (4)
1986	554.0	412.0	350.0	271.0
87	562.0	417.0	354.0	273.0
88	570.0	423.0	357.0	276 0
89	578.0	428.0	361.0	278.0
1990	587.0	433.0	365.0	281.0
91	595.0	438.0	368.0	283.0
92	604.0	443.0	372.0	286.0
93	612.0	449.0	376.0	288.0
94	621.0	454.0	384.0	291.0
1995	630.0	460.0	388.0	293.0
96	639.0	465.0	392.0	296.0
97	648.0	471.0	396.0	299.0
98	657.0	477.0	400.0	301.0
99	667.0	482.0	404.0	304.0
2000	676.0	488.0	408.0	307.0
01	686.0	494.0	412.0	310.0
02	696.0	500.0	417.0	312.0
03	706.0	506.0	421.0	315.0
04	716.0	512.0	425.0	318.0
2005	726.0	518.0	430.0	321.0

Source: Calculated as a percentage of the total demand presented in Table (7.43).

Oman Market:

The Omani market was, and will continue to be, a very important export market for the U.A.E. cement industry. For example, in 1985, about 48 percent of the U.A.E. exported cement went to the Omani market.

Several attempts have been conducted to reach an acceptable model. Unfortunately, all these attempts have failed. These attempts include: the use of original data of both the dependent variable and the independent variable; the use of quadratic independent variable and original data of the dependent variable; the use of double logarithmic, the use of first difference for both the dependent and independent variable, anti-logarithmic model, polynomial model, and semi-logarithmic model. In all attempts there was a sign of auto correllation. Since a model has to be chosen to forecast the demand for cement in Oman and in turn the import of cement from the U.A.E. by Omani market. The best of the worst has been chosen and the chosen model is shown here.

$$\text{Ln } DC_t = -6.605728 + 1.830640 \text{ Ln } GFCF_t$$

Table (7.45) presents the main statistical parameters of Oman's model, while Figure (7.9) shows the relationship between the actual and the predicted demand of cement in Oman over the period between 1970 and 1985.

Table (7.45)

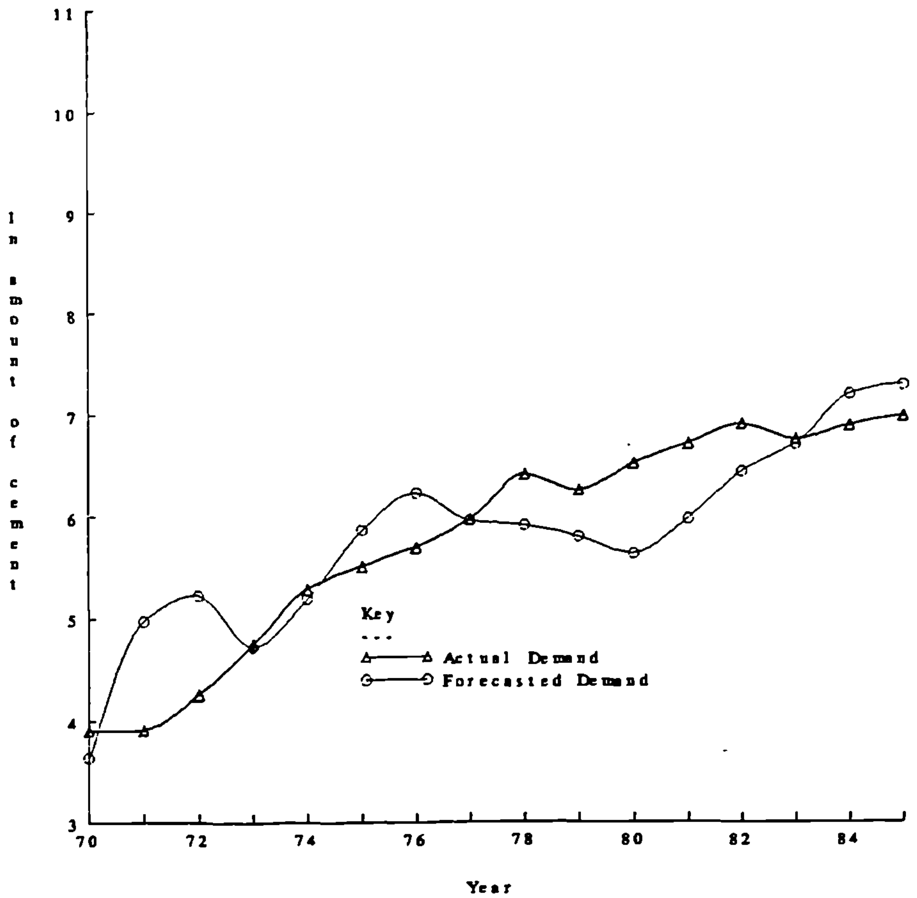
Statistical Parameters of Oman's Econometric Model

Parameter	Value
R-squared	0.73
F-statistical	38.19
T-Test	6.170 ($GFCF_t$)
DW-statistic	0.87
Standard error	0.2962 ($GFCF_t$)
r	0.86
df	14
n	16

Source: Computer print out, Tsp package.

Figure (7.9)

Actual and Forecasted Demand for Cement in Oman, 1970-1985



Clearly, as already mentioned, auto correlation is evidence, this is judged based on the low value of DW-statistic. Furthermore, the value of T-test of the independent variable is insignificant.

Despite these harsh facts, the model is used to forecast the demand for cement in Oman over the next two decades. Table (7.46) presents the forecast of cement demand in Oman using the model and the values of the exogenous variable generated through the use of scenario analysis, and Table (7.47) presents the import of U.A.E. cement by the Omani market calculated as a percentage of total demand presented in Table (7.46).

Table (7.46)

Forecasted Cement Demand in Oman

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	1047.0	506.0	369.0	288.0
87	1139.0	547.0	396.0	308.0
88	1239.0	589.0	426.0	330.0
89	1348.0	635.0	458.0	354.0
1990	1464.0	648.0	492.0	378.0
91	1595.0	740.0	528.0	405.0
92	1732.0	797.0	567.0	433.0
93	1885.0	859.0	610.0	465.0
94	2050.0	926.0	654.0	497.0
1995	2230.0	998.0	704.0	532.0
96	2426.0	1076.0	756.0	570.0
97	2639.0	1160.0	813.0	610.0
98	2871.0	1253.0	874.0	653.0
99	3124.0	1350.0	938.0	700.0
2000	3398.0	1456.0	1009.0	748.0
01	3696.0	1569.0	1082.0	802.0
02	4021.0	1692.0	1164.0	858.0
03	4690.0	1823.0	1250.0	920.0
04	5102.0	1966.0	1343.0	984.0
2005	5550.0	2123.0	1443.0	1053.0

Source: Calculated using the econometric model and the values of the exogenous variable generated by the scenarios.

Table (7.47)

Import from The U.A.E. by Omani Market,

1986-2005

(000) tons

Year	14.0% scenario (1)	12.0% scenario (2)	10.5% scenario (3)	8.0% scenario (4)
1986	147.0	61.0	39.0	23.0
87	159.0	66.0	42.0	25.0
88	173.0	71.0	45.0	26 0
89	189.0	76.0	48.0	28.0
1990	205.0	78.0	52.0	30.0
91	223.0	89.0	55.0	32.0
92	242.0	96.0	60.0	35.0
93	264.0	103.0	64.0	37.0
94	287.0	111.0	69.0	40.0
1995	312.0	120.0	74.0	43.0
96	340.0	129.0	79.0	46.0
97	369.0	139.0	85.0	49.0
98	402.0	150.0	92.0	52.0
99	437.0	162.0	98.0	56.0
2000	476.0	175.0	106.0	60.0
01	517.0	188.0	114.0	64.0
02	563.0	203.0	122.0	69.0
03	657.0	219.0	131.0	74.0
04	714.0	236.0	141.0	79.0
2005	777.0	255.0	152.0	84.0

Source: Calculated as a percentage of the total demand presented in Table (7.46).

Having calculated the import of U.A.E. cement by each individual country which comprises the present and the potential export markets for the U.A.E. cement industry, let us summarise these figures in a single table. Table (7.48) presents the total export demand for U.A.E. cement. The discussion of the figures in this table is given in the next section. However, a few facts should be noted regarding the seven econometric models developed earlier. First, the coefficient of the independent variable is high in the case of U.A.E., Saudi Arabia and Oman and low in the case of Kuwait, Iraq, Egypt and Iran. It is expected to have such a difference since the first group represents high income countries, whereas the second, with the exception of Kuwait, represents low income countries.

Another reason for the high coefficient of the independent variable of group one and low of group two is the development stage and in the case of Iraq and Iran is the war and the revolution in Iran prior to the war.

Second, two types of model have been used, a model lagged independent variable has been used for Kuwait and Egypt, whereas, an unlagged independent model has been used for the remaining five countries. Two criteria have been used to choose between different form of the models: first, statistical criteria which is the good fitness of the model measured by R-squared, T-test, Standard error and DW-statistic; and second, the form chosen should have an economic meaning.

It should be noted that for each country the following models have been constructed:

(1) linear model,

(2) double logarithmic model,

(3) anti-logarithmic model.

(4) quadratic model,

(5) polynomial model,

(6) double logarithmic with lagged dependent treated as independent in addition to lagged independent variable,

(7) semi-logarithmic model.

The choice between those models was based on the above two criteria.

Table (7.48)

Total Export Demand for U.A.E. Cement

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	931.0*	570.0*	422.0*	312.0*
87	964.0*	550.0*	389.0*	270.0*
88	1025.0*	581.0*	408.0*	279 0*
89	1088.0*	607.0*	424.0*	291.0*
1990	1156.0*	634.0*	443.0*	300.0*
91	2172.0+	671.0*	462.0*	311.0*
92	2264.0+	706.0*	485.0*	316.0*
93	2363.0+	1467.0+	506.0*	334.0*
94	2469.0+	1514.0+	530.0*	348.0*
1995	2841.0	1565.0+	1176.0+	362.0+
96	2970.0	1622.0+	1208.0+	377.0+
97	3101.0	1678.0+	1242.0+	873.0+
98	3269.0	1927.0	1280.0+	891.0+
99	3420.0	1995.0	1317.0+	913.+
2000	3582.0	2065.0	1500.0	936.0+
01	3755.0	2138.0	1543.0	958.0+
02	3937.0	2215.0	1590.0	982.0+
03	4179.0	2296.0	1637.0	1097.0
04	4390.0	2381.0	1689.0	1123.0
2005	4615.0	3761.0	1743.0	1152.0

(*) excluding the import by Egyptian, Iraqi and Iranian markets.
(+) excluding the import by the Egyptian market only.

7.9 Results Analysis:

This section concerns itself with the analysis of results of the previous two sections, namely sections (7.7) and (7.8). Let us start with the forecast of the home demand mentioned in section (7.7). It should be kept in mind that materialisation of the forecast appeared in Table (7.28) p.(314) is subject to availability of funds which in turn depends on oil prices and revenues.

As mentioned earlier, the forecast figures are possible and attainable but not assured. As can be noticed from Table (7.28) p.(314), between 1986 and 1991, the figures are slightly low under the four scenarios, this is due mainly to the completion of the major infrastructures in the country on the one hand and the recession in the economy on the other. Starting 1992 and till 1997, the situation would improve greatly; this is due partly to the improvement in the oil market, and in turn in oil revenues, and partly to the replacement activities for many projects which executed during the late 60's and early to mid 70's. The growth in the population is also expected to contribute to some extent to this growth in demand for cement. Between 1998 and 2005 a dramatic growth in the demand would take place, this is due to the same reasons mentioned previously, of course, provided that funds are available. With regard to the export market, the GCC countries are expected to import a great deal of their requirements from the U.A.E. This is due on the one hand to placing the economic agreement into effect and imposing protective tariffs against imports from outside the region on the other. Attention is now paid to each of the six export markets.

Kuwaiti demand is affected by almost the same factors as those affecting the U.A.E. demand, and this is equally applicable to other Gulf states. A glance to Table (7.31), p.(321) reveals that demand between 1986 and 1994 would be low and this is expected for a country like Kuwait with a small area, small population and the development in the country having reached its stagnation stage. Starting in 1995, the demand would pull up and would continue until 2005. Once again this behaviour is normal, partly because of the replacement activities which would take place for those projects which has been built during the 70's and early 80's, and partly because of the growth in the population and the need to cope with such expansion. Since the import of U.A.E. cement is of concern to us, therefore it is important to stress that the import by Kuwaiti market would continue. This is based on three assumptions: the cooperation between Gulf states, mainly GCC countries, would strengthen as time goes on; that Kuwaitis invest a great deal of money in the U.A.E. cement industry, therefore it is their obligation to buy from the U.A.E. rather than from other foreign countries; and finally, the scope for capacity expansion is almost nil due to the fact that no raw materials are in existence. Saudi demand is also affected, as already mentioned, by the same factors which affect U.A.E. and Kuwaiti demand. A careful look to Table (7.34), p.(325) shows that the predicted demand is slightly lower than it might actually be, especially over the period between 1986 and 1992. Although such a low demand is not unusual over this period of time, as we have seen in the case of the U.A.E. and Kuwait. It is not expected in the case of Saudi Arabia that demand drops sharply over this period of time. This is due to the fact that Saudi Arabia is of a large area and large population compared with the other GCC countries, and because the recession in the economy during 1982 and 1986 has delayed the completion of many projects; thus the process of construction is expected to continue over the period between 1986 and 1992 at its current level provided that funds are available. Starting in 1993/1994 things would return to normal and the demand would be mainly for maintenance and replacement activities and at a smaller scale for new projections to cope with the growth in population. As far as the import from the U.A.E. cement industry is concerned, Saudi´s import from U.A.E. cement is expected to continue but on a lower scale despite the fact that their own capacity might in theory be enough to cover the whole demand in Saudi Arabia. This is attributed to the fact that rural areas located closer to the U.A.E. border and far from Saudi cement plants have advantages of getting U.A.E. cement rather than their own. Iraqi and Iranian demand is affected by similar circumstances, namely the end of the war and the availability of funds. The latter is affected by oil prices and in turn revenues.

A glance to the forecast of demand in Iraq presented in Table (7.37), p.(331) reveals that the predicted demand in 1986 and 1987 is lower than it might actually be, this is because GFCF spent on construction for military purposes is not presented in the model. The same applies to Iran. The predicted demand in Iraq after 1987, and until the end of the period, year 2005, is expected to be near the actual, provided, of course, that the war ends and funds are available. It is not expected that all construction projects are to be executed immediately after the war and over a short period of time, rather it is expected to be stretched over a long period of time and the priority in the execution depends on the significance of the projects to the country. As far as the import from the U.A.E. is concerned; it is not expected that they, both Iraq and Iran, would expand their own capacity since they can get what they need at a cheaper price from the U.A.E. as well as other nations. Furthermore, because of their location close to the U.A.E., it would be much better for them to get their needs for cement from there.

Moreover, some assistance provided by the U.A.E. to those two nations might be in the form of cement rather than money. To start with, Oman's model was not so good. However, the predicted demand, especially under scenario (1), is within the attainable level. The same factors which affect the demand in other Gulf states are applicable here. As far as the demand from the U.A.E. is concerned, the import from the U.A.E. by Omani market is expected to continue but, of course, not at its current scale. Although, Oman has had its own plants since 1984 imports would continue to the regions closer to the U.A.E. borders and far away from their own plants. As time goes on, the cooperation between GCC countries is also expected to strengthen, consequently more import of cement from the U.A.E. is expected as opposed to the import from foreign nations like Korea and Japan. A quick look to Table (7.40), p.(333), which presents the demand for cement in Egypt, reveals that the predicted demand is within the achievable level. Egypt has plans to build complete cities to ease its housing problems, but, of course, materialising such plans depends wholly on the availability of funds which are affected by external and uncontrollable factors. If such plans are put into effect, the predicted demand is expected to be slightly lower than the actual. With regard to the import from the U.A.E. cement industry, the Egyptian market is considered to be a potential market to it. Hence, small percentages are used to calculate the import from the U.A.E. to avoid overestimation of the import by this market.

A glance to Table (7.48), p.(348) which presents total export demand for the U.A.E. cement industry reveals that the export to the Egyptian, Iraqi and Iranian markets was excluded for some of the years under the four scenarios.

This is attributed to the fact that the import of U.A.E. cement by Iraq and Iran are not expected to start until at least three years after the war ends, and we assumed that in scenario (1) the war ends in the year 1988, in scenario (2) the war ends by the year 1990, in scenario (3) the war ends by the year 1992 and in scenario (4) the war ends by the year 1994. Consequently, the starting time of the export to those two markets varies from one scenario to another.

With respect to the export to the Egyptian market, this market as mentioned earlier, is a potential one and therefore we assumed that some time may elapse before this market becomes an actual market and this lead time varies from one scenario to another.

Having highlighted the home and export demand for the U.A.E. cement industry, it is important to draw the reader's attention to the fact that no justified long range or short range forecast for home and export demand of the U.A.E. cement is reported. There was merely a forecast of a medium term type based on a regression model using GDP and population as independent variables. This forecast has been conducted by Gulf Organisation for Industrial Consulting (GOIC). The total forecast of the U.A.E. cement industry based on our forecasting approach is presented in Table (7.49), and for the purpose of decision making a high and low total demand within each five year interval and under the four scenarios is presented in Table (7.50) with average probabilities calculated on the basis of the opinion of a group of experts in the U.A.E cement industry (a copy of the survey used is presented in Appendix A). The figures of this latter table with the probability will be used in the scenario/strategies matrices which we are going to build in the next chapter. Figure (7.10) presents total demand for the U.A.E. cement industry between 1986 and 2005. Based on this figure, we strongly believe that the demand for U.A.E. cement is more likely to be higher than the lowest scenario and equal to or less than the highest one.

Table (7.49)

Total Demand for U.A.E. Cement

1986-2005

(000) tons

Year	scenario (1)	scenario (2)	scenario (3)	scenario (4)
1986	2880.0	1659.0	1344.0	966.0
87	3058.0	1715.0	1446.0	965.0
88	3279.0	1826.0	1534.0	1017.0
89	3514.0	1938.0	1623.0	1074.0
1990	3767.0	2053.0	1720.0	1133.0
91	3962.0	2187.0	1821.0	1166.0
92	5285.0	2326.0	1935.0	1256.0
93	5615.0	3198.0	2051.0	1322.0
94	5968.0	3363.0	2176.0	1408.0
1995	6608.0	3540.0	2928.0	1487.0
96	7018.0	3732.0	3074.0	1574.0
97	7260.0	3932.0	3230.0	2144.0
98	7959.0	4335.0	3398.0	2204.0
99	8468.0	4567.0	3572.0	2346.0
2000	9016.0	4813.0	3902.0	2458.0
01	9594.0	5074.0	4101.0	2576.0
02	10222.0	5351.0	4319.0	2701.0
03	10944.0	5646.0	4544.0	2922.0
04	11672.0	5961.0	4785.0	3061.0
2005	12452.0	7585.0	5041.0	3209.0

Table (7.50)

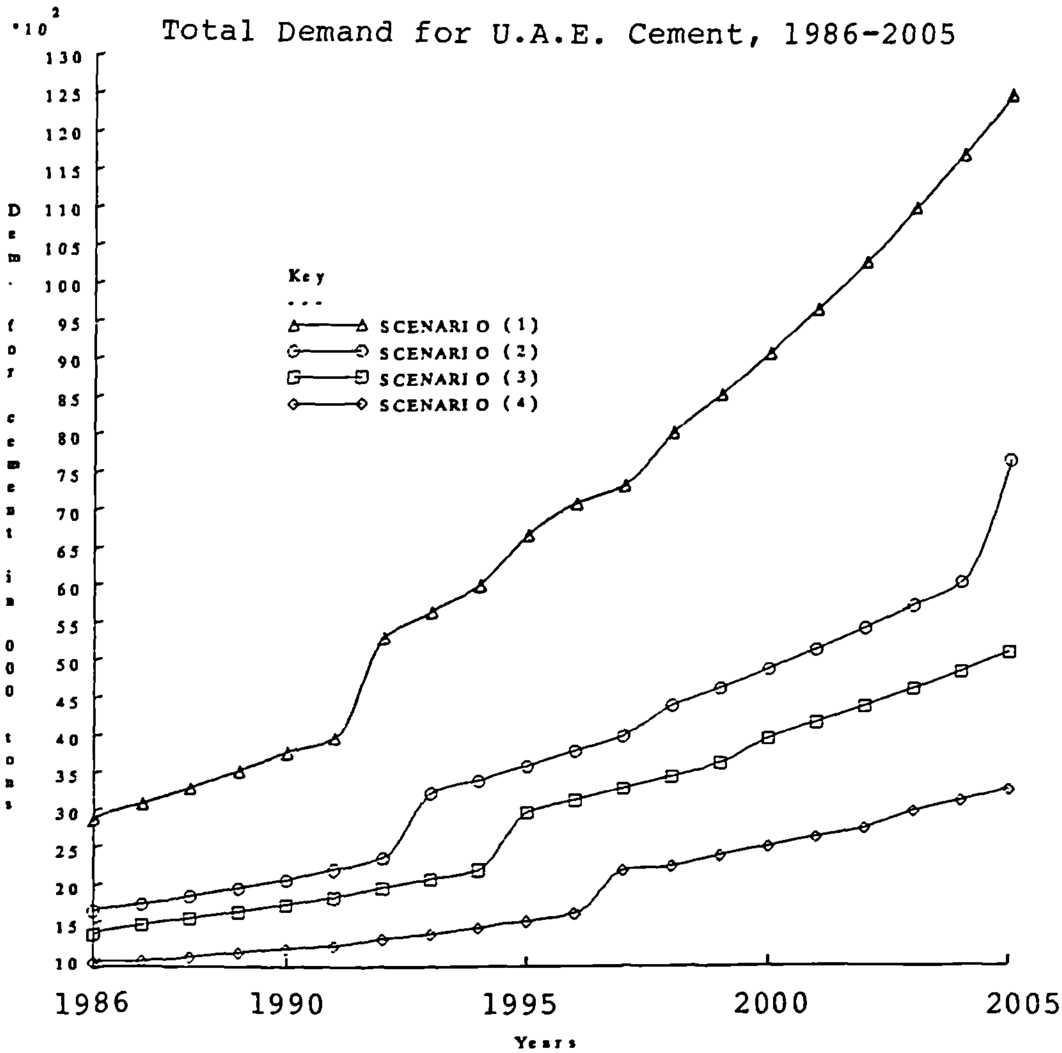
States of The Environment

(000) tons

Scenarios / Intervals	Scenario No.(1)		Scenario No.(2)		Scenario No.(3)		Scenario No.(4)	
	High	Low	High	Low	High	Low	High	Low
1986-1990	3700.0	2900.0	2000.0	1600.0	1700.0	1300.0	1100.0	1000.0
Probability	21.0%	22.0%	30.0%	34.0%	27.0%	28.0%	22.0%	16.0%
1991-1995	6600.0	3900.0	3500.0	2200.0	2900.0	1800.0	1400.0	1200.0
Probability	20.0%	30.0%	21.0%	24.0%	27.0%	29.0%	32.0%	17.0%
1996-2000	9000.0	7000.0	4800.0	3700.0	3900.0	3100.0	2500.0	1600.0
Probability	15.0%	21.0%	21.0%	24.0%	26.0%	24.0%	38.0%	31.0%
2001-2005	12400.0	9600.0	7600.0	5000.0	5000.0	4100.0	3200.0	2600.0
Probability	12.0%	15.0%	19.0%	17.0%	28.0%	26.0%	41.0%	42.0%

Figure (7.10)

Total Demand for U.A.E. Cement, 1986-2005



7.10 Conclusion:

The main objective of this chapter has been to estimate the environment of the cement industry as the first step toward implementing the proposed procedure.

From the discussion of this chapter one can draw the following conclusions: first, and foremost, that regardless of the forecasting techniques used, long term forecasting is more exposed to a high degree of errors than short and medium term. Second, the assumptions underlying the method of forecasting used, are far more important than the method itself. Third, unlike other research work where scenarios have been used as a one shot exercise, i.e. to evaluate demand for energy in the year 2000, this work concerns itself, for the purpose of planning, with evaluating the demand over a long period of time. Fourth, multiple forecasting is more realistic especially when a high degree of uncertainty is evident.

The next chapter examines the application of the remaining steps of the procedure developed in chapter six of this thesis.

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CHAPTER EIGHT

APPLICATION OF THE APPROACH:

STRATEGIES FASHIONING, EVALUATION, CHOICE AND IMPLEMENTATION

CHAPTER 8

APPLICATION OF THE APPROACH:

STRATEGIES FASHIONING, EVALUATION, CHOICE AND IMPLEMENTATION

8.1 Introduction

The main concern of the last chapter was to discuss the first step in the application of the proposed procedure. This chapter discusses the remaining steps in the application of this procedure. It examines the formulation of alternative strategies, the construction of the scenario/strategy matrices, the evaluation of alternative strategies presented in the matrices, and the choice between alternative strategies. It also examines the validity of the choice made under different circumstances. Finally it discusses the best methods of implementing the chosen strategy.

8.2 Strategies Fashioning:

In the previous chapter, the problem has been formulated, now attention is directed toward formulating alternative strategies to achieve decision makers' objectives. As mentioned in chapter six, there are several ways of going about formulating alternative strategies. It was decided to use an integrated method which consists of: brainstorming, logical method and thorough discussion with the decision makers. Table (8.1) presents a list of alternative strategies which resulted from the brainstorming and the logical method exercise. The number of alternative strategies is limited, due to technical constraints on the cut in capacity. This list was presented to the decision makers at the second level to choose those strategies which they consider to be practical and feasible or suggest their own alternative ones. This produced a shortened list. This shortened list is presented in Table (8.2). (A copy of the survey used is presented in Appendix A).

Table (8.1)

Alternative Strategies Based on Brainstorming and Logical Method

No.	Strategies
(1)	Do nothing strategy, keep the current level of capacity - (0.0% cut in capacity)
(2)	Cut the total capacity by 100% or shut-down the whole industry
(3)	Cut the total capacity by 75%
(4)	Cut the total capacity by 50%
(5)	Cut total capacity by 25%
(6)	Cut clinker capacity by 50% and keep full grinding capacity
(7)	Cut clinker capacity by 75% and keep full grinding capacity
(8)	Cut clinker capacity by 25% and keep full grinding capacity
(9)	Cut clinker capacity by 25% and cut grinding capacity by 50%
(10)	Cut clinker capacity by 50% and cut grinding capacity by 50%
(11)	Cut clinker capacity by 75% and cut grinding capacity by 25%
(12)	Re-organise the entire cement industry

Table (8.2)

Alternative Strategies Based on Decision Makers Choice

No.	Strategies
(1)	Do nothing strategy, or keep the current level of capacity. (zero cut in capacity).
(2)	Cut capacity by 100% or shut-down the whole cement industry
(3)	Cut total capacity by 50%
(4)	Cut total capacity by 75%
(5)	Cut clinker capacity by 25% and grinding capacity by 50%
(6)	Re-organise the entire cement industry
(7)	Establish a marketing organisation to carry out all marketing activities on behalf of cement factories

The first six strategies are evaluated against the four chosen scenarios over each interval of the four intervals. Strategy no. (7) has not been evaluated since quantitative evaluation of this strategy is somewhat difficult to carry out because it only exists as an idea at present and no details are available about timing, structure, costs and methods of such an organisation. Furthermore, this strategy is not directly relevant to the problem investigated since the problem facing the industry is having more capacity than needed and establishing a marketing organisation might reduce the problem in the short term but not eliminate it as there is and will continue to be a surplus of capacity at the world market level for many years.

8.3 Scenarios/Strategies Matrices Building

The generation of alternative strategies in the previous section was based on brainstorming, logical method (e.g.

halve the capacity or double capacity), and thorough discussion with the clients. Utilising the levels of the market generated in chapter seven by means of scenario analysis and econometric modelling; and alternative strategies generated in the previous section, we are going to construct scenarios/strategies matrices.

Eight matrices are built, two for each interval of the four five-year intervals, one for the low-level market, and one for the high-level market over each interval. The main assumptions on which these matrices are based, are outlined below. These assumptions are based to some extent on the opinion of a group of experts in the cement industry.

(i) there should be 300 thousand tons slack production (annual) over the planning horizon. This assumption was based on the decision makers' opinion that this amount of slack production is about right for this type of industry;

(ii) shortages cost would be DH 20 per ton of capacity over the planning horizon. This cost represents opportunity loss which is incurred for not satisfying the demand;

(iii) idle capacity holding cost would increase by 5 percent over the second and third intervals and remain constant thereafter. This assumption is based on the fact that the major components of this cost are incurred as a result of fuel and electricity and labour for maintenance which are locally available and the price of these are unlikely to go up more than what is assumed here;

(iv) re-organising the entire cement industry means merger and closure of plants owned by the same shareholders;

(v) no salvage or scrap value for retired assets. This assumption is based on the fact that no buyers are available to buy second-hand kilns and mills in the neighbouring countries, partly because there is no need for them, and partly because of high transportation costs.

Now attention is turned to the construction of the decision matrices. These matrices are presented in the next few pages and the method of calculating their contents is given in Appendix (D-1). It should be made clear that the figures presented in the upper level of the diagonal in each cell of the matrices represent either surplus or shortage in capacity depending on the sign (+) or (-) respectively, while figures in the lower level of the diagonal in each cell represent the outcomes of multiplying the surplus or shortage by the probability by the cost of surplus or shortage in capacity whichever the case may be.

The figures in the lower level of the diagonal in the last column in each matrix represent total expected costs, while the figures in the upper level of the diagonal represent the total expected shortages or surplus depending on the sign (-) or (+) respectively.

It is to be noted that the idle capacity holding costs consist of: maintenance costs, indirect labour cost, fuel and electricity and the increase in production costs (the difference between the cost per ton when capacity utilisation is 100% and the actual level of capacity utilisation) and depreciation.

In the following eight matrices, strategies one to six are used to mean the following:

Strategy (1): do nothing and in turn the total capacity remains 8 million tons p.a.;

Strategy (2): close down the whole industry or cut the current level of capacity by 100%;

Strategy (3): halve the current level of capacity, which means that the level of capacity will become 4 million tons p.a.;

Strategy (4): cut clinker capacity by 25% and grinding capacity by 50%, which means that the level of capacity will be 6 million tons p.a.;

Strategy (5): cut the current level of capacity by 75%, this would lead to the capacity being 2 million tons p.a.;

Strategy (6): re-organise the entire cement industry, this leads to capacity being 5.5 million tons annually.

It should be made clear that although a discount rate can be used for comparing profitability over a long time in the future, it has not been used for calculating the costs presented in the following matrices due to the fact that the choice of any particular value of the discount rate over a very long time in the future is difficult to justify. Furthermore, because of the absence of a capital market in the U.A.E. for religious reasons it would be inappropriate to use a discount rate.

Table (8.3)

Scenario/Strategy Matrix No.(1)

1986-1990 (high level)

Average probability	21.0%	30.0%	27.0%	22.0%	100.0%
scenarios (demand)	(1)	(2)	(3)	(4)	Total expected demand
Strategies	3700	2000	1700	1100	2078
					Total expected costs
Strategy (1)	+4000 / 131040	+5700 / 266760	+6000 / 252720	+6600 / 226512	+5622 / 877032
Strategy (2)	-3700 / 15540	-2000 / 12000	-1700 / 9180	-1100 / 4840	-2078 / 41560
Strategy (3)	0 / 0	+1700 / 79560	+2000 / 84240	+2600 / 89232	+1622 / 253032
Strategy (4)	+2000 / 65520	+3700 / 173160	+4000 / 168480	+4600 / 157872	+3622 / 565032
Strategy (5)	-2000 / 8400	-300 / 1800	0 / 0	+600 / 20592	-378 / 30792
Strategy (6)	+1500 / 49140	+3200 / 149760	+3500 / 147420	+4100 / 140712	+3122 / 487032

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) shortage and (+) excess in capacity.

Idle capacity holding costs DH 156 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

Table (8.4)

Scenario/Strategy Matrix No.(2)

1991-1995 (high level)

Average probability	20.0%	21.0%	27.0%	32.0%	100.0%
scenarios (demand) / Strategies	(1) 6600	(2) 3500	(3) 2900	(4) 1400	Total expected demand 3286
					Total expected costs
Strategy (1)	+1100 / 36080	+4200 / 144648	+4800 / 212544	+6300 / 330624	+4414 / 723896
Strategy (2)	-6600 / 26400	-3500 / 14700	-2900 / 15660	-1400 / 8960	-3286 / 65720
Strategy (3)	-2900 / 11600	+200 / 6888	+800 / 35424	+2300 / 120704	+414 / 174616
Strategy (4)	-900 / 3600	+2200 / 75768	+2800 / 123984	+4300 / 225664	+2414 / 429016
Strategy (5)	-4900 / 19600	-1800 / 7560	-1200 / 6480	+300 / 15744	-1586 / 49384
Strategy (6)	-1400 / 5600	+1700 / 58548	+2300 / 101844	+3800 / 199424	+1914 / 365416

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) capacity shortage, (+) idle capacity.

Idle capacity holding costs DH 164 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

Table (8.5)

Scenario/Strategy Matrix No.(3)

1996-2000 (high level)

Average probability	15.0%	21.0%	26.0%	38.0%	100.0%
scenarios (demand) / Strategies	(1) 9000	(2) 4800	(3) 3900	(4) 2500	Total expected demand 4322
					Total expected costs
Strategy (1)	-1300 / 3900	+2900 / 104748	+3800 / 169936	+5200 / 339872	+3378 / 618456
Strategy (2)	-9000 / 27000	-4800 / 20160	-3900 / 20280	-2500 / 19000	-4322 / 86440
Strategy (3)	-5300 / 15900	-1100 / 4620	-200 / 1040	+1200 / 78432	-622 / 99992
Strategy (4)	-3300 / 9900	+900 / 32508	+1800 / 80496	+3200 / 209152	+1378 / 332056
Strategy (5)	-7300 / 21900	-3100 / 13020	-2200 / 11440	-800 / 6080	-2622 / 52440
Strategy (6)	-3800 / 11400	+400 / 14448	+1300 / 58136	+2700 / 176472	+878 / 260456

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) shortage and (+) excess in capacity.

Idle capacity holding costs DH 172 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

Table (8.6)

Scenario/Strategy Matrix No.(4)

2001-2005 (high level)

Average probability	12.0%	19.0%	28.0%	41.0%	100.0%
scenarios (demand) / Strategies	(1) 12400	(2) 7600	(3) 5000	(4) 3200	Total expected demand 5644
					Total expected costs
Strategy (1)	-4700 / 11280	+100 / 3268	+2700 / 130032	+4500 / 317340	+2056 / 461920
Strategy (2)	-12400 / 29760	-7600 / 28880	-5000 / 28000	-3200 / 26240	-5644 / 112880
Strategy (3)	-8700 / 20880	-3900 / 14820	-1300 / 7280	+500 / 35260	-1944 / 78240
Strategy (4)	-6700 / 16080	-1900 / 7220	+700 / 33712	+2500 / 176300	+56 / 233312
Strategy (5)	-10700 / 25680	-5900 / 22420	-3300 / 18480	-1500 / 12300	-3944 / 78880
Strategy (6)	-7200 / 17280	-2400 / 9120	+200 / 9632	+2000 / 141040	-444 / 177072

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) shortage and (+) excess in capacity.

Idle capacity holding costs DH 172 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

Table (8.7)

Scenario/Strategy Matrix No.(1)

1986-1990 (low level)

Average probability	22.0%	34.0%	28.0%	16.0%	100.0%
scenarios (demand) / Strategies	(1) 2900	(2) 1600	(3) 1300	(4) 1000	Total expected demand 1706
					Total expected costs
Strategy (1)	+4800 / 164736	+6100 / 3235444	+6400 / 279552	+6700 / 167232	+5994 / 935064
Strategy (2)	-2900 / 12760	-1600 / 10880	-1300 / 7280	-1000 / 3200	-1706 / 34120
Strategy (3)	+800 / 27456	+2100 / 111384	+2400 / 104832	+2700 / 67392	+1994 / 311064
Strategy (4)	+2800 / 96096	+4100 / 217464	+4400 / 192192	+4700 / 117312	+3994 / 623064
Strategy (5)	-1200 / 5280	+100 / 5304	+400 / 17472	+700 / 17472	-6.0 / 45528
Strategy (6)	+2300 / 78936	+3600 / 190944	+3900 / 170352	+4200 / 104832	+3494 / 545064

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) shortage and (+) excess in capacity.

Idle capacity holding costs DH 156 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

Table (8.8)

Scenario/Strategy Matrix No.(2)

1991-1996 (low level)

Average probability	30.0%	24.0%	29.0%	17.0%	100.0%
scenarios (demand) / Strategies	(1) 3900	(2) 2200	(3) 1800	(4) 1200	Total expected demand 2424
					Total expected costs
Strategy (1)	+3800 / 186960	+5500 / 216480	+5900 / 280604	+6500 / 181220	+5276 / 865264
Strategy (2)	-3900 / 23400	-2200 / 10560	-1800 / 10440	-1200 / 4080	-2424 / 48480
Strategy (3)	-200 / 1200	+1500 / 59040	+1900 / 90364	+2500 / 69700	+1276 / 220304
Strategy (4)	+1800 / 88560	+3500 / 137760	+3900 / 185484	+4500 / 125460	+3276 / 537264
Strategy (5)	-2200 / 13200	-500 / 2400	-100 / 580	+500 / 13940	-724 / 30120
Strategy (6)	+1300 / 63960	+3000 / 118080	+3400 / 161704	+4000 / 111520	+2776 / 455264

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) shortage and (+) excess in capacity.

Idle capacity holding costs DH 164 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

Table (8.9)

Scenario/Strategy Matrix No.(3)

1996-2000 (low level)

Average probability	21.0%	24.0%	24.0%	31.0%	100.0%
scenarios (demand) / Strategies	(1) 7000	(2) 3700	(3) 3100	(4) 1600	Total expected demand 3598
					Total expected costs
Strategy (1)	+700 / 25284	+4000 / 165120	+4600 / 189888	+6100 / 325252	+3923 / 705544
Strategy (2)	-7000 / 29400	-3700 / 17760	-3100 / 14880	-1600 / 9920	-3598 / 71960
Strategy (3)	-3300 / 13860	0 / 0	+600 / 24768	+2100 / 111972	+102 / 150600
Strategy (4)	-1300 / 5460	+2000 / 82560	+2600 / 107328	+4100 / 218612	+2102 / 413960
Strategy (5)	-5300 / 22260	-2000 / 9600	-1400 / 6720	+100 / 5332	-1898 / 43912
Strategy (6)	-1800 / 7560	+1500 / 61920	+2200 / 90816	+3600 / 191952	+1626 / 352248

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) shortage and (+) excess in capacity.

Idle capacity holding costs DH 172 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

Table (8.10)

Scenario/Strategy Matrix No.(4)

2001-2005 (low level)

Average probability	15.0%	17.0%	26.0%	42.0%	100.0%
scenarios (demand) / Strategies	(1) 9600	(2) 5000	(3) 4100	(4) 2600	Total expected demand 4448
					Total expected costs
Strategy (1)	-1900 / 5700	+2700 / 78948	+3600 / 160992	+5100 / 368424	+3252 / 614064
Strategy (2)	-9600 / 28800	-5000 / 17000	-4100 / 21320	-2600 / 21840	-4448 / 88960
Strategy (3)	-5900 / 17700	-1300 / 4420	-400 / 2080	+1100 / 79464	-748 / 103664
Strategy (4)	-3900 / 11700	+700 / 20468	+1600 / 71552	+3100 / 223944	+1252 / 327664
Strategy (5)	-7900 / 23700	-3300 / 11220	-2400 / 12480	-900 / 7560	-2748 / 54960
Strategy (6)	-4400 / 13200	+200 / 5848	+1100 / 49192	+2600 / 187824	+752 / 256064

Volume in thousand tons, and value in thousand U.A.E. Dirhams.

(-) shortage and (+) excess in capacity.

Idle capacity holding costs DH 172 per ton of capacity.

Capacity shortage costs DH 20 per ton of capacity.

8.4 Strategies Evaluation

Once having constructed the scenario/strategy matrices, we must then evaluate different strategies presented in these matrices in order to choose the appropriate one. As mentioned in sub-section (6.3.4), two criteria were used to evaluate different strategies to tackle the problem under study. The first criterion is the reduction in the idle capacity holding cost and the capacity shortage cost; and the second criterion is the impact of the strategy on different parties which include: employees, shareholders, the consumers and the economy as a whole. These two criteria are applied to the strategies presented in the eight matrices constructed in the previous section, for both high and low levels market.

It is to be noted that although the decision makers have not participated in the evaluation of different strategies, they are of the opinion that the total capacity needs to be cut so that the operation rate can be improved.

Strategies Evaluation Under High-Levels Market

Strategy one: maintain ′status quo′ strategy

Over the first five-year interval (1986-1990), the total annual expected cost associated with this strategy would be DH 877 million annually, which is idle capacity holding cost. This cost represents about 88 percent of the total investment after depreciation. The total expected cost would decline and reach DH 462 million annually over the fourth interval (2001-2005), about 47 percent reduction in the total costs between the first and fourth interval would be achieved.

It should be pointed out here that the cement industry is making a loss at the present time and it is unlikely to be able to continue for a longer time in the future under these circumstances unless somebody (either the shareholders, the government or the bank) subsidises it. It seems to us that there is no justification for this subsidy and in turn nobody would be willing to put money into an unprofitable industry. Therefore action is needed.

This strategy could have an unpleasant impact on the shareholders, the economy and the well-being of the industry. In contrast, it would satisfy the employees and consumers. The shareholders would not be expected to make any profit from their original investments which amounted to around DH 2000 million. The economy as a whole could not benefit from an inefficient industry, and finally the future of the industry would be in question.

Its advantages for the employees and the consumers can be seen through securing steady employment and in turn wages (about DH 99 million annual wages) for the first group, and getting the right quantity of cheap cement on time for the second. It is cheap because of the surplus supply and the internal competition.

On financial grounds this strategy is not acceptable. It should be noted that although the total expected costs associated with this strategy are huge and this might lead to the conclusion that it would be impossible for the industry to continue in operation for one or two years at most, the actual figures might be much lower than these figures due to the fact that some plants close down from time to time for maintenance (for up to three months eespecially during the summer). Consequently, lots of staff are laid off, and this leads to a cut in costs, in addition to other ways of compensating losses, and also due to the errors in the costs provided to us.

<u>Strategy two: close down the whole cement industry</u>

The total expected cost associated with this strategy would be DH 42 million annually over the first interval (1986-1990). This cost would increase and reach DH 113 million annually over the fourth interval (2001-2005), or in other words, 169 percent increase in the total costs would be achieved. The total expected costs associated with this strategy represent capacity shortages cost (or opportunity loss). Both the industry and the country would incur this loss.

The consequences of this strategy for different parties would be varying. For the shareholders it means loss of investments (about DH 1000 million); for the consumers the effect would be slightly smaller than that of other parties, but it means that they need to import the quantity they require and this usually can cause delays in delivery and questionable quality, especially in the absence of quality control procedures in the U.A.E.

For the employees it means a loss of employment and wages (about DH 99 million annual wages). Although this effect can be neglected in the short and medium terms, because 95 percent of the employees in the cement industry at the present time are foreigners, in the long run it should be taken into consideration, because more U.A.E. citizens are expected to join the industry since it would be difficult for them to find a job in the government.

Finally, for the U.A.E. economy as a whole it would be a loss of an industry which depends heavily on raw materials which are abundant and it is also a capital intensive industry which is suitable for a country like the U.A.E. where labour shortages exist.

It means also a loss of a generator of foreign exchange and the outflow of foreign exchange to pay for the imported cement. On political grounds and even on economic grounds this strategy is not acceptable, it is unwise to close down the whole cement industry since cement is a commodity continually needed and since the capital has already been invested in this industry.

Strategy three: to halve the current total capacity

This strategy would reduce total expected costs from DH 877 million annually in the case of strategy one to DH 253 million annually in this strategy, or about 71 percent reduction in total cost would be achieved over the first interval (the total costs associated with this strategy over the first interval represent 25 percent of total investment). The total expected costs associated with this strategy would decline to DH 78 million annually over the fourth interval, and this represents about 8 percent of total investments after depreciation. Comparing this strategy with strategy one over the fourth interval, a reduction of 83 percent could be achieved by this strategy.

The consequences of this strategy for different parties are encouraging. For the shareholders it means a loss of about DH 500 million of investments, but it would be better than the loss of whole investments as in the case of strategy two. They might benefit from their investments, especially when the price goes up as a result of imposing protective tariffs on cheap cement imported from Korea and Japan and the costs of production are likely to decline as a result of the increase in capacity utilisation rates.

For the consumers it means that they can get their requirements probably at higher prices and on time in the short and medium terms, but in the long run, or more specifically in the second half of the planning horizon they might experience shortages from time to time.

For employees it means loss of employment for some, about DH 50 million in wages could be lost. Despite the fact that the effect on the employees can be ignored in the short and medium term, because 95 percent of the employees are foreigners, in the long run it should be taken into account since more U.A.E. citizens are expected to join the industry due to the difficulty in finding jobs in the government.

Finally, for the economy as a whole it means that an efficient and an important industry would continue in operation and it would contribute to the GNP of the country. Furthermore, it would be able to compete in the export markets and generate a substantial amount of foreign exchange, but due to shortages in capacity which might be experienced from time to time which would lead to cuts in exports and this would affect the generated amount of foreign exchange.

This strategy might generate enough trading profits which could cover the total costs associated with it, especially in the medium and long terms.

Strategy four: cut clinker capacity by 25 percent and grinding capacity by 50 percent

This strategy means that the current total capacity is to be cut by 25 percent. The total expected idle capacity holding costs associated with this strategy would be DH 565 million annually for the first interval (1986-1990). This cost represents about 57 percent of total investments after depreciation. The total expected costs would decline to DH 233 million annually over the fourth interval (2001-2005). A reduction of 59 percent would be achieved between the first and the fourth interval. A comparison between this strategy and strategy one over the first interval (1986-1990), reveals that this strategy would achieve 36 percent reduction in the total costs, 50 percent reduction in the total expected costs could be achieved over the fourth interval (2001-2005).

The consequences of this strategy for different parties vary. While it might have good effects as far as employees and shareholders (in terms of the size of investments lost) are concerned, it would have almost no effect on the consumers and it would have negative effects on the economy, since the industry would still be operating at a great loss, and its ability to compete in the export market and to generate foreign exchange is questionable. For employees it means a loss of DH 25 million annual wages, and for the shareholders, a loss of around DH 250 million as investments.

For the consumers, its effect is mixed, they would be able to get what they want on time and at the right price, but in the last interval they might experience shortages.

This strategy would not generate enough trading profits which can cover the idle capacity holding costs, especially in the medium and the long run. Therefore subsidy is needed in order for the industry to stay in business.

Strategy five: to cut total capacity by 75 percent

The total expected costs associated with this strategy would be DH 31 million annually over the first interval (1986-1990), of which 68 percent would be idle capacity holding costs, whereas the remaining 32 percent would be capacity shortages costs. The total costs would increase to DH 79 million over the fourth interval (2001-2005).

Comparing this strategy with strategy one over the first interval reveals that this strategy could achieve 96 percent reduction in the total expected costs, over the fourth interval a reduction of 85 percent could be achieved by this strategy. With regard to its consequences for different parties, it can be argued that the consumers would be affected seriously since shortages might take place throughout the planning horizon. For the emplogees it means a loss of around DH 65 million as annual wages, and for the shareholders it means a loss of about DH 750 million as investments.

With regard to the economy as a whole, an efficient industry can still operate. High capacity utilisation rate, and the implementation of protective tariffs policy would lead to increase in selling prices and this in turn would benefit the shareholders as well.

Although the implementation of this strategy might lead to the generation of some trading profits, it would lead to cuts in the exports of cement and the imports of cement would increase over the time and this latter would lead to outflow of foreign exchange.

Strategy six: re-organise the entire cement industry

This strategy means a merger between companies owned by the same shareholders, such action will reduce the total capacity to about 5.5 million tons p.a. The total expected costs associated with this strategy would be DH 487 million annually, which is idle capacity holding cost. This cost accounted for about 49 percent of total investments after depreciation. This strategy would achieve 44 percent reduction in the total expected costs compared with strategy one over the first interval. The total expected costs associated with this strategy would decline to DH 256 million annually over the fourth interval.

This cost accounted for about 26 percent of the total investments after depreciation. A reduction of 45 percent would be achieved by this strategy compared with strategy one over the fourth interval.

With reference to the effects of this strategy on different groups one can argue that it would have a minor effect on consumers since most of the time they would be able to obtain their requirements at the right prices and on time, but prices might rise because of the implementation of protective policy against imported cement.

Although, there are fewer investment losses associated with this strategy (about DH 450 million), the shareholders are unlikely to benefit from its implementation since it would not generate enough profits to cover its total costs.

For the employees it means less loss of jobs and wages, about DH 54 million annual wages would be lost.

For the economy as a whole it would mean that an inefficient industry would continue in operation, unable to compete in the export markets and in turn generate foreign exchange and contribute to the GNP of the country.

The industry is unlikely to continue for a longer time in the future unless somebody subsidises it. We strongly believe that no subsidy can be guaranteed under these circumstances.

This strategy is unlikely to generate enough trading profits to cover idle capacity holding costs.

On the whole, this strategy is not acceptable on financial grounds.

Tables (8.11) and (8.12) summarise the quantitative and qualitative evaluation of the six strategies under high-levels market. It is to be noted that in the qualitative evaluation more credit is given to the effects on the shareholders and the economy as a whole.

Having evaluated different strategies under high-levels market, next is to evaluate these strategies in extreme circumstances.

Table (8.11)

Quantitative Evaluation of The Six Strategies (high-level)

Intervals / Strategies	1986 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		Feasibility	
	I	S	I	S	I	S	I	S	Yes	No
Strategy (1)	877.0	-	724.0	-	618.0	-	462.0	-	-	X
Strategy (2)	-	42.0	-	66.0	-	86.0	-	113.0	X	-
Strategy (3)	253.0	-	163.0	12.0	78.4	22.0	35.0	43.0	X	-
Strategy (4)	565.0	-	425.0	4.0	322.0	10.0	210.0	23.0	-	X
Strategy (5)	10.0	21.0	16.0	33.0	-	52.0	-	79.0	X	-
Strategy (6)	487.0	-	359.0	6.0	249.0	11.0	151.0	26.0	-	X

Value in million U.A.E. Dirhams

I: Idle capacity holding costs

S: Capacity shortage costs

Table (8.12)

Qualitative Evaluation of The Six Strategies (high-level)

Intervals / Strategies	1986 - 1990				1991 - 1995				1996 - 2000				2001 - 2005				Feasibility	
	E	C	S	EC	E	C	S	EC	E	C	S	EC	E	C	S	EC	YES	NO
Strategy (1)	VG	VG	VP	VP	VG	VG	VP	VP	VG	VG	VP	VP	VG	VG	VP	VP	-	X
Strategy (2)	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	-	X
Strategy (3)	A	A	G	G	A	A	G	G	A	P	G	G	A	P	G	G	X	-
Strategy (4)	VG	VG	P	P	VG	VG	P	P	VG	VG	P	P	VG	G	P	P	-	X
Strategy (5)	VP	VP	G	G	VP	VP	G	G	VP	VP	G	G	VP	VP	G	G	X	-
Strategy (6)	VG	VG	P	P	VG	VG	P	P	VG	VG	P	P	VG	VG	P	P	-	X

<u>Keys</u>:

E	employees	VG	very good
C	consumers	G	good
S	shareholders	A	acceptable
EC	economy	P	poor
		VP	very poor

Strategies Evaluation Under Low-Levels Market

Strategy one: maintain ′status quo′ strategy

The total expected costs associated with this strategy would be DH 935 million annually over the first interval (1986-1990). This total cost represents about 94 percent of total investments after depreciation. The total expected costs would decline to DH 614 million annually over the fourth interval (2001-2005) - about 61 percent of total investments after depreciation. A reduction of 34 percent would be achieved in the total costs between interval one and four.

It is unlikely that the cement industry would continue in operation under this situation unless somebody subsidised its operations. It seems unlikely that external subsidia can be guaranteed in these circumstances. It is more likely that cross-subsidy and cuts in costs by one means or another would take place. It is to be noted that the actual costs might be much lower than these in the matrices, partly because of the cuts in costs by means of closing down for very short periods once or twice a year, and partly because of the errors in the costs provided to us by the manufacturers.

With reference to its consequences for different groups, these consequences vary from one group to another. For employees it means that they could secure steady employment if the industry could continue under such hard circumstances (about DH 99 million as annual wages could be earned). For consumers, it means that they would be able to get their requirements at cheap prices and at the right time and quantity. The shareholders are unlikely to make any profits since the industry would be operating at high losses and because of low capacity utilisation rates and in turn high production costs its ability to compete in the export markets would be limited.

Likewise, the economy as a whole is unlikely to benefit from the industry under these circumstances. It is unlikely that the industry could generate any considerable amount of foreign exchange and contribute to the GNP of the country.

Strategy two: close down the whole industry

The total expected costs associated with the implementation of this strategy would be DH 34 million (3 percent of total investments), these costs are exclusively shortage capacity costs which represent lack of exploitation of the demand at home and abroad.

The total expected costs would increase to DH 89 million annually over the fourth interval, about 162 percent increase in the total costs could be achieved. Its consequences for different groups would vary.

For the employees it means loss of jobs and about DH 99 million as annual wages. For the consumers, it means that they need to import their requirements and this usually can cause delays in delivery and the goods may be of questionable quality, especially in the absence of quality control procedures in the U.A.E.

For the shareholders it means loss of investments (about DH 1000 million). For the economy of the U.A.E. it means a loss of an industry which depends heavily on raw materials which are abundant and it is also a capital intensive industry which is suitable for a country like the U.A.E. where labour shortages exist. Furthermore, it means that the country would import its requirements and this will lead to the outflow of foreign exchange.

Politically this strategy is unfavourable. Even on economic grounds it is unwise to close down the industry as a whole since the capital has already been invested and because the need for a commodity like cement will continue as long as there is life on earth.

Strategy three: to halve the current total capacity

The total annual expected costs associated with this strategy and over the first interval (1986-1990) would be DH 311 million, these accounted for 31 percent of total investments after depreciation. The total expected costs would decline to DH 104 million annually over the fourth interval (2001-2005).

About 67 percent reduction in the total expected costs could be achieved between interval one and four. Comparing this strategy with strategy one and over the first interval, it reveals that about 67 percent reduction in the total costs could be achieved. This percentage would increase to 83 percent over the fourth interval.

The consequences of this strategy for different parties are encouraging. For employees it means loss of employment for some, about DH 50 million annual wages could be lost. Although the effect of implementing this strategy on the employees could be ignored in the short term because the majority of the employees are foreigners, in the medium and long run it should be taken into consideration, since more

U.A.E. citizens are likely to join the industry due to the difficulty in finding jobs in the government.

For the shareholders, it means a loss of about DH 500 million as investments. Nonetheless, they might be able to make profits from the remaining shares, especially when the price goes up as a result of imposing protective tariffs on cheap cement imported from Korea and Japan, and the costs of production are likely to decline as capacity utilisation rates go up.

For the consumers, it means that they can get their requirements on time but probably at higher prices both in the short and medium terms, but in the long run, especially in the last interval, they are more likely to experience shortages.

For the economy as a whole, it means that an efficient and an important industry would continue in operation and it would contribute to the GNP of the country. Due to shortages in capacity which might take place in the last period, which will lead to cuts in exports to satisfy home demand, its ability to generate foreign exchange would be limited.

The generated trading profits could cover the associated idle capacity holding costs, but in some periods it might not be able to cover the whole idle capacity holding costs unless the profits per ton goes up and the actual idle capacity holding costs turned out to be lower than the ones used in this evaluation.

<u>Strategy four: cut clinker capacity by 25 percent and grinding capacity by 50 percent</u>

This strategy means that the current total capacity would be cut by 25 percent. The total expected costs associated with this strategy would be DH 623 million annually over the first interval (1986-1990), this cost accounts for 62 percent of total investments after depreciation.

The total costs would decline to about DH 328 million, this accounts for about 33 percent of total investments after depreciation. A reduction of 47 percent could be achieved between the first and the fourth interval.

A comparison between this strategy and strategy one over the first interval reveals that this strategy would achieve 33 percent reduction in the total costs, and 47 percent reduction in the total costs would be achieved over the fourth interval.

The effects of the implementation of this strategy on different groups are various. For the employees, it means a loss of jobs and about DH 25 million as annual wages. For the shareholders, although less loss of investments might be experienced, about DH 250 million, they are unlikely to make profits.

For the consumers, it means that they could get their requirements at the right price and on time. For the economy as a whole, it means an inefficient industry with low capacity utilisation rates, high production costs, and inability to compete in the export markets and generate foreign exchange, and it means also waste of resources.

The industry is unlikely to continue for a longer time under this strategy without subsidy either from external or internal sources.

It is unlikely that external subsidy could be guaranteed. On the other hand, cross-subsidy and cuts in total idle capacity holding costs could be used to save the industry for some time in the future.

This strategy would not be able to generate enough trading profits to cover idle capacity holding costs.

Strategy five: cut total capacity by 75 percent

The total expected costs associated with this strategy would be DH 46 million annually over the first interval (1986-1990), of which 88 percent would be idle capacity holding costs and the remaining 12 percent would be capacity shortages costs. This total cost represents about 5.0 percent of total investments after depreciation. The total expected costs would increase by 20 percent and would reach DH 55 million annually over the fourth interval (2001-2005). In this interval the total expected costs would be completely capacity shortages costs. Comparing this strategy with strategy one and over the first interval, one would find that about 95 percent reduction in the total costs could be achieved, this percentage would decline to 91 percent over the fourth interval.

Although this strategy might look attractive in the short term, in the sense that it would be able to cover the total costs associated with it, in the long run shortages might be experienced and this would lead to imports to satisfy the demand in the home market and this in turn might lead to the habit of importing from abroad at the expense of locally produced cement.

The effects of the implementation of this strategy on different parties are varying. For the employees, it means redundancy for the majority and a loss of about DH 65 million as annual wages.

For the consumers, it means that they would not be getting their requirements at the right prices and on time, especially in the second half of the planning horizon.

For the shareholders, it means a loss of about DH 750 million as investments. It might be able to generate trading profits and this would benefit the shareholders.

As far as the economy as a whole is concerned, an efficient industry can still operate, and high capacity utilisation rates coupled with the implementation of protective tariff policy would lead to an increase in selling prices. The main disadvantage of this strategy is the shortages in supply which would lead to the import of huge quantities of cement from abroad and in turn outflow of foreign exchange.

<u>Strategy six: re-organise the entire cement industry</u>

This strategy means a merger between plants owned by the same shareholders. The total expected costs associated with this strategy and over the first interval would be about DH 545 million annually. These costs account for about 55 percent of the total investments after depreciation. Over the fourth interval the total expected costs would reach DH 256 million, or about 53 percent reduction in the total expected costs could be achieved.

A comparison between this strategy and strategy one, over the first interval reveals that 42 percent reduction in the total costs could be achieved, this reduction would increase to about 58 percent over the fourth interval.

With respect to its effects on different groups, it can be argued that this strategy would have minor effects on consumers. Since most of the time they would be able to obtain their requirements at the right prices and on time, but prices might rise because of the implementation of protective tariff policy against imported cement.

Although less loss of investments associated with this strategy (about DH 450 million), the shareholders are unlikely to benefit from its implementation since it would not generate enough trading profits to cover the total costs associated with it. For employees it means less loss of jobs and wages, about DH 54 million annual wages could be lost. For the economy as a whole, it means that an inefficient industry would continue in operation, and it would not be able to compete in the export markets, generate foreign exchange and contribute to the GNP of the country.

The industry is unlikely to continue for a longer time in the future unless somebody subsidises it, and it seems unlikely that an external subsidy can be guaranteed under these circumstances. On the whole, this strategy is not acceptable on financial grounds.

Table (8.13) and (8.14) summarise the quantitative and qualitative evaluation of the six strategies under the low-levels market.

Table (8.13)

Quantitative Evaluation of The Six Strategies (low-level)

Intervals / Strategies	1986 - 1990		1991 - 1995		1996 - 2000		2001 - 2005		Feasibility	
	I	S	I	S	I	S	I	S	Yes	No
Strategy (1)	935.0	-	865.0	-	706.0	-	614.0	-	-	X
Strategy (2)	-	34.0	-	48.0	-	72.0	-	89.0	X	-
Strategy (3)	311.0	-	219.0	1.0	137.0	14.0	79.0	24.0	X	-
Strategy (4)	623.0	-	537.0	-	409.0	5.0	316.0	12.0	-	X
Strategy (5)	41.0	5.0	14.0	16.0	5.0	39.0	-	55.0	X	-
Strategy (6)	545.0	-	455.0	-	344.0	8.0	243.0	13.0	-	X

Value in million U.A.E. Dirhams

I: Idle capacity holding costs

S: Capacity shortage costs

Table (8.14)

Qualitative Evaluation of The Six Strategies (low-level)

Intervals / Strategies	1986 - 1990				1991 - 1995				1996 - 2000				2001 - 2005				Feasibility	
	E	C	S	EC	E	C	S	EC	E	C	S	EC	E	C	S	EC	YES	NO
Strategy (1)	VG	VG	VP	VP	VG	VG	VP	VP	VG	VG	VP	VP	VG	VG	VP	VP	-	X
Strategy (2)	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	VP	-	X
Strategy (3)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	X	-
Strategy (4)	VG	VG	VP	VP	VG	VG	VP	VP	VG	VG	VP	VP	VG	VG	VP	VP	-	X
Strategy (5)	VP	G	VG	VG	VP	A	VG	VG	VP	P	VG	VG	VP	P	VG	VG	X	-
Strategy (6)	VG	VG	G	G	VG	VG	A	A	VG	VG	A	A	VG	VG	A	A	-	X

Keys:

E	employees	VG	very good
C	consumers	G	good
S	shareholders	A	acceptable
EC	economy	P	poor
		VP	very poor

8.5 Strategy Choice

This section concentrates on the choice between the six Strategies evaluated in the last section. One Strategy is to be chosen and it must be suitable in the short and long runs and also under the best and worst circumstances.

Table (8.15) shows the ranking-order of the six Strategies based on quantitative evaluation.

This table shows that Strategies (2), (3) and (5) are consistently in the first 3 in rank order.

Table (8.15)

Ranking-Order of The Six Strategies

Based on Quantitative Evaluation

Strategies	Matrix (1)		Matrix (2)		Matrix (3)		Matrix (4)	
	H	L	H	L	H	L	H	L
(1)	6	6	6	6	6	6	6	6
(2)	2	1	2	2	2	2	3	2
(3)	3	3	3	3	3	3	1	3
(4)	5	5	5	5	5	5	5	5
(5)	1	2	1	1	1	1	2	1
(6)	4	4	4	4	4	4	4	4

H: High Level market

L: Low Level market

From the last section (section 8.4) we found that Strategies (2), (3) and (5) are feasible based on the quantitative evaluation under the high-levels market. On the other hand, Strategies (3) and (5) are feasible based on the qualitative evaluation. This means that Strategies (3) and (5) are feasible based on both the qualitative and quantitative evaluations.

Under the worst outcomes (Low-levels market), Strategies (2), (3) and (5) are feasible based on the quantitative evaluation. On the other hand, Strategies (3) and (5) are feasible based on the qualitative evaluation. Based on the previous discussion one can conclude that Strategies (3) and (5) can be chosen to tackle the problem under investigation, because both comply with the criteria we set out at the beginning of this section i.e. they are suitable in the short and the long runs and under the best and worst circumstances. Since one Strategy has to be chosen, we must choose between these two based on acceptable criteria. Under Strategy (5), and in particular over the long run, shortages in capacity are experienced far more than under Strategy (3), both in volume and in value, under both the best and worst circumstances.

This might drive us to favour Strategy (3) over Strategy (5) since shortages in capacity over long periods of time might force customers to look for other reliable suppliers, and this in turn will result in loss of customers and market shares especially in the export market. If we take into consideration the loss of employment, we find less loss of employment associated with Strategy (3) than with Strategy (5), and this makes Strategy (3) more favourable. Furthermore, if the two Strategies were evaluated in terms of cuts in assets, Strategy (3) gets more credit in this respect i.e. less cut in capacity takes place under this strategy.

Based on the previous discussion we can say that Strategy (3), to halve the current level of capacity, is the best Strategy of the six evaluated Strategies.

8.6 Sensitivity Analysis

It would be of interest to test the validity of the choice of the appropriate strategy carried out in the previous section. To do so, three main parameters are considered. These are: the probabilities assigned to each level of the market for each interval, the idle capacity holding costs, and capacity shortages costs.

The effect of the changes in probabilities assigned on strategy choice

A thorough investigation was made to find out whether the changes in the values of probabilities assigned to the levels of the market for each interval affect the strategy choice made or not. Several attempts are presented later.

These attempts are based on a range test of experts probabilities, i.e. we have tried the highest probability given to a certain scenario (level of the market) and the lowest probability given to another scenario (level of the market) over the same interval of time and then the probabilities assigned to the remaining two scenarios were adjusted so that the total probabilities could add to 1.0. In another attempt we reversed the probabilities assigned in the first attempt, i.e. the scenario (level of the market) which was given the highest probability in the first attempt was given the lowest probability in this attempt and the one was given the lowest probability in this attempt and the one which was given the lowest in the first attempt was given the highest probability in the second attempt. Sometimes we carried out random tests.

With reference to the difference in the number of attempts carried out in each case, it should be pointed out that the number of attempts in each case was based on the possibilities found, i.e. in some cases we know for sure and from the start that changing the probabilities assigned to two scenarios are not going to affect the position of these two scenarios, therefore we eliminate such attempts from the beginning.

It should be pointed out also that these attempts are not exhaustive of all possible combinations, and because of the time limit we restricted the number of attempts to that presented here.

Matrix (1) - High levels market

Attempt	Probabilities				Effects
1	51%,	0.0%,	27%,	22%	No
2	21%,	30%,	30%,	19%	No
3	51%,	0.0%,	30%,	19%	No
4	20%,	55%,	15%,	10%	No
5	0.0%,	55%,	23%,	22%	No

Matrix (2) - High levels market

Attempt	Probabilities				Effects
1	0.0%,	41%,	27%,	32%	No
2	20%,	21%,	40%,	19%	No
3	0.0%,	41%,	40%,	19%	No

4	45%,	21%,	24%,	10%	No
5	45%,	10%,	25%,	20%	No
6	0.0%,	16%,	24%,	60%	No
7	0.0%,	25%,	35%,	40%	No

Matrix (3) - High levels market

Attempt	Probabilities				Effects
1	5%,	31%,	26%,	38%	No
2	15%,	21%,	35%,	29%	No
3	5%,	31%,	35%,	29%	No
4	40%,	7%,	13%,	40%	No
5	0.0%,	10%,	15%,	75%	No
6	40%,	24%,	26%,	10%	Yes

Matrix (4) - High levels market

Attempt	Probabilities				Effects
1	12%,	19%,	35%,	34%	No
2	12%,	19%,	20%,	49%	No
3	35%,	20%,	35%,	10%	No

Matrix (3) - Low levels market

Attempt	Probabilities				Effects
1	55%,	18%,	17%,	10%	No
2	55%,	10%,	24%,	11%	No
3	0.0%,	25%,	50%,	25%	No

Matrix (4) - Low levels market

Attempt	Probabilities				Effects
1	50%,	5%,	20%,	25%	No

2	0.0%, 5%, 25%, 70%	No
3	0.0%, 30%, 28%, 42%	No
4	15%, 30%, 45%, 10%	No

All attempts, except one, showed that the choice was insensitive to the changes in the probabilities assigned to the market´s levels.

The one attempt which gave a positive answer, showed that 40%, 24%, 26%, and 10% when assigned to the four scenarios make strategy six more favourable over strategy three in terms of the expected total costs. We can argue that it is unlikely that the demand for cement produced in the U.A.E. reaches (9 million tons) with probability 40 percent. We believe, therefore, that lower probability attached to this level and higher probabilities attached to the two middle scenarios are more likely to be the case.

<u>The effect of the changes in idle capacity holding costs on strategy choice</u>

Several attempts have been carried out to test the effect of the changes in idle capacity holding costs on the chosen strategy by doubling and halving the current level of idle capacity holding costs for each interval.

Tables (8.16a) and (8.16b) present the effect of doubling and halving of the current level of idle capacity holding costs respectively. As indicated by Table (8.16a), the doubling of idle capacity holding costs affects the ranking-order of the six strategies, except strategy three which holds the same position over the planning horizon. Although strategies two and five are more favourable based on the total expected costs associated with the six strategies, strategy three is still to be chosen, since strategy two is not acceptable on political grounds, and strategy five is less favourable than strategy three in terms of loss of employment, magnitude of shortages in capacity experienced, and loss of investments.

Therefore, doubling idle capacity holding costs has no effect on the choice made.

Table (8.16a)

The Effect of Doubling Idle Capacity

Holding Costs on Strategy Choice

Strategies	Matrix (1)		Matrix (2)		Matrix (3)		Matrix (4)	
	H	L	H	L	H	L	H	L
(1)	6	4	6	6	6	6	6	6
(2)	1	1	2	2	1	2	2	2
(3)	3	3	3	3	3	3	3	3
(4)	5	6	5	5	5	4	5	5
(5)	2	2	1	1	2	1	1	1
(6)	4	5	4	4	4	5	4	4

H: High level market

L: Low level market

NB Figures in the above table represent the ranking-order of the strategies

Table (8.16b)

The Effect of Halving Idle Capacity

Holding Costs on Strategy Choice

Strategies	Matrix (1)		Matrix (2)		Matrix (3)		Matrix (4)	
	H	L	H	L	H	L	H	L
(1)	6	4	6	6	6	6	6	6
(2)	2	2	2	2	2	3	4	3
(3)	3	3	3	3	1	2	1	2
(4)	5	6	5	5	5	4	5	5
(5)	1	1	1	1	3	1	2	1
(6)	4	5	4	4	4	5	3	4

H: High level market

L: Low level market

NB Figures in the above table represent the ranking-order of the strategies

Table (8.16b) indicates that halving the idle capacity holding cost would change the ranking-order of the six strategies. Although strategies two and five are more favourable than strategy three in terms of total expected costs over the first half of the planning horizon, in the long run, strategy three is more favourable than these two strategies. Furthermore, strategy two is not acceptable on political grounds, which means that its acceptance and implementation is almost impossible. Strategy five is less favourable than strategy three for the reasons mentioned earlier.

To sum up, strategy three is still the most feasible regardless of the changes in the idle capacity holding costs.

<u>The effect of the changes in capacity shortages costs on strategy choice</u>

A test was carried out to find out how sensitive the choice made was to the change in capacity shortages costs. It was revealed that doubling the current capacity shortages costs affects the ranking-order of strategies two and three over the second half of the planning horizon and under high-level market. Over the low-level market, the doubling of the capacity shortages cost affects the ranking-order of strategies four and six over the second half of the planning horizon. As far as strategy three is concerned it ranks third over the first half of the planning horizon and first over the second half (under the high-level market). Under the low-level market, strategy three ranks third over the first half of the planning horizon, and ranks second over the second half. On the whole, strategy three is still more acceptable than the remaining strategies, since strategy two is unacceptable on political grounds, and strategy five is less favourable in terms of magnitude of capacity shortages, loss of employment, and loss of investments.

8.7 <u>Strategy Implementation</u>

Up to now the discussion concentrated on generating alternative strategies, evaluating selected ones, choosing between them and testing the validity of the choice.

The problem is not solved until the solution is implemented, therefore the discussion in this section is centred on the best method of implementing the chosen strategy. To go about doing so, first the objective of the chosen strategy needs to be clarified, then the resources needed are briefly outlined and the process of implementation is discussed and finally, the constraints placed on the implementation is examined.

The objective of the chosen strategy is to minimise the tangible and intangible costs incurred by the cement industry when moving from its current state to a more efficient one; i.e. since action has to be taken due to the fact that the current situation cannot be tolerated for much longer, then this action should achieve the best possible outcome for the industry concerned. The tangible costs include the idle capacity holding cost and capacity shortage cost, whereas the intangible costs include the consequences to the shareholders (owners), the consumers, the employees and the economy as a whole. The shareholders (owners) and the economy are given more credit.

With respect to the resources needed for the implementation, courage and compensation for those shareholders whose investments are to be lost are the main resources needed when implementing this strategy. The question which remains unanswered is "how to go about implementing this strategy?"

The implementation of the chosen strategy requires that some of the plants within the industry close down. This leads to the problem of choosing between the seven plants.

A tool which can be used for this purpose is called a multi-attribute decision making procedure. The application of this procedure requires the following steps: the identification of the decision making body, the definition of the objectives, the identification of alternatives, identification of criteria, the evaluation of alternatives with respect to the criteria, criteria weighting, overall evaluation of each alternative, sensitivity analysis and finally implementation (which is in our case the choice between the plants).

What follows is a discussion of these steps.

The decision making body

As mentioned in chapter one of this thesis, two levels of decision making exist. The decision to be taken regarding the choice between the seven plants rests on the first level (Ministry of Industry) because this decision affects the overall industry rather than the individual plant or company within the industry.

Statements of the objectives

The objectives which are to be accomplished as a result of reducing the overall capacity of the cement industry are:

(i) improve operations rate

(ii) improve profitability

(iii) strengthen competitiveness of the industry.

Alternatives identification

The alternatives given to us are: seven cement plants with different capacity sizes, numbers of employees, market sizes, amount of capital, geographical locations, and each having a source of raw materials, independent ownership and management.

Criteria for evaluation

The choice between the seven plants is to be based on fifteen criteria. These criteria formed the third level of the multiple criteria hierarchy. These are listed below.

1. <u>The quality of raw material</u>

This criterion determines the ability of the product to have competitive advantages over those imported from abroad. This of course gives those companies with good raw materials quality advantages over those with poor raw material quality.

2. <u>Location close to raw materials resources</u>

Because the transportation costs account for about 17 percent of the total manufacturing costs per ton of the output, a reduction in this cost would cause a reduction in the overall production cost.

3. <u>Location close to local market</u>

Again a reduction in the transportation costs of the finished product will improve the plant´s competitive advantages over other plants.

4. <u>Location close to domestic market</u>

The main domestic market centres are those of Abu Dhabi and Dubai, therefore locations close to these two centres would give the plant advantages over other plants.

5. <u>Location close to port</u>

Once again such a criterion is an important factor in reducing the total production costs and in turn selling prices and this, of course, leads to competitive advantages over plants far from ports.

6. <u>Causing pollution</u>

This criterion is very important as far as ecology and public health are concerned. Therefore, reducing the level of pollution, especially in highly populated areas is an important factor in choosing between different plants.

7. Providing employment for citizens

The industrial Federal law stated in one of its articles that 25 percent of the total employees of any organisation should be citizens. This aims at providing job opportunities for U.A.E. nationals. Hence, those plants which provide more job opportunities for citizens have more credibility over those which provide less job opportunities.

8. Plant size

This criterion has a great influence on the economies of scale available to a particular plant. Those large scale plants have the opportunity to achieve economies of scale in both capital and labour costs, and in turn reduce the average cost per unit.

9. Number of years in business

This criterion is an important factor which affects the production costs. Usually those plants which have been in business for a longer time have lower production costs than those which have recently entered the market.

10. Cost of production

Undoubtedly, this criterion has very important effects on the competitive ability of the plant both at home and abroad. It also affects the profitability of the plant. Therefore, plants with lower production costs are more favourable than those with high production costs.

11. Ownership of capital by citizens

Those plants whose capital is owned by U.A.E. nationals have advantages over those in which capital is owned by outsiders. This stems from the aim of the government toward encouraging the participation of the private sector in the industrialisation process of the Country.

12. Labour productivity

This criterion is an important factor which affects the profitability of the plant and also its competence ability. Therefore plants with high labour productivity are preferred over those with lower labour productivity.

13. Size of the local market

The local market is taken here to represent the market of the Emirate where the plant is operating. Those plants with large local markets have advantages over those with smaller local markets.

14. Capacity utilisation rate

An important factor which determines the costs of production per unit of output. The higher the capacity utilisation rate is, the lower the production costs per unit, and vice-versa.

15. Size of the export market

The export market plays a significant role in the survival of the plants in the U.A.E. cement industry. Therefore, those plants with large export markets have advantages over those with small export markets.

Evaluation of alternatives with respect to the criteria

The seven senior managers of the seven plants were asked to evaluate one another; i.e. each senior manager evaluates his plant and the remaining six plants (alternatives) in the industry, and makes his assessment on a scale of one to five, one if the alternative is poor, five if the alternative is very good. Table (8.19) illustrates the scores given to each alternative with regard to its performance in each criterion.

Weighting criteria

The seven senior managers were asked to give weight to each criterion and then an average weight was calculated for each criterion. Table (8.17) presents the fifteen criteria presented to the seven senior managers to give weight to each criterion on a scale between one point if the criterion is not significant at all, and five points if the criterion is extremely significant. The average weight given to each criterion is presented in Table (8.18).

Overall evaluation of each alternative

The overall evaluation of each alternative is presented in Table (8.20). The overall evaluation of each alternative was calculated using the following formula:

$$V_i = \sum_{j=1}^{k} W_j U_{ij}$$

Where: V_i is the overall evaluation of alternative i

U_{ij} is the evaluation of alternative i with respect to criterion j (scoring).

W_j is the relative importance of criterion j (weight).

K is the number of criteria.

Sensitivity Analysis

A sensitivity test was carried out on the average weight given to each criterion to find out whether the change in the weights assigned to the criteria affect the choice of the appropriate alternatives or not.

First test

Table (8.21) presents the average weight given to each criterion. The outcome of this test is presented in Table

(8.22). It indicates that plants (A), (E) and (G) have scored lowest. This is consistent with the results obtained in Table (8.20) which indicates that plants (A), (E) and (G) scored lower than the remaining plants.

Table (8.17)

List of Fifteen Criteria Presented to The Decision Makers

1)	Quality of raw materials	1	2	3	4	5
2)	Location close to raw materials sources	1	2	3	4	5
3)	Location close to local market	1	2	3	4	5
4)	Location close to domestic market	1	2	3	4	5
5)	Location close to port	1	2	3	4	5
6)	Causing pollution	1	2	3	4	5
7)	Providing employment for citizens	1	2	3	4	5
8)	Plant size	1	2	3	4	5
9)	No. of years in business	1	2	3	4	5
10)	Cost of production	1	2	3	4	5
11)	Ownership of capital by citizens	1	2	3	4	5
12)	Labour productivity	1	2	3	4	5
13)	Size of the local market	1	2	3	4	5
14)	Capacity utilisation rate	1	2	3	4	5
15)	Size of export market	1	2	3	4	5

Keys:

Not significant at all .... one point.
Slightly significant .... two points.
Significant .... three points.
Very significant .... four points.
Extremely significant .... five points.

Table (8.18)

Average Weight Given to The Fifteen Criteria

Criteria		Average weight
C1	Quality of raw materials	4 points
C2	Location close to raw materials sources	4
C3	Location close to local market	4
C4	Location close to domestic market	5
C5	Location close to port	3
C6	Causing pollution	4
C7	Providing employment for citizens	3
C8	Plant size	4
C9	No. of years in business	4
C10	Cost of production	5
C11	Ownership of capital by citizens	3
C12	Labour productivity	5
C13	Size of the local market	4
C14	Capacity utilisation rate	5
C15	Size of export market	4

Table (8.19)

Average Score Given to Each Alternative

Alternatives	Criteria															Total score
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	
A	nil	nil	3	3	3	-3	2	4	3	3	3	4	3	3	3	34
B	5	5	3	2	5	-3	2	4	3	4	3	4	3	4	5	49
C	4	3	4	5	3	-3	2	4	3	4	5	4	5	4	3	50
D	4	4	4	4	1	-3	3	4	4	3	5	3	4	4	3	47
E	4	3	3	4	3	-3	2	3	3	4	3	4	4	4	4	45
F	4	4	3	3	4	-3	3	4	4	3	4	3	4	4	4	48
G	4	4	3	2	3	-3	2	4	2	3	3	3	3	4	4	41

Table (8.20)

Multi-attribute Decision Making (original result)

Criteria no.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	Total weighted score
Plant A	nil	nil	12	15	9	-12	6	16	12	15	9	20	12	15	12	141
B	20	20	12	10	15	-12	6	16	12	20	9	20	12	20	20	200
C	16	12	16	25	9	-12	6	16	12	20	15	20	20	20	12	207
D	16	16	16	20	3	-12	9	16	16	15	15	15	16	20	12	193
E	16	12	12	20	9	-12	6	12	12	20	9	20	16	20	16	188
F	16	16	12	15	12	-12	9	16	16	15	12	15	16	20	16	194
G	16	16	12	10	9	-12	6	16	8	15	9	15	12	20	16	168

Table (8.21)

Sensitivity Analysis

Criteria		Average weight (points)		
		Original	First test	Second test
C1	Quality of raw materials	4	3	5
C2	Location close to raw materials sources	4	3	5
C3	Location close to local market	4	3	5
C4	Location close to domestic market	5	5	4
C5	Location close to port	3	3	4
C6	Causing pollution	4	4	3
C7	Providing employment for citizens	3	3	4
C8	Plant size	4	5	3
C9	No. of years in business	4	4	2
C10	Cost of production	5	5	3
C11	Ownership of capital by citizens	3	3	2
C12	Labour productivity	5	4	3
C13	Size of the local market	4	4	2
C14	Capacity utilisation rate	5	5	4
C15	Size of export market	4	5	2

Table (8.22)

Sensitivity Analysis (first test)

Average weight	3	3	3	5	3	4	3	5	4	5	3	4	4	5	5	Total weighted score
Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	
A	nil	nil	9	15	9	-12	6	20	12	15	9	16	12	15	15	141
B	15	15	9	10	15	-12	6	20	12	20	9	16	12	20	25	192
C	12	9	12	25	9	-12	6	20	12	20	15	16	20	20	15	199
D	12	12	12	20	3	-12	9	20	16	15	15	9	16	20	15	182
E	12	9	9	20	9	-12	6	15	12	20	9	16	16	20	20	181
F	12	12	9	15	12	-12	9	20	16	15	12	9	16	20	20	185
G	12	12	9	10	9	-12	6	20	8	15	9	9	12	20	20	171

Second test

Table (8.21) shows the average weight given to each criterion (third column of Table (8.21)).

The results of the second sensitivity analysis test is presented in Table (8.23). It indicates that plants (A), (E) and (G) have scored lower than the remaining four plants. Once again these results are consistent with that of Table (8.20).

Therefore, plants (A), (E) and (G) should be closed down and this would lead to a reduction in the total production capacity of the U.A.E. cement industry by about 50 percent. However, the closure of these plants is not as easy as it might look; it requires a great effort from the Federal Government which would include giving compensation, either financial, or through allowing the Emirates whose plants are to be closed to expand in other feasible industries. One form of financial compensation would be through transferring the shareholders of the closed companies to those which remain in operation. The question which remains unanswered is "what constraints are placed on the implementation of the chosen strategy?"

The main constraint is the political pressure from the local governments to keep plants in operation within their territories regardless of the economic feasibility. However, a compensation programme such as that, financial or other, would help greatly to convince those concerned to implement the chosen strategy.

Table (8.23)

Sensitivity Analysis (second test)

Average weight	5	5	5	4	4	3	4	3	2	3	2	3	2	4	2	
Criteria / Alternative	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	Total weighted score
A	nil	nil	15	12	12	-9	8	12	6	9	6	12	6	12	6	107
B	25	25	15	8	20	-9	8	12	6	12	6	12	6	16	10	172
C	20	15	20	20	12	-9	8	12	6	12	10	12	10	16	6	170
D	20	20	20	16	4	-9	12	12	8	9	10	9	8	16	6	161
E	20	15	15	16	12	-9	8	9	6	12	6	12	8	16	8	154
F	20	20	15	12	16	-9	12	12	8	9	8	9	8	16	8	164
G	20	20	15	8	12	-9	8	12	4	9	6	9	6	16	8	144

It is worth pointing out that the opposition to change whether internally, from inside the organisation, or externally from outside is common in all countries regardless of how developed they are, and is not peculiar to the U.A.E.

8.8 Conclusion

This chapter concerned itself with the remaining steps in the application of the analytical procedure developed in chapter six. It seems from the discussion of this chapter that this procedure is more appropriate than more complicated techniques like mathematical modelling and systems dynamics and it can accomplish what these complicated techniques can do. However, this should not lead to the conclusion that less complicated techniques are more favourable than complicated ones, rather it should be borne in mind that less sophisticated methods are more suitable for decision makers with a low level of awareness and knowledge in O.R. techniques and methodologies; and in an environment which is not familiar with such techniques. Moreover, one should avoid "using a cannon to kill a fly" whenever possible.

This chapter leads to the conclusion that the best strategy which should be adopted for the next twenty years is to cut the overall capacity by 50 percent. The implementation of such a strategy requires the closure of three plants. These three plants perform poorly compared with the remaining four plants. The implementation of this strategy would lead to the following outcomes:

(i) increase capacity utilization rate to 80-100%,

(ii) cut total expected costs by 60-80%,

(iii) achieve trading profits, especially in the long run. The compensation programme suggested would help convince the owners to accept the new solution. For the benefit of the clients an executive report is presented in Appendix (8.1).

The next chapter examines in brief the problems encountered during the progress of this research and the ways through which we could overcome these problems, also areas for further study are outlined.

Appendix (8.1)

EXECUTIVE REPORT

THE PROBLEM

The problem as we see it is a capacity problem, i.e. the industry has more capacity than needed.

This problem resulted from a lack of long range forecasting and unplanned expansion during the boom in the construction industry between 1974 and 1983 when the demand for construction and in turn the demand for cement was quite high.

THE SOLUTION

The methods of solution adopted by the industry were all short term solutions and against the public interest. For example, the formation of a cartel in order to control sales and prices did not last for very long and it was also against the public interest. Moreover, the intention to form a marketing organisation in order to control sales and prices is not expected to solve the problem since the problem is not a marketing problem, rather it is a capacity problem. Therefore the long range solution to this problem is to cut the overall capacity so that the operation rate, the competitive position and in turn profitability could be improved.

The question which might be raised here is "by how much the overall capacity should be cut?"

To answer such a question we need to look into the future to see how it looks. Long range forecasting was carried out using scenario analysis and econometric modeling. The reasons for using long range forecasting is mainly because the cement industry is a capital intensive one involving a great deal of investment and also its productive life is a long one. Therefore the decision to cut capacity should be considered over the long term planning horizon.

Long range forecasting is always subject to errors much more than short and medium term forecasting and it is necessary to look for a means of reducing such errors, since their elimination is almost impossible.

These errors arise as a result of the uncertainty associated with long range forecasting. For the purpose of clarifying uncertainty, scenario analysis has been used. Different scenarios have been developed with the help of a panel of four members of staff from different departments at the University of Kent. In order to estimate the future demand associated with the scenarios, econometric models were used.

Based on the outcomes of the forecasts, several strategies were evaluated taking into consideration the interests of different groups (e.g. shareholders, employees, customers and the economy as a whole.)

The strategies which were evaluated thoroughly are:

(1) to cut overall capacity by 100 percent.

(2) to cut overall capacity by 0 percent.

(3) to cut overall capacity by 50 percent.

(4) to cut overall capacity by 25 percent.

(5) to cut overall capacity by 75 percent.

(6) re-organise the entire cement industry, this involves cuts in capacity of about 31 percent.

After a thorough quantitative and qualitative evaluation of those strategies it was decided that Strategies (1), (2), (4), (5) and (6) are not feasible for the following reasons:

(i) not feasible on financial grounds (e.g. Strategies (2), (4), and (6)), in the sense that the total expected cost incurred as a result of implementing either of these strategies are likely to be unacceptably high.

(ii) not feasible on political and economic grounds (e.g. Strategy (1)), in the sense that the closure of the cement industry is undesirable since it is expected that there will be a continuing demand for cement in the future and since the capital has already been invested in the industry it is unwise to close it down. Furthermore, there might be political pressure which might preclude the implementation of this strategy.

(iii) not feasible on other grounds (e.g. shortages in supply and the size of assets cuts.) - Strategy (5), i.e. the adoption of this strategy is likely to result in shortages in capacity being experienced most of the time, and this might lead to loss of customers and market shares at home and abroad. Furthermore, the implementation of this strategy might result in a loss of foreign currency earnings and also large cuts in assets would be experienced.

Therefore, the only feasible strategy is Strategy (3), which is to cut the overall capacity by 50 percent.

THE IMPLEMENTATION OF THE SOLUTION

The implementation of this strategy (Strategy (3)) would result in the following outcomes:

(a) reduce the total expected costs (idle capacity holding cost and capacity shortage costs) by 60-80 percent.

(b) increase operation rate to 80-100 percent, from the current level of about 35 percent.

(c) achieve profits, especially in the long run.

The implementation of this strategy means that the overall capacity is to be cut by 50 percent, and in turn this means that some plants within the industry should close down. The question which might be asked here "which plant(s) to close down?"

The answer to this question involves the choice between different plants in order to decide which plants to close down based on multi-criteria.

To assist in choosing which plant should be closed, a multi-attribute decision model was employed. The use of this technique requires the evaluation of different plants based on different criteria, giving weight to these criteria, evaluating each plants with respect to each criteria, calculating the overall weighted score for each plant, and finally choosing those plants with the lowest overall score for closure.

The implementation of this technique led to the conclusion that plant (A), (E), and (G) should close down. Sensitivity tests were carried out through changing the weights given to each criteria, in order to be sure that the right choice was made. These tests confirmed the conclusion reached through the use of multi-attribute decision model.

One way of implementing the suggested solution is through a compensation programme, either financial or through allowing the Emirates whose plants are to close down to expand in other feasible industries. One form of financial compensation would be through transferring the shareholders of the closed plants to those which remain in operation.

CHAPTER NINE

PROBLEMS ENCOUNTERED AND AREAS FOR FURTHER STUDY

9.1 Introduction

9.2 Problems Encountered

9.3 Areas for Further Research

9.4 Conclusion

CHAPTER 9

PROBLEMS ENCOUNTERED AND AREAS FOR FURTHER STUDY

9.1 Introduction

The last chapter discussed the application of the developed procedure on the U.A.E. cement industry. In particular it discussed the generation of alternative strategies, the construction of scenario/strategy matrices, the evaluation of the strategies presented in the matrices against the chosen scenarios, the choice of the appropriate strategy, the sensitivity of the choice and finally the best method of implementation.

The purpose of the last two chapters was to demonstrate the application of some O.R./M.S. techniques to a real problem in the U.A.E. This chapter further develops the discussion of the problems encountered during the progress of this thesis and the means through which those problems have been overcome. Potential areas for further research are outlined.

9.2 Problems Encountered

During the progress of this thesis, there were many problems some of which are summarised below and discussed later.

1. lack of statistics or reliable statistics;
2. lack of reliable micro-economic data;
3. lack of reliable macro-economic data;

4. difficulty in finding willing people with the time to participate in the panel discussion;
5. difficulty in collecting information during the survey regarding the practice of O.R. in the U.A.E.;
6. lack of relevant material in the library;
7. the problem of financing the trip to carry out part of the research in the U.A.E.

Those were the main problems which we encountered during the progress of this thesis. In the following pages these seven problems are discussed in some detail and the ways through which they have been overcome are highlighted.

The first problem, lack of reliable and up to date statistics, is common in most developing countries and not peculiar to the U.A.E. though it is more serious in the U.A.E. than in many others. This problem was encountered when we started the forecasting exercise and the need for macro-economic statistics to be used for forecasting the demand for cement at home and abroad. To overcome this obstacle, statistics published by international organisations were used despite the fact that a difference between one source and another was experienced and this raises the question of validity of such statistics.

The second problem, lack of micro-economic data, was encountered during the research on chapter four, since no published materials or at least no comprehensive materials are available, which required that we design our own questionnaire to collect the data needed from primary sources.

It was very difficult to obtain up to date data from competing companies as information is considered to be confidential and not to be revealed to any outsider to avoid its transfer to competitors, and some of the interviewees have exaggerated facts by considering much trivial information as highly confidential, this made our task far more tedious than one would expect. To overcome this problem we usually refer to people with higher authority, for example, in one of the companies the general manager refused to provide us with the data needed so we referred to the chairman of that company and what we asked for was given to us.

The third problem, lack of macro-economic data, was encountered when collecting materials for chapter two of this thesis and the need for macro-economic data about the U.A.E. was a necessity. No up-to-date national accounts and annual statistics were available. For example, the national account and the annual statistical book for the year 1985 have not been published yet, and when published, figures available for the latest years are usually preliminary and liable to adjustment. This makes their use unfavourable. To overcome this obstacle the cultural attache was asked to help and a direct contact with the authority in the Ministry of Planning took place and after some time the required data was obtained.

The fourth problem, difficulty in finding willing people with the time to participate in the panel discussion, was encountered when developing the scenarios where different people with different backgrounds were required; two problems were faced: one was finding the right people, and the other was finding the most suitable time for all participants. It took some time until these two problems were resolved. My supervisor and Professor Flowerdew were of great help in overcoming this obstacle.

The fifth obstacle, the difficulty in collecting information from the members of the sample, during the survey of O.R. practice and education in the U.A.E., was faced during the preparation for chapter three. Although we used a personally administered questionnaire as a means of collecting data from the sample, most of the time questionnaires were not returned to us straight away. We were usually asked to call back and although we provided the interviewees with a stamped envelope, a second visit was necessary in many cases, which meant wasting time. Patience was the only available means to overcome this obstacle.

The sixth problem was a lack of relevant materials in the library. This problem was faced throughout the whole thesis, especially when dealing with chapters five, six and seven. The inter-library loan service was used as a means of overcoming this obstacle, but this procedure usually takes a long time. In some cases we have had to wait for more than a year to obtain the requested material and sometimes the requested material never came to light.

Finally, there was the problem of financing the trips to the U.A.E. to collect the relevant data and conduct the survey.

9.3 Areas for Further Research

This section examines areas for further research.

First, it would be of interest to see a work which investigates the following areas:

(a) The measurement of the increase in both O.R./M.S. users and the number of techniques being used, i.e. to use a questionnaire similiar to the one we used after some time in the future to see if there is an increase in both aspects, and follow this with an investigation into the reasons behind such increase.

(b) The measurement of the regularity of use of the techniques being used is an important indication of the level of adoption of O.R. techniques, i.e. the investigation of the correlation between the existence of such regularity and, for example, availability of skilled personnel, computing facilities, the size of the organisation and the like.

(c) The investigation of the use of O.R./M.S. techniques in various functional areas, i.e. investigating which functional area is using more O.R./M.S. techniques and the nature of the business of the organisation or company.

(d) The investigation of the desired location of O.R. group or department within the organisational structure of the current users and the potential ones.

(e) The investigation of the relationship between the wide use of particular O.R. techniques and business atmosphere (e.g. size of the market, competition, regulation ... etc.).

Second, most of the non-users of O.R./M.S. techniques are willing to use these techniques provided that their usage will improve the profitability of the users. Therefore it would be of interest to investigate the impact of O.R. on both productivity and profitability of the users and the outcomes of such research if proved to be positive will be a good incentive for non-users to adopt such techniques.

Third, when developing the scenarios we have followed a "literary approach" which is heavily based on the use of opinion and reasoning. There are other methods of constructing scenarios which are heavily based on the use of mathematics and computers. The application of such approaches for constructing scenarios and comparing their results with that of the one we used in this thesis might be a good subject for further research.

Fourth, the application of the procedure developed in this thesis on other capacity problems on micro- and macro-levels might be of interest. (e.g. plastics industry, oil refining industry, iron and steel industry and cement industry at GCC level.)

Fifth, Forrester says that the Kondratieff cycles are connected with the capital of the capital goods industry, in this case the capital of the cement industry. He says that the 50 years cycle is connected with building too many things like cement kilns when the time is good and that this over-reaction then leads to over-shooting. If productive capacity is reduced and after 20-25 years time when the current generation of buildings, run-ways, irrigation channels, and so on need replacing, you find yourself short of capacity, then you have to build capacity again and you tend once more to over-shoot. These sort of cycles can go on for 40-50 years. Here systems dynamic can be applied.

Sixth, further research into the application of other O.R. techniques in the U.A.E. would also be of interest since the publication of such research would undoubtedly encourage those non-users with knowledge in O.R./M.S. to accept and implement these techniques.

Seventh, a comparative study of the use of O.R. in the U.A.E. with that in other well established gulf states in terms of type of techniques used, the density of use, areas of application, backgrounds of O.R. personnel, and so on would be valuable in order to see if there is any link between the political, economic, social, administrative environment and the adoption of O.R. techniques.

9.4 Conclusion

This chapter was devoted to the examination of the obstacles faced during the progress of this thesis and the means through which those obstacles have been overcome; also areas for further research have been outlined.

Carrying out research about a third world country can be expected to face several obstacles but with courage one should be able to overcome such obstacles. The potential areas of research in third world countries in general and in the U.A.E. in particular are great but the main obstacles, as we have seen, are availability of data and the co-operation of personnel concerned.

CHAPTER TEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 10

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

10.1 Summary

This research has been concerned with the wide adoption of O.R. in the industrial and business organisations and companies in the U.A.E.

Its main objectives were to investigate the current status of O.R. practice in these organisations and companies and the problems hindering the wide adoption of O.R. in them.

It has also investigated the supply problem which consists of education and training of personnel to ease the process of promoting the widespread use of O.R. in the U.A.E., in particular in the organisations mentioned above. It has also demonstrated the application of some of O.R. techniques on a macro-level in a systematic manner as a means of demorating O.R. values and applicability.

This study represents the first attempt to investigate the level of O.R. awareness among industrialists, and businessmen and the problems which hinder the wide adoption of O.R. in the U.A.E. Further, it identifies the main requirements necessary for O.R. development.

To provide the reader with a coherent picture of the whole work prior to drawing the conclusions, the previous chapters are briefly summarised in this section.

Chapter one provided a brief discussion of the objectives of and motivation behind this work. It highlighted the statement of research problems, and it also attempted to shed light on the approach adopted.

Chapter two examined the political and economic background of the U.A.E. in order to provide the reader with a comprehensive picture of the political, economic and administrative environment in which O.R. has been and will be operating, i.e. the political and economic structure of the U.A.E., the process of industrialisation and the industrial policies, the three dimensions of the Federation's unity. The consequences of the weak unity were also given considerable attention in chapter two.

In chapter three a thorough examination of the survey of O.R. practice has been given. The main aim of this examination was to provide the reader with new information regarding the current status of O.R. practice in the U.A.E. Having examined the demand side, then the examination of the supply side, namely, O.R. education and training was central. Therefore, attention has been paid to this side. The problems which have served as impediments for the widespread use of O.R./M.S. techniques in the industrial and business organisations in the U.A.E. were given special attention.

Chapter four examined the cement industry. The purpose of this chapter was to study in-depth the cement industry and its problems. This industry has been used as a case study to demonstrate the application of some O.R. techniques in the industrial sector of the U.A.E. In this chapter, the technology of cement manufacturing used world-wide was examined. Some attention has been paid to the economic characteristics of the cement industry in general. It also highlighted the main aspects of the U.A.E. cement industry in particular. The problems which are currently facing the cement industry and the solutions adopted to cope with these problems are given special attention.

Chapter five focused on the problem of capacity planning.

An intensive literature survey was conducted to see what approaches have been adopted to tackle capacity problems.

Attention has been given to the problem of excess capacity, and some of the previous work in this area has been briefly discussed. The choice between different capacity planning strategies is influenced by several factors. Some of these factors have been highlighted in this chapter. Capacity decisions are very important for the future of a company or an industry, and any fault in this decision-making will lead to poor results.

Therefore, the negative consequences of misjudged capacity decisions have been discussed in chapter five.

Chapter six analysed the approach of this study. Two main research techniques have been adopted, namely, the survey method and a case study. This chapter examined the main characteristics of O.R. methods which would suit developing countries in general and the U.A.E. in particular. It highlighted the two components of the approach, namely, the explorative part and the applied part. Suggested areas of application for the procedure developed were also highlighted in this chapter.

Chapter seven discussed the first step in the application of the procedure developed in the cement industry. It examined the evolution of the state of nature, the market in this case.

This chapter discussed general methods of forecasting, it also paid considerable attention to forecasting methods used world-wide to forecast cement demand in particular. It focused on forecasting methods, which had been tested and turned down for one reason or another. This chapter discussed thoroughly the forecast of home and export demand for cement produced in the U.A.E.

Chapter eight follows on directly the issues mentioned in chapter seven. It discusses the remaining steps in the application of the developed procedure. In particular it examined the formulation of alternative strategies to tackle the problem under investigation. It also discussed the construction of scenario/strategy matrices utilising the market levels determined in chapter seven and the strategies being formulated with the help of the clients. The evaluation of a set of strategies has been highlighted. The choice between different strategies has also been given some attention in this chapter. The test of the sensitivity of the choice to different parameters was also discussed. Finally, the stage of implementing the chosen strategy was discussed in brief.

Finally, chapter nine outlines the problems encountered during the progress of this research and the ways through which they have been overcome. Moreover, areas for further research have been outlined.

10.2 General Conclusions

Conclusion Regarding The Practice of O.R. in The U.A.E.

O.R. practice in the U.A.E. is in its infancy stage, and there are many obstacles hindering the diffusing of this branch of technology in the U.A.E. in general and in the industrial and the business organisations in particular. Some of these obstacles are discussed below. The first three are considered as internal, within the organisation, obstacles, while the remaining three are considered as environmental obstacles.

(1) Lack of specialised personnel

The survey revealed that no specialised personnel with a degree in O.R./M.S. or related subjects was found in any of the responding organisations and companies. This of course is one of the main obstacles to the success of O.R. in the U.A.E., since without the availability of staff with adequate knowledge and training in O.R. its widespread use would be nothing more than a dream. Hallouda and Mortagy (1, 1984) advocated "Operations Research to grow needs qualified people to believe in it and to implement its solutions." p(284). Those staff should be locally available and trained, since the import of experts in this technology is quite costly and this would be another obstacle for the widespread use of O.R. in small and medium scale industrial and business organisations. Furthermore, even if those organisations could afford to invite experts from abroad, those are usually unfamiliar with the environment, culture and other aspects of the host country which are important for the effective use of O.R.

Moreover, it is U.A.E. government policy to replace foreign experts by U.A.E. nationals in the coming years, and this makes local staff preferable to those from abroad, in addition to the fact that some organisations do not need O.R. throughout the year and it would be more convenient for them to seek consultants' advice whenever they have to. Therefore, the availability of local staff is a necessity in this case.

(2) Lack of O.R. awareness

It was revealed by the survey that 36 percent of the responding organisations and companies were completely ignorant of O.R., 24 percent have very little knowledge in O.R., and 41 percent have reasonably good knowledge in O.R. This might lead to the conclusion that O.R. is well known in the U.A.E. in general and in the industrial and business organisations in particular. In fact, this is not true, mainly because about 94 percent of those who are aware of O.R. are foreigners and therefore no claim can be made that O.R. is well known in the U.A.E. Furthermore, none of the 52 user organisations and companies use O.R. as company policy, rather it is used by individuals within these organisations and companies. Once again no claim can be made that O.R. is well known in the U.A.E. in general and in the industrial and business organisations and companies in particular.

(3) Lack of willingness to use and management interest in O.R.

Another problem which hinders the diffusion of O.R. in the industrial and business organisations in the U.A.E. is a lack of willingness to use O.R. and management interest in

O.R. The survey revealed that of the 31 who are aware of O.R. but not using it at the present time 55 percent are not willing to use it in the future. About 7 percent of this group have not adopted O.R. because they have no interest in it. This lack of willingness to use O.R. and a lack of interest in it is more likely to have resulted from a lack of awareness of the value of O.R. and lack of faith and confidence in its applicability.

(4) <u>Lack of training schemes in O.R.</u>

Training is one way of preparing skilled personnel and this aspect is missing in the U.A.E. As revealed by the survey, no training in O.R. is provided in any of the 52 user organisations or companies. An investigation was carried out by the author to find out if there is any organisation or company which provides training in the use of O.R. techniques. This investigation revealed that no such organisation or company is in existence in the U.A.E. at the present time. Of course, lack of training in O.R. is likely to hinder the widespread use of O.R. in the U.A.E. in general and in the industrial and business organisations and companies in particular.

(5) <u>Inadequate O.R. education</u>

One O.R. course is taught for undergraduate students studying Business and Public Administration. The course is theoretically oriented and computers have not been introduced yet and also projects are not used. The content of the O.R. course is almost the same as those taught in the western world. Whilst from an academic point of view, there is nothing wrong with this, due to lack of training facilities in O.R. in the U.A.E., the University should take a broader role in teaching techniques which can be used in the country. Furthermore, one O.R. course is not enough to prepare professionals with a strong theoretical background which will enable them to hold the responsibility of applying O.R. techniques in an effective manner.

(6) Lack of computing facilities and maintenance services

The conducted survey revealed that 10 percent of O.R. users and 69 percent of the non-users have not acquired computers yet. The availability of computing facilities is an essential factor in the wide use of O.R. techniques.

The main obstacle to the wide use of computers is the availability of adequate maintenance services. These are hardly available in the U.A.E. and if they are available, they are not up to the standard of those in the developed countries.

Conclusion Regarding The Main Characteristics of O.R. Suitable for The Decision Makers and The Environment in The U.A.E.

There are a few characteristics which are believed to characterise O.R. techniques which are suitable for both the decision makers' needs and knowledge, and the environment in the U.A.E. These are listed below:

(1) Simplicity of the techniques

Since the use of O.R. in the U.A.E. is still in its infancy, it is unwise to introduce those techniques which are considered to be highly sophisticated and heavily grounded in mathematics.

Soft O.R. or social O.R. is believed to be more appropriate for nations like the U.A.E. where there is very little knowledge in O.R. For example, McCarthy (2, 1978) argued that "if O.R. is to be of any use in developing countries, it must eschew tedious mathematical techniques in favour of simple logical models." p.(168). GOH and Paul (3, 1981) also argued that "if O.R. cannot be presented in other than mathematical languages, management appreciation and support is most unlikely. p.(195). Furthermore, the conducted survey proved that the most popular techniques in the U.A.E. are those which are not considered to be sophisticated from the users point of view.

(2) <u>Less need for specialised personnel</u>

Another characteristic of O.R. techniques suitable for the decision makers needs and the environment in the U.A.E. is less need for skilled personnel. This is as a result of a lack of skilled personnel, and the import of skilled personnel in O.R. is costly and is not affordable for many organisations and companies.

Furthermore, experts from abroad are unfamiliar with the culture, social, economic and business environment in the country.

This might lead to ineffective use of O.R. techniques. Once again, the conducted survey confirmed that the technques being used are used because there are personnel in the organisation who have knowledge in them.

(3) <u>Less need for computing facilities and time</u>

The lack of adequate computing facilities would favour certain techniques as more suitable in the U.A.E. than others, i.e. those which need less use of computers, so that many can afford to use them.

(4) <u>Inexpensive</u>

Another characteristic of O.R. techniques suitable for the U.A.E. is inexpensive, i.e. less need for specialised personnel and at the same time available in packages which can be used in micro-computers. The costs of the usage of O.R. techniques should be justified by the resulting benefits in order to convince clients to adopt them. However, this is not an essential characteristic since most of those who use O.R. techniques are of medium and large size and they can usually afford to pay the prices of using these techniques.

(5) <u>Less need for data</u>

Data in the third world countries in general and in the U.A.E. in particular are hardly available and when they are available, they are usually unreliable. As revealed by the survey, most of the widely used O.R. techniques in the U.A.E. are dependent on data derived directly from the accounting system within the organisation or company. This means that those techniques which are more dependent on data from outside sources are less favourable than those which are dependent on internal sources.

<u>A General Theory in the Diffusion of O.R. into Industrial and Business Organisations in Developing Countries</u>

Idama (4, 1984) discussed a general theory for the introduction of O.R. into organisations.

His theory is based on the concept that the introduction of O.R. into organisations is a policy decision i.e. decision to introduce O.R. into organisations is taken by top management. Idama identified five factors as being essential for the introduction of O.R. into organisations. These are awareness, applicability, modality, availability and financeability. His definitions of these terms are as follows:

Awareness: the degree of awareness and understanding which exists about operational Research mainly at the highest level of decision making in an organisation.

Applicability: the range of decision making problems which are amenable to scientific method.

Modality: the status which the decision makers in an organisation are willing to accord to operational research in the structure of the organisation.

Availability: the availability of O.R. scientists of the right calibre and experience.

Financeability: the willingness to pay the prices of acquiring the best available expertise (personnel and otherwise).

Our research revealed that although O.R. awareness is an essential factor (but not sufficient by itself) in the introduction of O.R. into organisations, modality, availability and financeability are not. As revealed by the survey we conducted, of the fifty two organisations and companies using some form of O.R., none has an O.R. group or department. This means that O.R. has been introduced to these organisations without any consideration of modality.

The survey also revealed that availability of O.R. scientists is not necessary for the introduction of O.R. into organisations, rather the availability of personnel with adequate knowledge in O.R. is an essential factor in the introduction of O.R. Our survey revealed that none of the fifty two organisations and companies using some form of O.R. employs an O.R. scientist, rather they have personnel with knowledge in O.R. acquired through taking courses in O.R. or training or otherwise.

We believed that financeability is not an essential factor in the introduction of O.R. into organisations. This belief was confirmed by the survey we conducted in the U.A.E. This survey revealed that only very low percentage of the total non-users organisations and companies have not adopted O.R. because of the cost of it usage. This also was confirmed by two other surveys in Greece and Malaysia and Singapore, see Pappis (5, 1988) and Kwong (6, 1986) respectively.

The theory which we developed based on the analysis of the collected data is based on the concept of "bottom up" i.e. the introduction of O.R. into organisations occurred through personnel in the lower level of decision making in the organisations using O.R. within their departments or areas rather than the decision to introduce O.R. is taken by the top level of decision making.

Two sets of factors were identified as being important for the diffusion of O.R. into organisation in developing countries. The first set includes the internal factors, within the organisation, and the second set includes the environmental factors. The internal factors consist of: O.R. awareness, availability of specialised personnel and computers and willingness to use O.R., while the environmental factor consists of: good quality O.R.

education, availability of training schemes and computer maintenance. The definitions of the above terms are presented as follows.

<u>O.R. awareness</u>: in the sense that people at different levels of decision making in an organisation are aware of the theory and practice of O.R., what is O.R. about and for what purposes it is used.

<u>Availability</u>: the availability of personnel with adequate knowledge in O.R. (but not necessarily O.R. scientists) and also the availability of computers since most O.R. techniques require the use of computer to varying degrees.

<u>Willingness</u>: in the sense that people have the desire and the interest in O.R. as a problems solving tool.

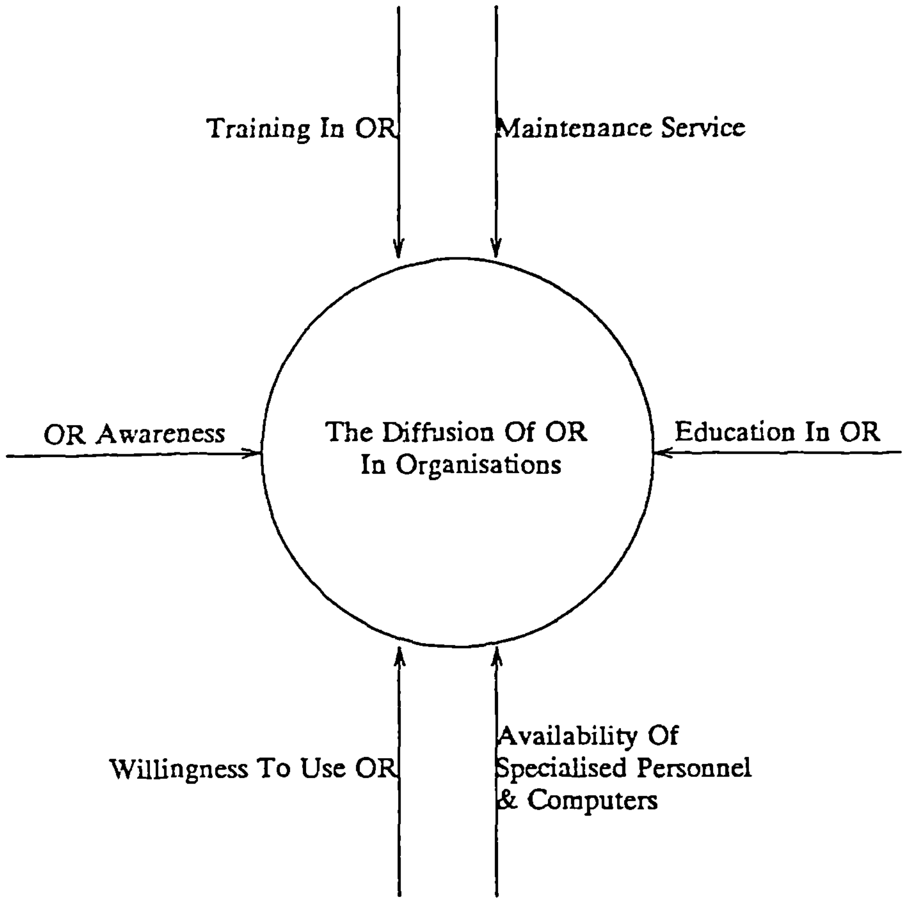
<u>Good quality O.R. education</u>: in the sense that it is relevant to the needs of the decision makers and to the environment of the country concerned, and suits students qualifications and backgrounds.

<u>Training schemes</u>: training needed to abolish the skill and knowledge of those who are aware of and willing to use O.R. and also those who do not have adequate knowledge in it but are willing to use O.R. techniques.

<u>Availability of computer maintenance</u>: the availability of computer maintenance which we believed is essential for promoting the use of computers and in turn O.R. techniques. Figure (10.1) shows the factors important for the diffusion of O.R. in organisations.

Figure (10.1)

Factors Important for the Diffusion of O.R. in Organisations



<u>Conclusion Regarding The Capacity Problem of The U.A.E. Cement Industry</u>

The U.A.E. cement industry is taken as a case study to demonstrate the contribution and value of O.R. in a developing and most newly industrialised country, the United Arab Emirates (U.A.E.). The reasons for choosing this industry is that the problems of this industry are self-evident, as are a number of possible solutions. Therefore, the use of O.R. techniques is to justify the intuition of the decision making bodies and to provide them with a more justifiable basis for their decision on one hand, and to convince people in the industrial and business organisations and companies of the values and contribution of O.R. on the other. The review of literature in the field of capacity planning revealed that most of the previous work was purely academic with very little evidence of implementation or management involvement. Furthermore, it was based largely on mathematical models, it was also dealing with micro-level capacity problems. Moreover, it placed very little emphasis, if any at all, on forecasting the future demand.

This study treats the problem of capacity planning in the U.A.E. cement industry as a strategic and long range problem where uncertainty is evident. Therefore, different scenarios were used to deal with the uncertainty, then by means of econometrics modelling these scenarios were converted into forecasts.

These forecasts were used to evaluate different strategies with the help of the decision making bodies. The involvement of management in this studies has taken three forms.

First, through assigning probabilities to different scenarios, secondly, through evaluating different strategies, and finally, through giving weight to different criteria for evaluating different plants in order to choose the plants which are overall the least efficient and in turn reduce the current capacity to an economic level by closing down the selected plants.

The procedure employed to tackle the problem of the cement industry was based largely on the concept of decision making under uncertainty, though the analytical tools in this procedure differ from that of decision making under uncertainty.

The main features of this procedure are: simplicity, flexibility, comprehensive, less need for computing facilities, can deal with uncertainty, it places more emphasis on forecasting future demand and the like.

10.3 Recommendations

In the last section the conclusions of this thesis were discussed. This section outlines the main recommendations of the study.

Recommendation on The Diffusion of O.R. in The U.A.E.

As mentioned in the previous section, there are obstacles which hinder the wide adoption of O.R. in the U.A.E. in general and in its industrial and business organisations in particular. There are a few factors which we believe to have a substantial influence on the wide adoption of O.R.

(1) Availability of training schemes

Undoubtedly, this factor is essential for the progress of O.R. in the third world countries in general and in the U.A.E. in particular, since the most serious obstacle to the adoption of O.R. is a lack of training schemes. Later we are going to discuss types of training needed and who should provide such training.

(2) Availability of computer maintenance services

Another main obstacle to the widespread use of O.R. in the U.A.E. is a lack of computing facilities. This is due mainly to inefficient maintenance services. Therefore the availability of adequate maintenance services would encourage the wide adoption of computers and this in turn would encourage the widespread use of O.R. techniques.

(3) Good quality education in O.R.

Good quality education in O.R. would be that which reflected and is relevant to the needs of the decision makers and the environment. Moreover, it should take into consideration the knowledge, experience and awareness of those who are going to use O.R. The quantity of O.R. education should also be emphasised. Further discussion about education in O.R. is given in the next section.

(4) Improve O.R. awareness

This is an essential factor which can assist in the wide adoption of O.R., since the survey revealed that O.R. is not very well known in the U.A.E. in general and in the industrial and business organisations in particular. Therefore, improving O.R. awareness is likely to enhance its chance of being adopted. The question which remains unanswered is "how can we improve O.R. awareness?"

There are many ways of going about improving O.R. awareness in third world countries in general and in the U.A.E. in particular.

One way is through seminars and conferences organised by Chambers of Commerce and Industry. For instance, in China as reported by Min Yi (7, 1981) lectures and conferences were used to popularise O.R. techniques during the popularisation period (1958-60). Another way is through training schemes.

A third way is through open lectures where industrialists and business men are invited to attend these lectures. A fourth way could be through regular columns in the newspapers, (business and economic section). Blumstein himself said that he had discovered operational research by reading an article in Fortune Magazine in April 1951. (8, 1987).

(5) <u>Improve the willingness to adopt O.R.</u>

It is not enough to have training schemes, computers, awareness in O.R. and good quality O.R. education. These should be coupled with the willingness to use O.R. The question which might be raised here is "how can we make people adopt O.R.?"

Provided that the four mentioned conditions were met, then convincing people to adopt O.R. is not an easy task.

First, the value of O.R. to its user should be demonstrated through using examples of the application of O.R. and benefits gained from its usage. Second, the faith in O.R. should also be improved, and this can be done through convincing people that the use of O.R. is preferable over traditional decision making tools such as trial and error, common sense, judgment, intuition and the like.

<u>Recommendation Regarding O.R. Education in The U.A.E.</u>

As argued by Muller-Merbach (9, 1985), education programmes in O.R. depend on the culture, the society's needs, the employment system, etc. Muller-Merbach argued that "education programmes in Operational Research depend on the culture of the country, the needs of the society, the employment systems, the resources of the university, the qualifications of students and many other criteria." p.(12).

Based on our investigation of O.R. practice, training and education in the U.A.E. we can recommend that the O.R. course taught at the U.A.E. University should include those techniques which we believe are more suitable for the decision makers´ needs and the environment in the U.A.E., and also suit the students qualifications. We believe that the O.R. course should include the following techniques: Linear programming, with special emphasis placed on the formulation of the problems and the interpreting of the results, and also on sensitivity analysis, Decision Theory, which is widely applied in the U.A.E. and needs less computing time and facilities and suits students qualifications and decision makers´ needs, experience and knowledge in O.R., forecasting Models, which are widely used and require little knowledge in O.R., Multi-attribute Decision Making Models, emphasis whould be placed on simple models, Statistical Analysis, Computer simulation, Scenario Analysis, Network Analysis, Transportation and Assignment Problems, Cost Benefit Analysis and finally, Inventory Models. A lecture or more about the history of O.R. and the steps needed to carry out an O.R. project should be included. Another O.R. course is necessary, but at a later stage. This course should include the following techniques: Non-linear programming, Mixed Integer Programming, Dynamic Programming, Game Theory, Markov Chains and finally the Manto-Carlo method.

These two courses should be compulsory for students studying Business Administration, Public Administration, Economics and Accounting. Micro-computers should be introduced for the purpose of teaching O.R. courses. Case studies using real life problems from the U.A.E. should also be introduced. In brief, we believe that each O.R. course should consist of: Lectures, Case Studies and Projects. Projects should deal with real life problems. By doing so a bridge between theory and practice can be achieved.

As mentioned in chapter three, no textbook in O.R. is used in teaching the O.R. course at the U.A.E. University at the present time, and because of a language barrier English textbooks cannot be used, and there are very few O.R. textbooks written in Arabic, and they are usually out of date and based mainly on western textbooks. As argued by Papoulias (10, 1984) "O.R. textbooks, old and new, do not appear to take into consideration or even mention any relationship between O.R. methods and techniques and the specific realities of a given country." p.(579). Therefore, a textbook which places emphasis on the techniques mentioned earlier and utilises the theoretical backgrounds mentioned in the western textbooks is essential so that the O.R. course can achieve its goals.

Recommendation Regarding Training in O.R. in The U.A.E.

Education provides the theoretical background, and it should be coupled with appropriate training, since the greatest benefit arises from both angles. The objectives of the training programme are: first, to improve O.R. awareness, recognition and belief of those at the highest level in the industrial and business organisations; and second to provide those at the operational level in these organisations with adequate knowledge and understanding in the use of O.R.

techniques. Three types of training are required in the U.A.E. at this stage:

The first type of training programme is designed for those who have some knowledge in O.R. and at the same time use O.R. in their organisations and companies. This programme should consist of the following activities:

(i) intensive training in O.R. techniques which are widely used in the country and computers and packages are to be used to demonstrate the use of these techniques. The aim here is to refresh the memory of those who acquired knowledge in O.R. a long time ago;

(ii) training in problems formulation, data collection, data analysis, and results interpretation;

(iii) intensive theoretical background in O.R. techniques which are more commonly used.

The second type of training programme is designed for those who have very little knowledge in O.R. and do not use any form of it at the present time. This programme should consist of the following activities:

(i) intensive theoretical background in the techniques which are widely used in the country;

(ii) comprehensive training in the use of these techniques in micro-computers;

(iii) intensive training in problems formulation, data collection, data analysis and results interpretation.

The third type of training programme is designed for those who have no previous knowledge in O.R. and who, of course, do not use any form of it. This programme should consist of the following activities:

(i) very comprehensive theoretical background in O.R. techniques which are more common in the country;

(ii) comprehensive training in the use of these techniques in micro-computers and packages;

(iii) intensive training in problems formulation, data collection, data analysis and results interpretation.

At this point the question which may be raised is "who should conduct these programmes? Is it the organisation itself? Is it an independent private organisation? Is it an independent public organisation?"

There is a two-fold answer to this question. First, large scale organisations and companies which usuallly have their own training centres, should design and execute in-house training programmes.

Second, for small and medium sized organisations where training is not needed throughout the year, it is more practical to assign the responsibility of training in O.R. to an independent organisation or company.

Regarding the question of the ownership of this independent organisation, we believe that a joint ownership of this independent training organisation would be more appropriate for the following reasons:

(i) the participation of the public sector in this organisation would persuade the government to adopt O.R. techniques in its departments.

(ii) the participation of the public sector in this organisation is going to prevent the private organisation from charging exaggerated fees for training services provided;

(iii) the involvement of the public sector in this organisation will give the private organisations confidence regarding the value of these techniques and this will encourage the participation in these programmes.

This organisation should have a strong link with the University especially with the department of business administration and the relevant departments so those can provide the trainers in this organisation with the theoretical background required. The trainers should be selected from those who have had long experience in the culture, social, economic and business environments in the U.A.E., and should have long experience in the use of O.R. techniques and the use of computers and packages.

Recommendation Regarding the Problem of The Cement Industry

As mentioned earlier in the thesis, the cement industry is taken as a case study to demonstrate the application of some of O.R. techniques in a real life situation in the U.A.E. with the hope that this might encourage the widespread use of O.R. techniques in the U.A.E.

The appropriate strategy which should be adopted by the cement industry is to cut its overall capacity by 50 percent. The implementation of this strategy would lead to the following outcomes:

(1) increase capacity utilization rate to 80-100 percent from the current level of around 35 percent.

(2) cut total expected costs by 60-80 percent.

(3) achieve trading profits, especially in the long run.

The cut in capacity involves closure of those plants which are believed to be overall the least efficient based on the fifteen criteria previously given, and the evaluation of the seven general managers of the seven plants. It is worth noting that the management in the seven plants has participated in the exercise of given score on a scale between 1-5 to each of the fifteen criteria and evaluating one another, i.e. each management has been asked to evaluate the other six plants with respect to the fifteen criteria.

Based on this evaluation some plants should close down, so that the operation rate of the industry can be improved and in turn this will benefit the industry, the economy, and the owners. More specifically, plants (A), (E) and (G) should close down since the investigation proved that these are overall the least efficient based on the fifteen criteria used.

The compensation programme suggested in chapter eight, which is either financial or takes the form of allowing the Emirates whose plants are to be closed to expand in other feasible industries.

The financial compensation programme might take the form such as transferring the ownership of the shareholders from the plant which will close down to those which are still in operation.

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Appendix (A): Questionnaires

Questionnaire (A-1) investigates OR practice in the U.A.E.

Questionnaire (A-2) investigates OR education in the U.A.E.

Questionnaire (A-3) data collection from cement manufacturers.

Questionnaire (A-4) data collection from cement manufacturers.

Questionnaire (A-5) probability assigning.

Questionnaire (A-6) strategy choice.

Questionnaire (A-7) criteria weighting.

Questionnaire (A-8) companies evaluation.

APPENDICES

Appendix (A) Questionnaires

Appendix (B) Tables

Appendix (C) Graphs

Appendix (D) Miscellaneous

(A-1)

The purpose of this questionnaire is to investigate the practice of operational research/management science in the UNITED ARAB EMIRATES.

Dear Sir,

Would you kindly answer the following questions as accurately as possible.

Part I: General Information.

NAME OF COMPANY/ORGANISATION:

NATURE OF THE BUSINESS:

NUMBER OF EMPLOYEES:

POSITION OF RESPONDENT:

EDUCATIONAL BACKGROUND OF RESPONDENT:

NATIONALITY OF RESPONDENT:

Part II: OR Awareness

[2.1] Have you heard about operational research (OR) or management science (MS)?

Yes ( ) No ( )

[2.1.1] If Yes. How?

1. Through taking courses.....
2. Training.....
3. Use.....
4. Other (please specify).......................

Part III: OR Usage

[3.1] Do you use OR/MS in our company/organisation?

Yes ( ) No ( )

If Yes,

[3.1.1] What techniques do you use?

1. Linear programming (LP).....
2. Computer simulation.....
3. Mixed integer programming.....
4. Dynamic programming.....
5. Decision theory.....
6. Forecasting models.....
7. Queueing theory.....
8. Inventory theory.....
9. Statistical analysis.....
10. Scenario analysis.....
11. Network analysis (PERT-CPM).....
12. Cost benefit analysis.....
13. Financial modeling.....
14. Risk analysis.....
16. Monte Carlo methods.....
17. Multi-attribute decision making.....
18. Other (please specify).....

[3.1.2] What are the reasons for using these techniques?

(a) Suitability for the problem examined.....
(b) Simplicity of the techniques.....
(c) Less need for computing time.....
(d) Less need for specialised personnel.....
(e) Less need for data.....
(f) Other (please specify)...................

[3.1.3] For what purposes do you use the previously mentioned techniques?

1. Distribution problem.....
2. Forecasting demand.....
3. Locating warehouses.....
4. Allocating resources.....
5. Product mix problem.....
6. Investment appraisal.....
7. Stock control.....
8. Production scheduling.....
9. Assignment problem.....
10. Project scheduling.....
11. Plant location.....
12. Capital budgeting.....
13. Project control.....
14. Maintenance and repair.....
15. Equipment replacement.....
16. Accounting procedures.....
17. Manpower planning.....

18. Quality control.....
19. Capacity planning.....
20. Profitability analysis.....
21. Price setting.....
22. Product design.....
23. Project evaluation.....
24. System analysis.....
25. Sales analysis.....
26. Supply planning.....
27. Operation planning.....
28. Other (please specify)........................

Part IV: OR Specialists and Training

[4.1] If you are using OR/MS techniques, do you have OR department and specialised personnels?

Yes ( ) No ( )

[4.2] If you are using OR/MS techniques, do you have computing facilities?

Yes ( ) No ( )

[4.2.1] If yes, what types of computer do you have?

....
....

[4.2.2] What type of packages do you use?

....
....

[4.3] Do you have training department or centre in your organisation/company?

Yes ( ) No ( )

[4.3.1] If yes, do you provide training in OR techniques?

Yes ( ) No ( )

[4.3.1.1] If yes, what kind of training do you provide to your employees?

....
....

Part V: Attitude Toward OR

[5.1] If you are not using OR/MS techniques, are you willing to use them?
Yes ( ) No ( )

[5.1.1] If Yes, in what aspects of your company/organisation OR/MS can be used?

....
....

[5.2] If you are not using OR/MS techniques, what techniques are you using to handle problems such as: product mix, transportation, forecasting, resource allocation and the like?

....
....

[5.3] If you are not using OR/MS techniques, what are the reasons?

(a) Not applicable.....
(b) Lack of computing facilities.....
(c) Lack of specialised personnel.....
(d) Management has no interest in OR/MS techniques.....
(e) Too costly.....
(f) Major decisions are made by parent company overseas.....
(g) No particular reason.....
(h) Other (please specify).......................

<u>Part VI: OR Problems and Characteristics</u>

[6.1] Do you see any problems in using OR/MS techniques in the U.A.E.?

Yes ( ) No ( ) Do not know ( )

[6.1.1] If Yes, what are these problems?

1. Technical.....
2. Financial.....
3. Administrative.....
4. Others (please specify).......................

[6.2] If there is no problem, why are you not using them? (Please give reasons)

i..............................
ii.............................
iii............................
iv.............................
v..............................

[6.3] What characteristics should OR techniques have in order to be suitable for the U.A.E. needs and environment?

i..............................
ii.............................
iii............................
iv.............................
v..............................

(A-2)

The purpose of this questionnaire is to evaluate operational research education in the U.A.E.
Please answer the following questions as accurately as possible.
(You can answer in in Arabic if you wish.)

PART I: STUDENTS

[1] Do you think that the currently taught operational research course is useful?

Yes ( ) No ( )

If No, why do you think so? (Please give reasons below)

i............................
ii...........................
iii..........................
iv...........................

[2] To which area should operational research (OR) give more attention?
(Please tick)

a. Linear programming problems. ( )
b. Decision theory. ( )
c. Queuing theory. ( )
d. Transportation problems. ( )
e. All the above. ( )
f. Other (please specify). ( )

....
....

Please give reasons for your choice in question [2]

i............................
ii...........................
iii..........................
iv...........................

[3] Do you think that you can apply what you learned in the (OR) course in the real life situations?

Yes ( ) No ( )

If yes, where can you apply it?

*In the public sector ( )
*In the private sector ( )
*In the industrial sector ( )
*Other (please specify) ( )

....

If No, what are the reasons?

i............................
ii...........................
iii..........................
iv...........................
v............................

[4] The practice of operational research (OR) can be introduced to the U.A.E.

*Strongly agree ( )
*Agree ( )
*Disagree ( )
*Strongly disagree ( )
*Undecided ( )

Please give reasons for your choice in question [4].

....
....

[5] If your answer in question [3] is yes, what managerial problems in the U.A.E. can be solved using OR techniques? (please give examples).

....
....

PART II: INSTRUCTORS

Please answer question (2) and (4) in part (I) in addition to the following questions.

[1] Do you think that OR course taught at the U.A.E. University is comprehensive enough?

Yes ( ) No ( )

If No, what other subjects should be included? (please specify).

a............................
b............................
c............................

[2] Do you think that OR course currently taught at the U.A.E. University suited to the clients' needs and the environment in the U.A.E.?

Yes ( ) No ( )

If no, what changes should be adopted to make it suit the U.A.E. needs?

....

[3] For what purpose OR can be used in the U.A.E. (please give examples).

a.............................
b.............................
c.............................
d.............................
e.............................

[4] What characteristics should OR have in order to be suitable for the U.A.E.?

i.............................
ii............................
iii...........................
iv............................

[5] Do you think another OR course is desirable?

Yes ( ) No ( )

If yes, what should it include? (please state below)

....
....

(A-3)

SECTION (1) (Financial Director)

I Source of finance

1. Government:

a. Local government .... DH ..... %

b. U.A.E. government .... DH ..... %

2. Shareholders:

a. U.A.E. citizen .... DH ..... %

b. Gulf " .... DH ..... %

c. Other " .... DH ..... %

3. Loans

a. Amount .... DH ..... %

b. Source:

1. ...., ... DH

2. ...., ... DH

3. ...., ... DH

II Cost of raw material

Ton of:	Cost (DH):
Limestone	....
Silica	....
Bauxite	....
Iron ore	....
Gypsum	....

III Cost of production/supplying:

Year	Cost of production	Cost of supplying	Cost of labour	Total profit/loss*
(1) 1975				
(2) 1976				
(3) 1977				
(4) 1978				
(5) 1979				
(6) 1980				
(7) 1981				
(8) 1982				
(9) 1983				
(10) 1984				
(11) 1985				

* Please give reasons for loss (if any).

Section (2)

I Production Capacity: (Production Director/ Production Engineer)

1. Are you working to your full capacity at the present time? ..... YES/NO
2. What is your full capacity? .... MT per year
3. What is your capacity per year if not the full one? .... MT per year
4. What will your factory's capacity be each year for the next 5 years? .... MT per year

II Raw Materials (Production Director/ Production Engineer)

Table (1)

Cement type / Raw materials	O.P.C. (1 ton)	S.R.C. (1 ton)	O.W.C. (1 ton)	Clinker (1 ton)	Maximum amount of raw material available
Limestone					
Silica					
Bauxite					
Iron ore					
Gypsum					

Table (2)

Year	Raw material (Amount-Type) (M.T.)						Total cost of raw material (DH)	Remarks
	Limestone	Silica	Bauxite	Iron Ore	Gypsum	Other		
(1) 1975								
(2) 1976								
(3) 1977								
(4) 1978								
(5) 1979								
(6) 1980								
(7) 1981								
(8) 1982								
(9) 1983								
(10) 1984								
(11) 1985								

III. Hours needed to produce a ton of different types of cement as shown below (Production Engineer)

Ton of	Number of man or machine-hours needed	Maximum number of hours available
O.P.C.	hrs.	hrs.
S.R.C.	hrs.	hrs.
O.W.C.	hrs.	hrs.
Clinker	hrs.	hrs.

IV. Production Plan: (General Manager/ Production Director)

(A) Does your company have any production plan for the next 5 years?

YES/NO ......

If Yes, please give brief description below.

....

....

(B) Production and Domestic Sales (Production Director/Sales Manager)

Year	Production per year (M.T.)				Domestic Sales (M.T.)				Total value of the sales
	O.P.C.	S.R.C.	O.W.C.	Clinker	O.P.C.	S.R.C.	O.W.C.	Clinker	
(1) 1975									
(2) 1976									
(3) 1977									
(4) 1978									
(5) 1979									
(6) 1980									
(7) 1981									
(8) 1982									
(9) 1983									
(10) 1984									
(11) 1985									

(C) <u>Export Sales</u> (Sales Manager)

Year	Export Sales (M.T.)			Total value of export Sales
	O.P.C.	S.R.C.	Clinker	
(1) 1975				
(2) 1976				
(3) 1977				
(4) 1978				
(5) 1979				
(6) 1980				
(7) 1981				
(8) 1982				
(9) 1983				
(10) 1984				
(11) 1985				

(D) Labour (Works Director)

Year	Number of employees			Number of employees		
	Local (citizen)	Arab	Foreigner	Management	Skilled	Unskilled
(1) 1975						
(2) 1976						
(3) 1977						
(4) 1978						
(5) 1979						
(6) 1980						
(7) 1981						
(8) 1982						
(9) 1983						
(10) 1984						
(11) 1985						

Section (3) General Manager/Sales Manager)

(Please use a separate sheet of paper, if needed)

I. Factors affecting domestic sales

What factors affect the domestic sales of cement in U.A.E.

1. ....

2. ....

3. ....

4. ....

5. ....

II. Sales Prediction

What information might help us to predict sales of cement for the next 5 years?

....

....

III. Integrated Production Plan (Chairman/General Manager)

Do you support the idea of integrated production plan for cement companies in U.A.E.?

Why or why not?

....

....

IV. Objectives

What is (are) the objective(s) of your company in making cement?

1. ....

2. ....

3. ....

4. ....

V. Manufacturing Methods (Production Engineer)

Describe the method of manufacturing which your company uses to produce each type of cement.

....

....

VI. Government Control (Chairman/General Manager)

Do you agree that the government of U.A.E. should decide the amount of cement to be produced yearly and the prices of cement?

Why or why not?

....

....

VII. Contribution to the Economy (Chairman/General Manager)

What is your company's contribution to the local and U.A.E. economy?

A. Local economy

....

....

B. U.A.E. economy

....

....

Please answer on a separate sheet of paper.

What is your evaluation of the future of the cement industry in terms of:-

A. Domestic Sales.

B. Export Sales.

C. Prices.

D. Government policy to save the industry?

What are the objectives of the Cement Manufacturers Association (CMA)?

....

....

(A-4)

Company name:

Date submitted:

Date collected:

Please answer the following questions as accurately as possible:

(1) What is the cost of production per ton of clinker and cement at the following levels of capacity utilization?

No.	Capacity utilization levels	Costs per ton of:			
		Clinker	Cement		
			O.P.C.	S.R.C.	O.W.C.
(a)	100% (fully utilized)				
(b)	90%				
(c)	85%				
(d)	70%				
(e)	60%				
(f)	50%				
(g)	below 50%				

Note: Whenever you cannot give an actual figure, please give an estimation based on your previous experiences.

(2) Production and sales per month for the year 1985.

Month	Production M.T.				Sales (Domestic) M.T.			
	O.P.C.	S.R.C.	O.W.C.	Clinker	O.P.C.	S.R.C.	O.W.C.	Clinker
Jan								
Feb								
Mar								
Apr								
May								
June								
July								
Aug								
Sept								
Oct								
Nov								
Dec								
Total								

(3) Destination and quantity of domestic sales for the year 1985

Destination	Quantity of (M.T.):			
	O.P.C.	S.R.C.	O.W.C.	Clinker*
Abu Dhabi				
Dubai				
Sharjah				
R.A.K.				
Ajman				
Fujairah				
Ummul Quwain				
Al-Ain				

*Please specify clinker sales to other plants in other regions or emirates.

(4) Export sales for the year 1985

Destination	Quantity (M.T.):			
	O.P.C.	S.R.C.	O.W.C.	Clinker
Oman				
Qatar				
Kuwait				
Bahrain				
Saudi Arabia				
Yemen				
Somalia				
India				
Pakistan				
....				
....				

(5) Production cost per ton of clinker and cement at .... % level of capacity utilization:

Items	Cost per ton of (D.H.):			
	Clinker	O.P.C.	S.R.C.	O.W.C.
Raw materials				
Wages*/salaries*				
Power				
Fuel oil/gas				
Maintenance				
Packing				
Depreciation				
Spare parts				
....				
....				

*Which related to production only.

(6) Raw materials usage and cost per ton for the year 1985

Items	Usage in a ton of clinker	Costs per ton of:
Limestone		
Silica		
Sand		
Clay		
Bauxite		
Iron ore		
Gypsum (in a ton of cement)		
Other		

Does the percentage of the raw materials in a ton of clinker differ with the difference in the type of cement? Show the difference.

(7) Installed capacity and capacity utilized for the year 1985

Year	Installed capacity (M.T.)		Capacity utilized (M.T.)	
	Clinker	Cement	Clinker	Cement
1985				
1986				
1987				

(8) If you have any comments, suggestions, or criticisms please write them on a separate sheet.

(A-5)

PROBABILITY ASSIGNING

interval	Scenario(1)		Scenario(2)		Scenario(3)		Scenario(4)	
	High	Low	High	Low	High	Low	High	Low
1986-1990 Probab- ility	3700.0 %	2900.0 %	2000.0 %	1600.0 %	1700.0 %	1300.0 %	1100.0 %	1000.0 %
1991-1995 Probab- ility	6600.0 %	3900.0 %	3500.0 %	2200.0 %	2900.0 %	1800.0 %	1500.0 %	1200.0 %
1996-2000 Probab- ility	9000.0 %	7000.0 %	4800.0 %	3700.0 %	3900.0 %	3200.0 %	2500.0 %	2100.0 %
2001-2005 Probab- ility	12400.0 %	9600.0 %	7600.0 %	5000.0 %	5000.0 %	4100.0 %	3200.0 %	2600.0 %

N.B. Figures in the Table represent home and export annual demand for cement in thousand tons.

How to use the Table:

The total percentage for each interval and for each level (high and low) should add to 100.0% under the four scenarios.

Example:
interval (1): 1986-1990.
Scenario (1) High, Probability 30.0%.
Scenario (2) High, Probability 20.0%.
Scenario (3) High, Probability 25.0%.
Scenario (4) High, Probability 25.0%.
Total percentage 100%.

This procedure is applied for low level in this interval and for high and low levels for the other intervals under the four scenarios.

(A-6)

Which strategies stated below are practical and implementable, and which are not? Why and Why not? Please tick (√) or (x) opposite each number.

( ) 1. Do nothing strategy - (keep the current capacity or 0.0% cut in capacity)

( ) 2. Cut capacity by 100.0% (No cement industry).

( ) 3. Cut capacity by 75.0%.

( ) 4. Cut capacity by 50.0% .

( ) 5. Cut capacity by 25.0%.

( ) 6. Cut clinker capacity by 50.0% and keep full grinding capacity.

( ) 7. Cut clinker capacity by 75.0% and keep full grinding capacity.

( ) 8. Cut clinker capacity by 25.0% and keep full grinding capacity.

( ) 9. Cut clinker capacity by 25.0% and cut grinding capacity by 50.0%.

( )10. Cut clinker capacity by 50.0% and cut grinding capacity by 50.0%.

( )11. Cut clinker capacity by 75.0% and cut grinding capacity by 25.0%.

( )12. Re-organize the entire cement industry.

( )13.

( )14.

( )14.

( )15.

( )16.

Please give reasons for your choices above.

....

....

....

....

....

(A-7)

NAME OF COMPANY:

Dear Sir;

Please give weight to the following criteria according to its significance to the survival of your company.

(1) Quality of raw materials	1	2	3	4	5
(2) Location close to raw materials sources	1	2	3	4	5
(3) Location close to local market	1	2	3	4	5
(4) Location close to domestic market	1	2	3	4	5
(5) Location close to port	1	2	3	4	5
(6) Causing pollution	1	2	3	4	5
(7) Providing employment for citizens	1	2	3	4	5
(8) Plant size	1	2	3	4	5
(9) Years in business	1	2	3	4	5
(10) Cost of production	1	2	3	4	5
(11) Ownership of capital by citizens	1	2	3	4	5
(12) Labour productivity	1	2	3	4	5
(13) Size of the local market	1	2	3	4	5
(14) Capacity utilization rate	1	2	3	4	5
(15) Size of export market	1	2	3	4	5

Keys:

* Not significant at all........one point.
* Slightly significant..........two points.
* Significant..................three points.
* Very significant.............four points.
* Extremely significant.........five points.

(A-8)

NAME OF COMPANY:

DATE SUBMITTED:

DATE COLLECTED:

NAME OF COMPANY EVALUATED:

Please circle one number only in each case.

N.B. Numbers below represent scores given in each case.

(1) Quality of raw materials	1 2 3 4 5
(2) Location close to raw materials sources	1 2 3 4 5
(3) Location close to local market	1 2 3 4 5
(4) Location close to domestic market	1 2 3 4 5
(5) Location close to port	1 2 3 4 5
(6) Causing pollution	-1 -2 -3 -4 -5
(7) Providing employment for citizens	1 2 3 4 5
(8) Plant size (Economies of scale)	1 2 3 4 5
(9) Years in business (Experience)	1 2 3 4 5
(10) Cost of production per ton	1 2 3 4 5
(11) Ownership of capital by citizens	1 2 3 4 5
(12) Labour productivity (Efficiency)	1 2 3 4 5
(13) Size of the local market	1 2 3 4 5
(14) Capacity utilization rate	1 2 3 4 5
(15) Size of export market	1 2 3 4 5

Keys:

* Very poor ....one point.
* Poor ....two points.
* Average ....three points.
* Good ....four points.
* Very good ....five points.

N.B. In the case of causing pollution (-1) is very good; (-2) is good; (-3) is average; (-4) is poor; and (-5) is very poor.

Appendix (B): Tables

Table

(B-1) macro-economic data for U.A.E.

(B-2) " " " " Saudi Arabia.

(B-3) " " " " Kuwait.

(B-4) " " " " Oman.

(B-5) " " " " Iraq.

(B-6) " " " " Egypt.

(B-7) " " " " Iran.

(B-8) Values of GNP and GFCF under 4 scenarios for S. Arabia.

(B-9) " " " " " " " " " Kuwait.

(B-10) " " " " " " " " " U.A.E.

(B-11) " " GDP " " " " " " Iraq.

(B-12) " " " " " " " " " Egypt.

(B-13) " " " " " " " " " Oman.

(B-14) " " " " " " " " " Iran.

(B-15) Values of GFCF in US$ for U.A.E. and S. Arabia.

(B-16) " " " " " " Kuwait and Oman.

(B-17) " " " " " " Egypt and Iran.

(B-18) " " " " " " Iraq.

(B-19) GFCF as % of GNP.

(B-20) Import of cement to and from the U.A.E. as % of total demand.

(B-21) Import of cement as % of total demand (historical data).

Table (B-1)

Data for U.A.E. forecasting models

year	GFCF (million U.A.E.DH) current prices	GDP deflator 1980=100	GFCF (million U.A.E.DH) 1980 prices	GFCF million $ 1980 prices	Cement consumption (000) MT	GNP million $ 1980 prices	GFCF$/ GNP $ %
1972	1119.8	26.000	4307.0	1173.0	230	9000.0	13.03
73	1375.8	26.296	5232.0	1425.0	253	9335.0	15.27
74	2673.3	62.652	4267.0	1162.0	747	12357.0	9.40
75	-	-	8666.0	2361.0	838	12754.0	18.51
76	-	-	10057.0	2740.0	1810	14530.0	18.86
77	-	-	14434.0	3932.0	2111	17175.0	22.89
78	-	-	16598.0	4521.0	2177	16633.0	27.18
79	-	-	16232.0	4422.0	1877	21288.0	20.77
1980	16385.0	100.000	16385.0	4463.0	2386	27551.0	16.20
81	14959.0	108.100	13838.0	3770.0	3084	24163.0	15.60
82	17510.0	107.700	16258.0	4429.0	2626	23101.0	19.17
83	15906.4	104.700	15192.4	4138.0	2670	28529.2	14.50
84	16059.0	99.500	16139.7	4397.0	2500	28447.0	15.46
85	-	-	14684.0	4000.0	2000	-	-

Sources: Ministry of Planning, U.A.E. National Accounts, Abu Dhabi, U.A.E., 1985.

Table (B-2)

Data for Saudi Arabia forecasting models

year	GFCF (million S.R.) current prices	GDP deflator 1980=100	GFCF (million S.R.) 1980 prices	GFCF million $ 1980 prices	Cement consumption (000) MT	GNP million $ 1980 prices	GFCF$/ GNP $ %
1970	1969	12.8	15382.8	4594.9	1130.6	35895.5	12.8
71	2196	14.7	14938.8	4462.0	1253.3	38801.1	11.5
72	2595	15.8	16424.0	4905.6	1210.6	45416.0	10.8
73	4706	18.9	24889.5	7434.1	1288.8	47559.0	15.6
74	6214	40.2	15457.7	4617.0	2567.3	61186.0	7.5
75	13222	56.3	23484.9	7014.6	2951.2	66409.0	10.6
76	26889	61.1	44008.2	13144.6	3938.0	80720.0	10.3
77	37684	66.1	57010.6	17028.3	6648.4	93722.0	18.2
78	51542	68.1	75685.8	22606.3	8469.7	98771.0	22.9
79	63412	70.9	89438.6	26714.0	8928.0	107317.0	24.9
1980	76864	100.0	76864.0	22958.2	12912.6	116655.0	19.7
81	81470	125.0	64968.1	19405.0	14254.4	125531.0	15.5
82	92227	124.0	74376.6	22215.2	17695.5	128831.0	17.2
83	87496	109.9	79614.2	23780.0	23808.5	104051.0	22.9
84	77019	99.0	77797.0	23236.9	19622.6	109232.0	21.3
85	66755	95.0	70268.4	20988.2	14932.7	103857.0	20.2

Sources: 1975-1980, annual report 1981 (1401), Saudi Arabian Monetary Agency.
1981-1982, Statistical Summary, 1985 (1405), Saudi Arabian Monetary Agency.
1983-1985, annual report 1986 (1406), Saudi Arabian Monetary Agency.

Table (B-3)

Data for Kuwait forecasting models

year	GFCF (million K.D.) current prices	GDP deflator 1980=100	GFCF (million K.D.) 1980 prices	GFCF million $ 1980 prices	Cement consumption (000) MT	GNP million $ 1980 prices	GFCF$/ GNP $ %
1970	63.23	105.1	60.16	222.81	528.0	3000.0	7.4
71	74.89	132.4	56.56	209.48	747.0	3121.0	6.7
72	86.48	135.0	64.06	237.26	676.9	2969.0	8.0
73	89.95	158.0	56.93	210.85	784.0	2809.0	7.5
74	140.83	43.2	326.00	1207.40	644.3	29378.0	4.1
75	154.70	45.0	343.78	1273.26	1431.9	29994.0	4.2
76	264.29	46.5	568.37	2105.07	1670.2	33793.0	6.2
77	336.51	51.0	659.82	2443.78	2355.7	33198.0	7.4
78	421.28	50.2	839.20	3108.15	2387.7	36104.0	8.6
79	508.22	70.6	719.86	2666.15	2191.9	39382.0	6.8
1980	606.94	100.0	606.94	2247.93	2099.4	33444.0	6.7
81	635.87	110.7	574.40	2127.40	2165.0	30249.0	7.0
82	861.00	109.8	784.15	2904.26	2330.0	26456.0	11.0
83	796.00	102.2	788.86	2884.67	2385.0	28097.0	10.3
84	633.00	102.8	615.76	2280.59	1339.0	28985.0	7.9
85	-	104.6	439.29	1627.00	1274.0	25954.0	6.3

Source: Ministry of Planning, National Accounts 1970-1984, May 1986, Kuwait.

Table (B-4)

Data for Oman forecasting models

year	GFCF (million Riyal) current prices	GDP deflator 1980=100	GFCF (million Riyal) 1980 prices	GFCF million $ 1980 prices	Cement consumption (000) MT	GNP million $ 1980 prices	GFCF$/ GNP $ %
1970	8.82	9.50	92.84	269.10	50.00	2763.0	10.0
71	21.36	11.10	192.43	557.77	50.00	2744.0	20.3
72	25.20	11.40	221.05	640.72	70.00	2843.00	18.6
73	26.64	15.90	167.55	485.65	116.00	1945.00	25.0
74	104.46	47.90	218.08	632.12	200.00	2522.00	25.0
75	154.80	49.00	315.92	915.71	250.00	3487.00	26.3
76	190.26	49.60	383.59	1111.86	200.00	3968.00	28.0
77	173.44	52.60	329.73	955.74	392.20	4133.00	23.1
78	164.10	50.75	323.33	937.19	615.90	4116.00	22.8
79	201.24	66.29	303.58	879.94	522.00	4125.00	21.3
1980	276.36	100.00	276.36	801.04	682.00	5343.80	15.0
81	345.36	103.12	334.91	970.75	834.80	6378.90	15.2
82	416.40	97.00	429.28	1244.29	1004.40	7120.00	17.5
83	435.36	87.16	499.50	1447.83	0867.00	8078.80	17.9
84	544.20	83.02	655.50	1900.00	1000.00	9189.00	20.7
85	571.84	82.96	689.30	1997.97	1100.00	-	-

Source: Directorate General of National Statistics, Development Council, Oman National Accounts, 1987.

Table (B-5)

Data for Iraq forecasting models

year	GFCF (million I.D.) current prices	Consumer price index 1980=100	GFCF (million I.D.) 1980 prices	GFCF million $ 1980 prices	Cement consumption (000) MT	GNP million $ 1980 prices	GFCF$/ GNP $ %
1970	103.3	38.5	268.3	909	1206	10035.6	9.1
71	113.0	39.5	286.2	970	1280	11285.0	8.6
72	118.9	41.9	283.8	962	1387	10736.6	9.0
73	183.4	44.1	416.0	1410	1716	11623.0	12.1
74	315.0	47.6	661.7	2243	1762	23725.0	9.5
75	397.6	52.1	763.1	2587	2387	25401.0	10.2
76	731.2	58.5	1249.9	4237	2793	29481.0	14.4
77	692.6	69.9	990.8	3359	3121	27125.4	12.4
78	865.4	75.2	1150.8	3901	6196	31630.8	12.3
79	1808.5	85.1	2125.2	7204	6747	44482.7	16.2
1980	2127.5	100.0	2127.5	7212	7009	53041.4	13.6
81	3252.2	121.0	2687.7	9111	6243	29352.2	31.0
82	3955.9	157.3	2514.9	8525	14000	28025.8	30.4
83	3695.7	204.4	1808.1	6129	14500	19760.0	31.0
84	3107.9	296.6	1047.8	3552	8955	11807.1	30.1
85	2380.7	370.7	642.2	2177	8103	9437.6	23.1

Sources: Ministry of Planning, Central Statistical Organisation, Iraq, 1986.
World Bank, World Table, 3rd edition, Washington, DC, 1985.
UN, Year book of National Accounts Statistics, Vol. 1., Individual Country Data - 1976, New York, 1977.

Table (B-6)

Data for Egypt forecasting models

year	GFCF (million E.P.) current prices	GDP deflator 1980=100	GFCF (million E.P.) 1980 prices	GFCF million $ 1980 prices	Cement consumption (000) MT	GNP million $ 1980 prices	GFCF$/ GNP $ %
1970	162.2	40.9	396.6	489.6	3340.0	8835.0	5.5
71	158.7	42.2	376.0	464.2	2521.0	9028.0	5.1
72	188.5	43.0	438.4	541.2	3025.0	10468.0	5.2
73	191.6	44.9	426.7	526.8	3054.0	10250.0	5.1
74	245.2	49.8	492.4	607.9	3084.0	10110.0	6.0
75	532.8	72.4	735.9	908.5	3599.0	8695.0	10.4
76	584.8	60.2	971.4	1199.3	3941.0	13426.0	8.9
77	735.2	67.9	1082.8	1336.8	4170.0	14140.0	9.5
78	1055.2	75.4	1399.5	1727.8	4438.0	13113.0	13.2
79	1482.8	82.9	1788.7	2208.3	5550.0	17610.0	12.5
1980	1954.8	100.0	1954.8	2413.3	5916.0	20580.0	11.7
81	2120.8	110.4	1921.0	2371.6	6932.0	20645.0	11.5
82	2460.0	126.8	1940.0	2395.0	10565.0	22290.0	10.7
83	2519.6	147.9	1703.6	2103.2	12799.0	21539.0	9.8
84	2638.0	172.3	1531.0	1890.1	8103.0	21006.0	9.0
85	2863.2	195.2	1466.8	1810.9	8022.0	21119.0	8.6

Sources: IMF, International Financial Statistics, Year book, 1986 and Vol. XL, No.12, - December 1987.
UN, Year book of National Accounts Statistics, Vol. I.1985, Individual Country data - 1976, New York, 1977.Vol. 1.

Table (B-7)

Data for Iran forecasting models

year	GFCF (million Riyal) current prices	GDP deflator 1980=100	GFCF (million Riyal) 1980 prices	GFCF million $ 1980 prices	Cement consumption (000) MT	GNP million $ 1980 prices	GFCF$/ GNP $ %
1970	105.1	14.7	715.0	9989.5	2544	75863.5	13.2
71	134.6	16.4	820.7	11466.3	2858	82482.1	13.9
72	174.5	17.6	991.5	13852.6	3634	88942.0	15.6
73	223.2	23.7	941.8	13158.2	4020	101404.0	13.0
74	341.2	38.1	895.5	12511.4	5239	106951.0	11.7
75	601.0	42.1	1427.6	19945.5	6250	110332.0	18.1
76	890.8	47.6	1871.4	26146.0	6700	116423.0	22.5
77	1056.3	56.0	1886.3	26354.2	8800	111254.0	23.7
78	1000.6	62.7	1595.9	22296.9	7015	106671.0	20.9
79	702.6	78.6	893.9	12489.0	8650	108362.0	11.5
1980	821.5	100.0	821.5	11477.5	8100	96849.0	11.9
81	929.4	118.4	785.0	10967.5	8100	98596.0	11.1
82	1113.3	132.8	838.4	11713.6	9750	113168.0	10.4
83	1737.3	150.1	1157.4	16170.5	10300	128006.0	12.6
84	1701.6	163.7	1039.5	14523.2	8955	128176.0	11.3
85	1436.2	166.0	865.2	12088.0	8103	121556.0	9.9

Sources: IMF, International Financial Statistics, Vol. XL, No.12, Washington DC, December 1987 and UN, Year book of National Accounts Statistics, Vol. 1, Individual Country data - 1976, New York, 1977.

Table (B-8)

Values of GNP and GFCF - Saudi Arabia

year	Scenario No. (1) million US$ (1980 prices)		Scenario No. (2) million US$ (1980 prices)		Scenario No. (3) million US$ (1980 prices)		Scenario No. (4) million US$ (1980 prices)	
	GNP (growth) 4.9%	GFCF as % of GNP 10.0%	GNP (growth) 4.3%	GFCF as % 8.0%	GNP (growth) 4.1%	GFCF/GNP 6.0%	GNP (growth) 3.9%	GFCF/GNP 4.0%
1985	103857.0	-	103857.0	-	103857.0	-	103857.0	-
86	108932.0	10893.0	108323.0	8666.0	108115.0	6487.0	107907.0	4316.0
87	114270.0	11427.0	112980.0	9038.0	112548.0	6753.0	112115.0	4485.0
88	119869.0	11987.0	117838.0	9427.0	117162.0	7030.0	116488.0	4660.0
89	125743.0	12574.0	122985.0	9832.0	121966.0	7318.0	121031.0	4841.0
1990	131904.0	13190.0	128190.0	10255.0	126967.0	7618.0	125751.0	5030.0
91	138367.0	13837.0	133702.0	10696.0	132173.0	7930.0	130655.0	5226.0
92	145147.0	14515.0	139451.0	11156.0	137592.0	8256.0	135751.0	5430.0
93	152259.0	15226.0	145447.0	11636.0	143233.0	8594.0	141045.0	5642.0
94	159720.0	15972.0	151701.0	12136.0	149106.0	8946.0	146546.0	5862.0
95	167546.0	16755.0	158224.0	12658.0	155219.0	9313.0	152261.0	6090.0
96	175756.0	17576.0	165028.0	13202.0	161583.0	9695.0	158199.0	6328.0
97	184368.0	18437.0	172124.0	13770.0	168208.0	10092.0	164369.0	6575.0
98	196402.0	19640.0	179525.0	14362.0	175105.0	10506.0	170779.0	6831.0
99	206026.0	20602.0	187245.0	14980.0	182284.0	10937.0	177439.0	7098.0
2000	216121.0	21612.0	195297.0	15624.0	189758.0	11385.0	184359.0	7374.0
01	226710.0	22671.0	203695.0	16296.0	197539.0	11852.0	191549.0	7662.0
02	237819.0	23782.0	212454.0	16996.0	205638.0	12338.0	199019.0	7961.0
03	249473.0	24947.0	221590.0	17727.0	214069.0	12844.0	206780.0	8271.0
04	261697.0	26170.0	231118.0	18489.0	222846.0	13371.0	214844.0	8594.0
05	274520.0	27452.0	241056.0	19284.0	231983.0	13919.0	223223.0	8929.0

Table (B-9)

Values of GNP and GFCF - Kuwait

year	Scenario No. (1)		Scenario No. (2)		Scenario No. (3)		Scenario No. (4)	
	GNP 4.6%	GFCF as % of GNP 5.0%	GNP 4.2%	GFCF as % of GNP 3.5%	GNP 3.8%	GFCF as % of GNP 3.2%	GNP 3.6%	GFCF as % of GNP 3.0%
1985	25954.0	-	25954.0	-	25954.0	-	25954.0	-
86	27148.0	1357.0	27044.0	947.0	26940.0	862.0	26888.0	807.0
87	28397.0	1420.0	28180.0	986.0	27964.0	895.0	27856.0	836.0
88	29703.0	1485.0	29364.0	1028.0	29027.0	929.0	28859.0	866.0
89	31069.0	1553.0	30597.0	1070.0	30130.0	964.0	29898.0	897.0
1990	32498.0	1625.0	31882.0	1116.0	31275.0	1001.0	30974.0	929.0
91	33993.0	1700.0	33221.0	1163.0	32370.0	1036.0	32089.0	963.0
92	35557.0	1778.0	34616.0	1212.0	33600.0	1075.0	33244.0	997.0
93	37193.0	1860.0	36070.0	1262.0	34877.0	1116.0	34441.0	1033.0
94	38904.0	1945.0	37585.0	1315.0	36202.0	1158.0	35681.0	1070.0
95	40694.0	2035.0	39164.0	1370.0	37578.0	1202.0	36966.0	1109.0
96	42566.0	2128.0	40809.0	1428.0	39006.0	1248.0	38297.0	1149.0
97	44524.0	2226.0	42523.0	1488.0	40488.0	1296.0	39676.0	1190.0
98	46572.0	2329.0	44309.0	1551.0	42027.0	1345.0	41104.0	1233.0
99	48714.0	2436.0	46170.0	1616.0	43624.0	1396.0	42584.0	1278.0
2000	50954.0	2548.0	48109.0	1684.0	45282.0	1449.0	44117.0	1324.0
01	52298.0	2615.0	50130.0	1755.0	47003.0	1504.0	45705.0	1371.0
02	54704.0	2735.0	52235.0	1828.0	48789.0	1561.0	47350.0	1421.0
03	57220.0	2861.0	54429.0	1905.0	50643.0	1621.0	49055.0	1472.0
04	59852.0	2993.0	56715.0	1985.0	52567.0	1682.0	50821.0	1525.0
05	62605.0	3130.0	59097.0	2068.0	54565.0	1746.0	52651.0	1580.0

Table (B-10)

Values of GNP and GFCF - U.A.E.

year	Scenario No. (1)		Scenario No. (2)		Scenario No. (3)		Scenario No. (4)	
	growth in GNP 5%	GFCF/GNP 13% million $	growth in GNP 4.5%	GFCF/GNP 9%	growth in GNP 4.3%	GFCF/GNP 5%	growth in GNP 4.1%	GFCF/GNP 4%
1985	28000.0	4000.0	28000.0	4000	28000	4000	28000.0	4000
86	29400.0	3822.0	29260.0	2633.0	29204.0	2482.0	29148.0	1895.0
87	30870.0	4013.0	30577.0	2752.0	30460.0	2589.0	30343.0	1972.0
88	32414.0	4214.0	31953.0	2876.0	31770.0	2700.0	31587.0	2053.0
89	34035.0	4425.0	33390.0	3005.0	33136.0	2817.0	32882.0	2137.0
1990	35737.0	4646.0	34893.0	3140.0	34560.0	2938.0	34230.0	2225.0
91	37524.0	4878.0	36463.0	3282.0	36046.0	3064.0	35633.0	2316.0
92	39400.0	5122.0	38104.0	3429.0	37596.0	3196.0	37094.0	2411.0
93	41370.0	5378.0	39819.0	3584.0	39213.0	3333.0	38615.0	2510.0
94	43439.0	5647.0	41611.0	3745.0	40899.0	3476.0	40198.0	2613.0
95	45611.0	5929.0	43483.0	3913.0	42658.0	3626.0	41846.0	2720.0
96	47892.0	6226.0	45440.0	4090.0	44492.0	3782.0	43562.0	2832.0
97	50287.0	6337.0	47485.0	4274.0	46405.0	3944.0	45348.0	2948.0
98	52801.0	6864.0	49622.0	4466.0	48400.0	4114.0	47207.0	3068.0
99	55441.0	7207.0	51855.0	4667.0	50481.0	4291.0	49142.0	3194.0
2000	58213.0	7568.0	54188.0	4877.0	52652.0	4475.0	51157.0	3325.0
01	61124.0	7946.0	56626.0	5096.0	54916.0	4668.0	53254.0	3462.0
02	64180.0	8343.0	59174.0	5326.0	57277.0	4869.0	55437.0	3603.0
03	67389.0	8761.0	61837.0	5565.0	59740.0	5078.0	57710.0	3751.0
04	70758.0	9199.0	64620.0	5816.0	62309.0	5296.0	60076.0	3905.0
05	74296.0	9658.0	67528.0	6078.0	64988.0	5524.0	62539.0	4065.0

Table (B-11)

Values of GDP and GFCF - Iraq

year	Scenario No. (1)		Scenario No. (2)		Scenario No. (3)		Scenario No. (4)	
	GDP growth 3.5% million US$	GFCF/GDP 13%	GDP growth 3.0%	GFCF/GDP 10%	GDP growth % 2.5	GFCF/GDP 7.5%	GDP growth % 2.2	GFCF/GDP 6.0%
1985	9437.6	-	9437.6	-	9437.6	-	9437.6	-
86	9767.9	1270.0	9720.7	972.0	9673.5	726.0	9645.2	579
87	10109.8	1314.0	10012.3	1001.0	9915.3	744.0	9857.4	591
88	10463.6	1360.0	10312.7	1031.0	10807.7	810.0	10074.3	604
89	10829.8	1408.0	10622.0	1062.0	11077.9	830.0	10295.9	618
1990	11208.8	1457.0	10940.7	1094.0	11354.8	852.0	10522.0	631
91	11601.1	1508.0	12268.9	1227.0	11638.7	873.0	10753.5	645
92	12007.1	1561.0	12637.0	1264.0	11929.7	895.0	10990.0	659
93	12427.3	1616.0	13016.1	1302.0	12227.9	917.0	11209.8	673
94	12862.3	1672.0	13406.6	1340.0	12533.6	940.0	11456.4	687
95	13312.5	1730.0	13808.8	1380.0	12846.9	964.0	11708.4	703
96	13778.4	1791.0	14223.0	1422.0	13168.0	988.0	11966.0	718
97	14260.6	1854.0	14649.7	1465.0	13497.0	1012.0	12229.3	734
98	14759.7	1919.0	15089.2	1509.0	13834.4	1038.0	12498.3	750
99	15276.3	1986.0	15541.9	1554.0	14180.3	1064.0	12773.4	766
2000	15811.0	2055.0	16008.2	1600.0	14534.8	1090.0	13054.4	783
01	16364.4	2127.0	16488.4	1649.0	14898.2	1117.0	13341.6	800
02	16937.2	2202.0	16983.1	1698.0	15270.7	1145.0	13635.1	818
03	17530.0	2279.0	17492.6	1749.0	15652.5	1174.0	13935.0	836
04	18144.6	2359.0	18017.4	1802.0	16043.8	1203.0	14241.6	854
05	18779.7	2441.4	18557.9	1856.0	16444.9	1233.0	14554.9	873

Table (B-12)

Values of GNP and GFCF - Egypt

year	Scenario No. (1)		Scenario No. (2)		Scenario No. (3)		Scenario No. (4)	
	GNP 2.6%	GFCF/GNP 7.0%	GNP 2.3%	GFCF/GNP 5.0%	GNP 2.1%	GFCF/GNP 4.0%	GNP 1.9%	GFCF/GNP 3.5%
1985	20000	-	20000	-	20000	-	20000	-
86	20520	1436	20460	1023	20420	817	20380	713
87	21054	1474	20930	1047	20849	834	20767	727
88	21601	1512	21411	1071	21287	851	21162	741
89	22163	1551	21903	1095	21734	869	21564	755
1990	22739	1592	22407	1120	22190	888	21974	769
91	23330	1633	22990	1150	22656	906	22392	784
92	23937	1676	23519	1176	23132	925	22817	799
93	24559	1719	24060	1203	23618	945	23251	814
94	25198	1764	24613	1231	24114	965	23693	829
95	25853	1810	25179	1259	24620	985	24143	845
96	26525	1857	25758	1288	25137	1005	24602	861
97	27215	1905	26428	1321	25665	1027	25069	877
98	27923	1955	27036	1352	26204	1048	25545	894
99	28649	2005	27658	1383	26754	1070	26030	911
2000	29394	2058	28294	1415	27316	1093	26525	928
01	30158	2111	28945	1447	27890	1116	27029	946
02	30942	2166	29610	1481	28476	1139	27543	964
03	31746	2222	30291	1515	29074	1163	28066	982
04	32571	2280	30988	1549	29685	1187	28599	1001
05	33418	2339	31700	1585	30308	1212	29142	1020

Table (B-13)

Values of GNP and GFCF - Oman

year	Scenario No. (1)		Scenario No. (2)		Scenario No. (3)		Scenario No. (4)	
	GNP 4.7%	GFCF/GNP 14.%	GNP 4.2	GFCF/GNP 9.5%	GNP 4.0%	GFCF/GNP 8%	GNP 3.8%	GFCF/GNP 7%
1985	11200.0	-	11200.0	-	11200.0	-	11200.0	-
86	11766.4	1647.3	11670.4	1108.7	11648.0	931.8	11625.6	813.8
87	12319.4	1724.7	12160.6	1155.3	12113.9	969.1	12067.4	844.7
88	12898.4	1805.8	12671.3	1203.8	12598.5	1007.9	12526.0	876.8
89	13504.6	1890.6	13203.5	1254.3	13102.4	1048.2	13002.0	910.1
1990	14139.3	1979.5	13758.0	1307.0	13626.5	1090.1	13496.1	944.7
91	14803.8	2072.5	14335.8	1361.9	14171.6	1133.7	14009.0	980.6
92	15499.6	2169.9	14937.9	1419.1	14738.5	1179.0	14541.3	1017.9
93	16228.0	2271.9	15565.3	1478.7	15328.0	1226.0	15093.6	1056.6
94	16990.7	2378.7	16219.0	1540.8	15941.1	1275.3	15667.2	1096.7
95	17789.3	2490.5	16899.8	1605.5	16578.7	1326.3	16262.6	1138.4
96	18625.4	2607.6	17609.6	1672.9	17241.8	1379.3	16880.6	1181.6
97	19500.8	2730.1	18349.2	1743.2	17931.5	1434.5	17522.0	1226.5
98	20417.3	2858.4	19119.9	1816.4	18648.8	1491.9	18187.8	1273.1
99	21376.9	2992.8	19922.9	1892.7	19394.8	1551.6	18878.9	1321.5
2000	22381.6	3133.4	20759.7	1972.2	20170.6	1614.6	19596.3	1371.7
01	23433.5	3280.7	21631.6	2055.0	20977.4	1678.2	20341.0	1423.9
02	24534.9	3434.9	22540.0	2141.3	21816.5	1745.3	21114.0	1478.0
03	26688.0	3736.3	23486.7	2231.2	22689.2	1815.0	21916.3	1534.1
04	27942.3	3911.9	24473.1	2324.9	23596.8	1887.7	22749.1	1592.4
05	29255.6	4095.8	25501.0	2422.6	24540.7	1963.3	23613.6	1653.0

Table (B-14)

Values of GNP and GFCF - Iran

year	Scenario No. (1)		Scenario No. (2)		Scenario No. (3)		Scenario No. (4)	
	GNP 3.2%	GFCF/GNP 14.5%	GNP 2.7%	GFCF/GNP 12%	GNP 2.3%	GFCF/GNP 10.0%	GNP 2.0%	GFCF/GNP 8.5%
1985	121556	-	121556	-	121556	-	121556	-
86	125446	18190	124838	14981	124352	12435	123987	10539
87	129460	18772	128209	15385	127212	12721	126467	10750
88	133603	19372	131671	15801	130138	13014	128996	10965
89	137878	19992	135226	16227	133131	13313	131576	11184
1990	142290	20632	138877	16665	136193	13619	134208	11408
91	146843	21292	142627	17115	139325	13933	136892	11636
92	151542	21974	146478	17577	142529	14253	139630	11869
93	156391	22677	150433	18052	145807	14581	142423	12106
94	161396	23402	154495	18539	152514	15251	145271	12340
95	166561	24151	158666	19040	156022	15602	148176	12595
96	171891	24924	162950	19554	159611	15961	151140	12847
97	177392	25722	167350	20082	163282	16328	154163	13104
98	183069	26545	171868	20624	167037	16704	157246	13366
99	188927	27394	176508	21181	170879	17088	160391	13633
2000	194973	28271	181274	21753	174809	17481	163599	13906
01	201212	29176	186168	22340	178830	17883	166871	14184
02	207651	30109	191195	22943	182943	18294	170208	14468
03	214296	31072	196357	23563	187151	18715	173612	14757
04	221153	32067	201659	24199	191455	19146	177084	15052
05	228230	33093	207104	24852	195858	19586	180626	15353

Table (B-15)

Ln GFCF (1980 $)

year	United Arab Emirates				Saudi Arabia			
	Scenario(1)	(2)	(3)	(4)	Scenario(1)	(2)	(3)	(4)
1985	8.294	8.294	8.294	8.294	9.952	9.952	9.952	9.952
86	8.249	7.876	7.817	7.547	9.296	9.067	8.778	8.370
87	8.297	7.920	7.859	7.587	9.344	9.109	8.818	8.408
88	8.346	7.964	7.901	7.627	9.392	9.151	8.858	8.447
89	8.395	8.008	7.943	7.667	9.439	9.193	8.898	8.485
1990	8.444	8.052	7.985	7.708	9.487	9.236	8.938	8.523
91	8.492	8.096	8.027	7.748	9.535	9.278	8.978	8.561
92	8.541	8.140	8.070	7.788	9.583	9.320	9.019	8.600
93	8.590	8.184	8.112	7.828	9.631	9.362	9.059	8.638
94	8.639	8.228	8.154	7.868	9.679	9.404	9.099	8.676
95	8.688	8.272	8.196	7.908	9.726	9.446	9.139	8.714
96	8.736	8.316	8.238	7.949	9.774	9.488	9.179	8.753
97	8.754	8.360	8.280	7.989	9.822	9.530	9.219	8.791
98	8.834	8.404	8.322	8.029	9.885	9.572	9.260	8.829
99	8.883	8.448	8.364	8.069	9.933	9.614	9.300	8.868
2000	8.932	8.492	8.406	8.109	9.981	9.657	9.340	8.906
01	8.980	8.536	8.448	8.150	10.029	9.699	9.380	8.944
02	9.029	8.580	8.491	8.190	10.077	9.741	9.420	8.982
03	9.078	8.624	8.533	8.230	10.125	9.783	9.460	9.021
04	9.127	8.668	8.575	8.270	10.172	9.825	9.501	9.059
05	9.176	8.712	8.617	8.310	10.220	9.867	9.541	9.097

Table (B-16)

Ln GFCF (1980 $)

year	Kuwait				Oman			
	Scenario(1)	(2)	(3)	(4)	Scenario(1)	(2)	(3)	(4)
1985	7.390	7.390	7.390	7.390	-	-	-	-
86	7.213	6.853	6.759	6.693	7.407	7.010	6.837	6.702
87	7.258	6.894	6.797	6.729	7.453	7.052	6.876	6.739
88	7.303	6.935	6.834	6.787	7.499	7.093	6.916	6.776
89	7.348	6.975	6.871	6.799	7.545	7.134	6.955	6.814
1990	7.393	7.018	6.909	6.834	7.590	7.145	6.994	6.850
91	7.438	7.059	6.943	6.870	7.637	7.217	7.033	6.888
92	7.483	7.100	6.980	6.905	7.682	7.258	7.072	6.925
93	7.528	7.140	7.018	6.940	7.728	7.299	7.112	6.963
94	7.530	7.182	7.054	6.975	7.774	7.340	7.150	7.000
95	7.618	7.223	7.092	7.011	7.820	7.381	7.190	7.037
96	7.663	7.264	7.129	7.047	7.866	7.422	7.229	7.075
97	7.708	7.305	7.167	7.082	7.912	7.463	7.269	7.112
98	7.753	7.347	7.204	7.117	7.958	7.505	7.308	7.149
99	7.798	7.388	7.241	7.153	8.004	7.546	7.347	7.187
2000	7.843	7.429	7.279	7.188	8.050	7.587	7.387	7.223
01	7.869	7.470	7.316	7.223	8.096	7.628	7.425	7.261
02	7.914	7.511	7.353	7.259	8.142	7.669	7.465	7.298
03	7.959	7.552	7.391	7.294	8.226	7.710	7.504	7.336
04	8.004	7.593	7.428	7.330	8.272	7.751	7.543	7.373
05	8.049	7.634	7.465	7.365	8.318	7.793	7.582	7.410

Table (B-17)

Ln GFCF (1980 $)

year	Egypt				Iran			
	Scenario(1)	(2)	(3)	(4)	Scenario(1)	(2)	(3)	(4)
1985	7.5016	7.5016	7.5016	7.5016	-	-	-	-
86	7.2696	6.9305	6.7056	6.5695	9.8086	9.6145	9.4283	9.2628
87	7.2957	6.9537	6.7262	6.5889	9.8401	9.6411	9.4510	9.2827
88	7.3212	6.9763	6.7464	6.6080	9.8716	9.6678	9.4738	9.3025
89	7.3467	6.9985	6.7673	6.6267	9.9031	9.6944	9.4965	9.3222
1990	7.3727	7.0211	6.7890	6.6451	9.9346	9.7211	9.5192	9.3421
91	7.3982	7.0475	6.8090	6.6644	9.9661	9.7477	9.5420	9.3619
92	7.4242	7.0699	6.8298	6.6834	9.9976	9.7745	9.5647	9.3817
93	7.4495	7.0926	6.8512	6.7020	10.0291	9.8010	9.5875	9.4015
94	7.4753	7.1156	6.8721	6.7202	10.0606	9.8276	9.6324	9.4206
95	7.5011	7.1381	6.8926	6.7393	10.0921	9.8543	9.6552	9.4411
96	7.5267	7.1608	6.9127	6.7581	10.1236	9.8809	9.6779	9.4609
97	7.5522	7.1861	6.9344	6.7765	10.1551	9.9076	9.7006	9.4807
98	7.5781	7.2093	6.9546	6.7957	10.1866	9.9342	9.7234	9.5005
99	7.6034	7.2320	6.9754	6.8145	10.2181	9.9609	9.7461	9.5202
2000	7.6295	7.2549	6.9967	6.8330	10.2496	9.9875	9.7689	9.5401
01	7.6549	7.2772	7.0175	6.8522	10.2811	10.0141	9.7916	9.5599
02	7.6806	7.3005	7.0379	6.8711	10.3126	10.0408	9.8143	9.5797
03	7.7062	7.3232	7.0586	6.8896	10.3441	10.0674	9.8371	9.5995
04	7.7319	7.3454	7.0792	6.9088	10.3756	10.0941	9.8598	9.6193
05	7.7575	7.3684	7.1000	6.9276	10.4071	10.1207	9.8826	9.6391

Table (B-18)

Ln GFCF (1980 $)

year	Iraq			
	Scenario(1)	(2)	(3)	(4)
1985	-	-	-	-
86	7.147	6.879	6.588	6.361
87	7.180	6.909	6.612	6.382
88	7.215	6.938	6.697	6.404
89	7.250	6.968	6.721	6.426
1990	7.284	6.998	6.748	6.447
91	7.319	7.112	6.772	6.469
92	7.353	7.142	6.796	6.490
93	7.388	7.172	6.821	6.512
94	7.423	7.200	6.846	6.532
95	7.456	7.230	6.871	6.555
96	7.490	7.260	6.896	6.576
97	7.525	7.290	6.920	6.599
98	7.560	7.319	6.945	6.620
99	7.594	7.349	6.970	6.641
2000	7.628	7.378	6.994	6.663
01	7.662	7.408	7.018	6.685
02	7.697	7.437	7.043	6.707
03	7.731	7.467	7.068	6.729
04	7.766	7.497	7.093	6.750
05	7.800	7.526	7.117	6.772

Table (B-19)

Gross Fixed Capital Formation* as % of GNP

	Scenario (1)	Scenario (2)	Scenario (3)	Scenario (4)	Scenario (5)	Scenario (6)
U.A.E. GFCF$/GNP$	13.0%	9.0	5.0	8.5	6.5	4.0
Saudi Arabia GFCF$/GNP$	10.0%	8.0	3.5	6.0	4.0	2.5
Kuwait GFCF$/GNP$	5.0%	3.5	2.5	3.2	3.0	1.5
Oman GFCF$/GNP$	14.0%	9.5	6.0	8.0	7.0	3.5
Iraq GFCF$/GNP$	13.0%	10.0	5.0	7.5	6.0	3.0
Egypt GFCF$/GNP$	7.0%	5.0	2.5	4.0	3.5	2.0
Iran GFCF$/GNP$	14.5%	12.0	7.0	10.0	8.5	5.0

* *Gross fixed capital formation (GFCF) spent on building and construction only.*

Table (B-20)

Import of Cement to and from The U.A.E. as % of Total Demand

Country	Scenario (1)	Scenario (2)	Scenario (3)	Scenario (4)	Scenario (5)	Scenario (6)
U.A.E.	4.0%	6.0	8.0	6.5	7.5	9.0
Saudi Arabia	12.0%	9.0	7.0	8.5	8.0	5.0
Kuwait	15.0%	13.5	11.0	12.5	12.0	10.0
Oman	14.0%	12.0	7.0	10.5	8.0	6.0
Iraq	4.0%	3.5	2.0	3.0	2.5	1.9
Egypt	10.0%	8.5	6.0	8.0	7.0	5.0
Iran	8.0%	6.5	4.0	6.0	5.0	3.0

Table (B-21)

Import of Cement as % of Total Demand
(Historical data)

Year	U.A.E.	S. Arabia	Kuwait	Oman	Egypt	Iraq	Iran
1970	100%	41%	100%	100%	0.03%	-	2.6%
71	100	44	100	100	0.0	-	2.9
72	100	25	100	100	0.06	28	2
73	100	22	63	100	0.07	34	8
74	100	59	71	100	0.03	1	14
75	99	62	56	100	3.0	11	20
76	90	71	76	100	15	2	19
77	72	81	80	100	24	2	21
78	64	79	74	100	32	24	13
79	29	70	56	100	46	21	2
1980	20	78	40	100	48	25	1.2
81	26	67	25	100	51	24	1.2
82	22	60	98	100	55	43	2.7
83	20	65	86	100	57	34	3.0
84	77+	62	87	60	64	0.54	-
85	55+	34	83	38	59	0.44	0.20

(-) Not available.
\+ Figures for 1984 and 85 from World Statistical Review, No. 8, December, 1986.

Appendix (C): Graphs

Graph

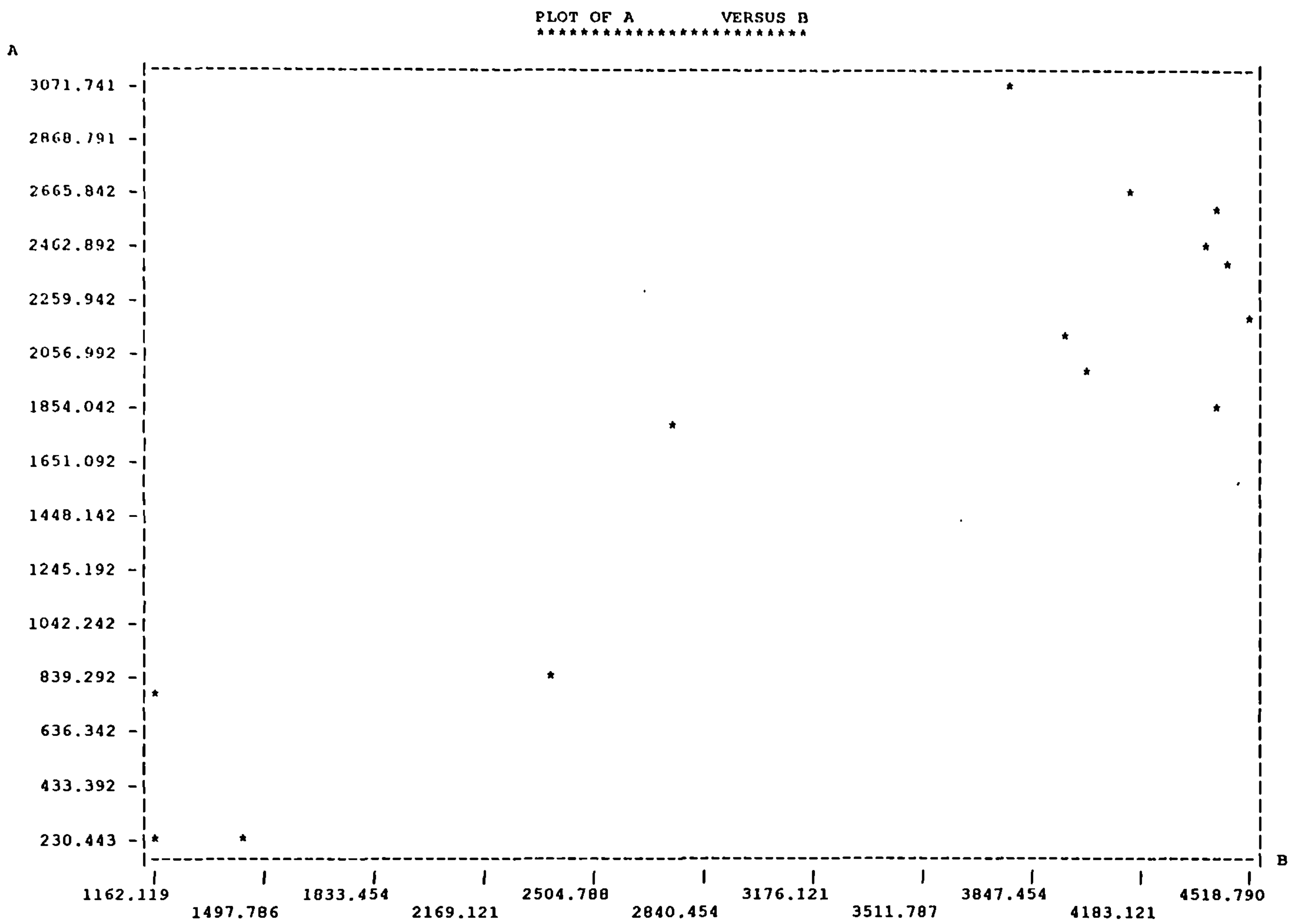
The following abbreviations are used in the graphs:

A: Demand for cement.

B: Gross fixed capital formation spent on building and construction.

UAE

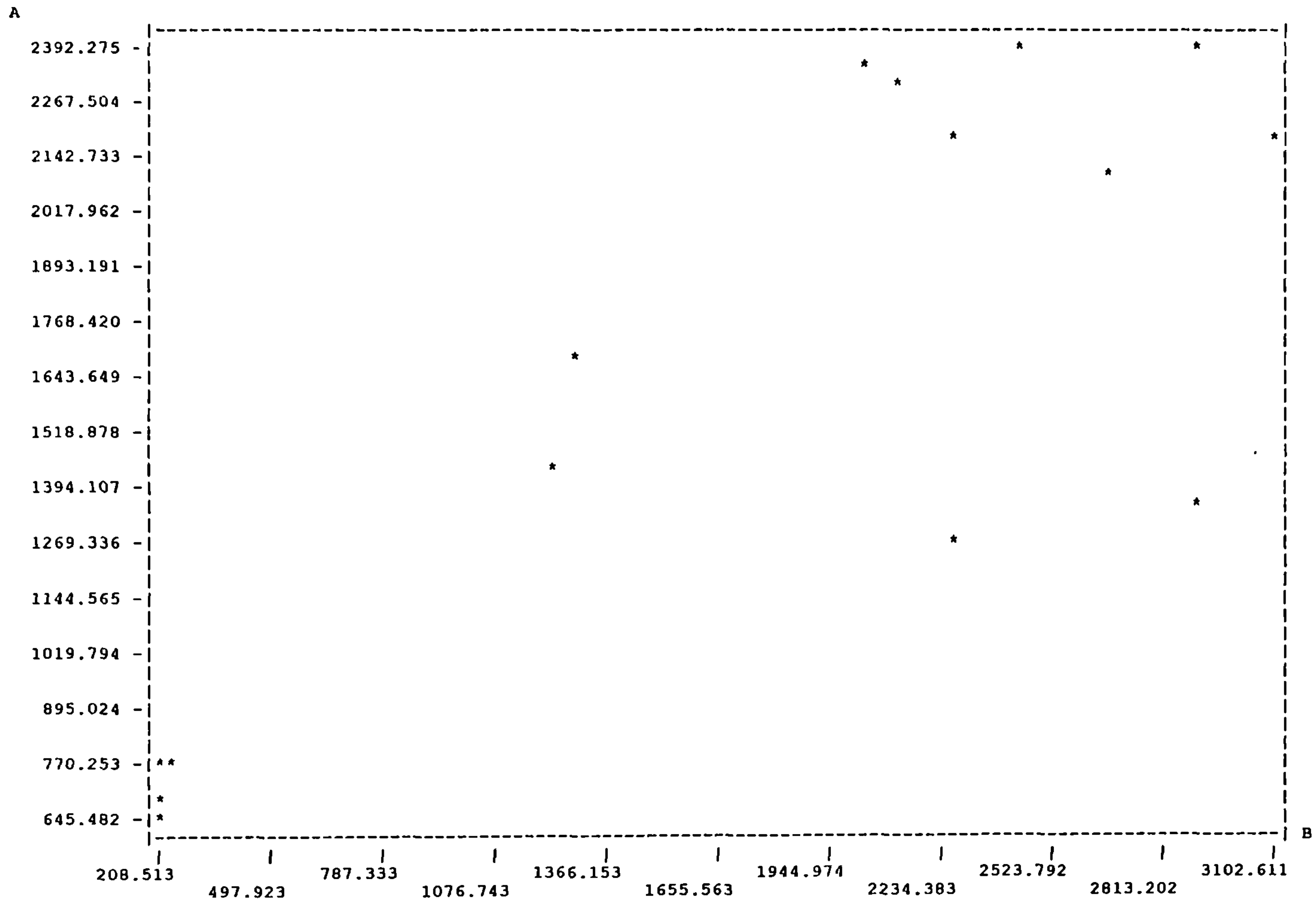
Graph (C-1)


PLOT OF A VERSUS B
A
3071.741
2868.791
2665.842
2462.892
2259.942
2056.992
1854.042
1651.092
1448.142
1245.192
1042.242
839.292
636.342
433.392
230.443
B
1162.119
1497.786
1833.454
2169.121
2504.788
2840.454
3176.121
3511.787
3847.454
4183.121
4518.790

LOGKUAT

Graph (C-2)

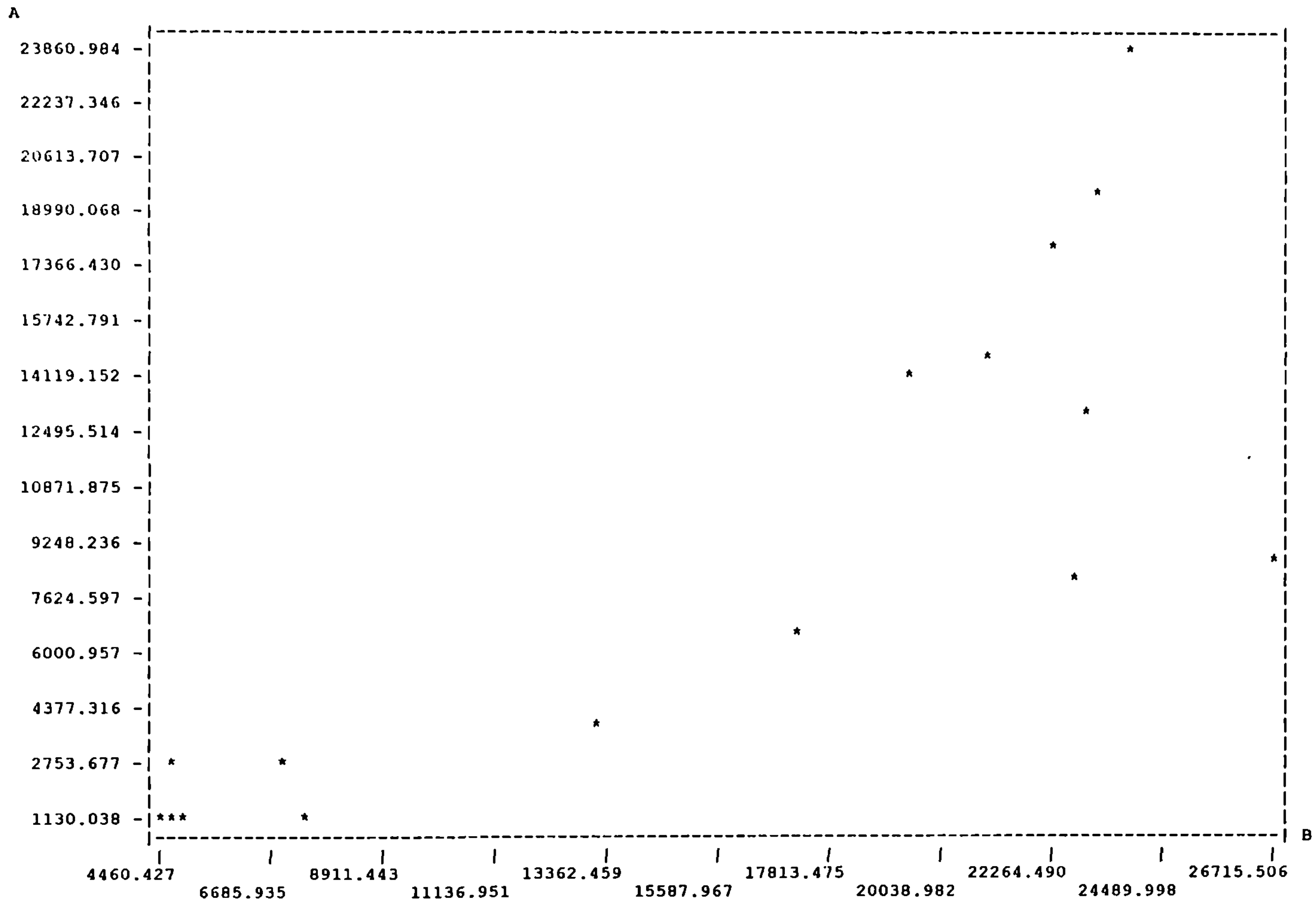
PLOT OF A VERSUS B



SAUDI

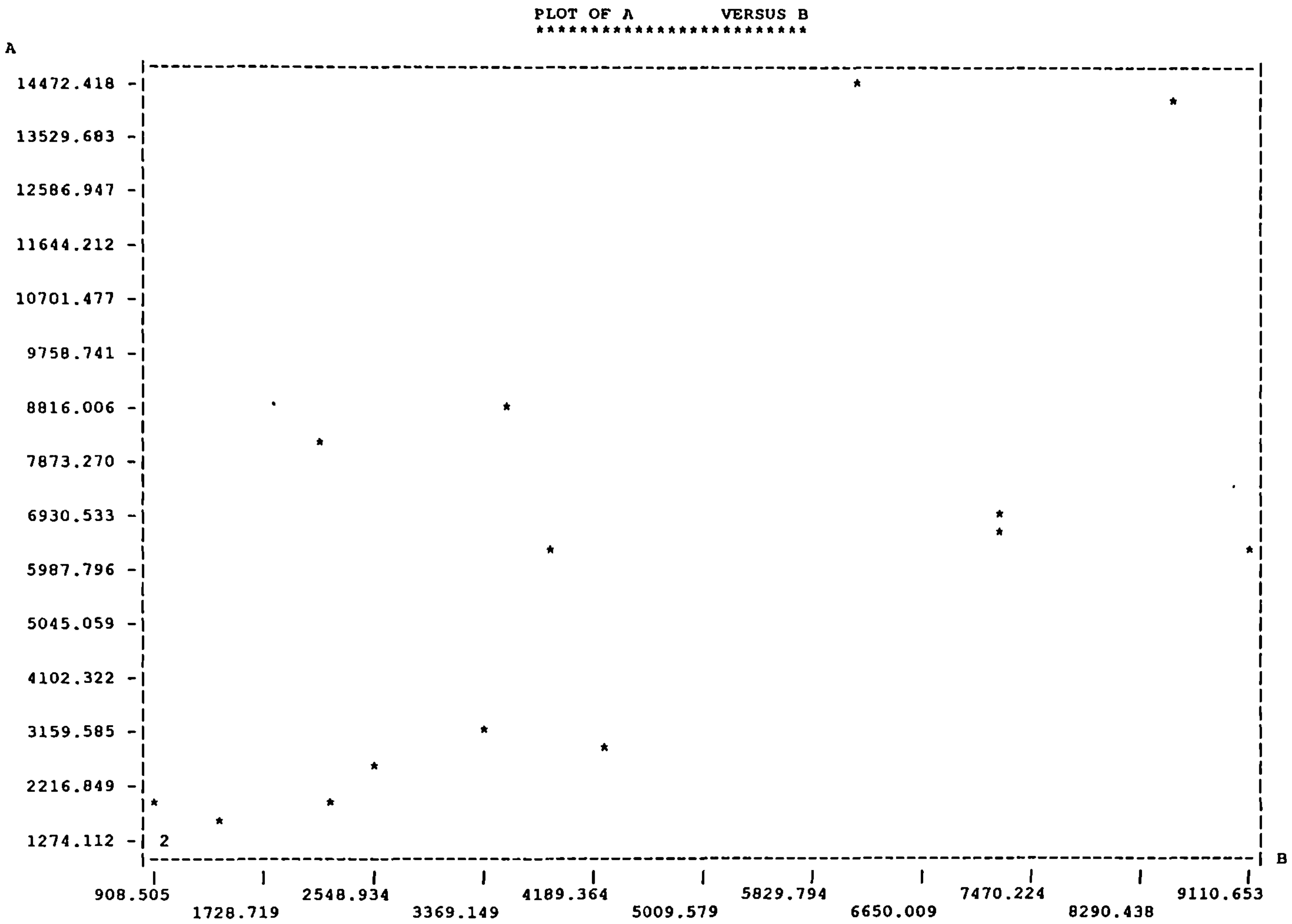
Graph (C-3)

PLOT OF A VERSUS B
****



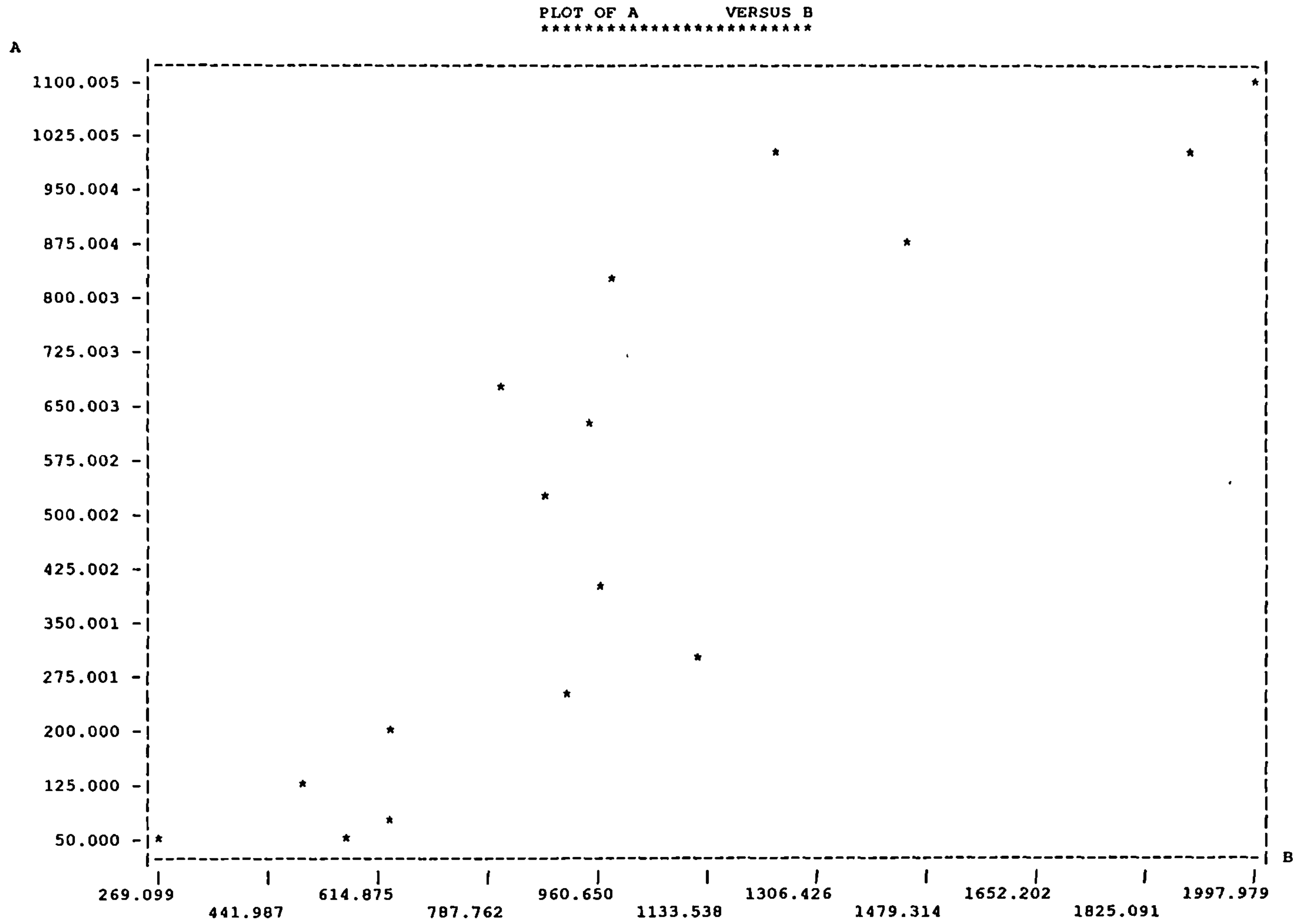
IRAQ

Graph (C-4)



OMAN

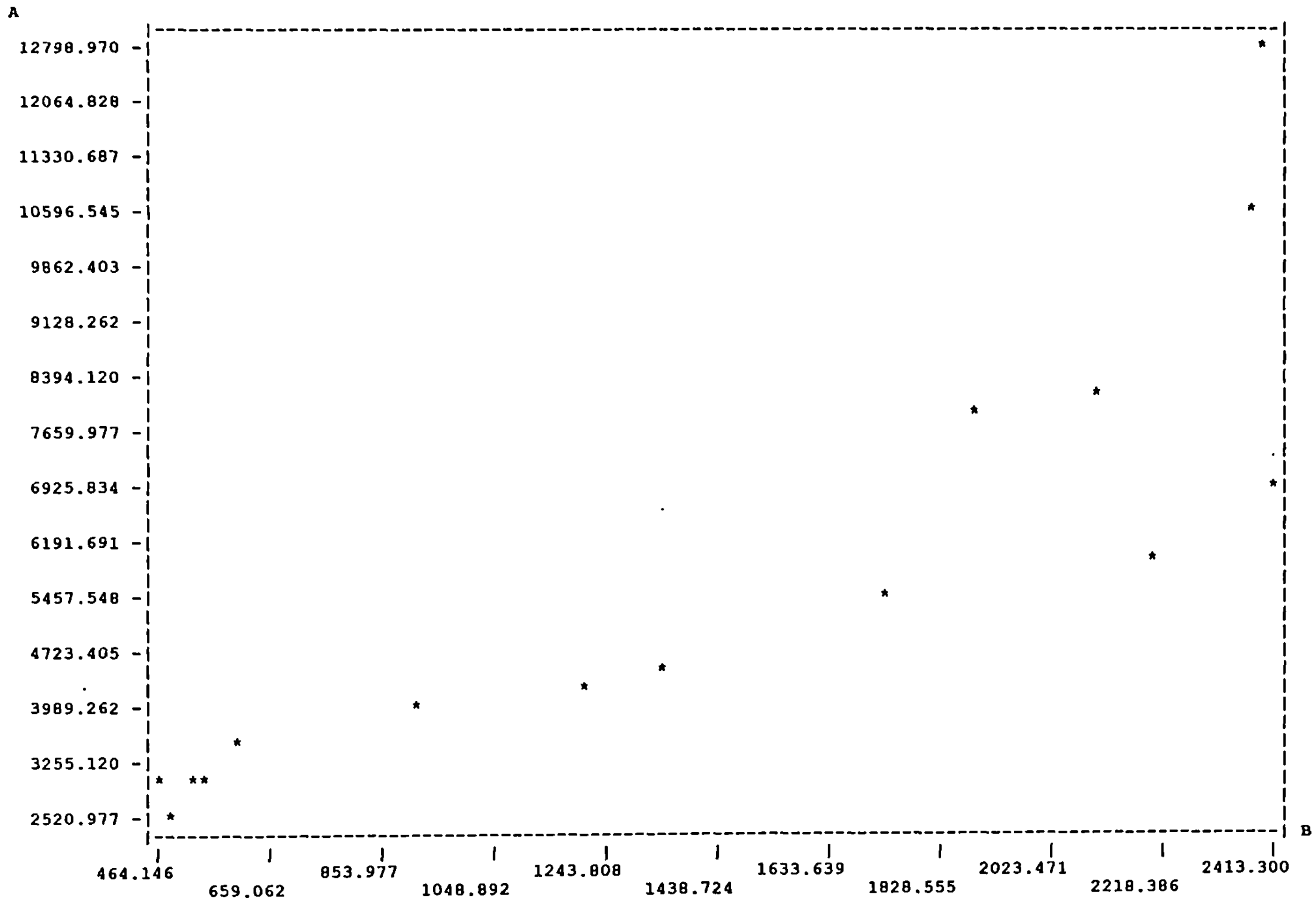
Graph (C-5)



EGPTLOG

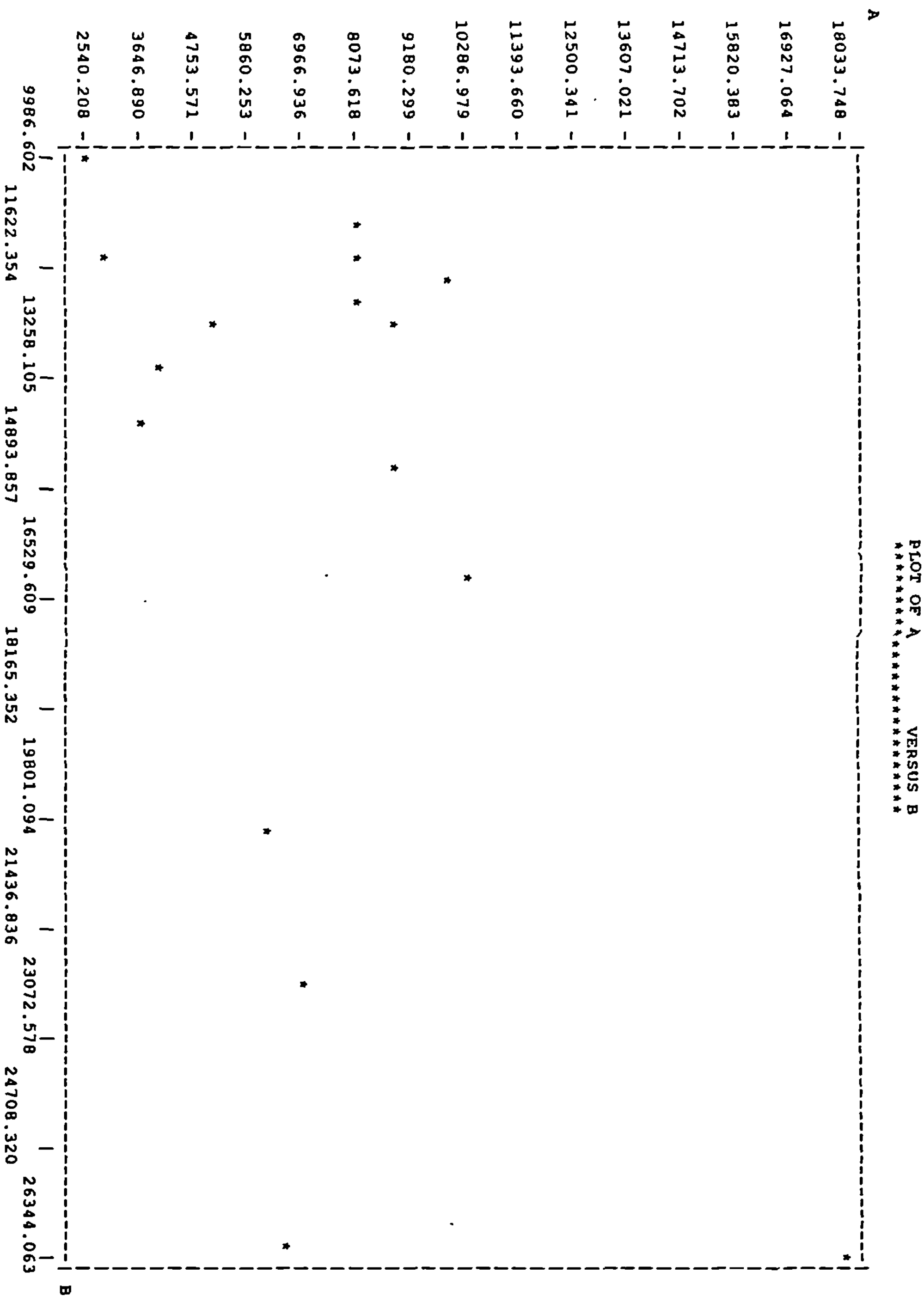
Graph (C-6)

PLOT OF A VERSUS B



IRAN

Graph (C-7)



Appendix (D) Miscellaneous

(D-1) Calculation of figures in scenarios/strategies matrices.

(D-2) Several attempts to improve the quality of the regression models.

Appendix (D-1)

Calculation of the figures in the cells of scenario/strategy matrices

In chapter eight we constructed eight scenarios/strategies matrices. Here we are going to explain how we came up with the figures shown in the cells of these matrices. Matrix no.(1), p.(367) is taken as an example to demonstrate the method of calculation used.

Scenario (1)/Strategy (1) Cell:

The figure (+4000) thousand tons in this cell represents the difference between total capacity and total demand plus slack production.

(8000,000 - 3,700,000 + 300,000) = 4,000,000 tons

The figure (131,040) thousand in this cell represents the 4000 multiplied by probability (21%) multiplied by the idle capacity holding cost per ton of capacity which is (DH 156) or in other words:

4000 X 21% X 156 = DH 131,040 thousand.

Scenario (2)/Strategy (1) Cell:

The figure (+5700) thousand tons represents surplus in capacity, it is the difference between total capacity and total demand plus slack production.

8000,000 - 2,000,000 + 300,000 = 5,700,000 tons.

The figure (266,760) thousand Dirhams represents the 5700 multiplied by the probability (30%), multiplied by DH 156 (idle capacity holding cost) or numerically speaking:

5700 X 30% X 156 = DH 266,760 thousand.

The same procedure is followed when calculating the values in the remaining cells in this matrix and the cells in the other matrices as well.

Appendix (D-2)

Several attempts to improve the quality of the regression models

The following regression models have been tested for each of the seven countries which comprise the home and the export market for U.A.E. cement.

(1) Double logarithmic
$\ln DC_t = c + b \ln GFCF_t$

(2) Double logarithmic and lagged
$\ln DC_t = c + b \ln GFCF_t + b_1 \ln GFCF_{t-1} + b_2 \ln DC_{t-1}$

(3) Quadratic
$DC_t = c + b\ (GFCF_t)^2$

(4) Linear model
$DC_t = c + b\ GFCF_t$

(5) Semi-logarithmic
$DC_t = c + b \ln GFCF_t$

(6) Anti logarithmic
$\ln DC_t = c + b\ GFCF_t$

(7) Polynomial model
$DC_t = c + b\ GFCF_t + b_1\ (GFCF_t)^2 + b_2\ (GFCF_t)^3$

Due to space limitations, these models are not presented in this appendix, rather they are kept with the author and are available on request.