AN INVESTIGATION OF THE ATTITUDES OF LABORATORY STAFF TO THE ESTABLISHMENT OF ACCREDITED LABORATORIES IN THE LIBYAN CHEMICAL AND PETROCHEMICAL INDUSTRIES

TAHER AREBI SHIHUB

Research Institute for the Built and Human Environment,
School of the Built Environment, University of Salford, Salford, U K

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Abstract

Accreditation of laboratories has been a subject of considerable interest because product quality guarantee has become one of the prime factors to be considered in the present time of highly competitive industrial activity. Accreditation is still a new issue for the laboratories in Libya. These laboratories need to establish a new strategy on accreditation focusing on the difficulties and barriers of implementation. The main aim of this research is to identify the attitudes of laboratory staff towards factors related to the establishment of accredited laboratories' in the Libyan Chemical and Petrochemical Industries.

A total of 400 questionnaires were sent to laboratories within the Libyan chemicals and petrochemicals industries sector. 350 usable questionnaires out of the 400 were returned, thus giving a response rate of 87.5%.

The analysis led to the development of critical success factors to establish laboratories' accreditation by comprising 72 factors into 28 factors arranged in six categories: technical, management, culture, communication, quality and training, which affects laboratories' accreditation.

This research identifies that the following are considered the main factors that affect the establishment of accreditation: Root causes of problems, Sampling procedure, Calibration of reference standards, Quality of equipment and resources, time and resources to do the job, Physical conditions at work, Quality of technical records, Quality is more important than volume of sales, Uncertainty of measurements, Security of records ,Happy to work in the laboratory, Periodic internal audits, Reports include information requested by client, Regular and effectiveness of meetings, Commitment to excellent customer services and continuous quality improvement, Loyalty and respect towards employees, Communication process, training, Staff involvement in the improvement process and, Clarity of job description

The findings from this study will provide scholars, consultants and managers with valuable information on how to deal with laboratories accreditation issues.

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List of Abbreviations

The meaning of the abbreviations used in this research is listed in alphabetical order below.

Abbreviation	the Meaning of the Abbreviation
DAM:	German Academy for Metrology
FA:	Factor Analysis
GDP:	Gross Domestic Product
IEC:	The International Electro technical Commission
ILAA:	International Laboratory Assessment and Accreditation
ILAC:	International Laboratory Accreditation Cooperation
ISO:	The International Organization for Standardization
LNCSM	Libyan National Centre for Standardisation and Metrology
NOC:	National Oil Corporation
SI:	The International System of Units
SPSS:	Statistical Package for the Social Sciences
UKAS:	United Kingdom Accreditation Service
UNIDO:	United Nations Industrial Development Organization

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Product quality is quickly becoming the major factor in consumer choice. This is correct whether the purchaser is a person or a large company. Therefore, quality assurance has become one of the prime factors for consideration in order to achieve highly competitive industrial activity at the present time. Limited awareness among the public regarding the role and purpose of accreditation is a major constraint, one of several constraints for accreditation in the Arab region.

This study identifies the factors that affect the establishment of laboratories' accreditation with the Libyan chemical and petrochemical industries. This chapter gives an introduction to the subject area of the research that is presented in this thesis. It illustrates the importance of laboratories' accreditation and the factors that affect the establishment of laboratory accreditation.

The research presents the area of chemical and petrochemical industries as a field of study from where a laboratories' accreditation process can be used as a basis to develop such accreditation programmes in other business fields. This chapter also provides a summary of the research by discussing the research objectives, the research contribution and it presents an outline of the research methodology and the thesis structure.

1.2 Research problem

In late 1999 the International Organization of Standardization (ISO) and the International Electro technical Commission (IEC) issued the ISO/IEC 17025 International Quality Standard which incorporates all of the necessary requirements for testing and calibration laboratories to prove their technical competence and the validity of the data and the results they produce. ISO/IEC 17025 replaced the previous standards EN 45001 and ISO/IEC Guide 25 that had already been employed by laboratories worldwide.

In Libya (a rather small country by comparison with most countries in the world) testing laboratories need to establish an accreditation system following these international standards in order to prove their technical reliability and competence. Among these testing laboratories are those within the chemical and petrochemical industries.

Although there has been a substantial interest in the improvement of business management the interest in quality management has been significantly less prominent in Libya. In addition, there are some problems, similar to that of any other third world nation, in marketing Libyan products due to a lack of laboratories' accreditation. Such problems include the dissatisfaction of customers with quality as well as an increase of the prices of goods. Obvious examples include product failures and some companies' inadequacy in meeting legal requirements or customer quality requirements.

Many researchers mention that organizational culture should be taken into consideration in order to implement any quality programme. Kekale and Kekale (1996) pointed out that wherever basic approaches to quality management are adopted, an organization needs to develop a suitable implementation approach which is culturally feasible. This means that the key issue for effective implementation is the extent to which the approach is accepted within an organization, and is therefore undertaken with a real commitment to making it work. Also Kochan (1993) stated that a dependable way to develop an efficient quality assurance programme was by ensuring that the differences in culture, language or organization should be taken under serious consideration when implementing the quality standard.

The application of such an accreditation system requires a great deal in human resources, top management commitment, organizational effort, expertise and expenses. Vlachos et al.(2002) demonstrated that greater efficiency and team work were the key benefits stemming from the application of the ISO/IEC 17025 standard when implementing and maintaining the ISO/IEC 17025 quality assurance system in the General Chemical State Laboratory (GCSL) of Greece.

1.3 The research need

The broad context of this research concerns laboratories' accreditation within the Libyan chemical and petrochemical industries. Laboratories' accreditation is a sensitive issue for all organizations. Maurice (2003) suggested that today the world

has become a global village and domestic and export trade is vital to the development of any country's economy.

Another study conducted by Vanisina (1999) suggested that in order to implement a successful quality programme it is necessary to review the organizational culture and realize an integrated procedure for change in organizational performance. Schlesinger and Heskett (1991) argued that customer satisfaction is rooted in employee satisfaction and they have developed the service income chain model, where internal service quality drives employee satisfaction, employee retention, and external services' quality. External service quality drives customer satisfaction, customer retention, and profit. They also argued that increased external service quality, customer satisfaction and profitability will have a positive effect on employee satisfaction. In addition, improved employee satisfaction will result in improved internal service quality.

There are many barriers to international trade such as tariffs, quotas and poor quality products. Accreditation is one of the keys to lowering the barriers to the international trade, the whole basis of which is to create confidence in the work carried out by certification and inspection bodies as well as testing and calibration laboratories, located anywhere in the world. Maurice (2003) also mentioned that, in the absence of internationally recognized accredited facilities, tests carried out in an exporting country would have to be repeated by a recognized laboratory in the importing country and an adverse test report could result in the rejection of an entire shipment of products or manufactured goods. As these may have already

been transported half way around the world this could be a very costly exercise for the exporter. In the field of accreditation, this is often summarized by the saying 'Tested once - accepted everywhere'.

In order to improve both the productivity and quality of work undertaken by chemical and petrochemical laboratories accreditation provides a means of determining the competence of laboratories to perform specific types of testing, measurement and calibration. While international trade is fundamentally linked to supply capacity and cost, laboratory testing and the recognition of test results is a final determinant as to whether the goods produced by the exporter are acceptable in other countries.

Generally, the customer will usually insist that the factory supplying them has a quality system based on International Standard Organization ISO 9000, and here accreditation is the key to providing assurance that certification bodies operating in one country follow the same strict procedures as those in other countries.

Accreditation bodies, which recognize the competence of testing and calibration, should use international standards as the basis for their accreditation. Laboratories' accreditation needs to cover both management and technical requirements. It is the responsibility of companies seeking accreditation of their laboratories from central accreditation bodies to adopt the international standard ISO/IEC 17025 as the basis for the accreditation of their companies' testing and calibration.

Laboratories and central accreditation bodies in Libya should have links with accreditation bodies such as the United Kingdom Accreditation Service (UKAS), the International Laboratory and Accreditation Cooperation (ILAC) and the German Academy for Metrology (DAM).

Whalen and Rahim (1994) pointed out that major common difficulties in the implementation of quality programmes are, among others, lack of management commitment, conflict of labour force, lack of suitable training for workers, failure in developing successful communication channels as well as failure to change organizational attitude. In addition Newall (1990) mentioned that the most common barrier in applying a quality programme is the lack in acceptance by middle and lower managers and the limited knowledge and training of many executives. Oakland (1989) and Taylor (1995) mentioned that a major factor in the successful implementation of a quality programme was if top management was completely dedicated to the programme, beyond just the public announcement of such a programme.

There is a gap, which currently exists in chemical and petrochemical industries laboratories in Libya between the laboratories current status and ISO/IEC 17025 requirements. The purpose of this research is to address the issue of accreditation for Libyan testing and calibration laboratories and to identify and investigate the factors that affect the establishment of accreditation of chemical and petrochemical industries' laboratories in Libya.

The factors illustrated above show the need for the accreditation in order to enable these laboratories to comply with the international standard ISO/IEC 17025.

The details of the intricacies of obtaining such accreditation are covered in the relevant ISO/IEC 17025 guide and standards and references are given to the appropriate documentation that is available from national and international standards organizations. What this research aims to provide is to identify and investigate the factors that affect the establishment of laboratory accreditation within the Libyan chemical and petrochemical industries.

1.4 Justification for research

Globalization of trade has become more and more important for all countries worldwide. Libya's economy is strongly built on the export of oil, gas and petroleum products and on the import of foodstuff and manufactured products. Such trade has existed for centuries but there is a much higher awareness today with regard to the safety and security of products and services. Although Libya has a very strong position in international trade, its products must fulfil international standards and requirements in order to remain competitive.

Libyan products that are to be exported should be tested and certified to international standards in order to meet the expectations of the trading partner/partners. The same is true for foreign products imported into Libya which must also be in full compliance with international safety regulations to avoid any adverse affects to Libyan citizens.

The key element to lowering barriers to international trade is accreditation. Should tests and certification be carried out, say in an exporting country (such as Libya) where there is an absence of internationally recognized accredited facilities, tests would also have to be repeated by a recognized laboratory and certification bodies in the importing country.

While accreditation is often thought to be mainly required for export purposes, it has an even larger role to play within Libya's domestic economy. One of the major tasks of Libyan authorities will be to protect local consumers from dangerous goods being imported from abroad. As a result, laws on consumer protection as well as a functional market surveillance system based on a good quality infrastructure and conformity assessment will become necessary in the future.

In Libya, testing and calibration laboratories need to be accredited according to international standards in order to prove their competence and reliability to perform specific types of tests or calibration .The following points support the need for this research:

Currently, Libya is striving to move forward in its development process by making use of the present favourable international context and by setting up new frameworks for action in the economic and social fields, UNDP (2005).

Libya has lately witnessed several positive developments in terms of both its governance and economic performance indicators. According to UNIDO (2005) the

country has been on a growth path for several years that culminated in 7.1 % real growth in GDP in 2003.

- The overall performance of Libya has benefited from favourable international oil markets, bearing in mind that this commodity remains the main source of foreign currency income for the country (up to 95 % in 2003) as well as the main source of income for the national budget (reaching 76 % in 2003).

- When some products created by Libyan industry are exported, they are firstly tested by the producing company in their laboratory. However, these companies' laboratories do not have accreditation and this causes other international companies to carry out the test too. Due to the lack of Libyan companies' laboratories' accreditation, multiple testing and certification requirements incur extra charges and time consumption.

- The researcher during his twenty years of work experience in chemical and petrochemical sector, noted that due to the lack of Libyan laboratories' accreditation, employees from different departments do not trust the laboratories' results, which create an atmosphere of animosity between laboratory employees and employees from other departments; this has a negative effect on the overall work of the company concerned.

- In recent years large new oil discoveries have been made in the Libyan oil industry such as Ghadames and el-Bouri fields, as well as in the Sirte basin. Libya would like foreign companies' help to raise the country's production capability back to the point of the early 1970s. Thus, in May 2002, Libya

invited many foreign oil and gas companies to a meeting to discuss issues related to exploration, production and manufacturing sharing agreements. These companies will face some problems due to the lack of accredited laboratories, such as the specification and standard of raw materials and additives for the chemical and petrochemical industries.

- Laboratory accreditation is still a new issue for the organizations in Libya. These organizations need to establish a new strategy towards laboratory accreditation focusing on overcoming the difficulties and barriers to the introduction and implementation of laboratory accreditation in such a culture.
- Saxena (2004) stated that Libyan laboratories and industrial research centres needed support and improvement in such areas as space management and in the placing of some equipment to meet the criteria and requirements for accreditation.

Consequently, this research is seeking to identify and investigate the factors that affect the establishment of accreditation in Libyan chemical and petrochemical industries' laboratories. This research project aims to examine the importance of accrediting laboratories in these organisations in order to reduce cost and time consumption. This study deals with the chemical and petrochemical industries because of the importance of these industries for the economic development and growth of Libya.

1.5. Research aim

The main aim of this study is to identify the attitudes of laboratory staff towards factors related to the establishment of accredited laboratories' in the Libyan Chemical and Petrochemical Industry.

1.6. Research objectives

The research aim will be achieved by the following objectives:

- To identify and investigate the factors that affect the establishment of laboratories' accreditation as gained from the literature review.

- To understand the common types of barriers affecting the implementation of ISO standards around the world.

- To review the literature of the activities of some international organizations relating to testing, calibrations and accreditation.

- The United Nations Development Programme (2006) cited that the Libyan Industrial Research Centre had a plan to establish laboratory accreditation in Libya since 1997, but for reasons related to affiliation, the plan has fallen short of achieving their objectives.

- To make recommendations on how to achieve accreditation and for further research in the area of this research.

1.7. Research contribution

This research attempts to identify the factors that affect the establishment of accreditation of Libyan chemical and petrochemical industries' laboratories and to assess the importance of accreditation. In addition, this research attempts to contribute to plug a gap in knowledge concerning accreditation issues in Libya. Also, this study may help decision-makers in Libya by providing requisite information to deal with accreditation issues.

1.8. Research questions

1- What are the attitudes of the laboratory Staff towards factors that related to the establishment of Accredited Laboratories in the Libyan chemical and petrochemical industries?

2- What is the relationship between these factors and laboratories' accreditation?

1.9. Research methodology

The methodology adopted for this research consists of five main stages:

- Preliminary research.
- Comprehensive literature review.
- Developing a preliminary framework.
- Collection of data and information based on a questionnaire.
- Data analysis.

The above stages are briefly described below.

1.9.1 Preliminary research

Because of the author's background and interest in the field of manufacturing and quality systems, an initial idea about the research subject was developed. Then, on the basis of the preliminary literature review and following brainstorming sessions with the PhD supervisor, a more detailed research proposal was prepared. Through the preliminary research it was found that there were very many articles about ISO 9000 and TQM but very few about ISO/IEC 17025.

1.9.2 Comprehensive literature review

The literature referred to during the research was mainly related to laboratories' accreditation, ISO/IEC 17025, ISO 9000 and Total Quality Management. The literature review resulted in the development of a preliminary, conceptual model for the purpose of the research. The review of literature continued throughout the research but the main body of the literature review is collected in chapters two and three.

1.9.3 Developing a preliminary conceptual framework

Based upon the literature review and ISO/IEC 17025 requirements, a preliminary framework including six factors that affect the establishment of laboratories' accreditation was developed. Based on the research questions and objectives provided previously, each factor indicated which areas required empirical investigations. The conceptual framework is provided in chapter three.

1.9.4 Collection of data and information

The main tools for data collection in this research were based on a postal questionnaire. The tools are discussed in chapters five and six respectively.

1.9.5 Data analysis

At this stage, the data analysis in terms of the questionnaire analysis resulted in the development of the final framework. The main findings of data analysis from the questionnaire are discussed in chapter six and seven.

1.10 Organization of the thesis

This study is divided into eight chapters, as shown in Figure 1.2. Chapter one is committed to an introduction to the study, including research objectives, research questions, the methodology, the significance of the study and the organisation of the thesis.

Chapter two covers basic information relating to Libya and includes a general overview of the country, including its history, geography, government, economy, and industry

Chapters three and four of this thesis address the literature review. Chapter three covers the introduction of laboratories' accreditation and includes different definitions of laboratories' accreditation as well as the purpose of accreditation, the scope of accreditation, the objectives, the value of accreditation, the process, the criteria for accreditation and its role in laboratories. In addition, it covers the impact of accreditation on exports.

Chapter four addresses ISO/IEC 1705 requirements, registration and implementation processes and identifies the factors that affect the establishment of laboratories' accreditation and ISO implementation.

Chapter five of the study addresses the research methodology and comprises research objectives and questions, research strategy, data collection, questionnaire development, scales, distribution of questionnaires, response rate, data analysis techniques and the validity and reliability of the research instrument. Chapters six and seven concentrate on the results, analysis and discussion. Finally, chapter eight covers conclusions and recommendations. The thesis ends with references and Appendices A, B, and C, which relate to chapter six.

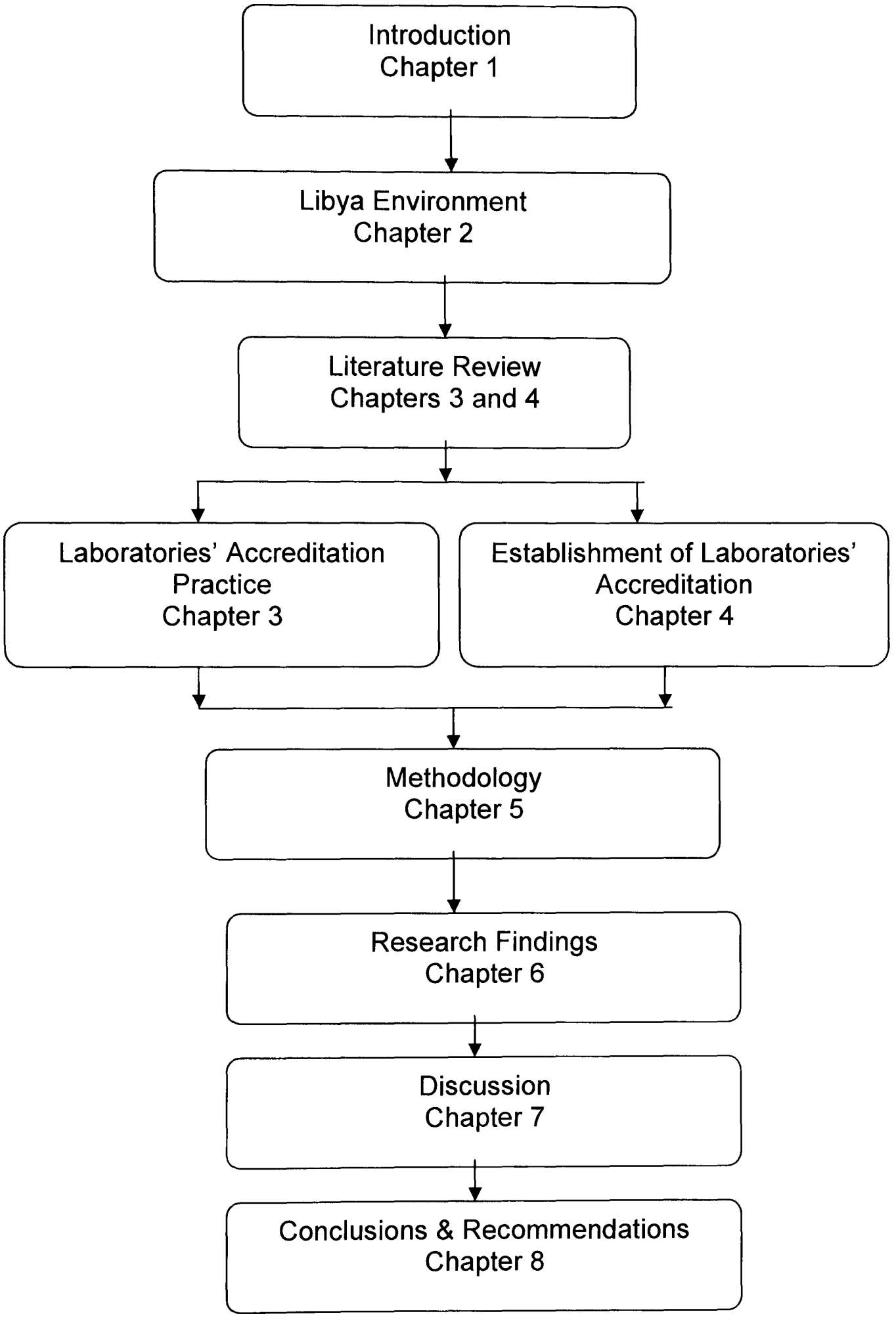


Figure: 1.1 Organisation of the thesis

1.11. Conclusion

This chapter explains the research aim, objective, research question, research problem, research methodology and the organisation of the thesis. In addition, it explains the literature review concerning laboratories' accreditation. It also states that this research attempts to contribute effectively to plugging the gap in knowledge concerning laboratories' accreditation issues in Libyan industries. In addition, it identifies the factors that affect the establishment of laboratories' accreditation within the Libyan chemical and petrochemical industries.

The next chapter covers the Libyan background such as the country's history, geography, government economy, and industrial environment

CHAPTER TWO

THE LIBYAN ENVIRONMENT

2.1 Introduction

This chapter, which covers the Libyan background, is divided into two parts. The first part is committed to a general overview of the country's history, geography, economy and political structure. In the second part, the Libyan industrial environment is discussed. The researcher used his work experience with regard to this thesis in order to write about Libyan culture, management and economy. This was felt necessary in order to provide the reader with background information about Libya.

2.2 Historical and geographical background

Libya is located in North Africa on the coast of the Mediterranean Sea. It is bordered on the east by Egypt; on the south by Sudan, Chad, and Niger; and on the west by Algeria and Tunisia. Libya extends over 1,759,540 square kilometres, making it the 17th largest nation in the world by size. Libya is somewhat smaller than Indonesia and is roughly the size of the US state of Alaska. Libya has 1770 kilometres (1100 miles) of coastline, which means that Libya has the longest coastline of any African country bordering the Mediterranean.

The climate is mostly dry and desert-like in nature. However, the northern regions enjoy a milder climate. The population of Libya is 6,173,579 (July 2008, estimate.)

with a growth rate of 2.216%. (2008, estimate.). Ruheat and El-Magbary (2005) stated that through the period from 1973 to 1984 the Libya yearly population increase rate was 4.2% and it is one of the maximum rates in the world, as shown in Table 2.1.

Table 2.1: Libyan population growth rates (1970-2005)

Period	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005
Rate of increase	4.17%	4.37%	4.37%	2.57%	1.97%	1.95%	1.93%

Source: (Ruheat and El-Magbary, 2005)

Approximately 90% of the people live in less than 10% of the area, mostly along the coast. More than half the population is urban, concentrated to a greater extent, in the two largest cities, Tripoli and Benghazi.

2.3 The Libyan political structure

Handy (1993) pointed out that if an organization is looking for success, it has to take into consideration the political reality in a country. Libya adopted a new system in 1977 which differed from the other traditional governmental management systems, for all the Libyan sectors. It is called the Jamaherian system or popular system. In this system, the General People's Congress is on the top of the pyramid authority, which involves people's congresses in the cities, General people's

committee, unions, and other professional leagues. The General People's Congress, which determines the authority's policies and forwards them to the General People's Committee, The General People's Committee can change policies, decisions and procedures that have been performed by a specific secretariat, for example, Secretariat of Industry (Ministry of Industry) and Secretariat of Education.

2.4 Cultural differences

Libya is culturally similar to its neighbouring Maghrebian states. Libyans consider themselves very much a part of a wider Arab community. The Libyan state tends to strengthen this feeling by using Arabic as the only official language.

In Libya social relations are very much tied to consideration of, and concern for, the family. This means that family obligations have priority over any other obligations such as work obligations. The Islamic religion and the Arabic language cover all Libya and are the two main elements in Libyan culture. The cultural factor is a very important factor to be taken into consideration within this study, because of its direct influence on the establishment of laboratories' accreditation.

Organizational culture is an idea in the field of organization studies and management which describes the psychology, attitudes, experiences, beliefs and values (personal and cultural values) of an organization. Organizational culture has been defined as "the specific collection of values and norms that are shared by

people and groups in an organization and that control the way they interact with each other and with stakeholders outside the organization" (Black, 2003).

In the west many models were designed to meet special needs which may not always have the same capability and suitability for other nations. Western models should be modified to become more suitable and easier to apply to developing countries.

Many studies stated within the literature review suggest that the reliable way to develop an efficient quality programme is to consider the differences in culture, language, building teamwork, opportunities for growth and development and decentralised decisions; all of which should be taken into serious consideration, when implementing the quality programme.

Thus the study of laboratories' accreditation implementation in Libyan laboratories cannot be properly carried out without an understanding of the environment and the government's impact on the implementation of the accreditation system.

2.5 The Libyan economy

The Libyan economy depends primarily upon revenues from the oil sector which contribute about 95% of export earnings, about one-quarter of the Gross Domestic Product (GDP) and 60% of public sector wages. This oil income combined with a small population provides Libya with one of the highest per capita GDPs in Africa.

Other manufacturing sectors, which account for about 20% of GDP, have expanded from processing mostly agricultural products to include the production of petrochemicals, iron, steel, and aluminium. Libya imports about 75% of its food due to its climatic conditions and poor soil which gives limited agricultural output.

From the 1970s Libya has been expanding, modifying and upgrading its industry sector as one of the main strategies designed to meet the country's development plan requirement. One of the main Libyan development plans is to accelerate the process of economic diversification in order to achieve a wider developed economy. The oil industry will be a vital part of the Libyan economy for a long time to come. The aim is to use petroleum and petrochemical products as a resource for diversified industrial growth, rather than as a single export commodity.

In 1978, the Libyan authorities started to eliminate private ownership and established a comprehensive system of price controls. Since 1988, encouragement has been given to private partnerships and cooperatives in manufacturing. Most aspects of production and trade remained under public control.

In 1993, some laws and decisions have been issued from the General People's Congress and the General People's Committee for establishing shareholding and partnerships companies. But the large size organisations, such as manufacturing organisations have remained as a public sector (up to now). Trade was opened to private entities to work beside the public sector enterprises. The public sector

encourages workers to become involved in the day-to-day management organisations in which they work.

In 1994, the Libyan authorities put a plan for replacing foreign labour with Libyans, improving productivity and profitability in all sectors such as agriculture and manufacturing sectors. The pace of an effective Libyanisation policy is essentially governed by the availability of Libyan replacements, especially in the major strategic industries such as the oil industry and manufacturing sector. Ramadan (2002), noted that Libya is still facing a shortage of skilled and trained people in several fields, because new needs have been appearing as a result of the changes in the economic and social structure. There are many issues that have played an important role in formulating the current situation of human resource development that include:

i. The economic development programs implemented in the 1970s have imposed much pressure on management development and education establishments to provide the number of qualified, trained and educated people needed to fill the shortage found in development plans.

ii. The direct governmental control of the public sector and the centralisation in the planning of economic projects caused the need for high-qualified people able to manage these projects.

iii. The expansion that happened of the public sector led to greater need for high qualified managers.

After the 1st September revolution, the plan was to develop the Libyan economy based on oil revenue. Large areas of land were reformed for agricultural and many industrial factories were established. For example, Misurata steel complex, Abukamash chemicals complex, cement, fabrics, food, chemical and petrochemicals industries. This change in Libya's economy has been create the human resources necessary to operate and manage new public enterprises.

It is seen that it is very difficult to separate an assessment of Libya's economy from Libya's political ideology. The central authority interventions influence day-today operations in terms of changes in organisational structure, location or site, responsibilities or authorised budgets, employment conditions and personnel and management appointments. The central authorities' interventions lead to a state of instability that causes a reduction in productivity and raises the cost of the product. The instability of the organisational system causes continual changes in government and institution's laws, rules and regulations.

The Libyan public sector faced many changes regarding the political attitudes of the country. For example, in the 1990s, the Libyan government issued a decision that the Libyan companies must train their employees in the Libyan National Institute of Public Administration and left no possibility to do training abroad. This institute suffers from a shortage of the required resources to enable it to meet this responsibility. That caused a shortage in availability of skilled employees in the companies.

The government policy of limiting imports just to necessity goods caused an increase in the prices and decrease in the quality of local products. Also, the embargo imposed by the United Nations in 1992 caused an increase in the costs of imported raw materials. That led to an increase in prices of local product and low quality products as a result of low quality imported raw materials. The embargo also led the Libyan companies to not get the high technology equipment and spare parts especially from western countries (Agnia, 1997).

2.6. The Libyan oil industry

In Libya oil exploration started in 1955. In April 1955 the national petroleum law No. 25 was passed. In 1959 the first oil field was discovered and oil exports started in 1961. Oil and natural gas are considered to be the country's most important industry and represent the backbone of Libya's economy.

Due to the great importance of this industry, Libya from the very beginning, has always given it priority and utmost regard, as well as acknowledging that these industries represent the major income for Libya's economy and thus consequently the government brought about complete control over them. (They were previously run by foreign companies (Gannous, 1998).)

Libya is an important oil and gas exporter especially to European markets. After the suspension of United Nations' (UN) sanctions in 1999, international oil and gas

companies including United States (US) oil companies are looking forward to working in the Libyan energy market again. This will allow Libya to buy oil industry equipment for its oil fields, export facilities and refineries; purchases which were previously banned.

There appears to be great international interest in investing in the Libyan oil and gas sectors and Libya has opened its doors but there is a cautious approach to foreign investment (Martin, 1999). In 1970 Libya was 6th in terms of world oil production. The Libyan oil and gas industry has been managed by the National Oil Corporation (NOC) since 1968 and its role has been limited. However, the NOC helped in setting up joint venture exploration projects with foreign oil firms.

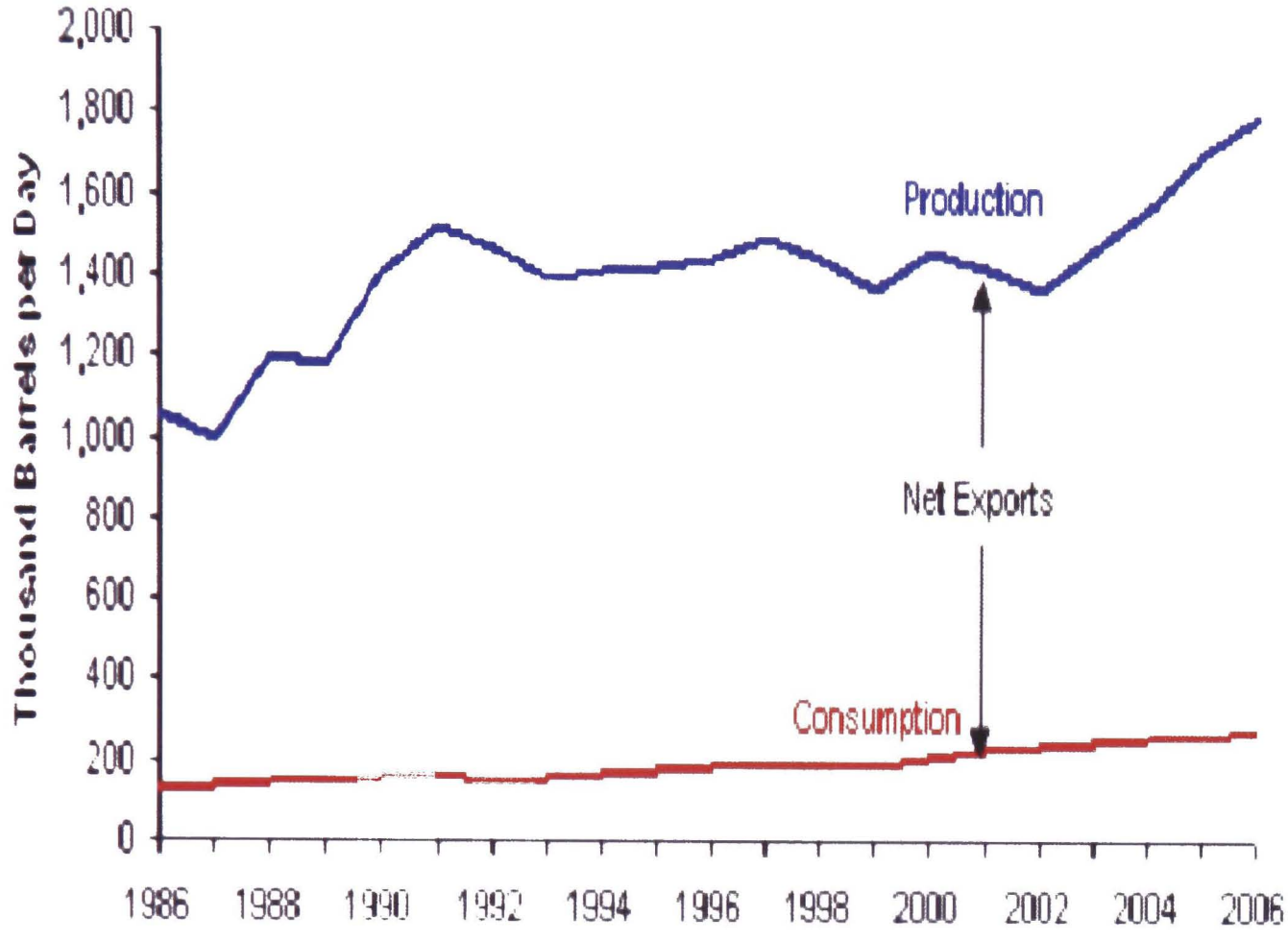
Libya opened a two-year negotiation with its 20 foreign operating companies in 1970 in order to negotiate an increase in the posted price upon which its oil revenue was calculated. Probably the most important in aspect of the oil and gas industry is directing the production and correcting prices and protecting the oil wealth.

A number of international oil firms are involved in exploration/production agreements with the NOC. In 1982, Exxon and Mobil, both American oil companies withdrew from Libya. Five other American oil companies (Amerada Hess, Grace

Petroleum, Occidental, Marathon and Conoco) remained until 1986. When the political situation got worse, all US oil firms left Libya.

According to the National Oil Company (NOC) Libya would like to raise oil production from 1.80 million Barrels per Day (bbl/d) in 2006 to 2 million bbl/d by 2008 and to 3 million bbl/d by 2010-2013. For a large part, NOC production goals depend on its ability to finance its share of development costs. Future foreign investment into the oil sector is likely, especially with the improved investment climate that stems from the United Nations and the United States lifting sanctions. Previously, sanctions had caused delays in a number of field development and Enhanced Oil Recovery (EOR) Projects and had deterred foreign capital investment. Overall, Libya is considered a highly attractive oil province due to the low cost of its oil recovery (as low as US $1 per barrel at some fields), the high quality of its oil due to low-sulphur content ("sweet"), crude oil at very low cost and its proximity to European markets.

Figure 2.1 represents Libya's oil production and consumption, from 1986 to 2006. Libya is a major oil producer but much of its wealth has been squandered over the years. Despite efforts to diversify its economy, the hydrocarbons sector still accounts for 95% of total exports (much of it to Spain and Italy), 30% of GDP and 75% of total fiscal revenue, (Official Energy Statistics from the US Government,2007).



Source: BIA International Energy Annual 2006,

Figure 2 .1: Libyan oil production and consumption

2.7. Refining and downstream

From the 1970s Libya has been expanding, modifying and upgrading its industrial sector as one of its main strategies, as part of the country's development plan, One of the main Libyan development plans is to accelerate the process of economic diversification to achieve a more-developed widespread economy. The oil industry will be a vital part of the Libyan economy for a long time. The goal is to

use petroleum and petrochemical products as a resource for diversifying industrial growth, rather than as a single export commodity.

According to the Energy Information Administration (2007) Libya has five domestic refineries with a combined capacity of 378,000 bbl/d. Libya's refineries include: Ras Lanuf export refinery, completed in 1984 and located on the Gulf of Sirte, with a crude oil refining capacity of 220,000 bbl/d; Azzawiya refinery, completed in 1974 and located in north-western Libya, with a crude oil processing capacity of 120,000 bbl/d; Tobruk refinery, with a crude capacity of 20,000 bbl/d; Brega, the oldest refinery in Libya, located near Tobruk with crude capacity of 10,000 bbl/d; and Sarir, a topping facility with 8,000 bbl/d of capacity.

Libya's refining sector, reportedly, was impacted upon by UN sanctions, specifically UN Resolution 883 of November 11, 1993, which banned Libya from importing refinery equipment. Libya is seeking a comprehensive upgrade to its entire refining system, with a particular aim of increasing output of gasoline and other light products (i.e. jet fuel). As of early June 2007, NOC was evaluating investment proposals for upgrading the Ras Lanuf refinery. Total cost of the upgrade is estimated at US $2 billion. NOC is also expected to re-tender an engineering, procurement and construction contract for upgrading the Azzawiya refinery. In addition to refinery upgrades, Tamoil Africa and Occidental Petroleum Corporation reportedly have plans to build new refineries near Melitah.

2.8. Petrochemicals and other industries

The petrochemicals industry is centred at the Marsa al-Brega plant, which produces methanol, ammonia, and urea. Despite the fact that the plant operates at only 35% of its capacity, its production of urea and ammonia far exceeds domestic demand. A major plant producing ethylene, propylene, and butane was opened at Ras Lanuf in 1987. A second phase of the Ras Lanuf complex was to produce benzene, butadiene, methyl tertiary butyl ether (MTBE), and butane-1, but as of 2008, it had not yet been completed.

The Abu Kammash petrochemical complex produces ethylene dichloride (EDC), polyvinyl chloride (PVC), and vinyl chloride monomer (VCM). The iron and steel industries at Misratah began operations in 1990.

Libya's other manufacturing industries are small, lightly capitalized, and devoted primarily to the processing of local agricultural products (tanning, canning fruits and vegetables, milling flour, and processing olive oil), and the production of textiles, building materials and basic consumer items. Handicraft products include carpets and rugs, silver jewellery, textiles, glassware and leather goods.

2.9. The role of the Libyan National Centre for Standardisation & Metrology

In Libya the importance of quality and standardization issues in general were realized as early as in 1990, when the Libyan government established the Libyan National Centre for Standardisation and Metrology (LNCSM), as a result of the

General People's Congress law No. 5 for the year 1990 regarding standardization and metrology. Under law number 5/1990, it is the responsibility of the LNCSM to develop an effective quality programme along with standardization at a national level. It should help, promote, encourage and support Libyan organizations in adopting quality programmes (LNCSM, 1999).

2.10. Conclusion

This chapter covers the Libyan background, including the country's history, geography, government, economy and culture. In addition, this chapter reports on the Libyan oil, chemical and petrochemical industries. The next chapter presents laboratories' accreditation practice, such as accreditation definition, purpose of laboratories accreditation.

CHAPTER THREE

LABORATORIES' ACCREDITATION PRACTICE

3.1 Introduction

The aim of this chapter is to clarify the benefits of accreditation of industrial laboratories within developed and developing countries. Within the quality movement there is an approach that is gaining considerable popularity; it is called accreditation.

Therefore, this chapter will explore the accreditation field, identifying it, discussing the evolution of accreditation, its mission, purpose and goal. This chapter will also discuss the scope of accreditation, its objectives, and the value of accreditation, the process, and the criteria for accreditation and its role in laboratories. In addition, it will discuss the subjects related to accreditation such as the impact of accreditation on exports, the differences between the processes used for laboratories' accreditation and the certification and general requirements for accreditation of laboratories.

3.2 Accreditation definitions

Before engaging in a description of the benefits derived from accreditation and discussing accreditation issues, it is appropriate to start with the definition of accreditation. Accreditation has been defined as "the formal recognition that a testing laboratory has been deemed competent to carry out specific tests or specific type of tests" (ISO/IES8402, 1994) .

There are a group of words such as authorization, certification, inspection and regulation that can be confused with accreditation. Ellie (1990) described 'authorize'

as 'to make legal by authority', and 'regulate' as 'a means to manage or organize by restrictions', and Ellie also defines 'accreditation' as 'a system of impartial outside peer review for determining compliance with a set of standards.

There are also many definitions noted by accreditation associations. For example, Felix et al., (1993) in a working group of the Federation of European Laboratory Animal Science Associations (FELASA) defined laboratory accreditation as "an impartial outside agency that has reviewed the operation of a laboratory and found it to be in accordance to the specification, set forth by laboratory itself".

Fickelson (1990) stated the key words for accreditation are:

"Formal" - there is predefined criteria to be met and practical steps to be followed.

"Recognition" - The accreditation is published.

"Competent" - Technical competence must be established.

"Specific" - The range of competence is distinct in technical terms.

Generally, from the previous definitions, accreditation can be described as the process by which a laboratory becomes officially certified to show to its customers that it operates under acceptable international standards and provides good quality, so that the public can trust in its services.

3.3 Background and evolution of accreditation

According to the European Federation of National Associations of Measurement (2000) accreditation has developed in many stages:

- 1st stage: in the nineteen fifties, laboratories' accreditation was implemented by some nations, such as Australia to develop testing and quality.
- 2nd stage: in the nineteen seventies, accreditation of calibration laboratories according to international standards was the main focus.
- 3rd stage: in the nineteen eighties, in order to assist in reducing the technical difficulties of trading, laboratories' accreditation was developed to gain international acceptance of test data by the adoption of the General Agreement on Tariffs and Trade (GATT).
- 4th stage: the focus was on the implementation of ISO 9000 standards in laboratories' accreditation.

Finally, in the 1990s, Europe focused on accreditation of all types of measurements and anything pertaining to the conformity assessment field.

Today, these successive layers underline most of the national accreditation schemes which have developed world-wide. This evolution, however, has resulted in a shift from an essentially technical approach to accreditation with higher focus on its economic and commercial consequences. Governments and economic partners have become more involved and accreditation bodies have had to be more aware to their

needs and expectations, in addition to, and sometimes to the detriment of, a strong relationship with the operators.

3.4 Purpose of laboratory accreditation

The main purpose of accreditation is to prevent many deviations from occurring and to give the laboratory's customers confidence in the quality of the services provided by the laboratory. Basically ISO 8402 defined quality as meeting all aspects of the needs of a customer. For testing and calibration the main needs of the customer are for results that are: fit for their intended purpose, delivered on time, and provided at minimal cost.

According to the ISO/IEC 17025 standard, (1999) the purpose of accreditation is so that during the exchange of products between different countries the products do not require retesting, meaning that the output of analysis should be the same everywhere within allowable deviation.

So, laboratories that have an official statement such as an accreditation certificate will receive more confidence from economic agents in the services supplied. In addition, many researchers, such as Fickelson (1990), suggested that the purpose of laboratory accreditation bodies is to assess the capability of laboratories and their ability to produce dependable data. Ratliff (2003) also pointed out that a laboratory's product can be defined as the report issued as the result of analytical, measurement, or testing activity conducted on a sample or samples received from some source.

It is obviously clear that the purpose of laboratories' accreditation is to assess the personnel, procedures and technical competence in order to demonstrate that a laboratory meets the international standards' requirements and that a laboratory's competitiveness is determined by the quality of the services or products provided.

3.5 Objective of laboratory accreditation

When a laboratory is selected to fulfil testing, calibration or measurement needs, this laboratory should be able to make accurate and reliable results. Consequently, laboratory accreditation can achieve the following objectives:

- To minimize risk.

Trinidad and Tobago Bureau of Standards (2004) suggested that accreditation provides consumers with confidence that everything from accredited products or services are safe and meet the specification and standards, and thus that choosing an accredited laboratory minimizes the risk of producing a faulty product. However, the European Co-operation for Accreditation organisation (2003) stated the advantage of accreditation is to reduce the risk of business.

So, accordingly, as has been discussed above, there are many advantages of the one test–one standard to the manufacturer such as reducing direct and indirect costs, free access to all markets without extra costs, less administration and the simplification and rationalization of procedures.

- To buy with confidence

The United Kingdom Accreditation Service UKAS (2004) suggested recently that it is very difficult to buy from a known dealer due to a strong competitive market. Thus accreditation is needed to maintain trading confidence, especially where there is marketing competition because it is difficult to protect your market against high-quality products at low cost.

In the current time, environment, safety and health subjects will determine the acceptability of a product by the customer. Accredited certification is the tool by which products can penetrate foreign markets because technical barriers to trade are reduced, quality is increased and exports are improved. Accreditation itself may instil confidence in a customer in a laboratory's competence and integrity.

Accreditation plays an important role in developing countries in continuing their economic development because it assists in reducing technical barriers to trade.

- A marketing advantage

Many studies suggest that accreditation is advantageous for marketing. Oakland and Morris (1998) commented that gaining an organizational reputation through quality is not easy to achieve. Another study, conducted by Trinidad and Tobago Bureau of Standards (2004) indicated that accreditation is a market access tool for an organization to export product or to submit tenders. Oakland and Morris (1998) stated that the benefits of an accredited test are that marketability is increased and that it provided confidence in, and more acceptances of, the test results.

Accreditation means that laboratories have the necessary resources such as qualified operators and the appropriate equipment in order to ensure the reliability of test reports and to improve their competitiveness and marketability. So the main advantages of 'one test-one standard' to the market are less confusion, less expensive products, open competition and a wider use of certified products.

- To avoid expensive retesting

Retesting of product incurs extra charges and additional time consumption and the reputation of the testing organization goes down. Laboratory accreditation provides the chance to prevent retesting problems.

The European Co-operation for Accreditation organisation (1999) explained that an accredited laboratory means that the laboratory applies surveillance activities such as assessment plans or undergoes any activities undertaken by an accreditation body at any time to observe the performance of that accredited laboratory Surveillance activities include assessing the laboratories' performance in the implementation of quality systems.

3.6 Accreditation and quality policies

Ratliff (2003) suggested that in order to meet laboratories' accreditation requirements, laboratories should have quality policies' guidance and that the highest authority within a laboratory should issue it. It is the responsibility of a laboratory's management what the quality goals of the laboratory are to be. Quality objectives

should be based on that particular laboratory's policies, priorities and field of interest or accrediting bodies.

David (1998) stated that the standard requires that the supplier's management with executive responsibility define and document its policy for quality. The quality policies' guidance with respect to meeting customer requirements may contain such information as:

- Training programmes for the improvement of quality.
- Calibration procedures, specifications and instructions.
- How to increase preventive measures in order to decrease the cost of correction.
- How to supply a laboratory with appropriate substances for quality assurance.

Thus laboratories should employ appropriate quality control procedures as a means of monitoring day-to-day performance.

3.7 Laboratory infrastructure and environmental conditions

Laboratory infrastructure has been defined as "the work space, buildings in which the laboratory conducts its business, together with the necessary testing and analytical equipment and supplies, plus its administrative support such as clerical, financial, and purchasing activities" (Ratliff, 2003). The laboratory should have appropriate work conditions, such as temperature and humidity control, in order to increase quality and productivity. Ratliff (2003) pointed out that the temperature for a laboratory environment should be 68°F - 73°F with a relative humidity of 35-50%, and provide

laboratories with adequate lighting and follow the recommended requirements for electrical power, dust, vapour and vibration.

3.8 The importance and structure of laboratories' accreditation

In an earlier study Morris and Mackey (2004) concluded that accredited laboratories perform better than non-accredited ones. This conclusion is not unexpected given that accreditation is dependent on conformance to a quality management standard (ISO/IEC 17025, Canadian Association CAN-P-4D). Morri (2004) also discussed that the best approach to guarantee permanent high quality analytical outcome and conformance to ISO/IEC 17025 through accreditation is to make sure that the laboratory has good management tools. Nowadays, many countries around the world have one or more organizations responsible for the accreditation of their nation's laboratories. Most of these accreditation bodies have now adopted an international standard, called International Organization for Standardization/International Electro technical Commission 17025 (ISO/IEC 17025) as the basis for the accreditation of their country's testing and calibration laboratories. Adoption of this international standard has helped countries adopt a uniform approach to determining laboratory competence. This uniform approach allows countries with similar accreditation systems to establish agreements between themselves, based on mutual evaluation and acceptance of each other.

3.9 Accreditation within developing countries

The United Nations (2003) mentioned accreditation is still a relatively new service in most developing countries. In 1990s accreditation services in developing countries and within the Arab region were provided by the private sector or by another country's national accreditation authority. By the late 1990s national accreditation bodies began to appear in developing countries, generally as part of the ministry of industry or within a national standardization organization. Accreditation at that time came under the jurisdiction of these organizations.

This caused problems for transparency and independence between accreditation, certification and standard–setting authorities. However, these problems are often brought about because of limited technical and human capability as well as limited financial resources. As a consequence of United Nations policy (2003) in developing countries, the national accreditation body is now usually an independent authority that is separate from the standard-setting foundation so as to avoid confusion and the politicization of accreditation services. Government intervention is the exception rather than the rule and the accreditation bodies generate revenue from membership and service fees.

3.10 Accreditations in the Arab region

The United Nations (2003) stated that many Arab countries have established national standardization bodies (NSB) and have achieved reasonable knowledge and capabilities in the area of standardization. Nevertheless, there are still other countries

that have only started to achieve national accreditation bodies. Only four Arab countries have certification accreditation bodies: Tunisia, Egypt, Saudi Arabia and Jordan. Only the Tunisian Accreditation Council (TUNAC) has Accreditation Body Member status in the International Accreditation Forum (IAF).

3.11 Laboratory accreditations in the Arab region

According to the United Nations (2003) there are only six Arab countries which have an accreditation body that has the ability to accredit laboratories according to international standards such as ISO 17025, These are: the Accreditation Unit (AU), Jordan Institution for Standardization and Metrology (JISM); the Ministry responsible for Industry in Morocco (MCI); the National Laboratories' Accreditation Bureau (NLAB) of Egypt; the Palestinian Council for Laboratory Accreditation, Palestinian Standards Institution; the Ministry of Industry, Quality Assurance Department, Saudi Arabia Standards Organization (SESO) and the Tunisian Accreditation Council (TUNAC)

Technical assistance for accreditation bodies in the Arab region is being given and is requested from different sources in order to support the competence of these institutions because they are inexperienced. For example, UKAS in the United Kingdom provided technical aid to the Egyptian National Accreditation Council (EGAC) during the early years of the Council's organization. Also the Jordan Institution for Standardization and Metrology (JISM) combined with UKAS in order to technically support its accreditation programme.

Jordan (JISM):

According to the United Nations (2003) the Accreditation Unit (AU) at JISM was created as a non-profit governmental organization. In 2000 the Accreditation Unit was allowed to perform accreditation services. The unit had accredited many laboratories in different areas such as mechanical, civil, chemical, food and environmental. In 2001, partial liberty from JISM was given to the AU.

Egypt (EGAC):

According to the United Nations (2003) in 1996 the Egyptian National Accreditation Council (EGAC) commenced accreditation procedures such as product certifiers, testing and calibration laboratories, personnel certifiers and inspection bodies. The introduction of EGAC in different sectors is a significant step for Egypt

For instance, the Egyptian Environmental Policy Program is providing assistance to EGAC in order to strengthen it is capacity to perform accreditation assessments of environmental laboratories

Morocco (MCI):

MCI is authorized to provide laboratories' accreditation services according to ISO 17025 requirements, such as assessing the ability of personnel, equipment, testing and inspection.

Palestine:

The accreditation process by the Palestinian Standards Institution is made with reference to ISO 17025. The Palestine Council for Laboratory Accreditation is a section of the Palestinian Standards' Institution and engineers and scientists provide the accreditation activities.

According to the UN (2003) in Palestine there are about 12 civil laboratories and food laboratories have also been accredited according to ISO/IEC 17025 standards.

3.12 Planned accreditation bodies in the Arab region

According to the United Nations (2003) there are many Arab countries which have initiated the process of establishing a National Accreditation Body (NAB) because of increasing accreditation benefits. For example:

- Algeria and Qatar: at the moment there are no accreditation bodies, but in future there are plans to establish one.
- In United Arab Emirates, the Emirates Authority for Standardization and Metrology is responsible for accreditation work.
- Additionally, there are plans to set up an accreditation unit within Yemen, namely a standardization metrology and quality control organization.

In the 1990s there were discussions between the members of the Gulf Cooperation Council (GCC) to create a central regional accreditation organization for GCC member states within the Gulf Standards and Metrology Organisation (GSMO).

3.13 The accreditation process in the Arab region

The United Nations (2003) have indicated that the laboratory accreditation procedures adopted in most Arabic countries is the same. For example, there are five main steps in the process for laboratory accreditation in Morocco. These steps are:

A request for accreditation; an assessment of the applicant's request to determine if the applicant's preliminary files have or have not the adequate capacity to proceed with an accreditation audit; an audit to examine the capability of the organization; the audit report which includes the assessment of the organization, and the decision made, which is dependent on the audit team report.

Every year the accredited laboratories should be checked by the accrediting body to assess that it is still competent. According to International accreditation organisation such as ILAC, UKS... etc, accreditation is for five years in cases where annual reviews are accepted. Laboratories are subject to annual surveillance and are re-assessed every five years and the renewal date of ISO/IEC 17025 Certificate confirms the latest date of renewal of accreditation.

3.14 Assessment of accreditation bodies in the Arab region

The United Nations (2003) pointed out that there are many barriers that explain why accreditation bodies in the Arab region are still in short supply, such as:

- A narrow technical capacity to provide accreditation services at a national level.
- Lack of knowledge among the public concerning the role of, and the reason for, accreditation.
- Limited existing requirements for accreditation services at the national level.
- Lack of financial and human resources

Although, accreditation of laboratories would be costly for manufacturers it would provide increasing international confidence in the goods and services produced in the Arab region. In fact, while voluntary accreditation can play an essential role in increasing international confidence in the conformity assessment of Arab goods and services designed for export, it can also provide a tool for increasing competitiveness in the local market. This has happened in countries that have concerns on safety, health and environmental issues.

3.15 Laboratory accreditations in Libya

UNIDO (2005) assessed the Industrial Research Centre (IRC) for compliance with ISO/IEC 17025 and found that some aspects such as the calibration of equipment, internal audits, control of nonconforming testing and management review were not at all addressed, while other aspects were only understood a little; the knowledge and understanding of most of the technical and management requirements for laboratories' accreditation was poor in the Libyan IRC.

In March 2005 Libya signed up with other parties (IRC, UNDO, and UNDP) to start a project to establish a laboratories' accreditation body. The project is totally funded by Industrial Research Centre (IRC).

The objective of this project is to provide useful assistance to the Industrial Research Centre's laboratories to assess and attain the requirements for accreditation. The project will also improve human resources by training laboratory experts in quality

management systems and in laboratory information management systems; in the operational and application aspects of sophisticated equipment; in specialized technical issues and by certifying competence to work as laboratory assessors.

The Industrial Research Centre's laboratories require accreditation in order to commence their analytical capability and so that there will be international acceptance of any certificates or analysis issued by them

Additionally, if the IRC is accredited, the country will save the overseas exchange which is currently spent on requesting testing from accredited laboratories from outside the country, this being a frequent requirement of the importing country. The country will also have better footing in the event of legal arguments in international trade in the cases of product conformity assessment as per international standards.

3.15.1 Laboratories accreditation procedures

Based on the international laboratories accreditation organisation the laboratories can have either all or part of their testing and calibration activities accredited. The accreditation process involves a thorough evaluation of all the elements of a laboratory that contribute to the production of accurate and reliable test data.

The evaluation process can take one to several days, and involves the use of specialist technical assessors who evaluate the specific types of testing or measurement being performed. The assessment criteria are based on the international standards ISO/IEC17025, which are used for evaluating laboratories throughout the world. So in order to manage the process of laboratories accreditation

in Libya, The laboratory should be aware about the standards criteria that accreditation bodies used to assess the laboratory.

Laboratory accreditation bodies use this standard specifically to assess factors relevant to a laboratory's ability to produce precise, accurate test and calibration data, including the:

- Technical competence of staff
- Validity and appropriateness of test methods
- Traceability of measurements and calibrations to national standards
- Suitability, calibration and maintenance of test equipment
- Testing environment
- Sampling, handling and transportation of test items
- Quality assurance of test and calibration data

At the end of the assessment a detailed report on the evaluation is presented to the laboratory, highlighting any areas that require attention and corrective action prior to the laboratory being recommended for accreditation.

Once accredited, the laboratory is re-evaluated periodically to ensure its continued compliance with requirements, and to check that its standard of operation is being maintained. The laboratory may also be required to participate in relevant proficiency testing programs between reassessments, as a further demonstration of technical competence.

3.16 Conclusion

This chapter explains the definitions, the objectives of laboratories' accreditation, the background to laboratories' accreditation, accreditation requirements and the accreditation process in developed and developing countries. In addition, it covers the literature review concerning laboratories' accreditation and accreditation issues in Libyan industries. The next chapter goes on to identify the factors that affect the establishment of laboratories' accreditation and ISO implementation.

CHAPTER FOUR

FACTORS AFFECTING THE ESTABLISHMENT OF LABORATORIES' ACCREDITATION

4.1 Introduction

In recent years the quality of manufacturing products has become one of the most important factors that influence national and international business and economic patterns.

Ferguson (1996) pointed out that numerous quality standards have been developed and adopted over the years, with the ISO family of standards representing an international consensus on good management practices that have the aim of ensuring that an organisation can deliver products or services that meet the customers' quality requirements.

The ISO standards can be applied to any type of organisation (private or public including government services) independent of the size of the organization or the kind of products manufactured or services provided.

Suzik ,1999 and Vlachos et al. , (2000) mentioned that compliance with the ISO/IEC 17025 international standard also means operating according to ISO 9001 or ISO 9002 standards, since the former contains those requirements of the latter

which are clearly related to the nature and scope of the testing and calibration laboratories.

The rapid growth in implementing quality assurance systems such as ISO 9001 and ISO 9002 in many organisations and enterprises dictates the need for laboratories in compliance with the ISO/IEC 17025 standard.

The uptake of quality programmes in Libya, such as ISO implementation, is still very poor. Such implementation is a new area for Libyan organisations. These organisations need to establish a new strategy towards ISO standard implementation and laboratory accreditation.

According to the 2005 ISO survey (ISO, 2005) up to the end of December 2005, at least 776,608 ISO 9000:2000 quality management systems' certificates had been issued in 161 countries and economies in the world, amongst them only 35 ISO 9001/2000 certificates had been issued in Libya.

The 2005 survey total represents an increase of 29 certificates issued (about 500%) when compared with 2004 when a total of only 6 certificates were issued in Libya. Also the survey shows at least 111,162 ISO 14001 environmental management system certificates had been issued in 138 countries and economies. Only 3 ISO 14001 certificates were issued in Libya from 2004 until December 2007 as shown in Table 3.1.

Table 4.1:ISO Certification Growth in Libya from End of 2003 to End of 2007

Types of ISO certificates	Dec. 2003	Dec. 2004	Dec. 2005	Dec. 2006	Dec. 2007
ISO 9001:2000 for Quality Systems	4	6	35	46	55
ISO 14001:2004 for Environmental Management Systems	-	3	-	3	3
ISO/IEC 17025 for Laboratories' Accreditation	-	-	-	-	1

According to the 2007 ISO survey (ISO, 2007) up to the end of December 2007 at least 951,486 ISO 9001:2000 certificates had been issued in 175 countries and economies, and up to the end of December 2007 at least 154,572 ISO 14001:2004 certificates had been issued in 148 countries and economies, Up to the end of December 2007 at least 35,198 ISO/TS 16949:2002 certificates had been issued in 81 countries and economies and up to the end of December 2007 at least 12,985 ISO 13485:2003 certificates had been issued in 84 countries and economies.

At the end of December 2007 at least 7,732 ISO/IEC 27001:2005 certificates had been issued in 70 countries and economies. According to the 2009 ISO survey (ISO, 2009) very few ISO certificates had been issued to Libyan organisations compared to other countries in the Arab world. Only 55 ISO 9001:2000 certificates and 3 ISO 14001 certificates had been issued in Libya as shown in Table 4.1.

Although ISO 9001:2000 and ISO 14001 certificates were issued the ISO 2007 survey (ISO, 2007) showed there were no other ISO certificates issued in Libya such as ISO 13485 or ISO/IEC 27001.

The Organisation for Economic Co-operation and Development (OECD) (2006) concluded that in order for a company to obtain ISO/IEC 17025 certification, a company must not only be consistent, but must also be proficient in testing the quality of their products.

Many researchers have attempted to identify the factors that affect the implementation of quality standards in developed and developing countries. Winston et al. (2006) pointed out that the high degree of interdependence in the modern economic infrastructure means that many organisations cannot produce or create high quality goods or services if the quality of its inputs is inadequate. Another study conducted by Kochan (1993) stated that differences in culture and language had to be taken into account if an organisation wished to create a dependable way of developing a quality assurance programme.

Woan and Lin (2008) cited many studies and suggested that the most important reason for implementing ISO standards is that customers prefer to buy from suppliers that are ISO certified (Carlsson and Carlsson, 1996; Johnson et al., 1997).

Thus the chemical and petrochemical laboratories in Libya should be developing an efficient quality programme such as implementation of ISO/IEC 17025.

4.2 Factors to be taken into consideration in developing countries.

Many studies carried out by many researchers such as Al-Sulimani and Sharad, (1994); Youssef and Zair (1995) and Magd (2008) stated that, despite the number of publications covering quality programmes and the amount of research on quality programmes, little empirical work has been carried out in the Arab world.

The emphasis on customer satisfaction or customer-driven quality is considered by many experts and writers as a major success in quality management implementation. Studies carried out by Deming (1986). Crosby (1989), Oakland and Porter (1994), Rao et al. (1996) and Zairi (1996) considered measuring customer satisfaction as a basis for implementing a quality programme. In addition, an emphasis on listening to customers and trying to satisfy their needs is very important factor in implementing and maintaining a quality programme.

A study conducted by Wong (1998) identified that a lack of real understanding of the principles of quality programmes, due to a lack of training and education in order to develop a quality mindset within the work force and particularly within the leadership, led to a failure in many of the quality programmes' implementation in developing countries.

Another study undertaken by Khalifa and Elain (2000) pointed out that the awareness and understanding of quality programmes is still at very low level In

developing countries and the success factors that lead to the implementation of successful quality programmes are not well-known in most developing countries. Kekale and Kekale (1996) indicated that wherever a quality management system is adopted an organization needs to develop a suitable implementation approach and culture factor should be taken in consideration.

There are many studies in developing countries that highlight the many factors that affect the implementation of quality programmes. Ho (1995), Krasachol et al. (1998) and Lee (1999) mentioned that the lack of governmental support of quality activities is considered one of the major factors in the non-implementation of quality management programmes. They also found a lack of information such as lack of statistical data, a lack of effective information and a lack in liaising programmes between the organizations and their governmental, ministries to facilitate improvement activities.

In addition, Muna (1980) and Al-Suleiman (1984) found that contextual factors such as politics and culture played a role in Arab management organization. Study conducted by Al-Zamany et al. (2002) categorized the difficulties of implementing quality management in Arab countries into three main categories.

The first category contained factors that were related to government issues such as lack of governmental support for quality programmes and the selection and assessment of managers in public organizations. The second category listed the difficulties of implementing quality programmes due to the lack of technical knowledge and the shortage of skilled personnel to implement these activities.

The third category of difficulties showed the difficulties in the implementation of quality programmes that were related to current organizational practices which are related to the culture such as people's attitudes or inappropriate managerial traditions.

On the other hand, Anschutz (1995) and Zamany.et al. (2002) concluded that business organizations in the Western world have developed due to quality issues being included in the planning process of those organizations.

The development of quality programmes within Middle Eastern countries is less than in Western countries due to a number of reasons. Such reasons include the fact that many organizations in the Middle East have not operated as commercial companies because of different forms of government interference and because the companies have been protected from international competition by government imposed tariffs and trade barriers, a ready market and a lack of any pressure from the market or from existing customers.

The lack of any role within the quality systems sector played by the government is considered as one of the main reasons for the country's attitude towards quality and a general unawareness of the concept of quality management has led to a lack of innovation and improvement activities in these organizations.

Another study performed by Al-Khalifa and Aspinwall (2000) indicated that in order to move forward in terms of quality practices it is necessary to create a driving

force, which is usually associated with either pressure from customers or comes from an initiative from the owner or the managing director.

Sayeh et al. (2005) stated that in order for Libyan organizations' quality programmes to succeed many factors to instigate the desired culture should be taken in consideration such as building up teamwork, opportunities for growth and development, decentralized decisions, and the need to understand that the implementation of quality programmes has to be done with careful planning. So government policies of protectionism and the local ready market means that the organization focuses on mass production and neglects the quality programme and customers' satisfaction.

Thus, based on these studies the researcher can conclude that there are many factors, investigated by many researchers, that affect the successful implementation of quality management such as a lack in creating a driving force; a lack of training on, and in the understanding of, the principles of quality; lack of top management commitment; lack of action taken by middle management, cultural factors such as people's attitudes or inappropriate managerial traditions are a critical factor; lack of governmental support for programmes within the quality field; a lack of information such as lack of statistical data & effective information; a lack of effective communication; the fact that awareness and understanding of quality programmes is still at very low level and the fact that the major success factors for successful quality implementation are not well-known in most developing countries; materials and purchased parts; teamwork, training and education; all these factors

affect the establishment and implementation of the quality factors in Middle Eastern Countries and developing countries.

4.3 Implementation of the ISO/IEC 17025 quality assurance system

The international quality standard ISO/IEC 17025 specifies all the requirements needed for sound management (clause 4) and for technical competence for the laboratory tests and calibrations carried out (clause 5). In addition, the laboratories which comply with ISO/IEC 17025 also comply with the ISO 9000 – Quality Management System Requirements. This means that laboratories that comply with ISO/IEC 17025 will, therefore, also operate in accordance with ISO 9001 or ISO 9002.

In contrast, certification under ISO 9001 and ISO 9002 does not of itself demonstrate the competence of the laboratory to produce technically valid data and results.

Establishing accreditation systems based on international standards and linked with international accreditation agreements, provide assurance to trading partners that suppliers of tests and certificates are competent and at the same time accredited organizations can overcome trade barriers and comply with the requirements of the WTO/TBT Agreement Little empirical work has been carried out on ISO/IEC 17025. Vlachos et al. (2002) stated that to effectively implement the ISO/IEC 17025 quality standard, there are a number of measures and factors that should be taken into consideration. These factors are: senior management

support, training, documentation, test methods, audits' review, equipment and method validation.

- **Senior management support**

Gillespie (1998) stated that an absence of upper management commitment is the main reason for the failure of a quality programme. This occurs when top management fails to understand the magnitude of the effort required.

Vlachos et al. (2002) highlighted senior management commitment to quality should be active in all of the quality process from design to implementation and then through to maintenance. To do this they need to be provided with resources such as money, training ....etc

- **Training**

Vlachos et al. (2002) pointed out that adequate training of employees is vital especially in developing countries, since there is a considerable lack of experienced personnel in quality matters in these countries

- **Documentation**

The quality system documentation should be in accordance with the ISO/IEC 17025 standard and the involvement of the company's employees is major component requirement in achieving a quality programme. Thus, quality can be considered as an employee involvement process that captures the ideas of the individual performing a specific job.

A new study conducted by Magd (2008) found that the main benefits from implementing the ISO certificate were improved documentation and also improvement in the efficiency of the quality system and in achieving customer satisfaction.

- **Audits and review**

The new issue of the standard introduced by the ISO/IEC 17025 standard requires the introduction of international quality audits and reviews, scheduled and conducted on regular basis, and carried out within the framework of the quality system. Tsiotras and Gotzamani (1996) stated that there is a lack of well-trained and experienced internal quality auditors in developing countries.

- **Test methods**

Vlachos et al. (2002) pointed out that top priority should be given to test methods beginning with procedures and implementing the uniform documentation. Test methods' texts should include system suitability checks, quality control schemes, specifications, safety measures as well as data validation and the equipment employed. Certified reference standards should be purchased for the purpose of internal checks and calibration.

- **Equipment**

Vlachos (2002) stated that a detailed programme of calibrations and checks with specialized standard procedures for each class of equipment should be provided when implementing a new quality assurance system.

- **Method validation**

Vlachos (2002) pointed out that method validation is one of the most important tasks. Standard operating procedures for method validation should be written and applied. Also, indicated participation in external proficiency tests is important for all laboratories worldwide planning to be accredited according to international quality assurance standards.

- **Proficiency testing**

Taylor and Fulford (1981) and Hassemer (1996) suggested that involvement in proficiency testing has a direct useful impact on laboratory performance. Middlebrook and Morris (2006) stated that laboratories' accreditation and proficiency testing are a powerful combination, providing the tools required to successfully manage a laboratory. Proficiency testing allows a laboratory to monitor performance, providing a feedback mechanism for identifying areas of concern for investigation and corrective action.

4.4 Problems and obstacles during the implementation period

A number of organizations have reported considerable problems during the planning and implementation of quality programmes. (Patel and Randell ,1994; Stevenson and Barnes, 2002) pointed out that the most critical problems concern the documentation process; the lack of ISO knowledge and experience; the lack of time and resources; the commitment of top management and personnel and the creation of system ownership.

Another study conducted by Aldowaisan and Youssef (2006) mentioned that small companies are not in position to qualify a satisfactory number of employees during and after an ISO realization project, nor can they finance the cost of preparation, development and registration. Aggelogianno et al. (2006) pointed out that the implementation of a quality programme requires the commitment and cooperation of the work force.

Top management should ensure that all employees should know how the quality programme would benefit them and how the quality programme would help the organization in critical areas such as the reduction of defective products, the improvement of internal communication, the increase in customer satisfaction, the increase of share market and the opportunity for infiltrating new markets.

4.5 Problems in quality management in the developing countries

The state of quality management in developing countries cannot be separated from their mainstream economic and industrial development. The problems encountered in their quality management arise from a lack of infrastructure and advanced technology.

Sandholm (1999) stated that factors that impeded the improvement of quality in the developing countries included low purchasing power, a shortage of goods, foreign exchange constraints, an incomplete infrastructure, inadequate leadership and insufficient knowledge.

Bruun and Mefford (1996) believed that customer expectations of quality in such regions are low, thus causing some problems in those countries. Firstly, the export abilities of firms in those countries are affected by quality when competing with other goods manufactured by more developed nations. Secondly, local workers lack the required efficiency and skills in performing their jobs. Thirdly, using traditional inspection techniques in the plants of developing countries leads to inefficient and high cost operations.

Mersha (1997) argued that sub Saharan African countries are faced with a number of problems that hinder the implementation of TQM. They are: government interference and control; a shortage of goods; foreign exchange constraints; insufficient infrastructure and local capital scarcity.

In addition, Goonatilake (1988) claimed that the reason for the low quality of products in the developing countries is due to a lack of qualified production managers because of the country's negligence in providing industrial engineering and management education. However, attributing the problems of quality to the paucity of production managers might not be accurate since the problem is broader than this and also includes a lack of skilled labour.

In exploring quality problems in the Libyan industry, Tarbaghia (1996) discovered various shortcomings such as a lack of knowledge about quality techniques, an absence of strong incentives for good quality, poor materials, poor specifications, and poor equipment. Aly (1996) stated that the implementation of quality

programmes in the Middle East is not spreading quickly enough and claim that the reasons for this are because of bureaucracy, traditional cultures and a lack of sufficient training and education.

Sandholm (1999) claimed that to overcome quality problems in developing countries, not only companies but also governments should intervene to provide solutions. He mentioned areas of improving the progress towards quality, at national level such as: standardization, certification, export inspection, legislation, national promotion, education and training, external assistance, institutional infrastructure and professional societies.

Mersha (1997) suggested that governments in the least developed countries should provide an appropriate environment that has a reasonable infrastructure for industry as a whole. On the other hand, Bruun and Mefford (1996) suggested taking some measures inside an organization to overcome quality problems in the developing countries. They emphasized the need to implement quality issues' elements, such as continuous improvement, quality-driven goals, supplier relations and, most importantly, worker involvement. They recommended that implementing quality programmes in developing countries should be accompanied by changes in the culture and attitudes of the local workforce.

Similarly, Madu, (2003) asked for a cultural transformation in developing economies, in order to make changes within organisations for better quality and performance. In order to achieve transformation, they suggested that companies

adopt long-term planning and develop human resources through education, training, enrichment of jobs and awareness-raising programmes.

Most importantly, management has to assure employees that the transformation is beneficial to the organization in the long run. Magd (2008) found a lack of top management commitment and the lack of qualified personnel to be major barriers for the implementation of ISO in Egyptian iron manufacturing organizations.

4.6 Development of a conceptual framework

Sekaran (2003) defined the theoretical framework as " a conceptual model of how one theorises or makes logical sense of the relationships among the several factors that have been identified as important to the problem".

From the review of the literature a researcher can develop a conceptual theoretical framework. It gives the foundation for the final framework (Najmi and Kehoe (2000). The primary purpose of a conceptual framework is to indicate the key elements of types of barriers that could face any laboratories in the implementation of ISO/IEC 17025 standards.

4.7 Factors that emerged from the literature review of the research

Various attempts have been made by different researchers to identify the factors that affect the implementation of laboratories' accreditation and quality issues. The

literature abounds with lists of variables supposedly influencing the quality and accreditation of laboratories.

The researcher has derived the barriers that affect the establishment and implementation of quality standards in many manufacturing organizations in different countries. These barriers were identified as:

- Lack of human resources including: lack of a real understanding of the principles of quality programmes, lack of training and education, lack of a motivation system, lack of employees' training in how to solve problems, lack of opportunities to use employees' skills effectively and lack of involvement by all staff for continuously reviewing and improving processes.

- Cultural barriers that include: resistance to change, wrong people in the wrong position, inappropriate managerial traditions, relationships with supervisor, relationship of individuals, people involvement in attending meetings, the celebration of social events, ease of adjustment to new requirements, senior managers taking time to talk informally to employees, more co-operation than competition between different departments

- Technical barriers that consist of: materials and purchased parts, time and resources, method validation, selection of test methods, lack of technical knowledge, shortage of skilled personnel, utilities, calibration difficulties and insufficient technology, corrective action, technical records, difficulty in

understanding the ISO/IEC 17025 standard's requirements and benefits, and accommodation and environmental conditions

- Management barriers that contain: lack of top management commitment, documentation control, quality system policies, lack of awareness, lack of communication and information related to QMS issues.

4.8 The structure of the conceptual framework

As can be seen from the literature review and previous discussions, some writers grouped the barriers (that affect the establishment and implementation of quality programmes and ISO standards) as found by their research, into different groups. A review of these previous studies and the ISO/IEC 17025 requirements reveals some common factors that affect laboratories' accreditation.

The researcher categorized six types of factors that affect the establishment of laboratories' accreditation. These form the main areas of the conceptual framework as shown in Figure 4.1 of this study.

Most of the technical factors related to Personnel, Accommodation and Environmental Conditions, Tests and Calibration Methods and Method Validation, Equipment, Measurement Traceability, Sampling, Handling of Test and Calibration Items, and Reporting the Results in the theoretical frame work were driven from ISO/IEC 17025 requirements and the other technical factors which related to

Documentation, audits and review, test methods, equipments, method validation, refrences materials such as Physical condition at work ,Enough resources, Enough space from Vlachos ,2002; Taylor and Fulford,1981 and from ISO/IEC 17025 Gap analysis questionnaire to determine the weaknesses in the laboratory's quality system.

Factors related to Management System, Document Control, Services and Supplies, Service to the Customer such *as* Meeting customer needs, Continuous quality improvement , Customers' satisfaction , Corrective Action, Preventive Action, Control of Records, Internal Audits were driven from ISO/IEC 17025 management requirement

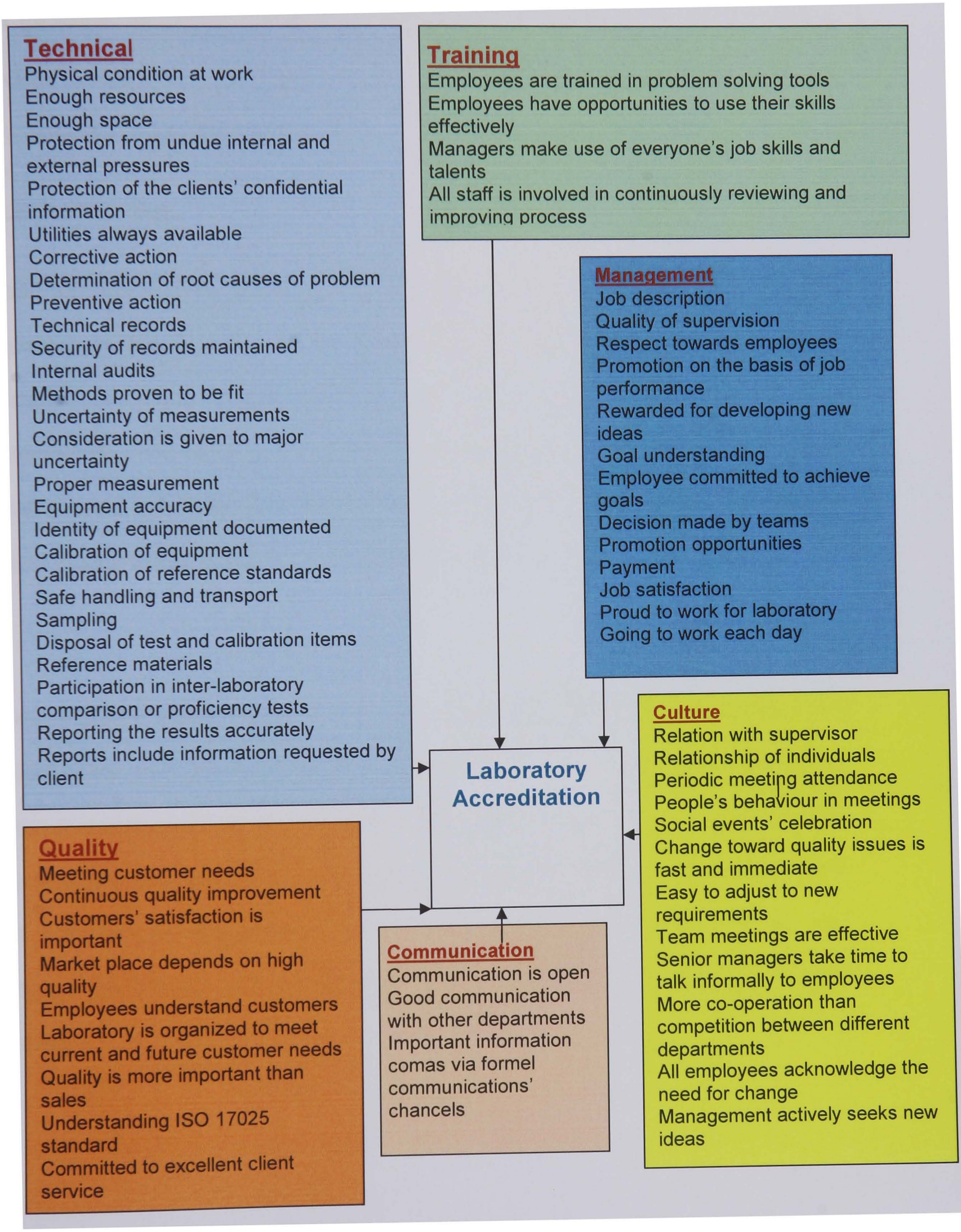


Figure 4.1:Theoretical framework of the study as the outcome of literature

The generally perceived factors that influence accreditation performance can be grouped under the headings of technical, management, quality, cultural, communication and training factors.

Technical factors

Based on the barriers pointed out by many researchers, as outlined in the beginning of this chapter, it is obvious that technical barriers are those which represent the difficulties that have been found by management and employees in understanding the standard's requirements. Zhao et al. (2000) pointed out that materials and purchased parts are the major source of quality problems and thus supply quality management is an important aspect of quality management.

Oakland (2000) stated that self-assessment highlights strengths and improvement opportunities and drives continuous improvement. Vlachos and Michail (2002) stated that time and resources should be provided to various departments in order to assimilate completely the accreditation requirements. Many researchers stated that difficulties in implementing quality programmes are related to the lack of technical knowledge and the shortage of skilled personnel to implement these activities.

Management factors

The management barriers are created by the organization management itself, such as weakness in leadership and top management commitment towards the implementation of a quality system. Many studies in developing countries such as Ho (1995) Krasachol et al. (1998) and Lee (1999) found that the lack of governmental and management support for a quality programme is considered one of the major factors in the non-implementation of quality management programmes.

Baidoum (2003) quoted Ramirez and Loney (1993) Zairi and Youssef (1995) Ali (1997) Ahire et al. (1996) Dayton (2001) Saraph et al. (1989) Flyn et al. (1994) Thiagarajan (1996) Rao et al. (1999), Pun (2001), Sureshchandar et al. (2001) Lau and Idris (2001) and Li et al. (2001) who found by several empirical studies that the commitment from top management was a critical factor in implementing any quality programme.

In addition, Baidoum (2003) quoted several studies such as Lorente et al. (1998), Li et al. (2001), Claver et al. (2001), Zhang et al. (2000), Rao et al. (1999), Westlund and Lothgren (2001), Bowden (2000), Wuagneux (2002) and Kanji (1998) which identified that employee empowerment, the management of people including teamwork, a consideration of culture, employee motivation. Also, they considered that the act of maximizing employee involvement in the quality process requires the organization to make major adjustments to incorporate this.

Oakland (2000) stated that middle management must explain the importance of quality to the employees for whom they are responsible. In addition, Oakland (2000) highlighted the importance of rewards and recognition in the quality process. Teamwork is also considered as a critical success factor in the successful outcome of a quality programme implementation.

Quality factors

Quality barriers are those barriers that have been created by the attitudes of management, employees and customers towards quality. Al-Zamany et al. (2002) stated that a lack of any pressure from the market or from existing customers and the lack of any role played by the government is considered to be one of the main reasons for the general attitude towards quality and the lack of awareness of the concept of quality management. Al-Khalifa and Aspinwall (2000) pointed out in order to move forward in terms of quality practices it is necessary to create a driving force, which is usually associated with pressure from customers or is implemented by an initiative from the owner or the managing director.

The emphasis on customer satisfaction or customer-driven quality is considered by a number of researchers and writers as a major success factor in implementing a quality programme. Deming (1986), Crosby (1989), Oakland and Porter (1994), Rao et al. (1996) and Hitchcock and Willard (2002) considered the measuring of customer satisfaction as a cornerstone of a quality programme. They also mentioned that listening to customers and trying to satisfy their needs is important factor in implementing a quality programme.

Cultural factors

The organizational cultural barriers are those barriers that have been generated by the behaviour of management and employees and their feelings towards the establishment and implementation of accreditation. Kekale and Kekale (1996) stated that wherever approaches to quality management are adopted, an organization needs to develop a suitable implementation approach, which is culturally feasible.

Kochan (1993) suggested that the reliable way to develop an efficient quality assurance programme is to consider the differences in culture and language. These should be taken under serious consideration when implementing a quality standard. Another study related to the implementation of quality programmes in Libya conducted by Sayeh (2005) stated that if a quality programme is to succeed in Libyan organizations there are many factors to instigate the desired culture that should be taken in consideration such as building teamwork, opportunities for growth and development and decentralized decisions.

Muna, (1980) and Suleiman (1984) found that contextual factors such as politics and culture play a role in Arabic management organizations. Oliver (2007) found that strategies for the implementation of international standards should be devised accordingly to suit different information cultures. Thus, difficulties in implementing quality programmes are related to current organizational practices which, in turn, are related to culture including people's attitudes or inappropriate managerial

traditions. Therefore, organisational culture is a key factor that needs to be taken into account when Libyan industrial laboratories consider establishing laboratories' accreditation or the implementation of standards.

Communication factors

Communication has been defined as "the process by which information is exchanged and understood by two or more people", (Huse, 1982). Communication barriers include ineffective communication, lack of information, and difficulty of access to test laboratories and includes a lack of statistical data, effective information and communication between the organizations and their ministries to facilitate improvement.

Thus, the researcher can conclude communication is important for the success of any quality initiative and it is critical from the beginning of implementing change. If the communication is effective, the work is performed more efficiently and problems are solved more quickly. Thus a positive relationship exists between good communication and the implementation of quality programme.

Training factors

Training has been defined as "an organized procedure which brings about semi-permanent changes in behaviour for a definite purpose" (Jinks, 1979). The purpose of training and development is to bring about the desired changes in any enterprise. Training barriers include lack of education and training programmes, lack of coordination and the planning of training programmes.

Wong (1998) pointed out that the lack of a real understanding of the principles of quality programmes due to a lack of training and education to develop a quality mindset with n the work force, and specifically within the leadership, led to the failure of many of the quality programmes being implemented in developing countries.

Baidoum (2003), Rao et al. (1999), Zhang et al. (2000), Black and Porter (1996) and Tamimi (1998) found in recent empirical studies that training and education are critical factors in the successful implementation of quality programmes. Zhang et al. (2000) considered that investment in education and training is important for quality success.

4.8.1 The commitment of top management to ISO/IEC 17025

Clauses 4.1 and 4.2 of ISO 17025 cover management responsibility, which includes top management commitment and the provision of the resources necessary for the implementation of ISO/IEC 17025.

Durand et al. (1997), Benson and Sherman (1995), Lal (1996) and Ho (1995) asserted that top management commitment is probably the most important factor in the process of ISO implementation. In order to illustrate the importance of top management commitment to ISO implementation, Johnson (1997) considered it an absolute prerequisite in ISO implementation, arguing that without such commitment, no quality initiative can succeed.

Thus, top management may contribute to the process of implementation of ISO/IEC 17025 in laboratories in significant ways, by supporting the programme, by developing and establishing the vision, objectives, policy and strategy, assuring resources and success, monitoring implementation and eliminating barriers to implementation.

4.8.2 The establishment of implementation teams

Before planning for the establishment and implementation of SO/IEC17025, the laboratory may form a special team for the purpose of executing this process. The team should be responsible for the overall planning of ISO/IEC 17025 implementation and the allocation of resources. In addition, the team should approve the project definition, conduct a management review, plan for the design and documentation, and also has the responsibility of carrying out the actual implementation of the ISO/IEC 17025 management and technical requirements.

Johnson (1997) argued that ISO requires top management to assign a management representative who has sufficient authority to be able to develop and monitor the elements of the quality system, and to establish a liaison with the registrar. Durand et al. (1997) presented some of the responsibilities of this team such as assessing current status, establishing a project structure, educating project team members, identifying responsibilities for quality system elements, developing project plans and choosing the registrar.

4.8.3 Attitude of laboratory personnel towards accreditation

One of the biggest challenges in implementing a quality system in a laboratory lies in overcoming the natural reluctance of team members, and convincing them of the value of quality assurance to justify the effort that will be required.

So, when implementing a change process there should be an awareness that individuals will go through a psychological process, which causes resistance. Tools, such as a force field analysis and a stakeholder analysis, help to navigate more efficiently through the whole change process, to stimulate behavioural change and to involve all stakeholders. In addition, a good structured approach, by using for example a communication plan, will help to develop better strategies to overcome resistance.

It is essential not to answer resistance with resistance. On the other hand, it is not just enough to listen and acknowledge. It might be a challenge for a manager to dare to deviate from the original change process, when it is clear that the resistance revealed some precious indications to do so. It might be a contradiction to defend change while refusing to have an open attitude to change oneself.

A quality system includes a description of the staff and the organization as well as procedures, registration and action rules that are operating in a particular laboratory. These are compiled in a so-called quality handbook (Dybkaer et al., 1993). The laboratories are accredited when they pass an inspection or audit in which the laboratory Jansen organization and service is viewed as a whole,

including the quality handbook, handling of external quality assessment results and professional functioning of the staff (, 1995).

Few, if any, studies exist on the attitude of technical laboratory personnel towards laboratory accreditation. The technologists play a critical role in the success of a quality system. They would perform the procedure according to the standard operating procedures. One could expect that the introduction of a quality system with changes in the way of working, the additional paperwork, the stiffening of the procedures and the decreased possibility for personal initiative would not be welcomed by the technologists.

In order to know the attitude of laboratory personnel towards accreditation, a study conducted by Verstraete et al (1998) found that the major advantages were the fact that everything was traceable, that the technologists felt surer about the procedures to follow, received more responsibilities and had a better knowledge of the tests they performed. The major disadvantages were the increased paperwork, discrepancies between the procedures and the reality, the fact that more attention is paid to the formalities than to the quality of the results and that the accreditation process decreased the adaptability. The number of advantages mentioned seemed to increase with the interval since the accreditation. This study add to the finding of Verstraete that technical training program such as training to determining root cause of problems, quality of technical records are very important to establish accreditation.

4.8.4 The assessment of current capability

An assessment of the current quality system is useful to compare a laboratory's actual capabilities with the requirements of ISO/IEC 17025. One way to accomplish this evaluation is to conduct a gap analysis, to identify any gap in any technical or management elements. Once such elements have been identified, action plans should follow.

4.8.5 Education and training for ISO

At the beginning of ISO implementation educational programmes for all employees, including top managers, should be conducted. Such programmes may disseminate general knowledge about ISO, such as its concepts and benefits, the changes that are to be made to processes, and its cultural implications.

Arora (1996) and Durand et al. (1997) stated that top managers should receive training in understanding quality systems, in understanding their role in the quality system and in the effort required for implementation. In addition, more specific training programmes may be provided by an ISO representative and his/her team, for instance to internal auditors. These trainings may give instructions in organising and preparing documentation, devising a quality manual and how to undertake calibration, internal auditing and measurements.

4.8.6 The establishment of a quality management system

This is probably the most important step in implementing ISO/IEC 17025 since it comprises the 14 clauses of the standard. Establishing the quality system elements

requires a laboratory to design implementation procedures for ISO/IEC 17025 management and technical clauses. The management clauses of ISO/IEC 17025 start with organization (Clause 4.1) and end with management reviews (Clause 4.14). These management requirements are:

Organization, Management System, Document Control, Review of Requests, Tenders, and Contracts, Subcontracting of Tests and Calibrations, Purchasing Services and Supplies, Service to the Customer, Complaints, Control of Nonconforming Testing, Corrective Action, Preventive Action, Control of Records, Internal Audits

Technical clauses start with general factors (clause 5.1) and end with reporting the results (Clause 5.10).The technical requirement are:

Personnel, Accommodation and Environmental Conditions, Tests and Calibration Methods and Method Validation, Equipment, Measurement Traceability, Sampling, Handling of Test and Calibration Items, and Reporting the Results

Durand et al. (1997) suggested some criteria for when designing the procedures for establishing the quality system elements; the procedures should comply with the requirements of the relevant standards and satisfy the intent of the quality plan. The plans should also be efficient business-wise, be compatible with other elements and be acceptable to the employees who perform the functions necessary.

4.8.7 Implementing ISO/IEC 17025

At this stage, the laboratory should have already planned and established the quality system, trained its employees, and established documentation. Since the quality system is ready for implementation, management should start implementing ISO/IEC 17025. Management should periodically review the quality system and ensure its compliance to ISO requirements as demanded by sub-clause 4.14.1 (management review). At all stages of implementation, training and education should be provided as required and should not finish once the quality system has been established. According to Process Quality Associates Inc (PQA), (2009) research carried out into what makes ISO/IEC 17025 implementation a success has revealed 11 critical success factors. They are, in order of importance:

1. Top management leadership and commitment.
2. A simple, compréhensive implémentation plan.
3. Training and support for everyone involved or affected by the implementation project.
4. Buy-in and voluntary support and commitment from a critical mass of people.
5. Early successes that clearly prove that ISO/IEC 17025 will benefit customers, suppliers, management and especially workers.
6. Resources and time to achieve all that needs to be done.
7. Rapid communication, feedback, and recognition on efforts made, results achieved, and work to be done.
8. Expert, pre-experienced advice, coaching, cheerleading, pre-warnings, and technical expertise on ISO 17025 implementation.

9. Auditing, training, and remedial assistance to achieve consistent compliance to minimum requirements.
10. Dress-rehearsal audit, final fixes, then formal registration audit by accredited registrar.
11. Continuous assessment improvement and re-registration of system.

4.8.8 Performing an internal quality audit

The laboratory should ensure that the requirements of ISO/IEC 17025 are complied with through internal audits as a requirement of Clause 4.13 of ISO/IEC 17025. A person who is not directly responsible for the activity being audited should perform the internal audit. Internal auditing should be performed inside the laboratory against ISO 17025/IEC requirements, or it could be against any other standard or procedure.

Middleton (1997) explained that internal auditing starts with the planning of the audit programme through selecting the team, determining the scope, identifying information sources, developing an audit plan and formulating checklists. The next step is to execute the internal auditing whereby the representative of the department being audited must attend the auditing process to facilitate the auditors (Lal, 1996).

The execution of the audit will be through observation and questions, verifying record keeping and selecting records for examination (Arora, 1996). Middleton (1997) and Arora (1996) stated that the result of the internal auditing, together with

details of non-conformities found in the department are then reported to management. This report usually includes the scope of the audit, the standard against which the audit was carried out, the non-conformities found, recommendations for corrective actions and the report distribution list.

Follow-up and corrective measures should be taken to ensure that non-conformities or discrepancies have been corrected and will not recur. The conducting of a company's internal audit in order to assess the status of a quality system is a regular occurrence, yet never seems to be popular or necessarily results in a positive or beneficial outcome.

A study conducted by Michael et al. (2007) to improve the process model for internal auditing found that the management of internal auditing is too focused on programme achievement and not on the resulting value from improvement action.

4.9 Theoretical framework of the study as the outcome of literature

Based on the literature review a theoretical framework was developed to facilitate the research study. The framework depicts the relationships between the variables in the laboratory accreditation process.

The aim of the framework is to facilitate the investigation of which factors are important for achieving an outstanding accreditation performance and how these factors relate to laboratories' accreditation performance. The framework can also assist in determining how important these factors are when they are used to predict

laboratories' accreditation performance. The research framework is represented in Figure 4.1. There are six main groups of independent variables, namely:

(1) Technical variables;

(2) Management variables;

(3) Quality variables;

(4) Cultural variables;

(5) Training variables; and

(6) Communication variables.

The impact and interaction of these independent variables will determine the dependent variable, which is, in this study, laboratories' accreditation.

4.10 The Registration Process

Registration to ISO/IEC 17025 involves a third party assessment of the laboratory to examine its compliance with the requirements of the ISO/IEC 17025 management and technical elements. The laboratory, after implementing ISO/IEC 17025 and performing internal auditing, may seek registration for ISO/IEC 17025 through such a third party assessment. The first step in the registration process is to select the registrar, who may or may not perform a pre-assessment audit, but will perform the formal audit, and conduct a surveillance assessment. The next sections present the registration process stages in more detail.

4.10.1 Choosing the registrar

The choice of a registration agency depends on a number of criteria including its accreditation, costs, previous experience, reputation, knowledge and its auditing procedures. However, in the UK, the United Kingdom Accreditation Service (UKAS) is the regulating agency of registrars, while RAB, the Registrar Accreditation Board, is the regulatory body in the United States.

Once a registration agency is accredited in the UK, UKAS grants it the use of the UKAS logo on its documentation, which in turn can be used for laboratories that are registered to ISO/IEC 17025. In the UK, the accreditation of the auditor is administered by the Institute of Quality Assurance (IQA). The scheme governing the accreditation of auditors is called the "International Register of Certificated Auditors" (IRCA). Under this scheme, the auditor must meet certain requirements in order to be eligible. These include academic qualifications, work experience, quality experience, and auditor training.

4.10.2 Assessment

The assessment is a third party audit of the ISO/IEC 17025. The registration process starts with the dual signing of an application by the registrar and the laboratory, stating the scope of registration and the agreement of the laboratory to comply with the requirements of registration and to supply the necessary information.

The firm then provides its quality manual and information on its quality system and documentation. The next step is audit planning, which entails the preparation of the assessment activities, the nomination of the audit team and informing the laboratory of the team names.

The assessment starts with an opening meeting to introduce the audit team, explain objectives, review the assessment programme and confirm logistical arrangements. The team will then proceed to the assessment of the quality system against the ISO/IEC 17025 requirements. In a closing meeting, the lead auditor will present the assessment report to the laboratory showing the non-conformities, each non-conformity item is included in a separate Non-Compliance Report (NCR). The registrar should make a decision, based on the nature of the non-conformities, as to whether to grant the certification and whether to make it conditional for correcting any non-conformity. After granting the ISO certificate the laboratory will have the right to use the logo of registration to ISO/IEC 17025 in its advertising or publications.

4.10.2 Surveillance visits

To ensure the continual compliance of the firm with ISO/IEC 17025 requirements, periodic assessment of the laboratory takes place in annual surveillance visits. However, the majority of registration agencies may undertake two visits a year (Arora, 1996). The ISO certificate may be withdrawn as a result an assessor's decision during surveillance visits if the firm does not comply with ISO 9000.

4.11 ISO/IEC 17025 registration and implementation processes

In this section the researcher illustrates the main factors and processes applied in order to achieve the certification. The implementation of a quality programme requires a working framework that acts as a reference standard to assess that system.

4.11.1 Main factors of registration

Accreditation bodies that recognize the competence of testing and calibration laboratories should use the international standard as the basis for their accreditation. ISO/IEC 17025 Section 4 and 5 specifies the management and technical requirements for laboratories accreditation. Section 4 of ISO/IEC17025 specifies the management competence such as a laboratory's management system, quality system polices, documentation, corrective action, preventive action and internal audits. Section 5 specifies the technical competence for the type of tests that laboratories carry out. There are many factors that determine the correctness and reliability of the tests performed by laboratories.

These factors include human factors, accommodation and environmental conditions, test methods and method validation, equipment, measurements and sampling. Obviously, top management commitment, management and employee attitudes towards the system, training and education programmes and communication with, and the involvement of, employees are important factors in the certification process in any laboratory. They should all be taken in

consideration by any laboratories' management to avoid those becoming barriers in the implementation of ISO/IEC 17025 standard.

Badri and Donald (2008) identified the nine critical factors of QMS implementation in an organisation as: the role of top management, quality policy, the quality department's role, design of product or service, training, supplier quality management, process management or operation procedures, employee relations and quality data.

4.11.2 Organisational culture and its change

To establish and implement quality programmes effectively in any laboratory or organisation, an investigation and assessment of the existing organisational culture and management approach should be taken into consideration.

The organisational culture is how an organisation's employees behave when changing an existing management system. For example, resistance to change to different forms of management is a common aspect that emerged from any new change process in the organisation.

Management should investigate the existing organisational culture in order to implement the new process effectively. Bellou (2008) quoted by Schein, (1986) stated that organizational culture refers to the deeper level of basic assumptions and beliefs that are shared by organizational members, which, operating unconsciously, define a common overall view of the organization and its environment.

Several researchers such as Davies (2000), Pettigrew (1992) and Stone (1996) have identified organizational culture as an important element of successful organizational initiatives, including increasing the quality of services. Human resource management means managing people within the employer-employee relationship. It involves the productive use of people in achieving the organization's strategic objectives and satisfying individual employee needs.

Ghobadian and Gallear (2000) stated that factors that can influence the culture of an organization include education and training of employees, participation programmes for employees, enhanced communication programmes, revision of procedures and policies, a rewards system and the behaviour of top management.

To successfully establish quality programmes a cultural change is required in order to replace the traditional methods and ideas with newer ideas and beliefs in how the organization's work is undertaken. Goetsch and Davis (2000) stated that every organization has separate cultures that react to change - the advocates and the resisters.

Therefore, organisational culture is a key factor that needs to be taken into account when considering the establishment of laboratories' accreditation and the implementation of standards in the Libyan industrial sector.

4.11.3 Preparing for ISO certification

The main purpose of laboratories' accreditation or any quality system is to satisfy the customers and users of the products and services of that laboratory or company as to the suitability of the product or service for its designed purpose. According to Long et al. (1991) one of the objectives of a quality system is to establish a set of processes and procedures that ensure quality is maintained and improved in the long term.

Medeiros (2000) stated that if any organization is to effectively manage its products/services then it must set operational activity within a defined quality framework consisting of a formal quality policy, established and agreed quality objectives and a quality programme that both addresses the achievement of these objectives and measures the progress towards and the accomplishment of them. According to Eldar and Ronen (1995) the development of any quality assurance programme consists of three stages. These stages are:

- **The preparatory stage (planning stage)**

This stage consists of setting the appropriate climate for the introduction of the programme and also the planning for its implementation. Vuori (1988) stated that in raising the awareness of the need for a quality assurance programme (such as laboratories' accreditation) people have to be convinced that quality assurance (Q A) is required. New and Couillard (1981) pointed out that the planning of changes and interventions consist of:

1. Availability of QA policy papers, personnel and budget.

2. Recruitment of team leaders and members.
3. Crystallization of strategies and ways to effect change.

- **The process and development stage**

According to Donabedian (1989) this stage includes, and consists of, the formulation of criteria and standards and the setting up of working teams. It also includes the restructuring of staff or equipment.

- **Evaluation**

Evaluation has been defined as the process of description and judgment conducted for the purpose of determining the effectiveness of the programme. It is possible to conduct an evaluation of a QA programme while the programme is in progress in order to determine how it is progressing and to discover what interventions and modifications are indicated. Elder and Ronen (1995) stated that quality programmes should be evaluated at their completion for the purpose of evaluation and that written material is needed for the documentation of various activities.

According to (Pola ,1998; Fuentes et al,2000) there are four main stages of the process described by the ISO standard. These stages are:

Diagnosis, planning, documentation, and implementation

- The diagnosis stage implies a deep analysis of the company's situation in order to identify the gap between the present working model and the model

proposed for the company Fuentes divided the diagnosis stage into three steps. These steps are:

1. Information collection
2. Information analysis
3. Presentation of conclusions.

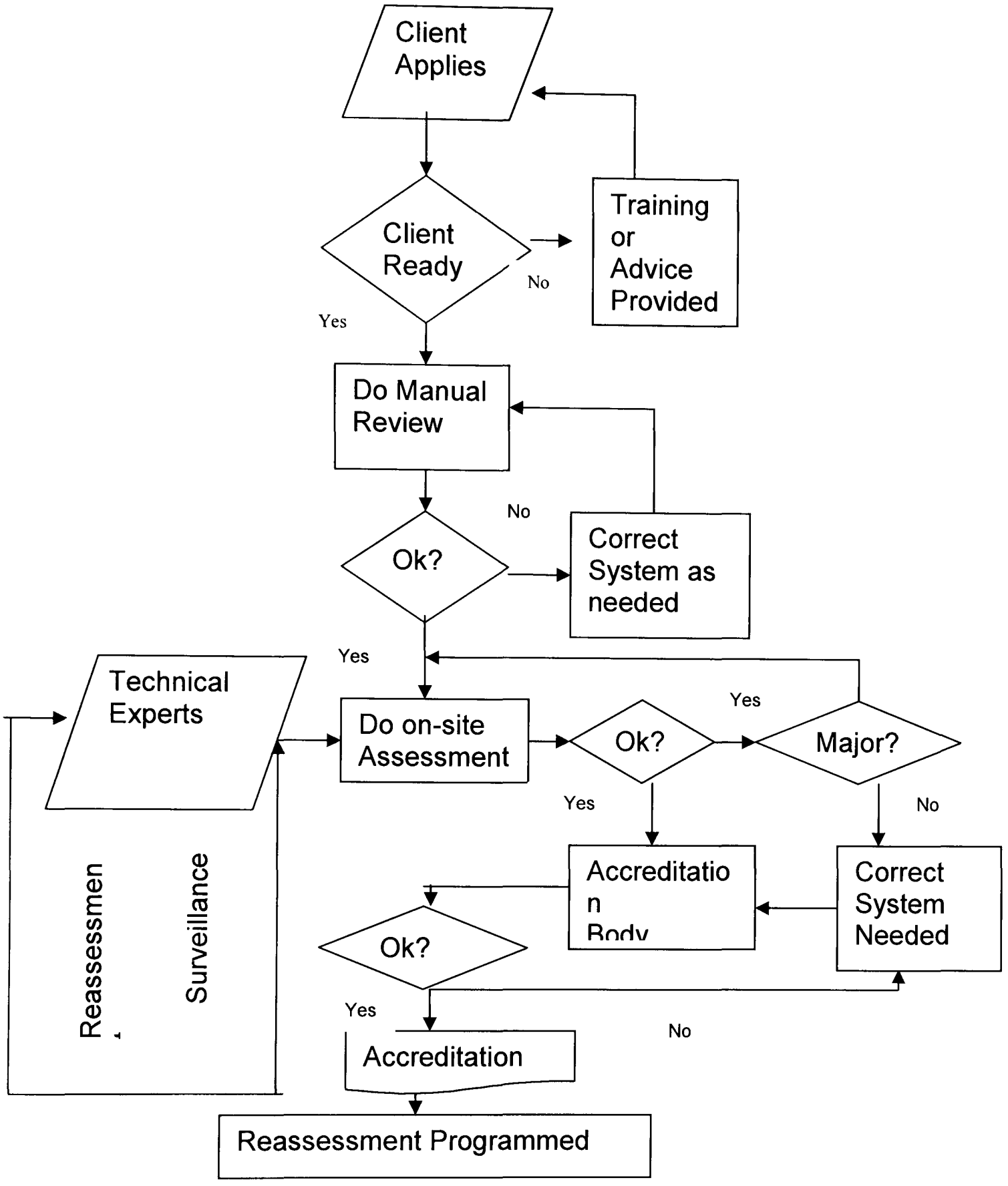
- The planning stage consists of the definition of objectives, delineation of the stages, designation of responsibilities and resource allocation and putting in place a team leader who can plan/schedule the remaining phases.
- The documentation stage consists of policy and objectives, general proceedings and specific instructions. Dale (1994) stated that procedures and working instructions' manuals should be documented and put together.
- The implementation stage consists of implementation, training, system evaluation and internal audits. Senlle and Stoll (1994) highlighted that the system, once established, must be checked periodically to confirm effectiveness and, in particular, to find out if it meets the proposed objectives.

Alongside this process is the training for the whole of the organization based on the present levels of awareness and expertise, on attitudes and aptitudes. Besterfield et al, (1995), Hockman et al. (1994) and Senlle and Stoll (1994) stated that certification consists of the application for certification, documentation examination, a formal system examination certification and registration and maintenance audits.

Thus the accreditation process can be summarized as shown in Figure 3.2 accreditation process chart.

4.12. Accreditation process chart

Based on the literature review, an accreditation process chart was developed to facilitate the research study. The accreditation process chart shows the procedures that the laboratories should follow in order to achieve accreditation. The aim of the accreditation process chart is to facilitate investigation as to which stage the laboratory is on in terms of the goal of achieving accreditation. The chart can also assist in determining the gap between the laboratory's current situation and the requirements of accreditation. Thus the accreditation process can be summarized as shown in Figure 4.2 accreditation process chart.



Source: International Accreditation New Zealand, 2005

Figure 4.2: Accreditation Process Chart

4.13 Conclusion

This chapter explains the problems in quality management in the developing countries, management, technical, training, culture, and communication factors that affect quality programs, the development and structure of the conceptual framework; and developed an accreditation process chart. In addition, the literature review of ISO/IEC 1705 registration and implementation process and identifying the factors that affect the establishment of laboratories' accreditation and ISO implementation, commitment of top management to ISO/IEC 17025, the establishment of implementation teams, organisational culture and its change, preparing for certification

The next chapter presents the research methodology and the methods of data collection.

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CHAPTER FIVE

RESEARCH METHODOLOGY

5.1 Introduction

This chapter presents the research methodology and the methods of data collection. Research methodology is very important as it can guide researchers on what steps are needed to be taken in order to meet the objectives of the research.

The first section deals with the research philosophy, the research strategy, the research method and questionnaires' techniques. The second section focuses on the data collection process such as printing, sampling procedure and questionnaire distribution. The third section explains the process of the pilot study and the reliability of scales.

5.2. Methodology

Research methodology has been defined by Kumar (2005) as a taught supporting subject in several ways in many academic disciplines at various levels by people committed to a variety of research paradigms. According to Hussey and Hussey (1997) there are two main research paradigms or philosophies. The two paradigms can be labelled positivist and phenomenological. Amaratunga et al., (2002) stated that logical positivism uses quantitative and experimental methods to test hypothetical-deductive generalizations.

In contrast, phenomenological inquiry uses qualitative and naturalistic approaches to inductively, t-holistically understand human experience in a context. Hussey and Hussey (1997) also stated that the research aim and objectives are the main factors that determine an appropriate research methodology. However, a research methodology needs to describe the overall approach used to generate new knowledge, based on research philosophies to enable this knowledge generation.

The research model shown in Figure 5.1 was developed to illustrate the overall strategy of inquiry which moves from philosophical assumptions to the research strategy and research methods employed.

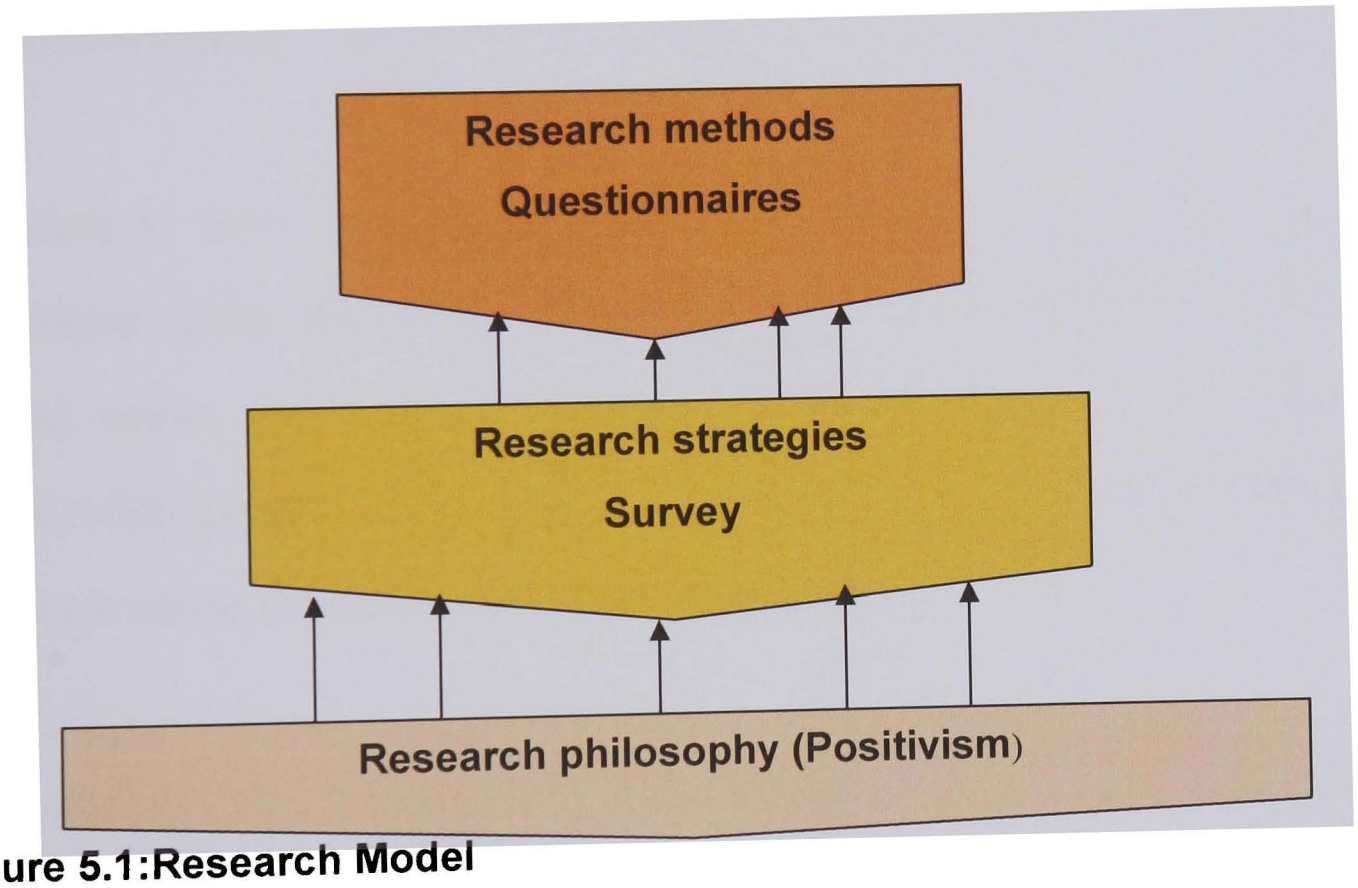

Figure 5.1:Research Model

5.2.1 Research philosophy

This research will answer questions relating to the establishment of laboratories' accreditation and ISO/IEC 17025 in Libyan chemicals and petrochemicals' laboratories.

The first question to be answered is: What are the attitudes of the laboratory Staff towards factors that related to the establishment of Accredited Laboratories in the Libyan chemical and petrochemical industries with particular reference to the technical management, quality, training, communication and cultural factors that affect the establishment of laboratories' accreditation? Moreover, what is the relationship between laboratories accreditation and the factors that affect it?

According to Collis and Hussey (2003), positivists are interested in the inter-relationship of the objects they are studying and believe that these objects were present before they took an interest in them. Additionally, Saunders and Liptrot,(1993) stated that knowledge in positivism is limited to observed facts and that which can be deduced from those observed facts.

Consequently, the research aim is to investigate the factors that affect the establishment of accreditation in Libyan Chemical and Petrochemical manufacturing laboratories. So the positivism philosophy is appropriate to this research.

5.2.2 Research strategy

The research strategy is the plan, structure and strategy of going about the research. Robson (1993) stated that experiment, survey and case study are three traditional research strategies. Choosing the appropriate research methodology depends on several elements within the study.

The success of the research depends on the way in which the primary data is collected, analyzed, and produced. Bell (1993) argued that studying the pros and cons of each approach will help the researcher to choose the most appropriate type, based on the circumstances surrounding the research.

Wilson (1996) stated that choosing any method depends on the nature of the research questions and therefore no single method can be considered the best. Bell (1993) contended that choosing the appropriate research method is influenced by the amount of available time the researcher has.

This particular research is carried out using the survey strategy in order to identify the factors that affect the establishment of laboratories' accreditation and ISO /IEC17025.

5.3. The chosen strategy (survey research)

Fink (1995) defines the survey as "a system for collecting information to describe, compare or explain knowledge, attitudes, and behaviour". The methodology adopted for this research is the survey research since it is an inexpensive way of collecting data and the results can be generalized.

Gill and Johnson (1997) argued that surveys are strong in population validity and reliability. They added that results could be generalized with a high degree of confidence since the method involves the careful, random selection of samples. Moreover, they claim that using highly structured questionnaires which produce quantifiable data would be reliable for this research. They argued that the more structured the methodology, the better the replication will be, consequently, the more reliable it will be.

Babbie (1998) claimed that survey research is useful in describing the characteristics of a large population. The main purpose of the survey, as Easterby-Smith et al. (1991) stated, is to obtain information about the population. Saunders et al. (1997) argued that the survey is very common in business studies since it allows the collection of large amounts of data from a small population in an inexpensive way. Babbie (1998) agreed with Easterby-Smith et al. (1991) that survey research could be the most frequently used mode of observation in social sciences.

This research needs to obtain opinions and information from manufacturing laboratories that intend to establish accreditation. Due to this research philosophy, therefore, the survey is the suitable research strategy. Burgess (2001) outlined the basic process of undertaking a survey as shown in Figure 5.2

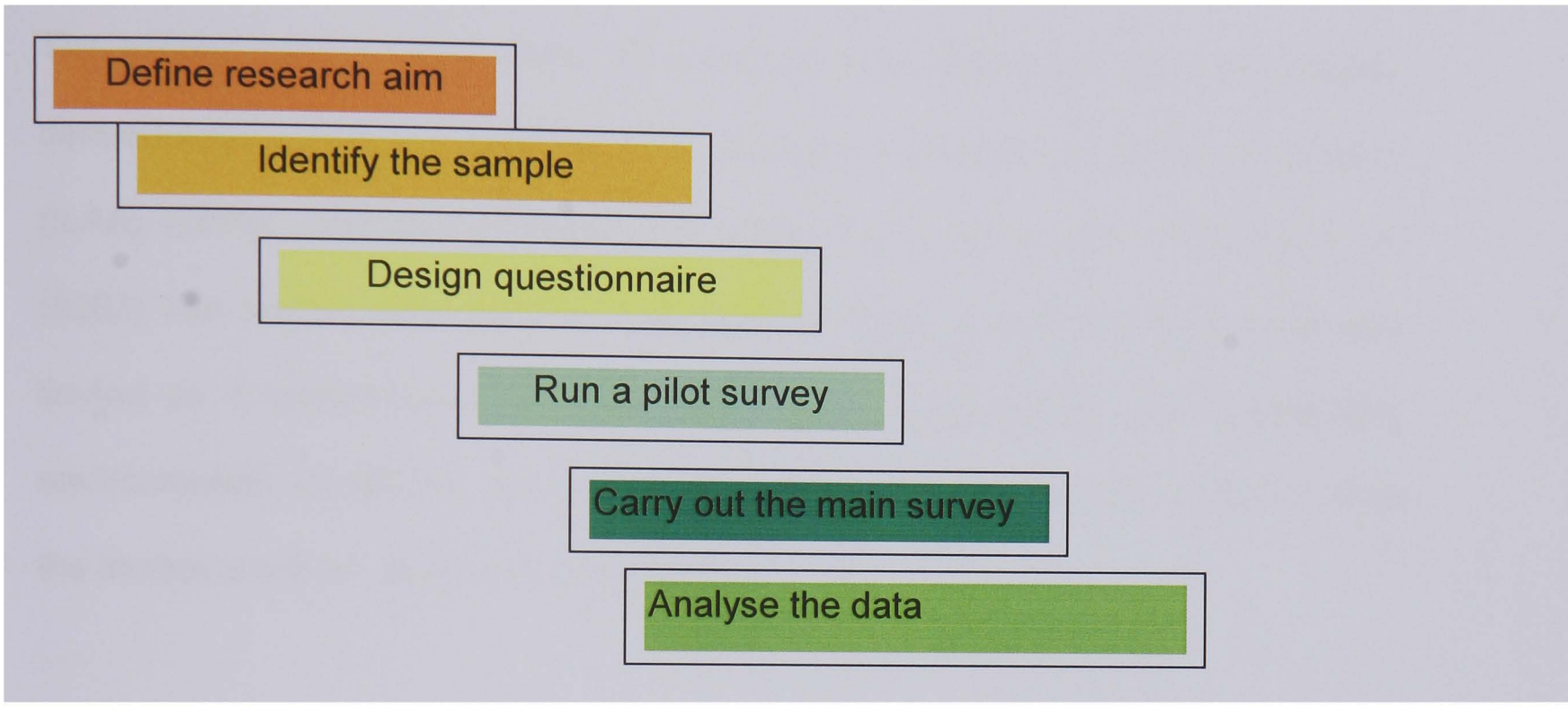

Figure 5.2:Survey design process

5.4. Research method

Kumar (2005) defined the research method as "the tool of data generation and analysis about a situation, issue or group of people". In order to gather data for this research, the questionnaire method was chosen due to the advantage that the designed questionnaire could be sent to a large number of laboratories in a limited time.

A total of 400 questionnaires were sent to a variety of Libyan chemical and petrochemical manufacturing laboratories. The questionnaire designed in this study consisted of two parts, firstly, investigating the background of the laboratory and,

secondly, investigating the factors that affect the establishment of accreditation. The first part was designed to determine fundamental issues, including size of the laboratory, scope of its work, etc.

The second part of the questionnaire consisted of statements about the factors, derived mainly from the International Laboratory of Assessment and Accreditation (ILAA) (2006), and from different QM researches such as from Vlachos et al. (2002) Ten factors were carefully examined by Vlachos et al. but their study was limited as it lacked items in relation to cultural characteristics, job satisfaction, environmental conditions and communication. Therefore, the major factors from the literature will be examined in this study.

5.5. Questionnaire development

This section deals with the development of the questionnaire and includes the questionnaire design, the questionnaire format, sources of ideas in writing the questions, scales of measurement, type of questions and Arabic translations of the questionnaire.

5.5.1. Questionnaire design

A questionnaire is a form containing a set of questions, especially one addressed to a statistically significant number of subjects as a way of gathering information for a survey. In the case of a postal questionnaire it is possible to collect a great amount of data within a reasonable period of time and at an acceptable cost.

However, it is not possible to get in-depth information or to have a discussion with respondents in specific areas.

The design of a questionnaire is a long process that requires careful attention. Burgess (2001) explained that the strength of the data analysis depends on the good design of the questionnaire and on the data collection procedures. The questionnaire design should also address the needs of the research. So the questions asked should serve the research aim and objectives and be well prepared.

A questionnaire is a powerful evaluation tool and should not be produced carelessly. It is important to remember that a questionnaire should be viewed as a multi-stage process starting with the definition of the aspects to be examined and ending with the interpretation of the results. Saunders et al. (1997) have suggested that an appropriate response rate should be between 30 and 50 percent. Every step needs to be designed carefully as the final results are dependent on the questionnaire process design. Burgess (2001) stated that the process of survey research can be outlined as follows in Figure 5.3

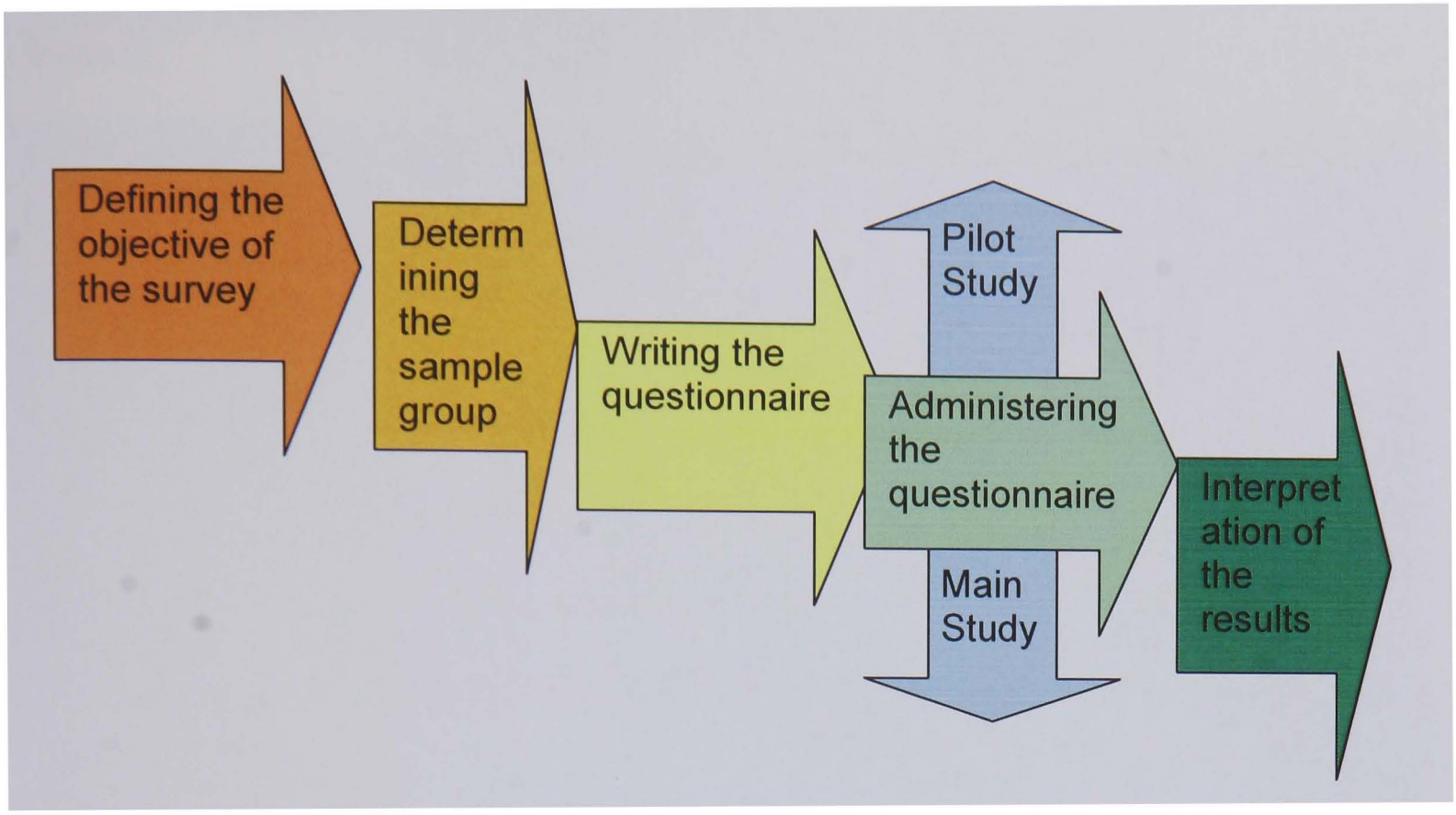

Figure 5.3: Questionnaire Design Process

There are many advantages of the questionnaire method such as providing a high degree of anonymity for respondents and it also provides time for the respondents to think about their answers. Also, Hussey (2003), stated that a questionnaire survey is cheaper and less time-consuming than other methods. There are some disadvantages to a questionnaire, for example a questionnaire requires simple and easily understood questions and instructions.

Saunders and Liptrot (1993) stated that it is one the easiest things in the world to produce a set of questions and give them to subjects, but questionnaire design is an art in itself. Poolton (1994) summarized some of the main advantages and limitations of the postal questionnaire method, as given in Table 5.1

Table 5.1: Advantages and Disadvantages of a Questionnaire

Method	Advantages	Disadvantages
Postal questionnaire	Fast, low cost and geographically flexible Can permit leisurely and thoughtful replies to questions Statistical tests are easy to apply and data is 'objective'	Low response rates so there is an increased likelihood of a response bias Depends on straightforward and simple questions Design of the survey is critical because answers are 'final'

However, there are two important things in a questionnaire's design that should be taken in consideration.

- Relevance of the information to the purpose of the survey.
- Accuracy of the information.

To achieve accuracy and relevant information for the survey the questionnaire included the information about the factors that affect the establishment of laboratory accreditation in the Libyan chemical and petrochemical manufacturing sector. In order to make sure that the information was accurate the respondents chosen were laboratory employees, supervisors, technical managers, and/or clients of the laboratories.

Burgess (2001) stated that respondents are more likely to answer short, attractive, clearly thought through, and well presented questions. Thus the researcher considered the simplicity of the questions, the logical flow of the questions and ensured that the wording used only had one meaning. The researched also carefully considered the question content, the question phrasing, the response format, the question sequence and the characteristics of the questionnaire when designing the questionnaire.

The researcher observed the advice given by Rummel and Ballaine (1963) that questionnaires should be long enough to cover the essential elements of the research, but not too long to the degree that the respondents might consider them as too time-consuming. Rummel and Ballaine maintained that short questionnaires have a better chance of being answered, and consequently, the response rate will be higher. However, they recommended that the researcher should design questionnaires that will secure adequate data, and distribute a large number in order to offset any possible low return rate.

Aireck and Settle (1985) argued that, when designing the questionnaire, the researcher should observe five attributes: questionnaires should be focused on the topic; questions should be short enough to convey the meaning; and questions should be simple and the researcher should avoid asking leading questions in a leading way, the number of questions should be as limited as possible due to overloading

The researcher depended on his practical experience, skills and the knowledge which has come from the literature search as well as from other studies which have used questionnaires. To increase the response rate and to enhance the quality of the answers, the purpose of the questionnaire was explained to all participants, and the questionnaires were sent to managing director or personnel managers, and laboratories' employees. Also, introductory letters and reply envelopes were provided in order to increase the response rate.

5.5.2. Sources of ideas in writing questions

The design of the questionnaire was based on a review of the literature surrounding ISO/IEC 17025, and on quality management studies. In addition, clauses from ISO/IEC 17025 were used in developing the questionnaire. The researcher also investigated previous studies in ISO 9000 and TQM and used them in addition to the literature review when designing the questionnaire.

5.5.3. Questionnaires techniques

The questionnaires used in the study are to be found in Appendix A. The questionnaire consisted of two main parts. The first part was concerned with potential independent variables, that is, the type of the laboratory and the scope of the work, the recipient's position in the laboratory and education level, the number of employees. In the second part, various factors that affect the establishment of laboratories' accreditation were investigated. The development of each part of the questionnaire is considered below.

5.5.3.1 First part: research characteristics

Laboratories were asked to give the type and the scope of their work, the education level and position in the laboratory of the respondent, the number of employees in the laboratories, the marital status and the gender of the employees.

The type and scope of the laboratories' work can provide the researcher with information to simplify the laboratories' category in the data analysis. The respondent education level and job position within the laboratory will reflect attitudes from different education and management levels which may help the researcher to discover which levels of management or education have a crucial influence in laboratory change.

5.5.3.2. Second part: factors affecting laboratories accreditation

The researcher considered the factors that affected the readiness of Libyan manufacturing laboratories in implementing accreditation; These factors were related to International standards ISO/IEC 17025 requirements and the other factors were related to the cultural issue.

First, general questions were asked concerning general categories of factors which came from both technical and management issues such as leadership, policy, people and resources and which cause laboratories accreditation problems. Some of the factors in these questions related to management systems such as: the

rewards system, job satisfaction, communications and information, training, knowledge, quality programmes and internal audits.

The other questions related to the technical issues such as laboratories' facilities and environmental conditions, corrective and preventive action, equipment, validation of methods, measurement traceability, assuring the quality of test and calibration results, control of records, reporting the results, storage, handling and sampling. There were also some questions related to culture characteristics such as the relationship of individuals and groups, the relationship with authority etc.

Second, general questions were asked concerning the critical factors that caused laboratories accreditation problems such as lack of management commitment, documentation, international competition, and a lack of any pressure from customers and international competition, people's negative attitude towards accreditation etc.

In addition to the above questions, the writer added a general open-ended question following the above two sections of questions. This was intended to supply a space for the recipients to express their feelings and comments on anything that had not been covered by the questionnaire but that the respondent thought was important.

5.6. Attitude scales

The questionnaire was planned to obtain the attitude of employees in the Libyan manufacturing laboratories, regarding whether they accepted the listed factors as causing problems for laboratories' accreditation and whether they thought it practical to implement the suggestions put forward by the questionnaire in future. Thus, the adoption of Likert scales seemed appropriate.

5.6.1 Scales of measurement

Aireck and Settle (1985) defined a response scale as "merely a representation of the categories or continuum along which respondents arranged themselves". The researcher mainly used a 5 point Likert scale. The use of scales instead of forced Questions, such as yes/no questions helps in ascertaining the degree of agreement or the extent to which the respondent evaluated or did something.

Anderson et al. (1983) stated that the Likert scale has a number of advantages, such as being easy to accomplish, and it can be evaluated through the standard techniques of item analysis, factor analysis and reliability analysis. The researcher was successfully able to employ factor analysis by using ordinal scales of *5* points.

In general, the researcher used the ordinal scale, which establishes an ordered relationship between the persons or objects being measured. On this scale, a number represents the degree of doing or agreeing with something. In the case of the Likert scale of *5* points, the researcher used number *5* to represent the strongest agreement and number 1 to represent the weakest agreement with the

statement given. In the questionnaire the researcher used the 5 point Likert scale in the majority of the questions, although in one question a 3-point scale was used.

5.6.2 Likert scales

A Likert scale requires a respondent to indicate the degree of agreement or disagreement with each of a series of statements related to the attitude object. Its primary objective is to make sure that the statement is measured by the same range of assessment Oppenheim (1987) and Hussey and Collis (2003) stated that Likert Scales have the advantage of being relatively easy to construct and the number of different statements, which can be provided in a list, does not take up much space is simple for the respondent to complete and simple for the researcher to code and analyse.

5.6.3 Question types

Hague (1993) stated that questions are usually classified into three types: these classifications are: behavioural, attitudinal and classification. Behavioural questions seek factual information, such as the occupation of respondents or how often they do something. Attitudinal types of questions ask what respondents thought of something. The third type of question is classification, which seeks to group respondents according to age, gender, etc. The researcher used all three types of questions.

Most questions can be classified into two groups: closed or open-ended. A closed question involves offering respondents a number of defined response choices.

They are asking to mark their response using a tick, cross, or circle etc. The choices may be such as a simple Yes/No, Male/Female; or may involve a range of different choices.

On the other hand, open-ended questions typically begin with words such as "Why" and "How", or phrases such as "Tell me about..." Often they are not technically a question, but a statement which implicitly asks for a response.

Pallant (2001) stated that closed questions are usually quite easy to convert to the numerical format required for SPSS. Thus most questions in this study are closed questions. In order to avoid omitting some important factors that affect the establishment accreditation of Libyan manufacturing laboratories and to encourage the respondents to express any additional views on this issue (and giving them more space within the questionnaire to do so) the writer supplied one open-ended question for the respondents.

The data produced from this open-ended question would need to be analyzed separately from the closed-ended questions. The writer considered that the data provided by this open-ended question could provide valuable insights into the attitude of the employees and could provide valuable reference for future suggestions.

5.6.4 The covering letter

The covering letter gave the aim of the survey and stated the importance of the research. It also gave the names and address of the research institution. The letter

also assured the confidentiality of the respondents and encouraged them to reply. The covering letter was written on the letterhead of the School of the Built Environment, University of Salford, with the intention of giving the respondents a creditable initial impression.

5.6.5 The pilot study

Wilson and McClean, (1994) emphasized the need to conduct a pilot test and consider its findings. The pilot study would also provide the researcher with the necessary accurate information upon which to build the next questionnaire. Wilson and McClean argued that pilot testing should include all aspects of the questionnaire design, such as appearance, the covering letter, instructions, question layout, and the time taken to complete it.

Bell (1993) suggested that the researcher, when conducting a pilot test, could ask certain additional questions, such as how much time the questionnaire takes to answer; if the instructions are clear, and whether or not there is any ambiguity in the questions. The researcher might also ask the respondents if they felt they had any objections to answering any of the questions; whether or not there are any major elements that have not been covered; if the layout was appropriate; and finally, the researcher may ask for any comments.

The researcher ensured that the questionnaire be reviewed by a quality specialist, Based on his comments, the researcher made any recommended changes. Having designed the questionnaire, a pilot study was undertaken by sending the

questionnaire to the employees of six Libyan manufacturing laboratories and two postgraduate students at the Research Institute for the Built and Human Environment, University of Salford, in quality related area.

As the questionnaire was eventually going to be sent to Libya, it has written in both the English and Arabic language. Firstly it was written in English and then it was translated into the Arabic language.

5.7. Data collection

Rummel and Ballaine (1963) stated that primary sources are data that is directly collected, and for the first time, by the researcher. Ghauri et al. (1995) argued that when secondary data is not sufficient to answer the research questions, the researcher should collect primary data. They added that the methods of primary data collection included surveys, observation, and interviews.

The collection of primary data in this research was carried out using the questionnaire. Fully structured, self-administered questionnaires were posted to the employees in Libyan chemical and petrochemical industries' laboratories.

Data collection from respondents is the first step taken in such study. Yin (1993) stated that there are many forms of data collection such as questionnaires, personal interviews, observational techniques and documentations. In order to achieve the objectives of this study and to collect the maximum data from the

respondents, certain procedures were needed to be followed, the sample process. These issues are discussed separately below.

5.7.1 Sampling process

A 'population' has been defined by Foster (1998) as an entire set of objects of interests or people and a sample is a subset of a population. Czaja and Blair (1996) stated that determining sample size is not easy and the subject has been discussed in detail by many authors.

Pallant (2001) mentioned that there are two main issues to consider in determining whether a particular data set is suitable for factor analysis; sample size and the strength of the relationship among the variables. While there is little agreement among authors concerning how large a sample should be, the recommendation generally is the larger the better.

In a small sample the correlation coefficients among the variables are less reliable, tending to vary from sample to sample. Factors obtained from small data sets do not generalize as well as those derived from large samples. Pallant (2003) cited Tabachnick and Fidell (1996) who reviewed this issue and suggested that it is reassuring to have at least 300 cases for factor analysis.

Due to the fact that data is measured on the categorical scale and to the relationship between the variables, some statistical tests, such as factor analysis and regression testing are appropriate for this research analysis.

Due to the large size of a population, it is adequate to assess a proportion. Obviously, the closer to 100% the better, but to try and achieve representativeness of this study sample, individuals was selected on an appropriate basis i.e., random It is often not necessary to survey the entire population. Instead, the researcher selects a stratified random sample of people from the population and surveyed them and then drew conclusions about how the entire population would respond based on the responses from this randomly selected group of people.

Due to the nature of three shifts working system in most of chemical and petrochemical laboratories, the questionnaire was distributed to 20 employees randomly in each shift to all shifts and units, although this process was slightly more time consuming.

Consequently, in order to ensure a satisfactory sample size and to allow for the possibility of spoiled questionnaires, 400 questionnaires were sent to managing directors, personnel managers and laboratories operators.

5.7.2 Distribution of Questionnaires

The questionnaires were sent with a letter (see Appendix A) and accompanied by a stamped addressed envelope for return of the questionnaires. The questionnaire and covering letter were first written in English and then translated to Arabic. The official language in Libya is Arabic. Consequently, the researcher decided to translate the questionnaire into Arabic.

The researcher and a quality manager bilingual in Arabic/English carefully performed the translation of the questionnaire (Appendix A). Based on the best knowledge of the researcher, no Arabic language books or materials on ISO/IEC17025 have been published. The researcher took into consideration the technical idioms included in the questionnaire, which required precise and careful translation. Upon completion of the translation, an experienced Assistant Professor in the Department of English at the Al-Fateh University in Libya reviewed and approved the translation as ready for distribution.

The researcher had two alternatives for distributing the questionnaires: sending via post or delivery and collection. Saunders et al. (1997) and Churchill (1995) stated that the delivery and collection of the questionnaire differs from postal distribution in some aspects in that it involves higher costs, has a higher response rate, takes more time.

The costs of undertaking fieldwork were provided to the researcher. The duration of the data collection was determined to be three months but this could have been extended if necessary. Therefore, the researcher decided to use the delivery and collection distribution method to ensure the highest possible response rate.

5.7.3 Response rate

Of the 400 questionnaires that were distributed to the laboratories' employees, the researcher received 350 completed questionnaires, giving a response rate of 87.5%, which was considered to be satisfactory. Babbie (1998) argued that a 50%

response rate is adequate, 60% is good and 70% is very good. Saunders et al. (1997) expected the response rate of the delivery and collection method to be between 30-50%.

5.8 Conclusion

This chapter presented the research methodology used to carry out the research. The overall philosophy of the research is positivism. The researcher adopted a survey as the research strategy for investigating the factors that affect Libyan chemical and petrochemical manufacturing laboratories' accreditation. The researcher adopted a questionnaire as the research method to obtain the data for this research.

The second section of this chapter focussed on how questionnaires were distributed to the various recipients. A detailed description of how the sample was selected has been given. In the next chapter, the method of analysis of the data generated by the study is described.

CHAPTER SIX

DATA ANALYSIS

6.1. Introduction

This chapter presents the analysis of the survey data. The main purpose of data analysis is to provide empirical answers to the research questions raised at the beginning of the research and presented in Chapter One. Some statistical analysis, such as factor analysis and regression analysis were used for this research analysis.

Also, this chapter presents the data analysis and the research results of the study. General information about the respondents and the laboratories under investigation were analysed using basic descriptive statistics, providing an overview of the general characteristics of the respondents as well as the participating laboratories. Factor analysis also was used to group the factors into smaller groups that share common similarities which make them more interpretable.

6.1.1. Factor analysis

Chatfield and Collins (1992) stated that factor analysis is a data reduction technique; it aims to analyze the correlations between a numbers of factors. The underlying assumption of factor analysis is that a number of factors exist to explain the correlations of inter-relationships among observed variables. West (1991)

explained that factor analysis is a technique for finding a small number of underlying dimensions from amongst a large number of variables.

6.1.1.1 Factor analysis requirements

In determining the appropriateness of factor analysis, the suitability of the data for factor analysis was measured. Pallant (2001) said that the adequacy and suitability of data can be measured by using two methods, the first one is according to the Tabachnick and Fidell (1996) who suggested that it is reassuring to have at least 300 cases for factor analysis.

The second is by using the Kaiser-Meyer-Olkin (KMO) test. Pallant added that factor analysis is acceptable if the value of KMO is between 0.5 and 0.99. However, Al-Madi, (2005) quoted Morgan and Griego, (1998) who recommended that KMO should be greater than 0.7, and is inadequate if less than 0.5. Concerning the Kaiser-Mayer-Olkin KMO Sampling Adequacy Value, it was computed using SPSS package Ver.16, and the result was acceptable (0.902).

6.1.2. Regression analysis

Regression analysis assesses the relationship between one or more dependent variables and independent variables in order to find a line that best predicts the relationship between the two. It is then possible to estimate the values of a dependent variable from the values of an independent variable

6.1.2.1. Multiple regressions

Multiple regressions are used to explore the ability of a set of factors on one factor and to find the best set of factors that affect on one fator. Multiple regressions and factor analysis are most appropriate for data analysis. Factors' analysis (FA) reliability tests and regressions were carried out to identify the critical factors that affect the establishment of laboratories accreditation.

6.2 Types of variables

Puri (1996),defined A variable is an observable quantity or attribute that varies from one member of the population being studied to another. The literature on statistics including Puri (1996) and Siegel and Castellan (1988) indicated that there are four types of measurement scales associated with variables - nominal, ordinal, interval, and ratio - and researchers should be aware of the implication of each for the interpretation of statistical tests.

6.3 Data examination, validity and reliability

Accuracy of measures will show whether the measurement instrument is appropriate or not. In this section, the researcher will focus on the aspects of measures which contribute to accuracy which are reliability and validity.

6.4. Validity of the research instrument:

Litwin (1995) specified four types of validity when testing a survey instrument. They are: face, content, criterion, and construct. Face validity relates to the instrument

being reviewed by any normal individual, while content validity refers to reviewing by experts. Criterion validity is a measure of how well the instrument compares to either another instrument or to a predictor. Construct validity is a theoretical long-term evaluation of the survey instrument with respect to how meaningful it has been after years of experience.

The researcher in this study used a content type of validity. As explained in the last chapter, the questionnaire design went through several stages. Firstly, a thorough literature review was carried out which included previous studies on quality management, ISO 9001, previous studies on ISO/IEC 17025, including the management and technical factors, for laboratories accreditation. The literature review contributed to the first draft of the questionnaire. Secondly, the supervisor reviewed the questionnaire and necessary changes were made.

Fourthly, a pilot study was undertaken by sending the questionnaire to chemical and petrochemical manufacturing laboratories' employees in Libya. These stages meant that the questionnaire was valid based on the best efforts made by the researcher.

6.5. Pilot study analysis

The analysis is explained in the following Tables: 6.1; 6.2 and 6.3

Table 6.1: Detailed Demographic Profile of the Respondents

No	Variables	size
1	Job classification	
	Operators Engineers	6
	Managers	3
	Supervisors	6
	Technicians operators	9
2	Education level	
	High school	9
	BSc	12
	MSc	3
3	User of laboratory service	
	Local companies	2
	foreign companies	1
4	Laboratory's scope of work	
	Chemical	2
	Petrochemical	1

Table 6.1, shows a detailed demographic profile of the respondents. The two items related to job specification (education level and job classification) showed that around ten of the respondents had completed high school, around twelve had completed a BSc (at university) and tow had completed MSc degree. Job classification showed that around nine of the respondent workers were technicians,

six were engineers, six were supervisors and three of the respondent workers were managers.

Regarding the two items related to laboratories' specification, the laboratory scope of work and the users of the laboratory's services the findings firstly showed that sixteen of the respondent working in chemical laboratories and eight in petrochemical laboratories

Table 6.2: Employee Satisfaction Factors that Affect Accreditation

	Factor elements	VD%	D%	N%	S%	VS%
Section A: Job management and rewards system						
A1	Clarity of job description	7	10	23	35	25
A2	The quality of supervision	13	20	14	32	21
A3	Loyalty and respect towards employees	19	16	28	17	20
A4	Promotion is on the basis of job only	10.5	18	19.5	28	24
A5	Rewards for developing new ideas	9	11	24	31	25
A6	Knowing and understanding goals	30	32.5	5	20	12.5
A7	Clarity of long term goals	20	34	6	24	16
A8	Involvement in decision-making	30	23	17	21	9
A9	Promotion opportunities	22	29	6	23	20
A10	The amount of payment received	17	23	13.5	27.5	19
A11	Financial compensation	22	28	10	23	17
A12	Happy and proud to work for laboratory	25	32	15	18	10
A13	Daily attendance rate	21	31	20	22	7
Section B: Cultural Characteristics						
B1	The relationship with authority	12	8	34	36	10
B2	The relationship of individuals and groups	17	23	17	19	21
B3	Regular meetings attended	13	17	22	30	18
B4	People's behaviour during meetings	15	17	20	35	13
B5	Celebratory events	13	12	25	30	20
B6	Change is fast and immediate	12	20	24	18	26

	Factor elements	VD%	D%	N%	S%	VS%
B7	Adjustment to new requirements	10	12	24	28	26
B8	Effectiveness of team meetings	9	17	23	26	25
B9	Time of talking informally to managers	12	18	18	28	24
B10	Co-operation between departments	16	38	14	20	12
B11	Employees acknowledge need to change	26	25	23	9	17
B12	Management looking at new ideas	6	16	24	30	24
Section C: Technical factor: Laboratory facilities (Environmental Conditions)						
C1	Physical conditions at work (noise etc.)	10	18.5	20	30	21.5
C2	Time and resources to do the job	8	22	10	33	27
C3	Space for doing all the activities	2	15	23	31	29
C4	Protection from undue pressures	17	23	9	35	26
C5	Protection of confidential information	15	20	28	20	22
C6	Appropriateness of utilities to be used	10	15	21	29	25
C7	Policy and procedure for corrective action	10	20	30	22	18
C8	Determine root causes of problems	17	9	35	23	26
C9	Procedures for preventive actions	12	5	29	31	23
C10	Procedures for quality records	15	10	29	25	21
C11	Security and confidentiality of records	12	23	24	20	19
C12	Schedule of periodic internal audits	14	15	23	27	21
C13	Method proven to be fit for intended use.	12	5	29	31	23
C14	Procedure to estimate uncertainty in tests	25	31	14	16	14

	Factor elements	VD%	D%	N%	S%	VS%
C15	Consideration given to all uncertainty components	30	37	13	12	8
C16	Measurements and test equipment	9.5	27.7	24.3	14.9	23.7
C17	Capability of equipment and software	20	38	10	12	20
C18	Existing identity of equipment	14	13	30	27	20
C19	Procedures for equipment calibration	12	14	29	20	27
C20	Calibration of reference standards	30	37	13	12	8
C21	Procedure for handling, transport…etc.	2	15	23	31	29
C22	Sampling plans and procedures	20	23	12	25	20
C23	Dealing with disposal of test items	12	8	13	37	30
C24	Regular use of reference materials	30	37	13	8	12
C25	Participation in inter-laboratory comparison	2	15	29	31	23
C26	Accuracy and clarity of reported results	20	37	26	7	10
C27	Information requested by customer	12	13	28	27	20
Section D: Communication and information						
D1	Communication is open in this laboratory	4	10	20	36	30
D2	Communication with other teams	10	15	20	38	17
D3	Information comes in a formal way	12	13	27	25	25
Section E: Training and knowledge						
E1	Employees are trained to problem solve	37	30	3	18	12
E2	Employees' opportunities to use their skills	4	10	20	36	30
E3	Trains employees to use skills and talents	12	13	23	27	25

	Factor elements	VD%	D%	N%	S%	VS%
E4	Involvement in continuously improving	10	15	25	30	20
Section F: Quality programme						
F1	Emphasis on meeting customer needs	13	20	22	25	20
F2	Continuous quality improvement	19	20	20	23	18
F3	Customers' satisfaction is important	27	23	25	15	10
F4	Success in the market depends on quality	29	21	7	23	20
F5	Employees understand customers	25	20	22	25	13
F6	Organizing to meet future costumer needs	12	20	28	13	20
F7	Quality is more important than sales	10	19	21	30	20
F8	Staff knowledge of ISO/IEC 17025 is sufficient	12	13	28	27	20
F9	Commitment to excellent customer service	32	28	23	7	10
F10	Continuous improvement	18	17	23	22	20
F11	Awareness of cost	27	23	25	15	10
F12	Established procedures are important	28	32	23	7	10
F13	Quality of resources to do the work	39	36	25	0	0

The 1st factor dimension evaluation is the management and rewards system. As shown in Table 6.2 based on the employees' judgments the respondents were satisfied with five out of thirteen factor elements. On the other hand, for seven out of thirteen factors, the respondents were dissatisfied except for one element (where they were neither satisfied nor dissatisfied) which was loyalty and respect towards employees. This dissatisfied percentage rate was higher than the satisfied

percentage rate, which showed mostly dissatisfaction for the management and reward system. The 2nd factor dimension evaluation is the cultural characteristics. This showed the respondents were satisfied with nine out of twelve factors. In contrast, in seven out of thirteen factors, the respondents were dissatisfied which showed most respondents had satisfaction for the cultural characteristics.

The 3rd factor dimension evaluation is the technical, laboratory facilities and environmental conditions. The respondents were satisfied with fourteen out of twenty-eight factors and the respondents were dissatisfied with six factors which showed that the majority of respondents were satisfied. The 4th factor dimension evaluation is communication. Respondents were dissatisfied with two out of three factor elements. One factor element was neither satisfied nor dissatisfied.

The 5th factor dimension evaluation is training. Up to 86% of the respondents were dissatisfied for two out of four factor elements. Up to 67% of the respondents were dissatisfied with only one factor and only one factor was neither satisfied nor dissatisfied which showed most of the respondents were dissatisfied about training. The 6th factor dimension evaluation is quality. The respondents were satisfied with seven out of thirteen factor elements and the respondents were dissatisfied about four factors. Only one factor was natural, that showed most of the respondents were aware about quality issues.

Table 6.3: Frequency distribution of the pilot study response

Issues	Critical factors	Important	Less important
1	Training and education	7	1
2	Top management commitment	7	1
3	Effective communication	6	2
4	Technical expertise on ISO 17025	6	2
5	Time and resources	7	1
6	Documentation process	6	2
7	Cooperation of work force	8	0
8	International competition	7	1
9	Any pressure from customers	4	4
10	Ready market and poor competition	2	6
11	Governmental support programmes	5	3
12	Effective information	3	5
13	People's bad attitude towards accreditation	5	3
14	Inappropriate managerial traditions	4	4

6.5.1 Analysis of pilot study responses

The responses of the respondents indicated that they had a level of distribution with ten factors coming out as important. Four factors were returned as less important than the other factors as shown in Table 6.3. However, in this investigation, the majority of the respondents considered ten factors, to be the

most critical factors that affect to establish and implement chemical and petrochemical laboratories' accreditation.

6.6. Main Study Analysis

The analysis is explained in the following sections

6.6.1 Reliability analysis

Litwin (1995) specified three methods of reliability assessment: test-retest, alternate form and internal consistency. Test-retest requires that the same respondents answer the questions at two different points in time in order to see how stable the responses are in order to know how reproducible a set of results is.

The second method is alternate-form, which requires the use of differently worded items to measure the same attributes. The third method of reliability is internal consistency which was used by the researcher.

In this research, the reliability of the scales used in the questionnaire was assessed by an internal consistency statistic, Cronbach's alpha coefficient. Internal consistency is based on the idea that items comprising a scale should show high levels of internal consistency. The higher the correlation among items in each scale the greater is the alpha value. High correlation implies that high scores on one question are associated with high scores on the other questions.

Cronbach's alpha coefficient is related to scale length; the longer the scale, the higher the alpha value and alpha ranges from 0 to 1. A scale of *5* points should

bring an alpha of more than .70, which means that the scale shares about half of its variance with a hypothetical alternative scale.

Norusis (1993) stated that Cronbach's alpha coefficient is considered the most popular and superior technique for estimating internal consistency. Internal consistency is a measure which assesses the degree to which the item used is internally consistent with other items comprising the scale. Pallant (2001) stated that Cronbach's alpha coefficient of scale should be above 0.7.

Table 6.4 summarizes the reliability coefficient for the scales used in this research. The minimum recommended level of alpha is often .70. Table 6.4 shows Cronbach's alpha coefficient of the reliability of the scales in the questionnaire.

Table 6.4: Cronbach's Alpha Coefficient of the Reliability of Scales

Subject of question	No. of Items	Coefficient alpha
Technical requirement	27	0.959
Management requirement	13	0.830
Cultural condition	12	0.851
Training dimension	4	0.842
Communication and information	3	0.844
Quality system	13	0.882
All items	72	0.971

According to Pavot (1991) and Pallant (2001) the satisfaction scale has good internal consistency with a cronbach alpha coefficient reported of 0.7. However, the results from the reliability analysis indicate that all items for the technical requirement, the management requirement, the cultural condition, the communication system as well as the quality system scales can be used for further analysis. Moreover, the results obtained show that all of them have satisfactory reliability coefficients. Also, the reliability coefficient obtained for all variables has a satisfactory reliability coefficient (0.971).

To increase the reliability and validity of measures, measuring variables were tested and statistical significance was analyzed using factor analysis and multiple regressions.

6.7 General information and classification

The aim of this part is to provide an overview of the demographic information on the respondents and laboratories under investigation. Based on the data available from survey, data files (350 records) were made via SPSS.

6.7.1Characteristics of Respondents and laboratories

This part includes the details of the respondents in terms of the laboratories they belong to, their experience, as well as their education background. The results are shown in Table 6.5. In terms of education level, the respondents' educational level is shown in Table 6.5 and Fig 6.1. As can be seen, the vast majority of respondents (209) with percentage of 59.7% held a Bachelor's degree

In terms the laboratory's scope of work, Table 6.5 shows that 200 of the 350 respondents surveyed (57.14%) were from the chemical laboratories industry and 150 (42.86%) were from the petrochemical laboratories industry.

In terms of occupation, the respondents' status indicated that the majority of the questionnaires were answered by technicians and engineers within the laboratories. This reflected the important views of the operators who have critical influence on the establishment of laboratories' accreditation. A total of 78.9% of the respondents were operators in their laboratories; among them there were 42% technicians and 36.9% engineers. 21.1% of respondents were leaders within their laboratories: among them there were 7.4% managers and 13.7% supervisors, as shown in Table 6.5.

Table 6.5: Characteristics of Respondents and laboratories

	Characteristics	Frequency	Percent (%)
Occupation	Engineer operators	129	36.9
	Manager	26	7.4
	Technician operators	147	42.0
	Supervisor	48	13.7
	Total	350	100.0
Education level	High School	40	11.4
	College	47	13.4
	BSc	209	59.7
	MSc	29	8.3
	PhD	5	1.4
	Other	20	5.7
	Total	350	100.0
Laboratory scope of work	Chemical	200	57.14
	Petrochemicals	150	42.86
	Total	350	100.0

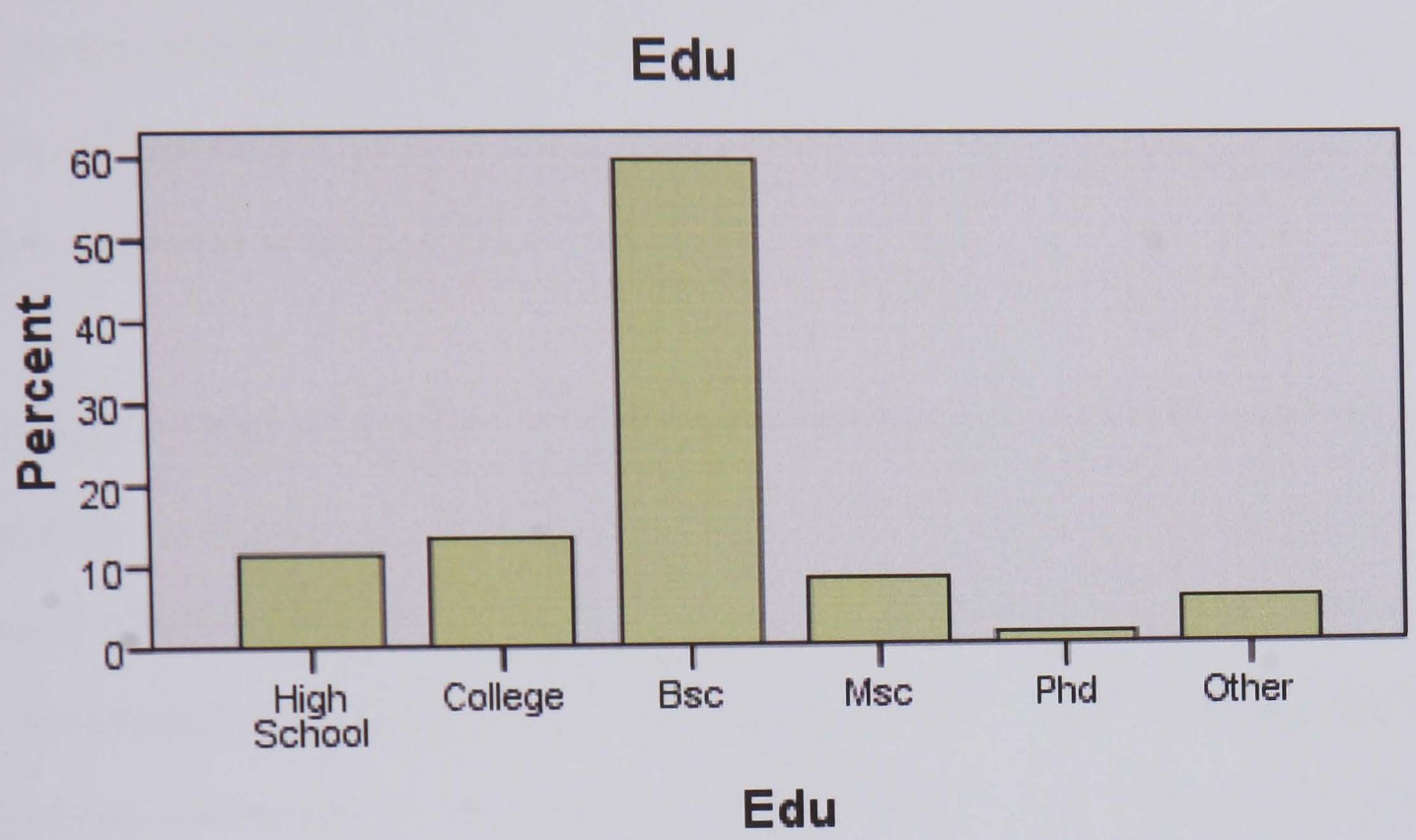

Figure 6.1: Respondents' education status

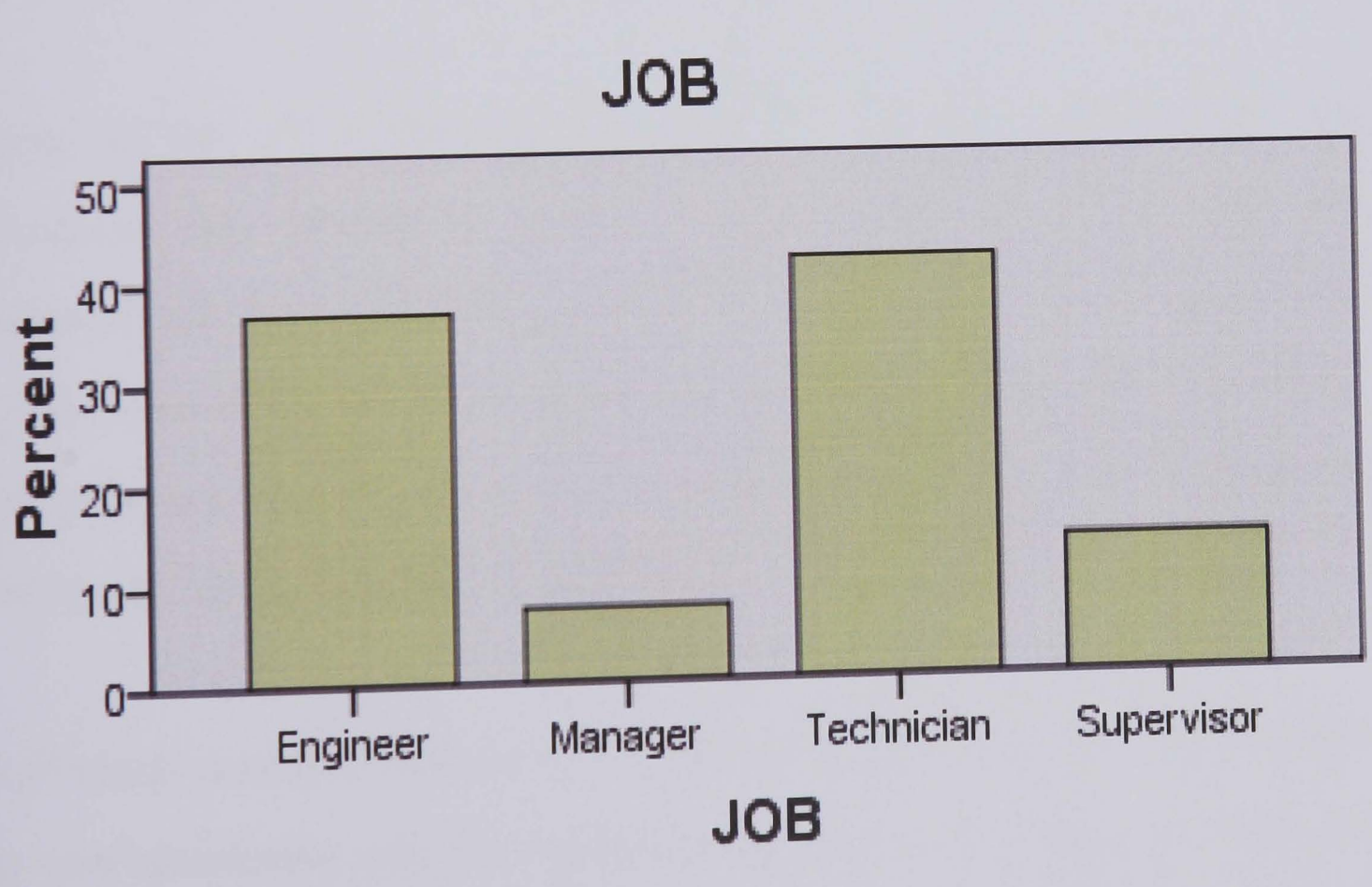

Figure 6.2: Respondents' job status

6.7.2 Employees' (managers and operators) satisfaction

This section shows the results of the statistics tests by using descriptive statistics to find out the degree of managers and operators satisfaction about Management, culture, technical, Communication, training and quality factors.

As shown in Table 6.6 based on employee judgment, the 1st component dimension evaluation is degree of employee satisfaction concerning the management and rewards system. 34.9% of respondents were very dissatisfied concerning reward for developing new ideas and 26.6% of respondent were very dissatisfied concerning involvement of employees in decision-making. Both factors represent 2 out of 13 factor elements. In other hand, respondents were satisfied for other 11 elements, and showed most satisfaction for management and reward system.

Looking at the 2nd component evaluation for cultural characteristics, the respondents were satisfied for 5 out of 12 factor elements. 27.4% were very dissatisfied with the effectiveness of team meetings and 27.7% of respondents were very dissatisfied concerning the time of talking informally to senior managers. These represent 2 factors out of 12; dissatisfied accounted for 2 out of 12, and 3 out of 12 was neither satisfied nor dissatisfied.

The 3rd factor dimension evaluation is the technical factors. 31.7% of respondents were very dissatisfied with the physical conditions at work (such as noise, air condition ... etc). 24% of respondents were dissatisfied with protection of clients' confidential information and proprietary rights. Neither satisfied nor dissatisfied

accounted for 5 factors out of 27. The respondents were satisfied with the rest of the elements.

The 4th factor dimension evaluation is communication and information. Table 6.6 shows that most respondents were very dissatisfied with all communication factors. The 5th factor dimension evaluation is training. Respondents were neither satisfied nor dissatisfied with two of the factors.

The 6th factor dimension evaluation is quality. The majority of the respondents were satisfied with eleven out of thirteen factors. Only two factors were neither satisfied nor dissatisfied which showed most of respondents were aware about the quality issues.

Table 6.6: Descriptive Analyis to Measure Employee's Satisfaction

	Factor elements	VD%	D%	N%	S%	VS%
Section A: Job management and rewards system						
A1	Clarity of job description	17.1	21.1	19.4	33.4	8.90
A2	The quality of supervision	8.3	19.4	26.0	35.7	10.6
A3	Loyalty and respect towards employees	17.4	12.0	25.1	32.6	12.9
A4	Promotion is on the basis of job only	24.6	22.9	13.4	28.6	10.6
A5	Rewards for developing new ideas	34.9	22.0	20.3	14.6	8.3
A6	Knowing and understanding goals	5.7	11.1	15.4	38.6	29.1
A7	Clarity of long term goals	17.1	23.1	19.7	28.6	11.4
A8	Involvement in decision-making	26.6	22.9	14.3	26.0	10.3
A9	Promotion opportunities	9.1	13.4	18.0	37.4	22.0
A10	The amount of payment received	25.1	16.6	22.6	26.6	9.1
A11	Financial compensation	7.1	8.6	20.6	47.1	16.6
A12	Happy and proud to work for laboratory	3.7	4.0	15.1	45.1	32.0
A13	Daily attendance rate	7.4	12.3	14.9	46.6	18.9
Section B: Cultural Characteristics						
B1	The relationship with authority	13.4	16.0	22.6	28.3	19.7
B2	The relationship of individuals and groups	4.9	12.6	20.9	36.3	25.4
B3	Regular meetings attended	16.0	21.7	21.4	27.7	13.1
B4	People's behaviour during meetings	16.6	13.7	37.7	24.6	7.4

	Factor elements	VD%	D%	N%	S%	VS%
B5	Celebratory events	23.1	19.7	27.7	24.6	4.9
B6	Change is fast and immediate	21.7	26.6	24.9	19.1	7.7
B7	Adjustment to new requirements	24.0	21.4	26.0	20,9	7.7
B8	Effectiveness of team meetings	27.4	20.9	26.3	17.7	7.7
B9	Time of talking informally to managers	27.7	12.3	21.1	24.3	14.6
B10	Co-operation between departments	15.1	14.6	25.1	27.1	18.0
B11	Employees acknowledge need to change	7.4	16.6	26.0	29.4	20.6
B12	Management looking at new ideas	20.6	28.3	18.3	22.0	10.9
Section C: Technical factor: Laboratory facilities (Environmental Conditions)						
C1	Physical conditions at work (noise etc.)	31.7	13.4	18.6	24.6	11.7
C2	Time and resources to do the job	15.7	16.6	32.0	24.6	11.1
C3	Space for doing all the activities	15.7	16.6	32.0	24.6	11.1
C4	Protection from undue pressures	22.9	15.4	19.4	29.4	12,
C5	Protection of confidential information	22.0	24.0	23.7	20.6	9.7
C6	Appropriateness of utilities to be used	19.4	8.3	21.4	30.9	20.0
C7	Policy and procedure for corrective action	13.7	12.6	25.4	28.9	19.4
C8	Determine root causes of problems	8.3	12.6	28.3	27.7	23.1
C9	Procedures for preventive actions	10.0	15.4	25.1	30.3	19.1
C10	Procedures for quality records	10.0	18.0	23.1	31.4	17.4
C11	Security and confidentiality of records	9.7	20.3	20.3	27.4	22.3
C12	Schedule of periodic internal audits	11.1	23.1	22.9	29.4	13.4

	Factor elements	VD	D	N	S	VS
C13	Method proven to be fit for intended use.	10.9	20.0	25.4	28.6	15.1
C14	Procedure to estimate uncertainty in tests	10.9	21.1	23.4	30.9	13.7
C15	Consideration given to all uncertainty components	12.9	14.9	35.1	26.6	10.6
C16	Measurements and test equipment	9.5	14.9	24.3	25.7	25.7
C17	Capability of equipment and software	10.0	15.7	23.1	35.7	15.4
C18	Existing identity of equipment	8.9	18.6	24.6	28.0	20.0
C19	Procedures for equipment calibration	9.7	13.4	17.7	40.3	18.9
C20	Calibration of reference standards	9.7	18.9	25.4	32.6	13.4
C21	Procedure for handling, transport…etc.	17.1	12.0	26.3	30.9	13.7
C22	Sampling plans and procedures	10.9	13.4	21.4	39.1	51.1
C23	Dealing with disposal of test items	12.0	15.4	26.9	32.0	13.7
C24	Regular use of reference materials	9.4	16.3	29.7	32.3	12.3
C25	Participation in inter-laboratory comparison	12.9	21.4	33.4	20.9	11.4
C26	Accuracy and clarity of reported results	9.7	8.9	21.4	38.6	21.4
C27	Information requested by customer	6.3	16.6	24.3	36.6	16.3
Section D: Communication and information						
D1	Communication is open in this laboratory	27.1	23.7	18.0	24.0	7.1
D2	Communication with other teams	28.6	22.9	22.0	16.6	10.0
D3	Information comes in a formal way	31.1	19.1	18.0	22.0	9.7
Section E: Training and knowledge						
E1	Employees are trained to problem solve	28.9	20.6	20.3	22.6	7.7

	Factor elements	VD%	D%	N%	S%	VS%
E2	Employees' opportunities to use their skills	25.7	23.7	21.7	19.4	9.4
E3	Trains employees to use skills and talents	24.9	20.0	23.1	20.3	11.7
E4	Involvement in continuously improving	20.6	22.3	25.4	22.9	8.9
Section F: Quality programme						
F1	Emphasis on meeting customer needs	21.1	19.1	20.9	27.7	11.1
F2	Continuous quality improvement	12.0	20.9	24.9	28.6	13.7
F3	Customers' satisfaction is important	8.3	9.7	14.9	42.6	24.6
F4	Success in the market depends on quality	10.9	3.4	22.6	35.7	27.4
F5	Employees understand customers	8.0	13.7	32.9	29.7	15.7
F6	Organizing to meet future costumer needs	13.7	14.6	23.7	29.1	18.9
F7	Quality is more important than sales	11.1	12.6	24.0	29.4	22.9
F8	Staff knowledge of ISO/IEC 17025 is sufficient	26.3	19.1	29.1	20.3	5.1
F9	Commitment to excellent customer service	11.7	12.9	26.0	32.9	16.6
F10	Continuous improvement	7.1	14.6	23.4	33.4	21.4
F11	Awareness of cost	2.3	18.0	29.1	33.7	16.9
F12	Established procedures are important	8.3	5.4	23.1	39.4	23.7
F13	Quality of resources to do the work	16.0	13.1	22.6	30.9	17.4

6.7.3 Managers' satisfaction

From the table, 6.7 it can be seen that the findings indicated that, the majority of respondents were satisfied with all management and rewards systems. However they were very dissatisfied on the factor of employees rewarded for developing new ideas.

The 2nd component evaluation is cultural characteristics. Respondents were satisfied with 8 out of 12 factor elements and 4 out of 12 were neither satisfied nor dissatisfied; these latter factors were people's behaviour during meetings; celebratory events; change is fast and immediate and the relationship with authority.

The 3rd component dimension evaluation is technical factors. The respondents were very satisfied with physical conditions at work such as noise levels, etc, but they were neither satisfied nor dissatisfied for 7 out of 27 factors; these factors were: availability of time and resources to do job; investigation to determine root causes of problems; availability of procedures for preventive actions; method proven to be fit for intended use, existence of procedures to estimate uncertainty of measurements in testing and calibration; is due consideration given to existing procedures to estimate the uncertainty of measurements in testing and calibration; and existence of procedures for the transportation, receipt, handling, storage, retention and/or disposal of test and/or calibration items.

The 4th component dimension evaluation is communication and information. Table 6.7shows that all respondents were satisfied with all communication factors.

The 5th component dimension evaluation is training. Respondents were satisfied with 75% of training factors, and were very dissatisfied with the factor employees are trained to use a wide range of problem-solving tools.

The 6th component dimension evaluation is quality. The majority of the respondents were satisfied with 12 out of 13 factors. Only for the continuous quality improvement factor was the result neither satisfied nor dissatisfied. All this showed that most of the respondents were aware about quality issues.

Table 6.7: Descriptive Analysis to measure Managers' Satisfaction

	Factor elements	VD	D	N	S	VS
Section A: Job management and rewards system						
A1	Clarity of job description	16.2	8.1	23.0	35.1	17.6
A2	The quality of supervision	6.8	5.4	25.7	45.9	16.2
A3	Loyalty and respect towards employees	9.5	12.2	29.7	33.8	14.9
A4	Promotion is on the basis of job only	16.2	28.4	18.9	29.7	6.8
A5	Rewarded for developing new ideas	28.4	20.3	17.6	21.6	12.2
A6	Knowing and understanding goals	6.8	13.5	9.5	33.8	36.5
A7	Clarity of long term goals	17.6	17.6	20.3	23.0	21.6
A8	Involvement in decision-making	21.6	23.0	9.5	37.8	8.1
A9	Promotion opportunities	9.5	16.2	24.3	25.7	24.3
A10	The amount of payment received	25.7	18.9	17.6	31.1	6.8
A11	Financial compensation	4.1	10.8	17.6	54.1	13.5
A12	Happy and proud to work for laboratory	0.0	8.1	23.0	33.8	35.1
A13	Daily attendance rates	5.4	17.6	8.1	45.9	23.0
Section B: Cultural Characteristics						
B1	The relationship with authority	18.9	16.2	23.0	31.1	10.8
B2	The relationship with individuals and groups	2.7	16.2	20.3	31.1	29.7
B3	Regular meetings attended	9.5	31.1	8.1	31.1	20.3
B4	People's behaviour during meetings	16.2	16.2	32.4	29.7	5.4

	Factor elements	VD%	D%	N%	S%	VS%
B5	Celebratory events	23.0	21.6	27.0	20.3	8.1
B6	Change is fast and immediate	16.2	17.6	32.4	20.3	13.5
B7	Adjustment to new requirements	21.6	13.5	23.0	28.4	13.5
B8	Effectiveness of team meetings	25.7	16.2	17.6	32.4	8.1
B9	Time of talking informally to managers	16.2	9.5	21.6	32.4	20.3
B10	Co-operation between departments	10.8	10.8	25.7	28.4	24.3
B11	Employees acknowledge need to change	0.0	23.0	16.2	40.5	20.3
B12	Management looking at new ideas	9.5	25.7	17.6	31.1	16.2
Section C: Technical factor: Laboratory facilities (Environmental Conditions)						
C1	Physical conditions at work (noise etc.)	21.6	16.2	8.1	29.7	24.3
C2	Time and resources to do the job	6.8	10.8	35.1	29.7	17.6
C3	Space for doing all the activities	12.2	16.2	21.6	29.7	20.3
C4	Protection from undue pressures	13.5	9.5	25.7	33.8	17.6
C5	Protection of confidential information	14.9	18.9	27.0	31.1	8.1
C6	Appropriateness of utilities to be used	8.1	8.1	28.4	39.2	16.2
C7	Policy and procedure for corrective action	6.8	16.2	23.0	33.8	20.0
C8	Determine root causes of problems.	5.4	17.6	24.3	20.3	32.4
C9	Procedures for preventive actions	4.1	13.5	32.4	32.4	17.6
C10	Procedures for quality records	6.8	18.9	18.9	31.1	24.3
C11	Security and confidentiality of records	2.7	17.6	18.9	24.3	36.5
C12	Schedule of periodic internal audits	5.4	27.0	25.7	28.4	13.5
C13	Method proven to be fit for intended use	5.4	20.3	32.4	32.4	9.5

	Factor elements	VD%	D%	N%	S%	VS%
C14	Procedure to estimate uncertainty in tests	5.4	16.2	37.8	35.1	5.4
C15	consideration given to all uncertainty components	13.5	6.8	41.9	35.1	2.7
C16	Measurements and test equipment	9.5	14.9	24.3	25.7	25.7
C17	Capability of equipment and software	1.4	10.8	25.7	44.6	17.6
C18	Existing identity of equipment	2.7	21.6	27.0	29.7	18.9
C19	Procedures for equipment calibration	10.8	10.8	17.6	44.6	16.2
C20	Calibration of reference standards	14.9	16.2	21.6	36.5	10.8
C21	Procedure for handling, transport…etc.	4.1	14.9	24.3	39.2	17.6
C22	Sampling plans and procedure	6.8	17.6	8.1	50.0	17.6
C23	Dealing with disposal of test items	6.8	13,5	36.5	21.6	21.6
C24	Regular use of reference materials	9.5	10.8	31.1	40.5	8.1
C25	Participationin inter-laboratory comparison	10.8	25.7	28.4	32.4	2.7
C26	Accuracy and clarity of reported results	6.8	8.1	18.9	41.9	24.3
C27	Information requested by customer	6.8	6.8	33.8	40.5	12.2
Section D: Communication and information						
D1	Communication is open in this laboratory	16.2	17.6	12.2	36.5	17.6
D2	Communication with other teams	20.3	10.8	24.3	27.0	17.6
D3	Information comes in a formal way	23.0	16.2	10.8	31.1	18.9
Section E: Training and knowledge						
E1	Employees' training for problem-solving	23.0	23.0	18.9	21.6	13.5

	Factor elements	VD%	D%	N%	S%	VS%
E2	Employees' opportunities to use their skills	14.9	16.2	21.6	37.8	9.5
E3	Trains employees to use skills and talents	12.2	24.3	18.9	37.8	6.8
E4	Involvement in continuously improvement	16.2	17.6	24.3	35.1	6.8
Section F: Quality programme						
F1	Emphasis on meeting customer needs	8.1	18.9	29.7	35.1	8.1
F2	Continuous quality improvement	14.9	13.5	35.1	25.7	10.8
F3	Customers' satisfaction is important	5.4	10.8	10.8	47.3	25.7
F4	Success in the market depends on quality	5.4	0.00	20.3	41.9	32.4
F5	Employees understand customers	6.8	6.8	25.7	37.8	23.0
F6	Organizing to meet future costumer needs	6.8	9.5	21.6	35.1	27.0
F7	Quality is more important than sales	13.5	10.8	16.2	39.2	20.3
F8	Staff knowledge of ISO/IEC 17025 is sufficient	18.9	9.5	23.0	40.5	8.1
F9	Commitment to excellent customer service	6.8	8.1	33.8	39.2	12.2
F10	Continuous improvement	2.7	13.5	14.9	51.4	17.6
F11	Awareness of cost	0.00	16.2	35.1	36.5	12.2
F12	Established procedures are important	6.8	5.4	14.9	55.4	17.6
F13	Quality of resources to do the work	8.1	13.5	27.0	31.1	20.3

6.7.4: Operator satisfaction

Table 6.8 shows the degree of satisfaction of the operators respondents concerning the Management, culture, technical, Communication, training and quality factors.

The 1st component dimension evaluation is the management and rewards system as shown in Table 6.8 based on employee judgment. The majority of respondents were satisfied with 10 out of 13 management and rewards system factors and they were dissatisfied with 3 out of 13 factors. These 3 factors were employees rewarded for developing new ideas, involvement of employees in decision-making, and the amount of payment received.

The 2nd component evaluation is cultural characteristics. Respondents were satisfied with 50% of the factors. For 25% of the factors they were neither satisfied nor dissatisfied; these factors were People's behaviour during meetings, and all employees acknowledge the need to change. 25% of the respondents' answers showed dissatisfaction with immediate and fast changes in any developing system and management looking for and seeking new ideas. Respondents were very dissatisfied about the duration of time to talk informally to senior managers.

The 3rd component dimension evaluation is the technical factors. The respondents were very satisfied with most of the technical factors, but they were neither satisfied nor dissatisfied for 4 out of 27 factors; these factors were: Consideration given to all uncertainty components; availability of measurements and test

equipment; participation in inter-laboratory comparison or proficiency testing programmes and availability of time and resources to do jobs. The Table also shows that the protection of clients' confidential information and proprietary rights.

The 4th component dimension evaluation is communication and information. Table 6.8 shows that all the respondents were dissatisfied with all communication factors.

The 5th component dimension evaluation is training. Respondents were neither satisfied nor dissatisfied with the majority of training factors. The 6th component dimension evaluation is Quality. The majority of respondents were satisfied with 12 out of 13 factors. Only for the factor staff knowledge of ISO/IEC 17025 is sufficient were they neither satisfied nor dissatisfied. Thus the table shows that most of the respondents were aware about quality issues.

Table 6.8: Descriptive Analysis of Laboratories' Operator Satisfaction

	Factor elements	VD%	D%	N%	S%	VS%
Section A: Job management and rewards system						
A1	Clarity of job description	17.4	24.6	18.5	33.0	6.5
A2	The quality of supervision	8.7	23.2	26.1	33.0	9.1
A3	Loyalty and respect towards employees	19.6	12.0	23.9	32.2	12.3
A4	Promotion is on the basis of job only	26.8	21.4	12.0	28.3	11.6
A5	Rewards for developing new ideas	36.6	22.5	21.0	12.7	7.2
A6	Knowing and understanding goals	5.4	10.5	17.0	39.9	27.2
A7	Clarity of long term goals	17.0	24.6	19.6	30.1	8.7
A8	Involvement in decision-making	27.9	22.8	15.6	22.8	10.9
A9	The promotion opportunities	9.1	12.7	16.3	40.6	21.4
A10	The amount of payment received	25.0	15.9	23.9	25.4	9.8
A11	Financial compensation	8.0	8.0	21.4	45.3	17.4
A12	Happy and proud to work for laboratory	4.7	2.9	13.0	48.2	31.2
A13	Daily attendance rates	8.0	10.9	16.7	46.7	17.8
Section B: Cultural Characteristics						
B1	The relationship with authority	12.0	15.9	22.5	27.5	22.1
B2	The relationship of individuals and groups	5.4	11.6	21.0	37.7	24.3
B3	Regular meetings attended	17.8	19.2	25.0	26.8	11.2
B4	People's behaviour during meetings	16.7	13.0	39.1	23.2	8.0
B5	Celebratory events	23.2	19.2	27.9	25.7	4.0

	Factor elements	VD%	D%	N%	S%	VS%
B6	Change is fast and immediate	23.2	29.0	22.8	18.8	6.2
B7	Adjustment to new requirements	24.6	23.6	26.8	18.8	6.2
B8	Effectiveness of team meetings	27.9	22.1	28.6	13.8	7.6
B9	Time of talking informally to managers	30.8	13.0	21.0	22.1	13.0
B10	Co-operation between departments	16.3	15.6	25.0	26.8	16.3
B11	Employees acknowledge need to change	9.4	14.9	28.6	26.4	20.7
B12	Management looking at new ideas	23.6	29.0	18.5	19.6	9.4
Section C: Technical factor: Laboratory facilities (Environmental Conditions)						
C1	Physical conditions at work (noise, etc.)	34.4	12.7	21.4	23.2	8.3
C2	Time and resources to do the job	18.1	18.1	31.2	23.2	9.4
C3	Space for doing all the activities	22.1	21.0	19.2	25.7	12.0
C4	Protection from undue pressures	25.4	17.0	17.8	28.3	11.6
C5	Protection of confidential information	23.9	25.4	22.8	17.8	10.1
C6	Appropriateness of utilities to use	22.5	8.3	19.6	28.6	21.0
C7	Policy and procedure for corrective action	15.6	11.6	26.1	27.5	19.2
C8	Determine root causes of problems	9.1	11.2	29.3	29.7	20.7
C9	Procedures for preventive actions	11.6	15.9	23.2	29.7	19.6
C10	Procedures for quality records	10.9	17.8	24.3	31.5	15.6
C11	Security and confidentiality of records	11.6	21.0	20.7	28.3	18.5
C12	Schedule of periodic internal audits.	12.7	22.1	22.1	29.7	13.4

	Factor elements	VD%	D%	N%	S%	VS%
C13	Method proven to be fit for intended use.	12.3	19.9	23.6	27.5	16.7
C14	Procedure to estimate uncertainty in tests.	12.3	22.5	19.6	29.7	15.9
C15	Consideration given to all uncertainty components	12.7	17.0	33.3	24.3	12.7
C16	Measurements and test equipment	12.3	16.7	30.4	26.4	14.1
C17	Capability of equipment and software	12.3	17.0	22.5	33.3	14.9
C18	Existing identity of equipment	10.5	17.8	23.9	27.5	20.3
C19	Procedures for equipment calibration	9.4	14.1	17.8	39.1	19.6
C20	Calibration of reference standards	8.3	19.6	26.4	31.5	14.1
C21	Procedure for handling, transport, etc.	20.7	11.2	26.8	28.6	12.7
C22	Sampling plans and procedure	12.0	12.3	25.0	36.2	14.5
C23	Dealing with disposal of test items	13.4	15.9	24.3	34.8	11.6
C24	Regular use of reference materials	9.4	17.8	29.3	30.1	13.4
C25	Participation in inter-laboratory comparison	13.4	20.3	34.8	17.8	13.8
C26	Accuracy and clarity of reported results	10.5	9.1	22.1	37.7	20.7
C27	Information requested by customer	6.2	19.2	21.7	35.5	17.4
Section D: Communication and information						
D1	Communication is open in this laboratory	30.1	25.4	19.6	20.7	4.3
D2	Communication with other teams	30.8	26.1	21.4	13.8	8.0
D3	Information comes in formal way	33.3	19.9	19.9	19.6	7.2
Section E: Training and knowledge						

	Factor elements	VD%	D%	N%	S%	VS%
E1	Employees training in problem-solving	19.6	19.9	31.5	22.8	6.2
E2	Employees' opportunities to use their skills	20.7	25.7	21.7	22.5	9.4
E3	Trains employees to use skills and talents	22.5	18.8	24.3	21.4	13.0
E4	Involvement in continuously improving	21.7	23.6	25.7	19.6	9.4
Section F: Quality programme						
F1	Emphasis on meeting customer needs	24.6	19.2	18.5	25.7	12.0
F2	Continuous quality improvement	11.2	22.8	22.1	29.3	14.5
F3	Customers' satisfaction is important	9.1	9.4	15.9	41.3	24.3
F4	Success in the market depends on quality	12.3	4.3	23.2	34.1	26.1
F5	Employees understand customers	8.3	15.6	34.8	27.5	13.8
F6	Organizing to meet future costumer needs	15.6	15.9	24.3	27.5	16.7
F7	Quality is more important than sales	10.5	13.0	26.1	26.8	23.6
F8	Staff knowledge of ISO/IEC 17025 is sufficient	28.3	21.7	30.8	14.9	4.3
F9	Commitment to excellent customer service	13.0	14.1	23.9	31.2	17.8
F10	Continuous improvement	8.3	14.9	25.7	28.6	22.5
F11	Awareness of cost	2.9	18.5	27.5	33.0	18.1
F12	Established procedures are important	8.7	5.4	25.4	35.1	25.4
F13	Quality of resources to do the work	18.1	13.0	21.4	30.8	16.7

6.8 Factor analysis

Factor analysis is a statistical technique which aims to analyze the correlations between a number of variables in order to reduce them to a smaller numbers of factors, and then to determine the correlation of each of the original variables with each factor.

The aim of factor analysis is to find the pattern of a large number of factors to see if they can be condensed into smaller sets of components that can be understood by a common label. Factor analysis is a technique for finding a small number of underlying dimensions from amongst a large number of variables (West, 1991) .

This technique was applied in this study to identify a relatively small number of factors that can be used to represent the relationship among these 72 sets of factors by reducing them into components containing some of the factors that share common ground..

6.10 Determining the number of factors

To determine how many components should be "extracted" by using Kaiser's criterion, latent roots or Eigen values, and Scree test criteria were used to determine the number of components.

(a) Latent roots or Eigen values

This is the most commonly used technique in deciding the number of factors to extract. The researcher only considered significant the components that have an Eigen value of 1.00 or more; all components with Eigen values less than 1.00 were considered insignificant and were disregarded.

b) Scree test

The Scree test is used to identify the optimum number of factors that can be extracted before the amount of unique variance begins to dominate the common variance structure. The scree test is obtained by plotting the Eigen values against the number of factors in their order of extraction, and the shape of the resulting curve is used to evaluate the cut-off point.

In factor analysis, a principal component approach is used with varimax rotation. The results of the analysis were in the form of 9 components, each component consists of many factors; the researcher chose only those factors with factor loadings of 0.4 or higher, based on the sample size and the criteria of the significance of factor loadings (Hair et al., 1998).

Hair et al. (1998) summarized the criteria or the significance of factor loadings in the following points: (1) The larger the sample size, the smaller the loading to be considered significant; (2) the larger the number of variables being analyzed, the smaller the loading to be considered significant; (3) the larger the number of factors, the larger the size of the loading on later factors to be considered significant for interpretation.

Based on a table as given by Hair et al. (1998), a decision was made regarding which factor loadings were worth considering. Table 6.9 contains the sample sizes necessary for each factor loading value considered to be significant.

Factor loadings are "the correlation of a variable with a factor" (Kline, 1994). Each factor had an Eigen value that represents the amount of variance accounted for by a factor; the higher the Eigen value the more variance it explains (de Vaus, 1996).

Table 6.9: Guidelines for Identifying Significant Factors' Loading

Factor Loading	Sample Size Needed for Significance
0.30	350
0.35	250
0.40	200
0.45	150
0.50	120
0.55	100
0.60	85
0.65	70
0.70	60
0.75	50

Source: Haïr et al, (1998, p.112)

Table 6.10, figures 6.3 and 6.4 shows factor analysis for laboratories' accreditation within the Libyan chemical and petrochemical industries. The results of the factor analysis comprised 9 components containing 58 factors that are supposed to explain all factors and represent them. Each component was given a label by the researcher depending on the factors it had and usually the greater the value of loadings of the variable, the more influence it had on the name of the label

Component 1, the factors that load highly on component 1 seem to all relate to different aspects of quality and technical issues; therefore, component 1 was given the label ' laboratory quality and technical issues' containing 28 factors such as: existing identity of equipment and software's, manufacturer's name, serial number and other related items to the equipment documented (loadings .718); existence of procedure to estimate uncertainty of measurements in testing and calibration (.711); capability of equipment and software (.709); and investigation to determine root causes of problems (709) etc.

Component 2, the factors that load on component 2 all seem to relate to work environment; therefore component 2 was named 'work environment ' containing 7 factors to improve the work environment such as communications (.744); to protect or insulate from undue internal and external pressures (.686); availability of time and resources to do the job (.678); and information and instructions come in a formal way (.670).

Component 3 was named ' training and development system, because the factors that load on component 2 all seem to relate to training, component 3 ', having 8 factors such as: managers train employees to use their skills and talents (.636); continuous quality improvement (.632); employees have opportunities to use their skills effectively in their job (.622); staff are involved in continuously reviewing and improving process (.622); and training to use a wide range of problem-solving tools (.518). In component 3, the first three factors were correlated, stressing the continuous training and development of employees to use their skills and knowledge.

Component 4 was named "management system" containing 5 factors: advancement and promotion is on the basis of job performance only (.677); the laboratory shows loyalty and respect towards employees (0.635); clarity of job description (.592); employees rewarded for developing new ideas (.581); and involvement of employees in decision-making (.577).

Component 5, the factors that load highly on component 5 seem to all relate to different aspects of cultural and social events; therefore, component 1 was given the label ' cultural and social events' containing 4 factors such as: people's behaviour during meetings (.683); the regular meetings attended (.581); events which are celebrated in the organization (.529).

Component 6 was given the name 'cost reductions and profit' containing 4 factors such as: awareness of cost (.543), and to make quality more important than

volume of sales (.504). Since both factors are about cost reduction and are correlated they were therefore grouped by factor analysis.

Component 7 was named rewarding and motivational system containing such factors as: happy and proud to work for the laboratory (.722); promotion opportunities (.560).

Component 8 was given the label job satisfaction, because the factor that load highly on component 8 seems to relate to job satisfaction, the component 8 containing the factor: Financial compensation (0.633).

Finally, component 9 had the label of ' work environment' and contained only one factor, which was to meet the requirement of the physical conditions at work such as noise, humidity...etc, and having loadings of .401.

Some factors load on more than one component as shown in fig 6.4 and table 6.10

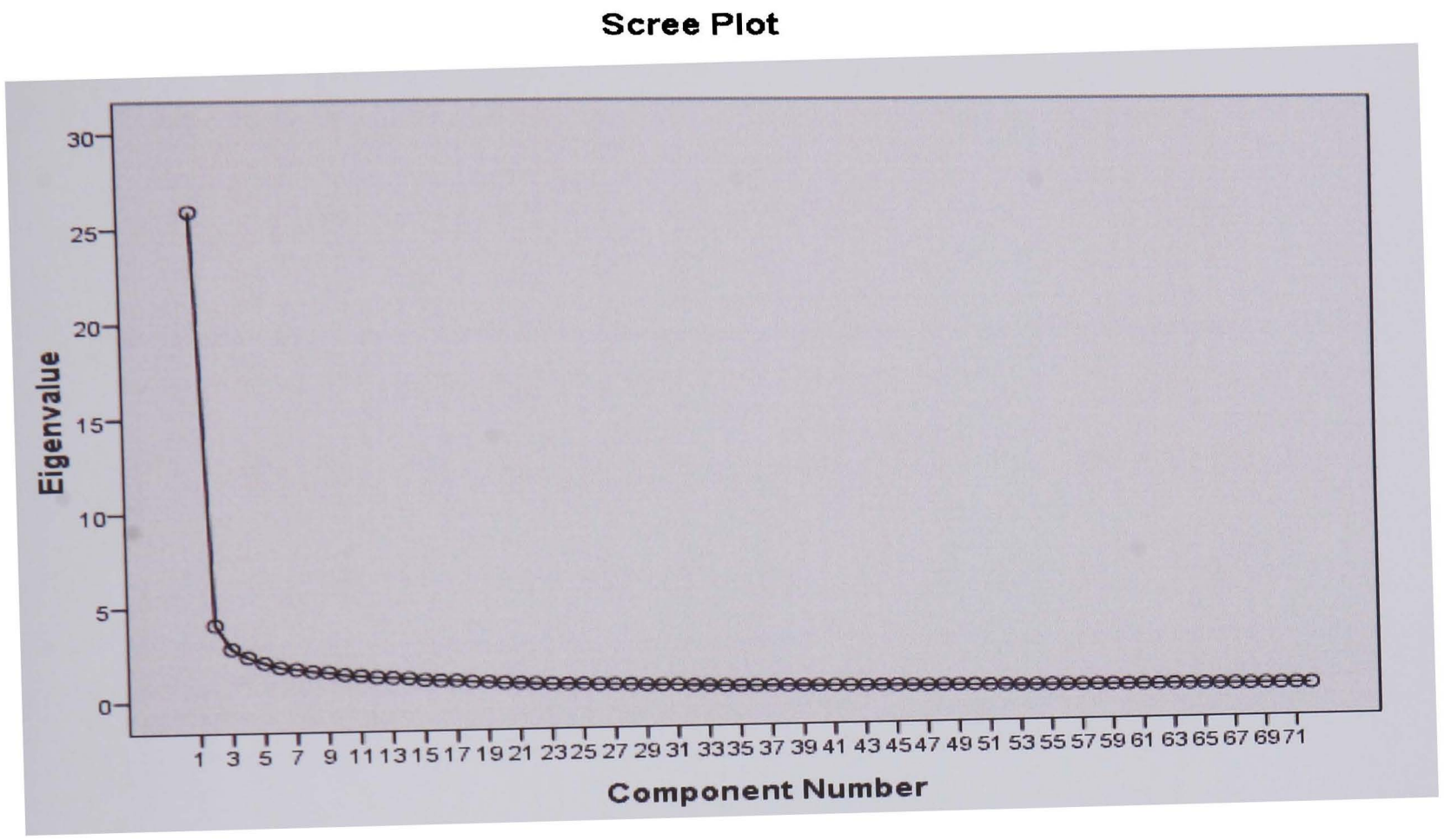

Figure 6.3:Scree test

Table 6.10: Factor Analysis of Factors that Affect Accreditation

Kaise Meyer Olki Measure of Sampling Adequacy (KMO test) = 0.902										
	Factors for establishment of laboratories' accreditation	Rotated component loadings								
		1	2	3	4	5	6	7	8	9
	Component 1 Laboratory Quality and Technical Issues (Eigen value=: 13.415)									
C18	Existing identity of equipment and its software	**.718**	.334	.024	.171	-.035	.114	.099	-.009	.149
C14	Procedure to estimate uncertainty of measurements.	**.711**	.092	.243	.008	.106	.144	.117	.027	.012
C17	Capability of equipment and software	**.709**	.380	.054	.193	-.090	.014	.004	.074	.011
C8	Investigation to determine root causes of problems.	**.709**	.140	.073	.220	-.085	.257	-.097	.210	.005
C15	Consideration given to all uncertainty components	**.704**	.104	.208	.038	.120	.088	.139	.004	-.047
C7	Policy and procedure for corrective action	**.696**	.204	.133	.182	.010	.163	-.030	.125	-.214
C13	Method proven to be fit for intended use.	**.691**	.090	.269	.039	.167	-.071	-.019	.075	.056
C19	Procedures for equipment calibration	**.682**	.094	.091	.127	.032	-.004	.091	-.024	.146
C20	Procedure for calibration of reference standards	**.652**	-.017	.279	.195	.018	-.028	.135	.123	.124
C25	Participation in inter-laboratory comparison	**.648**	.029	.288	.162	.237	.048	.123	-.093	-.084
C11	Security and confidentiality of records	**.644**	.041	.214	.049	.285	.196	-.080	-.044	.254
C9	Availability of procedures for preventive actions	**.644**	.061	.123	.178	.082	.238	.119	.287	.043

	Factors for establishment of laboratories' accreditation	Rotated component loadings								
		1	2	3	4	5	6	7	8	9
C26	Accuracy, clarity & objectivity of reported results	**.636**	.089	.156	.000	-.004	.220	.101	.249	-.173
F9	Commitment to excellent customer service	**.621**	.232	.107	-.002	.115	.263	.181	.114	-.161
C10	Procedures for quality and technical records	**.619**	.195	.021	-.007	.289	.301	.022	.117	-.004
C24	Regular use of certified reference materials	**.584**	.190	.084	.065	.021	.162	.132	.026	-.324
C6	Appropriateness of utilities to use	**.581**	.190	.296	.278	.099	.084	-.096	.155	.076
C21	Procedure for use of reference standards	**.572**	.319	-.004	.164	.238	.223	.230	-.043	.133
C23	Procedures for the disposal of test items	**.569**	.360	.167	.246	.072	.097	.117	-.027	.053
C22	Sampling plans and procedures	**.550**	.271	.111	.245	.195	.240	.030	.009	-.055
C27	Reports include information requested by client	**.548**	.190	.031	.083	.070	.116	.225	.065	-.237
F12	Established procedures are important	**.543**	.068	.142	.079	.074	.084	-.060	**.484**	.227
C16	Availability of measurements and test equipment	**.538**	**.429**	.186	.260	.088	.021	.017	.038	-.048
F13	Quality of equipment and resources to do the work	.520	.475	.184	.276	.036	-.017	-.043	.225	-.037
C5	Protection of clients confidential information	**.519**	.208	**.403**	.258	-.006	-.032	.059	-.250	-.010
F10	Continuous improvement	**.517**	.061	.212	.174	-.033	.148	.059	.399	.311

	Factors for establishment of laboratories' accreditation	Rotated component loadings								
		1	2	3	4	5	6	7	8	9
F8	Staff knowledge of ISO/IEC 17025 is sufficient	**.508**	.239	.131	.053	.147	-.013	.100	-.056	.003
C12	Schedule and procedure of periodic internal audits	**.503**	.075	**.422**	.188	.251	.116	-.012	-.005	.325
	Component 2 Communication									
D1	Communication is open in this laboratory	.194	**.744**	.107	.162	.040	.016	.184	-.099	-.092
D2	Communication with other teams in the organization	.187	**.737**	.191	.089	.105	.045	-.024	.017	-.138
C4	Protection or insulation from undue pressures.	.214	**.686**	.236	.092	.045	.185	.231	.103	.059
C2	Availability of time and resources to do the job	.233	**.678**	.167	.229	.066	.251	.066	.028	.186
D3	Information and instructions comes in a formal way	.209	**.670**	.153	.155	.179	-.118	-.108	-.006	-.263
C3	Enough space for doing all the activities	.188	**.613**	.301	.019	.158	.102	.165	.211	.205
C1	Physical conditions at work (noise, humidity etc.)	.269	**.596**	.261	.161	.142	.147	.067	.097	**.401**
	Component 3 Training and Development System (Eigen value= 5.859)									
E3	Managers train employees to use skills and talents	.176	.104	**.636**	.292	.118	.104	.100	.028	-.082
F2	Continuous quality improvement	.383	.240	**.632**	-.064	-.011	.215	.130	.025	.041
E2	Opportunities to use skills effectively in job	.170	.228	**.622**	.351	.062	.111	.082	.281	-.105

	Factors for establishment of laboratories' accreditation	Rotated component loadings								
		1	2	3	4	5	6	7	8	9
E4	Involvement in continuously improving process	.240	.247	**.622**	.201	.085	.273	.082	.015	-.043
F1	Emphasis on meeting customer needs	.384	.220	**.565**	.014	.073	.195	.158	.105	.012
B8	Effectiveness of team meetings	.212	.158	**.559**	.247	.366	-.177	-.105	.058	-.068
B7	Adjustment to new requirements	.229	**.431**	**.544**	.274	.092	-.036	.045	.051	.124
E1	Training to use a wide range of problem-solving tools	.352	.334	**.518**	.155	.087	.122	.007	.310	.001
B9	Time of talking informally to senior managers	.133	.284	**.517**	.302	.239	.007	.236	.116	.073
	Component 4 Management System (Eigen value= 4.394)									
A4	Promotion is on the basis of job performance only	.128	.158	.232	**.667**	.010	.132	-.026	.190	-.155
A3	Loyalty and respect towards employees	.279	.188	.120	**.635**	.251	.086	.202	.066	-.095
A1	Clarity of job description	.231	.218	.165	**.592**	.139	-.082	.222	.079	.040
A5	Employees rewarded for developing new ideas	.204	.324	.318	**.581**	.050	.071	.045	-.030	.165
A8	Involvement of employees in decision-making	.159	.097	.323	**.577**	.196	.258	.087	-.021	.209
	Component 5 Cultural & Social Events (Eigen value=: 3.514)									
B4	People's behaviour during meetings	.072	.164	.102	.058	.683	.075	.151	.106	.098

	Factors for establishment of laboratories' accreditation	Rotated component loadings								
		1	2	3	4	5	6	7	8	9
B3	Attendance at regular meetings	-.062	.089	.180	.191	.581	.292	.121	-.179	-.110
B5	Celebratory events	.307	.277	.316	-.016	**.529**	-.049	-.010	-.068	.100
	Component 6 Cost Reduction & Profit (Eigen value=: 3.089)									
F11	Awareness of cost	**.429**	.097	.062	.167	.168	**.543**	.129	.070	.139
F7	Quality is more important than volume of sales	.171	.029	.088	.053	-.062	**.504**	.158	-.082	.015
	Component 7 Job Satisfaction (Eigen value= 2.579)									
A12	Happy and proud to work for this laboratory	.044	.113	.121	.008	.050	.168	**.722**	.119	.174
A9	The promotion opportunities	.150	.066	.098	.268	.089	.249	**.560**	.012	-.096
	Component 8 Intensive, Rewarding and Motivations System (Eigen value= 2.273)									
A11	Financial compensation	.147	.038	.121	.150	.000	-.005	**.400**	**.633**	-.210
	Component 9 Work Environment (Eigen value= 1.900)									
C1	Physical conditions at work (noise, humidity…etc)	.269	**.596**	.261	.161	.142	.147	.067	.097	**.401**

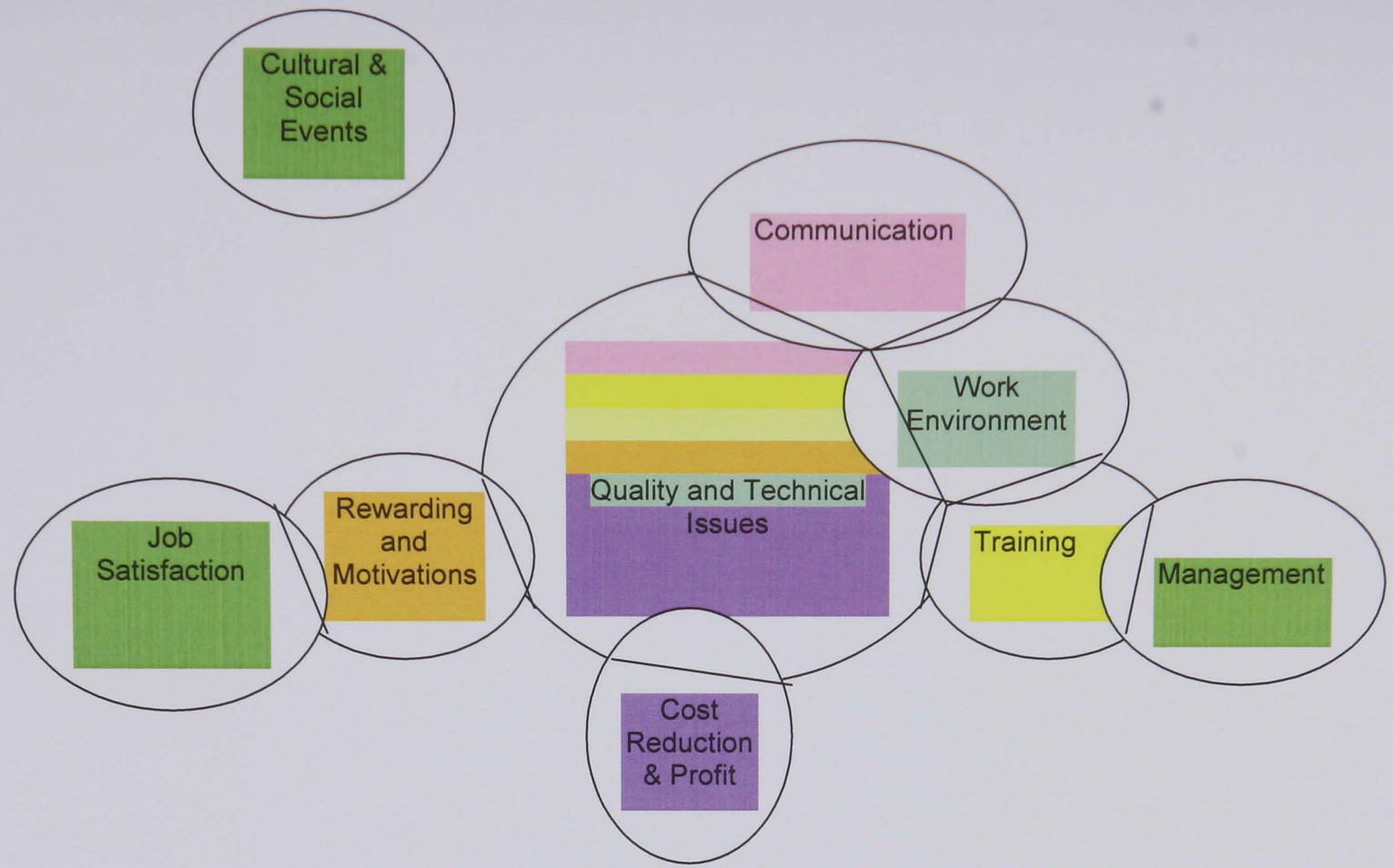

Fig 6.4: factors loaded in more than one component

6.11 Revised framework

The 72 factors were reduced to 58, by sing factor analysis. A revised frame work, consisting of these 58 factors, was produced and fed into a multiple regression model. The revised frame work is shown in Figure 6.5.

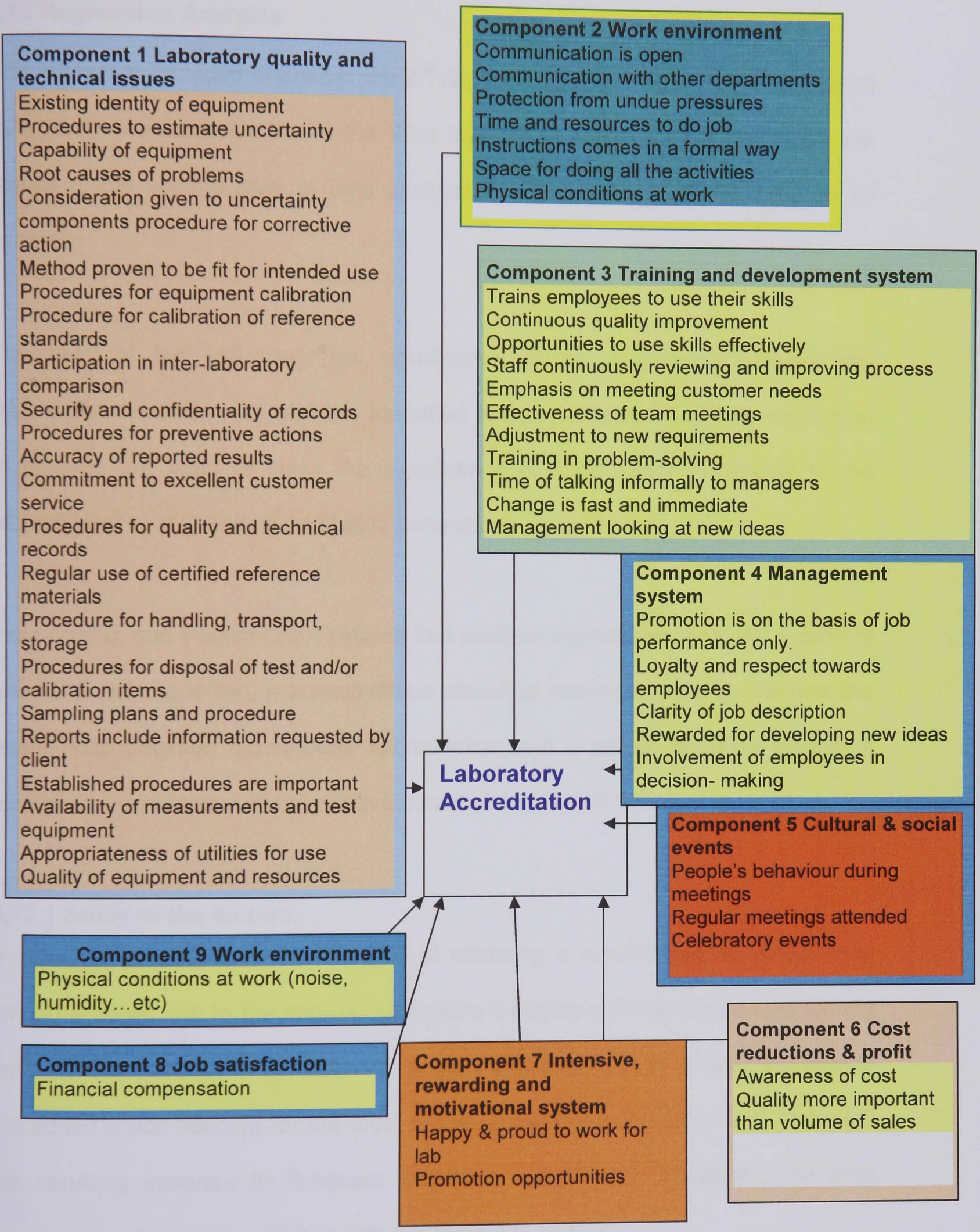

Figure 6.5: Revised framework of factors

6.12 Regression Analysis

This section is provided to answer the 2nd research question. This statistical level of data analysis is considered as the third level of testing the data, based on the results of the second level of data analysis which was the factor analysis for all variables.

This level of test will cover the significance of the relationship between the laboratories accreditation and the identified factors. Stepwise multiple regression techniques are used to show the significance of each factor in relation to the laboratories' quality and accreditation dimension.

Hair (2005), and Pallant (2001) stated that multiple regressions analysis, a form of general linear modelling, is a multivariate statistical technique used to examine the relationship between laboratories accreditation and a set of identified factors. It also gives an indication of the relative contribution of each factor.

6.12.1 Study of the factors

A stepwise procedure is one method of choosing a smaller set of factors from among a larger set. In the step up procedure it begins with the factors accounting for the most variance in the criterion factors, and then, one at a time, the factors are added which account for the most of the remaining unexplained variance, until the resulting increase in R-square becomes insignificant. Therefore, the best regression is the one associated with the largest R-square.

R-square value indicates how much the factors explain the level of variation in the factors. Thus the higher the R-square value is, the stronger the power of the factor to explain the factors in the study. The squared multiple correlation coefficients R-square indicate that the proportion of the variance of the criterion factors is accounted for by all the factors combined.

The significance of the factors as well as the significance of the overall test was indicated by the P-value, which expresses the percentage value of the probability that the coefficient of the factor is not equal to zero. In the overall study, statistical models were chosen on a significant level where P- value < 0.001 in order to give informative data about the laboratories accreditation.

Colman (2006) pointed out that, in using stepwise regression methods, setting criteria for entry and removal of factors is important, and the defaults which most analysis seems happy to use, are 0.05 probabilities for entry and 0.10 probabilities for removal.

6.12.2 Result of regression analysis

A total of 58 factors were measured in 350 cases and stepwise multiple regression analysis was applied to determine the relationships between these underlying factors in the laboratory accreditation performance. A summary of the regression results obtained from the preliminary analysis are shown in Table 6.11.

Table 6.11: Regression Analysis

	Order of variable entry	R	R-sq	ΔR-sq	Beta	t	Sig
Constant = 5.545							
F13	Quality of equipment and resources	.707	.500	.500	.058	6.365	.000
C22	Sampling plans and procedure	.818	.669	.169	.092	11.703	.000
B9	Time of talking informally to mangers	.879	.773	.104	.063	9.319	.000
F9	Commitment to excellent customer service	.918	.843	.070	.076	5.687	.000
C12	Periodic internal audits.	.934	.872	.029	.051	4.440	.000
E4	Staff involvement in improvement process	.944	.891	.019	.038	5.533	.000
C1	Physical conditions at work	.952	.906	.015	.053	10.880	.000
C8	Root causes of problems.	.959	.920	.014	.096	2.998	.000
A9	Promotion opportunities	.966	.934	.014	.023	6.168	.003
C27	Reports include information requested by client	.970	.941	.007	.047	11.998	.000

Fac.	Order of variable entry	R	R-sq	ΔR-sq	Beta	t	Sig
B3	Regular meetings	.974	.948	.007	.083	2.787	.000
F8	Sufficient knowledge of ISO/IEC 17025	.976	.953	.005	.020	7.780	.006
C14	Uncertainty of measurements	.979	.958	.005	.071	8.174	.000
A3	Loyalty and respect towards employees	.981	.963	.005	.068	3.587	.000
D3	Information and instructions comes in a formal way	.983	.967	.004	.034	7.811	.000
F2	Continuous quality improvement	.985	.971	.004	.065	6.371	.000
E1	Employees training to solve problems	.987	.974	.003	.056	7.783	.000
A12	Happy and proud to work	.988	.976	.002	.053	9.967	.000
B8	Effectiveness of team meetings	.989	.978	.002	.074	7.032	.000
C20	Calibration of reference standards	.990	.980	.002	.058	6.636	.000
F7	Quality is more important than volume of sales	.991	.981	.001	.042	6.385	.000

Fac.	Order of variable entry	R	R-sq	ΔR-sq	Beta	t	Sig
A1	Clarity of job description	.991	.983	.002	.051	4.955	.000
C10	Quality and technical records	.992	.984	.001	.045	6.931	.000
D2	Communication with other departments	.993	.985	.001	.067	5.274	.000
C15	Consideration given to all uncertainty components	.994	.986	.001	.048	5.580	.000
C2	Time and resources to do job	.994	.987	.001	.054	7.437	.000
A11	Financial compensation	.994	.988	.001	.049	6.634	.000
A8	Involvement of employees in decision-making	.994	.989	.001	.058	6.815	.000
C11	Security of records	.995	.990	.001	.049	5.114	.000
D1	Communication is open	.995	.990	.000	.036	3.861	.000

28 factors were found to have a significant association with laboratory accreditation performance at p <0.001 and R square = 0.990, as shown in Table 6.11. These factors are arranged below according to the highest beta coefficient correlation with laboratories' accreditation:

1- Root causes of problems

2- Sampling plans and procedure

3- Regular meetings

4- Commitment to excellent customer services

5- Effectiveness of team meetings

6- Uncertainty of measurements

7- Loyalty and respect towards employees

8- Communication with other departments

9- Continuous quality improvement

10- Time of talking informally with managers

11- Calibration of reference standards

12- Involvement of employees in decision-making

13- Quality of equipment and resources

14- Employees' training to solve problems

15- Happy and proud to work in the laboratory

16- Time and resources to do the job

17- Physical conditions at work

18- Periodic internal audits

19- Clarity of job description

20- Financial compensation

21- Security of records

22- Consideration given to all uncertainty components

23- Reports include information requested by client

24- Quality and technical records

25- Quality is more important than volume of sales

26- Staff involvement in the improvement process

27- Communication is open

28- Information and instructions comes in a formal way

Among all the factors, determining root causes of problems has the highest beta coefficient 0.096. Hence, it can be interpreted that determining root cause of problems is the most powerful factor of laboratory accreditation. Sampling plans and procedure has 0.092, regular meetings have 0.083, commitment to excellent customer service has 0.076, and effectiveness of team meetings has 0.074.

Consideration given to all uncertainty components Uncertainty of measurements has 0.071, loyalty and respect towards employees has 0.068, communication with other departments has 0.067, continuous quality improvement has 0.065, Time of talking informally with managers has 0.063, calibration of reference standards has

0.058, involvement of employees in decision-making has 0.058, employees' training to solve problems has 0.056, time and resources to do the job has 0.054. Both factors, happy and proud to work in the laboratory and physical conditions at work have 0.053. Both periodic internal audits and clarity of job description have 0.051. Financial compensation and security of records have 0.049. Consideration given to all uncertainty components has 0.048; reports include information requested by client has 0.047. Quality and technical records has 0.045, quality is more important than volume of sales has 0.043, staff involvement in improvement process has 0.038, communication is open has 0.036, and information and instructions comes in a formal way has 0.034. Promotion opportunities and sufficient knowledge of ISO/IEC 17025 are excluded because their significance is more than 0.001($p > 0.001$) as shown in Table 6.11.

6.13 Analysis of the third part of the survey

Based on the literature review of the major quality and laboratory accreditation issues, 19 issues were derived to construct this part of the questionnaire for this study in order to increase the reliability and validity of measures. This part of the questionnaire aimed to identify the awareness of the laboratories of each of the 19 factors as to its level of criticality in order to establish a strategy towards laboratory accreditation. Respondents were asked to rate each of the factors as to their level of importance to establish and implement accreditation in their laboratory, using the following criteria:

1-Very important or Critical factors (C) that you feel are critical and absolutely essential.

2- Important factors (I) that you feel are important but not absolutely essential.

3- Minor important factors (M) that you feel are of minor importance.

6.13.1 Frequency analysis

Table 6.12 shows the responses' distribution for accreditation factors according to their importance, by using the mode as the measure of central tendency for this level of investigation. A total of 16 quality factors were stacked on critical categories and two quality factors were included as important categories. One factor was returned as of minor importance. This factor was related to pressure from customers (see Figure 6.5). Thus, three types of modal categories were identified, that is, critical, important and of minor importance. These modal frequencies are presented in Table 6.13.

Table 6.12: Frequency Distribution of Response

Issue	C. Important	Important	M. Important
Training	286	28	31
Management commitment	227	89	34
Rapid communication	188	114	48
Technical expertise	210	87	53
Time and resources	185	111	54
Documentation process	185	105	60
Cooperation	201	97	52
International competition	186	101	63
Pressure from customers	97	117	140
Ready market	99	151	100
Government support programs	161	102	87
Effective information	201	97	52
People's bad attitude	112	145	93
Technical experience	200	92	58
Resistance to new responsibilities	141	122	85
Managers as motivators	175	102	73
Financial capacity	182	94	74
Appropriate technology	190	98	62
Awareness of accreditation	151	122	73

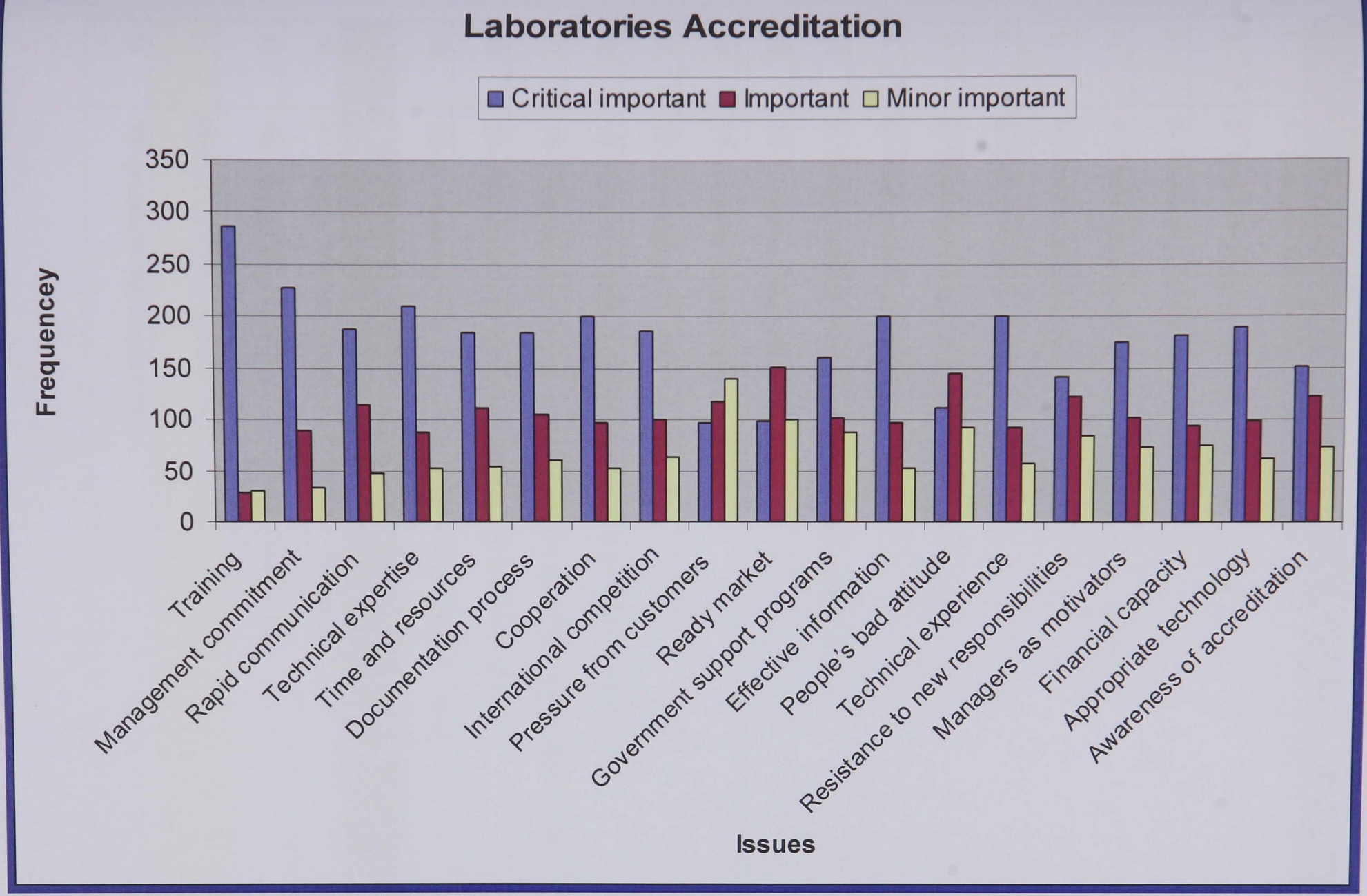

Figure 6.6:Frequency Distribution of Respondents

Table 6.13: Quality Factors Modal Category

Issue	Modal category- Critical
1	1- Training and education of employee
2	2- Top management commitment and involvement
3	3- Rapid and effective communication
4	4- Technical expertise on ISO 17025 implementation
5	5- Time and resources
6	6- Documentation process
7	7- Cooperation and commitment of work force
8	8- International competition
11	9- Governmental support of accreditation programs
12	10- Effective information
14	11- Experience amongst managers
15	12- Resistance to new responsibilities
16	13- Role of middle managers as transmitters of information
17	14- Financial capacity to meet the accreditation implementation cost
18	15- Appropriate technical knowledge amongst workers
19	16- A awareness of accreditation at the management level
	Modal category – important
10	17- Ready market and poor competitive environment
13	18- People's bad attitudes towards accreditation
	Modal category- minor importance
14	19- pressure from customers

6.13.2 Variation ratio

Using the variation ratio will help to separate the quality factors with majority consensus from other quality factors with no majority consensus as perceived by some respondents as of no consequence to the success or failure in the implementation process of a quality programme such as accreditation. Variation ratio can be calculated from this equation

Variation ratio = (100 – Mode frequency) / 100

Table 6.14 shows the computed variation ratio for the 14 accreditation factors returned by respondents as critical. The variation ratio values identified the 14 accreditation factors as having majority consensus (those with variation ratio values greater than 0.5). The findings, therefore, represent the fundamentals to build the stratified structure of the critical quality factors.

Table 6.14: Variation Ratio of Factors from Mode Frequency

Accreditation Issues		Variation ratio	Mode. Freq.
1	1- Training & education of employee	0.183	0.817
2	2- Top management commitment	0.363	0.637
4	3- Technical expertise on ISO 1702	0.423	0.577
7	4- Cooperation of work force	0.431	0.569
12	5- Effective information	0.437	0.563
14	6- Experience amongst managers	0.440	0.560
3	7- Rapid and effective communication	0.474	0.526
5	8- Time and resources	0.480	0.520
6	9- Documentation process	0.486	0.514
8	10- International competition	0.489	0.511
17	11- Finances to meet accreditation costs	0.489	0.511
16	12- Role of middle managers as motivators	0.500	0.500
11	13- Governmental support for programmes	0.557	0.443
15	14- Resistance to new responsibilities	0.603	0.397

6.13.3 Stratification of the identified critical quality issues

Using the range and the variation ratio provided an opportunity for objective judgment in the process of ordering and stratifying the critical issues, just as the mode did in the identification of these accreditation issues. Sorting and ordering these quality issues according to the level of consensus is measured by the

variation ratio, which shows how descriptive the mode is of the responses. Having identified the critical issues using the modal category, and developed the hierarchical structure using the variation ratio, the stratification of these critical issues becomes essential. Stratification of the quality issues, therefore, describes the identified accreditation issues with regard to their degree of impact in the successful implementation of a quality programme and applies a prioritization process to these quality issues according to their perceived criticality.

Table 6.15 presents the accreditation issues ranked in a descending order by their frequency distribution of the mode and the range of these issues. The criteria to be used in the stratification process are as follows:

Critical accreditation issues stratified in the first tier are those that have frequency distribution of the mode more than 75%, and this issue is training. Critical accreditation issues stratified in the second tier are those that are have frequency distribution of the mode between 60-74% and this issue is Top management commitment.

Critical accreditation issue stratified in the third tier, are those that are have frequency distribution of the mode between 55-64% and these issues are: expertise on ISO/IEC 17025; cooperation of work force; effective information; and the experience amongst managers. Critical accreditation issues stratified in the fourth tier, are those that are have frequency distribution of the mode between 50-54% and these issues are: effective communication; time and resources; documentation process; international competition; finance for accreditation; and

role undertaken by middle managers. Critical accreditation issues stratified in the fifth tier are those that are have frequency distribution of the mode less than 50% and these issues are: governmental support and resistance to new responsibilities

.

Critical accreditation issues stratified in the first and second tiers are those issues that are essential to successful laboratory accreditation implementation as perceived by the vast majority of respondents. Training and top management are issues that would impact on the successful implementation of laboratory accreditation.

The third and forth tiers are those issues perceived as absolutely essential by the majority of the respondents; while some respondents perceive them to be of no consequence with regard to the success of laboratories' accreditation.

Fifth tier includes two issues, which are arranged in order of their majority consensus level as perceived by the respondents as shown in the Table 6.15

Table 6.15: Accreditation issues' Clusters

Accreditation Issues		Variation Ratio	Mode Freq.	Sat. tier
1	1- Training of employee	0.186	0.817	1
2	2- Top management commitment	0.363	0.637	2
4	3- Expertise on ISO 17025	0.423	0.577	3
7	4- Cooperation of work force	0.431	0.569	3
12	5- Effective information	0.437	0.563	3
14	6- Experience amongst managers	0.440	0.560	3
3	7- Effective communication	0.474	0.526	4
5	8- Time and resources	0.480	0.520	4
6	9- Documentation process	0.486	0.514	4
8	10- International competition	0.489	0.511	4
17	11- Finance for accreditation	0.489	0.511	4
16	12-Role undertaken by middle managers	0.500	0.500	4
11	13- Governmental support	0.557	0.443	5
15	14- Resistance to new responsibilities	0.603	0.397	5

6.14 Analysis of the fourth part of the survey

This part of the questionnaire aimed at identifying the awareness of laboratories as to the importance of a quality system for their industries' sector development, and to observe the laboratory employees' attitude towards accreditation and ISO/IEC 17025 implementation. Frequency distribution is most appropriate for the data analysis as it allows the responses' distribution for a variable to be summarized by computing the typical value (point of central tendency). Table 6.16 shows the responses' distribution concerning the awareness of laboratories' employees towards accreditation.

6.14.1. The situation of quality activities in the investigated laboratories

The respondents were asked about the situation concerning quality activities in the investigated laboratories. It can be seen from the pie chart in Figure 6.7 that 54.6% of respondents that answered stated that their laboratories had a quality system, 40% of respondents who answered indicated that their laboratories did not have a quality system. 5.4% of the respondents did not answer the question.

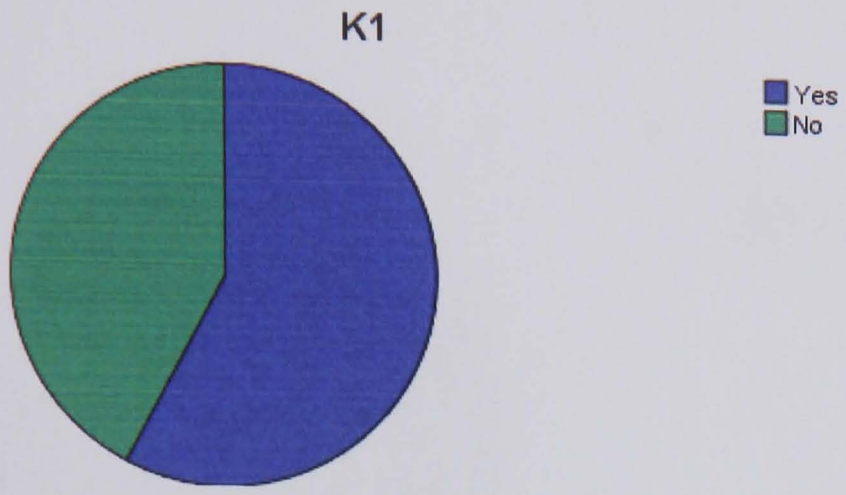

Figure 6.7: The situation of quality activities in the investigated laboratories

6.14.2. Availability of ISO/IEC 17025 Documentations

The respondents were asked whether their laboratory had a copy of ISO/IEC 17025. 83.1% of respondents who answered stated that their laboratory did not have a copy of ISO/IEC 17025. Only 11.4% of respondents that answered stated that their laboratory had a copy of ISO/IEC 17025, and 5.4% of respondents did not answer the question

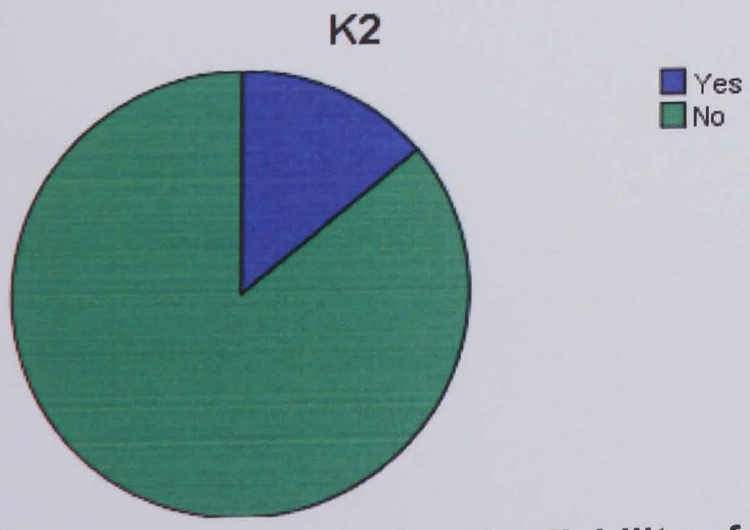

Figure 6.8: Pie Chart showing Availability of a Copy of ISO/IEC 17025

6.14.3 Improving Libyan industries by accreditation

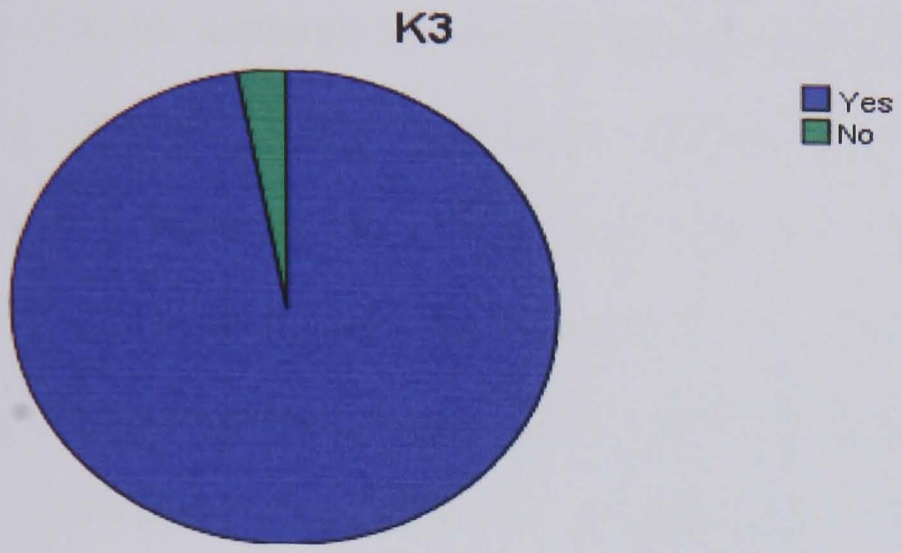

Figure 6.9: Accreditation as a Tool to Improving Libyan Industries

The respondents were asked concerning whether they believed that laboratory accreditation would improve Libyan industries. 96.9% of respondent who answered stated that laboratory accreditation would improve Libyan industries.

It can be seen from the above analysis that generally all the respondents considered that the implementation of laboratories' accreditation is important to Libyan industries.

6.15 Conclusion

This chapter shows the different techniques and considerations of data analysis and identifies the factors that affect the establishment of laboratory accreditation.

The first section illustrated the description of the method, which contributes to accuracy and provides reliability and validity. The second section tested the factors in order to reduce the overlapping of measured factors to a smaller set of factors. The third section explored the relationship between (laboratories' accreditation) and a number of factors. The fourth section dealt with the awareness of laboratories of each of the factors that affect the establishment of laboratory accreditation, including each factor's level of criticality in order to establish a strategy towards laboratory accreditation. The fifth section looked at the awareness of the laboratories concerning the importance of a quality system for the development of their industries' sector.

The next chapter will discuss the test results of the factors that affect laboratory accreditation. It will also discuss the test results of the relationship between the other factors which affect laboratory accreditation.

CHAPTER SEVEN:

DISCUSSION

7.1 Introduction

In this chapter the results of the research from the survey questionnaire presented in the previous chapter will be discussed. An interpretation of the findings will be derived from the quantitative data obtained in this study. This will lead to an understanding of the factors that affect the implementation of accreditation in Libyan chemical and petrochemical laboratories.

This research recognizes that there are many factors that could affect the establishment of industrial laboratories' accreditation and quality issues in Libya. Some of these factors may not have been identified in the existing literature on laboratories' accreditation and quality issues, as most of this previous research has been conducted in developed countries.

A preliminary review of the literature, as described in chapters three and four, suggested that it may be useful to have a study undertaken in a developing country looking at the factors that affect the implementation of quality programmes, (which is the basis of much of the research into implementing quality). However, the study may need to be extended to include specific issues of culture, training, communication, and quality service within the laboratories.

As indicated in chapter one, the research problem is that the testing and calibration in the laboratories within the chemical and petrochemical industries in Libya need to be accredited according to international standards in order to prove their competence and reliability to perform specific types of tests or calibration in order to lower the country's barriers to international trade.

In the absence of internationally recognized accredited facilities in Libya, tests and certificates carried out in the exporting country (Libya) would have to be repeated by a recognized laboratory and or certification body in the importing country.

The main research question addressed in this thesis has involved the need to identify and understand the factors that affects the establishment of laboratories' accreditation. There was no previous study that identified the factors that affect the establishment of laboratories' accreditation in Libya the study was

Therefore, undertaken with the primary aim of identifying, examining and providing an understanding of the factors that affect the establishment of laboratories accreditation in Libya. This was done in order to provide solutions to the problem of the lack of laboratories' accreditation within the country. These findings may lead to solutions that assist in setting up laboratories' accreditation according to an international requirement such as ISO /IEC17025.

7.2 Data collection methods and statistical techniques

Chapter six answered the research questions by identifying the factors that affect the establishment of laboratories' accreditation and the relationship between these factors and laboratories' accreditation.

The researcher aimed to develop an overall frame work describing the impact of management, technology, quality, training, culture and communication on laboratories' accreditation.

7.3 Discussion of the findings

In this part of the study we will draw some general conclusions about the significant relationships regarding each of the factors with laboratories accreditation. According to the findings from the respondents as given in the chapter six, the result showed that all factors are shown to be important, each with a different degree of importance, the level of importance varies from one factor of criteria to another.

The management, culture, technical, communication, training, and quality factors have been tested by asking the respondents in the first part of the survey 72 statements related to these factors which constituted the Likert scale used in measuring the respondents' attitudes and opinions about the affect of these factors in establishing laboratories' accreditation

The following sections discusses the results of different parts of questionnaire with reference to the establishment of laboratory accreditation in Libyan chemical and petrochemical industries, and hence, recommendations and areas for improvements.

7.3.1 Discussion the results from the factor analysis and stepwise regression

In order to answer this research questions, factor analysis was used to identify the factors that affect the establishment of laboratories accreditation in Libya chemical and petrochemical industries, and stepwise multiple regressions were used to determine the best model of laboratories accreditation utilization in Libya chemical and petrochemical industries.

The results of the factor analysis and multiple regressions involved 9 components containing 28 factors that are supposed to explain all factors and represent them, these components are:

Technical and quality component

The biggest challenge that faces an organisation is to offer a certain level of quality that meets individual requirements (Schneider, et. al., 1980).

Several studies have asserted that the difficulties in implementing quality programmes are related to the lack of quality and technical knowledge and a shortness of skilled personnel to implement these activities. Technical and quality factors have been tested in the first part of the survey.

Among all the technical and quality factors, the most important factors to establish Libyan chemical and petrochemical laboratories accreditation are: investigation to determine the root cause of the problem; sampling procedure; uncertainty of measurements in testing and calibration; calibration of reference standards; utilities always available and fit for purpose; capability of equipment and software is of the required accuracy; time and resources to do the job; periodic internal audits; security of records; reports requested by client, quality of technical records; quality is more important than volume of sales; continuous quality improvement; quality of equipment and resources.

Determine the root cause of the problem has the highest beta correlation coefficient 0.096, the beta correlation coefficient for all the rest of the factors was more than 0.046 as shown in Table 6.11. This finding is similar to, Oakland (1989); Dzus (1993), Olsen (1994) and McCullough (1995) Lipovatz et al. (1999); and Michael et al. (2007) who have suggested that the major barriers that cause an organisation to continue to fail in achieving quality are a lack of understanding of technical ISO requirements and the difficulties in implementing the corrective and preventive actions, documentation and data control, internal quality audits, quality systems and management systems and statistical methods

Communication factor component

Researchers have continually emphasised that the lack of communication between departments in an organisation is one of the most common barriers in quality standard implementation. The study showed that all respondents were not satisfied

with all the factors that were extracted by factor and regression analysis. *Communication factors* were tested in the first part of the survey by giving the respondents three statements related to communication factors. These statements were concerned: open communication channels upwards and downwards and the internal communication system.

Open communication system had beta correlation coefficient 0.036. Information and instructions comes in a formal way had beta correlation coefficient 0.034, and the beta correlation coefficient was 0.067 for communication with other teams.

These findings were in line with other researches findings. Rapid and effective communication; feedback; recognition of efforts made, results achieved, were found to be critical success factors by the research which was carried out by Process Quality Associates Inc (PQA) (2009).

Similarly, Al-Zamany et al. (1996) pointed out that in public Yemeni organisations there has been a lack of effective communication from top to bottom and vice versa. This happened because of a lack of trust between persons and the difficulties found by employees in having discussion with managers about issues relating to quality

Training and Development System component

The training factor has been tested by the responses from four statements in the first part of the survey, which used the Likert scale in measuring the respondents' attitude and opinions about training in order to establish laboratories' accreditation.

This study revealed a significant, positive relationship between the attitude towards employee training and the establishment of laboratories' accreditation in Libyan chemical and petrochemical industries. Two factors were extracted from the factor and regression analysis, as shown in Fig 7.1. These factors were employees given training to solve problems and employee involvement in improvement process. The result shows that given training to solve problems has beta correlation coefficient 0.056 and for the involvement of staff in the training and improvement process the correlation beta coefficient was 0.038.

This finding was in line with other author findings. Ashire and O'Shaughnessy (1998) and Wong (1998) concluded that the lack of a real understanding of the principles of quality programmes (due to a lack of training and education to develop a quality mindset within the work force especially within the leadership) led to the failure of many of the quality programmes being implemented in developing countries. This failure was because of a lack of effective management to organize and plan effective training programmes; problems being causes by such issues as an incompatible training programme for a particular trainee and lack of training resources.

Adequate employees' training such as short courses and seminars is vital, especially in Libya. Several recent studies have revealed that training and education are critical to successfully implement any quality programme such as laboratories' accreditation.

Management factors component

Three factors were extracted from the factor and regression analysis. These factors were: loyalty and respect towards employees, involvement of employees in decision-making, and clarity of job description.

The results from stepwise regression indicated that there is a positive relation between laboratories accreditation and management factors. The findings from the stepwise regression (as shown in the previous chapter) indicated that loyalty and respect towards employees has the greatest beta correlation coefficient (0.068) with laboratories accreditation. The beta correlation coefficient of involvement of employees in decision-making was 0.058, and for the Clarity of job description, was 0.050.

The findings indicate the respondents revealed that *the management factors* are very important to their laboratories in order to achieve the accreditation according to international standards such as ISO/IES 17025. This finding was similar and supported the finding carried out in Syria and Yemen by, Al-Zamany (2005),who pointed out that the lack of top management commitment is a barrier in Syrian and Yemeni organizations. This is because of the effect of a lack of effective leader and employee cultural belief systems in many Middle Eastern countries. This indicated that the management factors are very important factor in Libya similar as other developing countries.

Culture Component

Several studies assert that culture plays a significant role in Quality programs (Kochan, 1993; Kekale and Kekale , 1996; and Oliver, 2007). Cultural beliefs are key variables in the success or failure of quality and technology acceptance (Straub, et al., 2002). This is due to the fact that the adoption and use of new technologies vary in different social and cultural contexts.

Many items related to the Culture were tested in the first part of the survey. These items included: the relationship with supervisors, relationship of individuals and groups, the behaviour in regular meetings, the celebration of events; difficulties in adjusting to a new requirement, cooperation between different departments, and the amount of time that managers spend talking informally to employees. Among these items three were extracted, by using factor and regression analysis. These were: regular meetings which had the beta correlation coefficient 0.092; effective team meetings which, had beta correlation coefficient 0.074, and time to talk informally to employees had beta correlation coefficient 0.063.

This finding is consistent with other author findings. Sayeh (2005) commented that if a quality programme was to succeed in Libyan organisations there were many factors within the culture that should be taken into consideration such as building team work, decentralisation of decisions, opportunities for growth and development.

Cultural factors are a significant point of difference between people in the Middle East and those in the developed countries, and so it is important to study the cultural variables that foster and impede the adoption of new technology such as laboratories accreditation. So many researchers continually emphasize the importance of culture to the success of Quality program.

Cost reduction and profit

Quality costs are the costs associated with preventing, finding, and correcting defective tests, costs that result from poor quality, such as the cost of dealing with customer complaints, staff training, requirements analysis...etc, These costs are huge, many of these costs can be significantly reduced or completely avoided.

Two factors related to the cost issues were extracted from the factor and regression analysis. These factors were: Awareness of cost and Quality is more important than volume of sales. The beta correlation coefficient of this factor was 0.042. This finding was similar and supported the finding by Crosby (1984) who said that the establishment of procedures to calculate quality costs is not desirable. The quality function requires those costs to be small and to be related only to the manufacturing system. The laboratory has to set procedures for calculating quality costs properly and objectively.

Job satisfaction component

Job satisfaction is in regard to one's feelings or state-of-mind regarding the nature of one's work. Job satisfaction can be influenced by a variety of factors, e.g., the

quality of one's relationship with their supervisor, the quality of the physical environment in which they are works, degree of fulfillment in one's work, etc.

Two factors were extracted from the factor and regression analysis. These factors were: Happy and proud to work for laboratories, and promotion opportunities, the beta correlation coefficient of proud to work for laboratories was 0.053. This finding was similar and supported the finding carried out in developing countries studies by Oakland (1989), Zairi (1996) and Liang (1997) who concluded that management factors have a important impact on the adoption of decisions within quality programmes. These management factors being such as middle management must explain the importance of quality to the employees for whom they are responsible, and respect and motivate them.

(To my knowledge, there is no strong acceptance among researchers, consultants, etc., that increased job satisfaction produces improve job performance -- in fact, improved job satisfaction can sometimes decrease job performance. For example, you could let sometime sit around all day and do nothing. That may make them more satisfied with their "work" in the short run, but their performance certainly didn't improve.)

Motivation and rewards component

Motivation is a behavior that individuals can influence but not create. Even highly motivated individuals can get frustrated, discouraged, or tired on a project. Team members need to know they are valued, their efforts are noticed, and their good

work is appreciated. each employee is different and motivated or rewarded by different things.

This study revealed a significant, positive relationship between the rewarding and the establishment of laboratories' accreditation in Libyan chemical and petrochemical industries. The results show that financial compensation has beta correlation coefficient 0.049.

Work Environment Component

It makes sense that people that are happy within their working environment will work far more effectively and happily than those who are uncomfortable: it therefore makes sense to consider certain aspects, such as noise, ventilation, temperature, lighting ...etc, of laboratories employees' workspace quite carefully.

The operators were not satisfied about the physical conditions at work such as, noise, humidity etc, which had a correlation coefficient 0.053. This finding is unique as it has not been found in the literature review. So these research findings revealed that work environment such as, physical conditions play a role in Libyan organisation management

.

7.3.2 Discussion of the results from frequency analysis for the third part of the survey.

The respondents were asked to rate each of the issues as to their level of importance in establishing and implementing accreditation in their laboratories. In

the second part of the questionnaire, in order to increase the reliability of the results, the respondents were asked in other ways to categorise the quality factors according to their importance.

The study showed that 81.7% of respondents stated that the training factor is the first essential important factor to laboratories accreditation. 63.7% of respondents consider top management commitment as second essential critical factor to any quality programme. The study also showed that cooperation of the work force, effective information, experience amongst managers factors are the third important factor to laboratories accreditation by 55% respondents, as shown in Tables 6.14 and 6.15.

More than 50% of the respondents identified communication, time and resources, documentation, competition finance and role of middle managers as the forth important factors to laboratories accreditation. The research also showed less than 50% of respondent's ranked Governmental support and resistance to new responsibilities as the fifth factor to laboratories accreditation. Also the study showed the experience amongst managers as important in implementing laboratory accreditation.

According to the findings from the respondents as given in the tables 6.14 and 6.15, the result showed that, although all issues were important to laboratories accreditation, the majority of the respondents classified training issues as critically essential to chemical and petrochemical laboratories accreditation, followed by Top management commitment.

This result was consistent with those found by Mohanty (1994), Ngai and Cheng (1997), and Al-Zamany (2005), who said that lack of top management commitment , and inadequate training facilities were one of the major problems faced by developing countries..

7.3.3 Discussion of the results of the degree of employee's satisfaction.

The respondents were asked to rank the level of satisfaction degree about management, culture, technical, communication, training, and quality factors in order to assess the readiness of laboratories to get accreditation.

As can be seen from Table 6.6, most of respondents were satisfied with the most items that related to all factors, except involvement of employees in decision-making, rewards system, social events, meetings, talking informally to managers, work environment, communication and information system.

These points support the literature, backing up the points that have been emphasised in other studies. Although all employees should not be involved in all decisions, but should be involved in some decisions which relate to some issues such as, technical and culture ones.

According to the findings from the respondents as shown in the previous chapter Libyan chemical and petrochemical manufacturing laboratories mangers should take these items in their consideration for many reasons. These reasons are: to improve the laboratories quality system efficiency; for continual improvement; to improve the quality of products and services; to improve the laboratories

productivity; to improve customer satisfaction; to improve the organisation's documentation process; to improve the organisation's image; in order to stay in business; to improve/increase the competitive advantage of the laboratories; to provide a stepping stone towards ISO/IEC 17025.

7.3.4 Discussion of the results from the fourth part of the survey

According to the findings from the respondents as given in the Chapter Six, the result showed the following points. Regarding to the situation of quality activities in their laboratories, 54.6% of respondents stated that their laboratories had a quality system. It is clear that the quality system in Libya is a new concept. Although ISO 9000 registration started in Libya in 1999 with the General Electrics Company, most of the companies have only recently achieved certification to ISO 9001:2000. None of them have get ISO/IEC 17025 up to now since 2005. In Jordan, for comparison, Al-Maid (2005) found that ISO 9000 registration in the country started in the middle of 1990s. This comparison implies that the adoption of a quality program s very recent in Libya even in comparison with other developing countries.

Another finding covered the availability of quality document such as ISO/IEC 17025 from the fourth part of the survey respondents was asked whether their laboratory had a copy of ISO 17025. 83.1% of respondents who answered stated that their laboratory did not have a copy of ISO 17025, which mean lack of quality awareness among laboratories managers

.Regarding whether laboratory accreditation would improve Libyan industries or not, 96.9% of respondents stated that laboratory accreditation would improve

Libyan industries, According to the findings from the respondents as shown in the previous chapter, Libyan laboratories should implement the laboratories accreditation system for many reasons as it will improve Libyan industries.

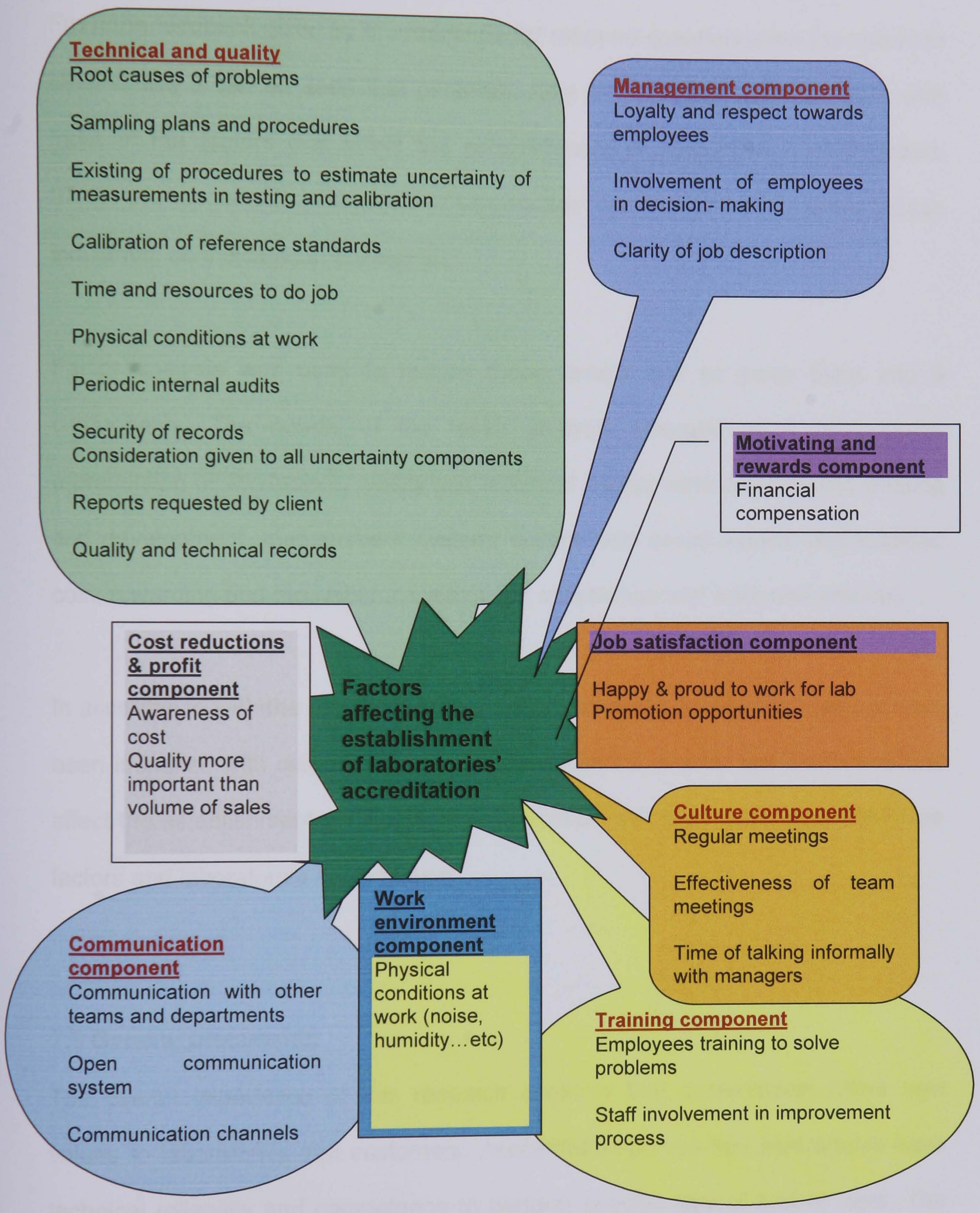

Figure 7.1:Factor and Regression Analysis Findings

7.4 Establishment of laboratories' accreditation and ISO /IEC 17025

From the feedback given by the respondents' returned questionnaires (as shown in chapter six) it can be seen that generally most of employees were satisfied with most of the factors that affect the establishment of laboratories' accreditation. 97.1% of respondents indicated that laboratories' accreditation will improve Libyan industries, as indicated in chapter six.

Factor analysis was used to reduce those factors and to group them into 9 components. The results of the factor analysis emerged as 9 components representing all the factors: quality and technical issues; work environment; training and development; management system; cultural and social events; accreditation cost; rewarding and motivational system, job satisfaction and work environment.

In accordance with the results of the regression analysis, twenty-eight factors have been identified with respect to the research questions of what are the factors that affect the establishment of laboratory accreditation, and the relation between these factors and laboratories accreditation.

7.5 General discussion

The overall experience of this research confirms that accreditation offers new values to laboratories and customers. Accreditation proves that laboratories have technical reliability and competence to perform specific type of test or tests. The

greatest benefit of accreditation in developing countries is to improve economic development because it reduces technical barriers to trade.

Accredited certification is the tool by which products can penetrate foreign markets, because technical barriers to trade are reduced, quality is increased and thus exports improved. Accreditation, in itself, can instil confidence in a customer in a laboratory's competence and reliability.

The findings of this study imply that respondents are very concerned about the importance of technical factors in establishing laboratories' accreditation and the following are considered to be of major importance: training, determination of the causes of problems, meeting customer needs, commitment to excellent customer services, resources and equipment to do the jobs, the availability of utilities and their fitness for purpose, procedures for sampling and the capability of equipment to provide the required accuracy.

Therefore, laboratories should ensure that those factors such as equipment, utilities and other related technology are available, properly developed and fit for purpose. The majority of respondents were concerned about training and about inefficient quality programmes these are further major factors affecting the establishment of laboratories' accreditation. Top management has concentrated on production.

The majority of respondents considered that the accreditation would improve Libyan industry. Therefore, all levels of management and employees should make

laboratories' accreditation the main goal of any employee they should attempt to establish accreditation and emphasize the usefulness of laboratories' accreditation according to the international standards, in order to improve productivity and the quality of products, and the development of the economy and industries.

7.6 Conclusion

This chapter focuses on the discussion of the research results from the survey questionnaire which were presented in the previous chapters. This chapter discussed the test results of the factors that affect laboratory accreditation and also discussed the test results of the relationship between the factors which affect laboratory accreditation in order to gain an understanding of the factors that affect the establishment of accreditation in Libyan chemical and petrochemical laboratories.

The next chapter will discuss how the research aim and objectives were met, the contribution to the existing knowledge and the originality of the research, the research findings, the research limitations and the recommendations for future work

CHAPTER EIGHT

CONCLUSION AND RECOMMENDATIONS

8.0 Introduction

In this chapter, the researcher will conclude with the main points carried out in the whole work and discuss the research results, how the research aim and objectives were met. The researcher will revisit the research questions, the contribution to the existing knowledge and the originality of the research, the research findings, and the research limitations and will finally present the recommendations for future work.

8.1 Conclusions

Today, due to lack of accreditation, multiple testing and certification requirements incur extra charges and much time spent upon the process. Accreditation to an international standard, such as ISO/IEC 1725, is of major importance to indicate the technical competence of laboratories and the reliability of their test results, the major key to the lowering of international trade barriers is accreditation.

The broad aim of this research study was to find out the effect of management, technical, communication, quality and training factors, as well as cultural factors, on the establishment of accreditation of laboratories in the Libyan chemical and petrochemical industries.

Many studies such as Baidoun and Zaire (2003) mentioned that, regardless of the quantity of research and the number of publications in this area, little study has on this aspect been carried out in the Arab world. The procedures and practicalities in setting up laboratories' accreditation such as, assessment of laboratories' capability, ISO/IEC 17025 requirements, laboratories' accreditation definitions, the background and evolution of accreditation, the purpose of laboratories' accreditation, accreditation in the Arab region, laboratories' accreditation in Libya, factors affecting the establishment and implementation of quality programmes were all discussed in relation to laboratories' accreditation in order to identify the factors that affect the establishment of the Libyan chemical and petrochemical industries laboratories.

How can the result of this research assist the Libyan chemical and petrochemical industries' laboratories to get a clear picture of its current problems and future actions? Throughout this thesis, the factors that affected the establishment of laboratory accreditation in the Libyan chemical and petrochemical industries have been identified.

Based on the factors pointed out by many researchers, as outlined in chapters three and four, and some factors raised from the pilot study and phone interview, it obvious that there are many factors affecting the establishment and implementation of laboratories' accreditation and quality issues, For example, Zhao et al., (2000) stated that technical and management factors such as material, time and resources, and technical knowledge are important factors in establishing

quality and accreditation, Also, Koch (1993) pointed out that an organisation needs to develop an efficient quality programme and also needs to consider the differences in culture.

Wong (1998) stated that a lack of training in order to develop a quality mindset led to failure in many of the quality programmes implemented in developing countries. In addition, Oakland and Porter (1994) mentioned that listening to customers and trying to satisfy their needs are important factors to bring about a quality programme.

Based on the literature review, there are points which supported the originality of this research. These important points are:

1. The shortage of studies in general in this area which indicate the barriers faced by laboratories in ISO /IEC17025 standards' implementation Not one of those studies was carried out in any Arabic laboratories. This supports the originality of this research and adds another contribution to the knowledge.

2. All the Arabic studies stated that organisations in Arabic countries come across two similar barriers; a lack of understanding of ISO standards and a lack of adequate training to implement ISO standards.

3. UNIDO (2005) assessed the Libyan IRC for compliance with ISO/IEC 17025 and found that such aspects as calibration of equipment, internal audits, control of nonconforming testing, and undertaking management reviews were not at all addressed, while other aspects were understood only a little and the knowledge and understanding of most of the technical and management requirements for laboratories' accreditation was poor. This also supports the originality of this research and adds another contribution to the knowledge.

This research study was undertaken to provide a better understanding of the impact of management, technical, cultural, quality, communication and training factors on laboratory accreditation. This study was conducted to support decision-makers in pinpointing the most important factors that affect the establishment of laboratories' accreditation.

The research approach was based on a provisional questionnaire, phone calls interviews, and a questionnaire. The study sample was selected according to Tabachnick and Fidell (1996) it is comforting to have at least 300 cases for factor analysis. In order to ensure a satisfactory sample size and to allow for possibility of spoiled returned questionnaires.

400 were employees selected randomly from the chemical and petrochemical laboratories in Libyan industries. Coding was applied to all the data that was collected before the statistical analysis. Certain statistical techniques such as

descriptive analysis, factor analysis, and regression were used in the statistical analysis of the data.

The data tests went through three stages i.e. the judgements of the operator personnel by listing their opinions on each element; factor analysis to reduce none important factors; the final stage was regression to see the relationships between laboratories accreditation and the factors that affect in accreditation.

The research findings indicated that the majority of the technical factors showed significant values in the factors affecting the establishment of laboratories' accreditation. The eleven main significant technical factors identified were: Root causes of problems; Sampling plans and procedures; Uncertainty of measurements; Calibration of reference standards; Time and resources to do the job; Physical conditions at work; Periodic internal audits; Security of records; Consideration given to all uncertainty components; Reports requested by client; and Quality of the technical records

The research findings indicated that many specific management factors showed significant values in the factors that affect the establishment of laboratories' accreditation. The five variables that had a significant effect on the establishment of laboratories' accreditation were: Loyalty and respect towards employees; Involvement of employees in decision-making; Employees were happy and proud to work for laboratories; Clarity of job description; and Job satisfaction.

The findings showed that the three communication factors that had the most significant effect on establishing laboratories' accreditation were: Communication with other teams and departments; open communication system; and Communication channels, for example, information and instructions coming through a formal communication channel. The significant cultural factors that had the most effect on the establishment of laboratories' accreditation were: Periodic meetings; Effectiveness of team meetings; and Time spent talking informally to managers.

The research findings indicated that many specific quality factors showed significant values in the factors that affect the establishment of laboratories' accreditation. The four variables that had a significant effect on the establishing laboratories' accreditation were: Commitment to excellent customer services; Continuous quality improvement; Quality of equipment and resources; and the belief that quality was more important than the volume of sales.The findings showed that the following two training factors had the most significant effect on establishing laboratories' accreditation: Training of employees to solve problems; Staff involvement in the improvement process

It can be concluded from the discussion of the findings that the research findings highlighted that some of the reasons, benefits and barriers in establishing laboratories' accreditation in the Libyan chemical and petrochemical industries are similar to other studies' findings across the world. Most of the identified problems in establishing Libyan laboratories' accreditation are related to a lack of

understanding of the ISO/IEC 17025 standard, to a lack of awareness of quality, and to a lack of knowledgeable personnel understanding ISO/IEC 17025 standards and QMS. There are also no local accreditation bodies in the country. The research also showed the importance of training programmes related to ISO/IEC 17025 standards in establishing and implementing effective QMS. Top management members should listen to employees, and information and communication should flow in a formal way within the organization.

The study revealed the importance of technical, management, quality, cultural and communication and training factors. The study also concluded that these were important factors: Root causes of problems, Sampling procedure, Calibration of reference standards, Quality of equipment and resources, time and resources to do the job, Physical conditions at work, Quality of technical records, Quality is more important than volume of sales, Uncertainty of measurements, Security of records ,Happy to work in the laboratory, Periodic internal audits, Reports include information requested by client, Regular and effectiveness of meetings, Commitment to excellent customer services and continuous quality improvement, Uncertainty of measurements, Loyalty and respect towards employees, Communication process, training, Staff involvement in the improvement process, and Clarity of job description

8.1.1 Meeting the aim and objectives of the research

The selection of a questionnaire strategy, or quantitative approach, was identified in chapter five to answer the research questions. The research was successful in

answering these questions through the questionnaire. The aim and objectives of this research were met.

The first objective was to review the literature of the activities of some international organizations relating to testing, calibrations and accreditation. This objective was achieved by building up a good knowledge by the researcher, through a comprehensive review of the literature of quality gurus' philosophies, of QM and QA approaches, of technical and management requirements and of ISO/IEC 17025 standards and ISO 9000 standards

The second objective was to identify and investigate the factors that affect the establishment of laboratories' accreditation as drawn from the literature review. This objective was achieved by creating a comprehensive knowledge, by the researcher, through a comprehensive literature review and identifying the important issues of implementation in the manufacturing public sector and also by utilizing literature from other sectors.

The researcher summarised these factors and developed a framework that involved the technical, management, training, quality, communication and cultural types of factors that had been found in that study. Figure 4.1 conveys the number of factors that affect the establishment of laboratories' accreditation as discovered by looking at previous studies, this being undertaken in order to achieve objective number two.

The third objective was to understand the common types of barriers that affect the implementation of ISO/IEC 17025 and ISO 9000 standards in laboratories and organisations around the world. This objective was also achieved by reviewing the literature relating to the common barriers affecting quality management in different countries.

This research has been a successful empirical study in identifying and investigating the many factors that affect the establishment of laboratories' accreditation in the Libyan chemical and petrochemical industries and has contributed to the body of knowledge by identifying some unique factors in this research.

These unique factors are a contribution of this research to the body of knowledge regarding laboratories' accreditation. They are not reported in any previous studies looked at in the literature review. Some of these factors are unique to the Libyan situation, being related to Libyan legislation and culture.

The aim of this research, as given in chapter one, was to identify the attitudes of laboratory staff towards factors related to the establishment of accredited laboratories' in the Libyan Chemical and Petrochemical Industry. It was accomplished through the achievement of the four objectives of this research, which were developed to support the aim. Some of the factors identified are unique factors to this research.

8.2 A critique of the research methodology

The study was carried out in connected stages whereby a survey strategy was chosen, as the philosophy of this research was positivism. This research needed to obtain opinions and information from Libyan manufacturing laboratories intending to establish accreditation. Due to this research philosophy, therefore, a survey was chosen as the research strategy.

Firstly, an intensive literature review was undertaken to understand the different issues concerning ISO/IEC 17025 standards and QMS implementations and to develop the conceptual framework of this research.

Secondly, in order to gather data for this research, the questionnaire method was chosen due to the advantage that the designed questionnaire could be sent to a large number of laboratories in a limited time. A total of 400 questionnaires were sent to a variety of Libyan chemical and petrochemical manufacturing laboratories.

The research questions were:

- "What are the attitudes of the laboratory Staff towards factors that related to the establishment of Accredited Laboratories in the Libyan chemical and petrochemical industries?
- "What is the relationship between these factors and laboratories' accreditation?

In this research, the first question's answer has identified many factors as shown in Fig 7.1. Some of these factors are unique factors to this research; others are similar to Arabic, Islamic, Western and other countries' findings.

The second research question's answer has come from the regression analysis of the factor analysis findings, as shown in Figure 7.1 of this research.

The purpose of this thesis is to get the opinions of Libyan chemical and petrochemical laboratories staff attitude towards the factors Related to the Establishment of Accredited Laboratories' in the Libyan Chemical and Petro-Chemical Industry, so as to take account of them in the planning process or make changes beneficial to the laboratories and individuals alike.

The advantages of laboratories staff attitude in order to provide data which can be used in planning and decision-making, also to allow decision maker to hear employees' opinions of which they may not otherwise be aware. In the other hand the disadvantages of employee attitude surveys are: it require a good deal of time to carry out and evaluate; incur significant costs in planning, implementing and evaluating

This thesis is not dealt with policy, customer requirements, and cost savings for laboratories but, mainly about the ISO/IEC 17025 requirement in order to gain these laboratories the certificate.

Although this thesis has succeeded to answer the research questions and identified the factors that affect the laboratories accreditation

The research methodology employed in the thesis faced a number of limitations and it could be improved by some modifications. A critique of the research methodology can be summarised as follows:

1. The field of study for this research was so broad and the review of the literature resulted in the development of a conceptual frame work which itself was a basis for surveys and eventually the final framework. Although the author was concerned for the justification of the elements of the frame work, it would have been worthwhile if some experts had been involved in the justification process.

2. Although the results of the pilot study were published in a paper and were presented at an international conference, it might have been better if the results had been discussed with a few selected laboratories prior to the distribution of the final questionnaire.

8.3 Research contribution

Most of the studies found in the literature review are from western countries and are related to QMS-ISO 9000 standards. There is a shortage in empirical studies in literature that have been carried out specifically to understand ISO/IEC 17025, the factors affecting the establishment and implementation of the new standard specifically in Libya and other Arabic countries. One contribution of this research is that it filled a part of this gap in this area which is limited in knowledge within Libyan and Arabic studies.

Another contribution of this research was that the researcher gathered lot of factors faced by different laboratories and organisations in different countries around the world in different years and compiled them into one Figure (Figure 4.1).
Figure 4.1 makes it easier for other researchers, or readers, to know the common factors that affect the establishment of laboratories' accreditation.

The third contribution of this research is that it has given an outline of many unique Libyan organisational and cultural factors. These types and numbers of factors constructed the elements of the theoretical framework in this research.

The fourth contribution of this study is that it has proved that there is a significant relationship between the establishment of laboratories' accreditation and management, technical, quality, communication, cultural and training factors.
How can the results of this research assist the laboratories in the Libyan chemicals and petrochemicals industries to get a clear picture of the current factors which affect the establishment of laboratories' accreditation, and recommend what future action should be taken. Throughout this thesis, the current factors which affect the establishment of laboratories' accreditation in the Libyan chemical and petrochemical industries have been identified as well as the future steps that should be taken by the laboratories' stakeholders.

Thus, in order to establish and implement laboratories' accreditation in the chemical and petrochemical industries in Libya, the following recommendations should be taken in consideration by the laboratories stakeholders:

- The Libyan chemicals and petrochemicals industries' laboratories need to under go a cultural change to establish accreditation according to ISO/IEC 17025 and this change would rely heavily on a strong lead being given by those in charge.

- It would be advantageous to train and educate laboratories' employees to follow proper procedures and to gain technical and management knowledge. Training could be in the form of seminars or short training courses held by professional institutions. Participants in this training could range from senior leaders to outside operators and the training could cover different issues relating to accreditation such as root causes of problems, preventive action, etc.

- Improvements could be made in the supervisory systems through fairness in the work place, justice, payment satisfaction, etc.

- There are sufficient technical tools, equipment, utilities, calibration procedures, documentation etc. in Libya (although maybe there are some gaps in this listing that remain to be filled). However, the main problem is that they are often not properly implemented or supported by effective supervision of works. Lack of trained supervisory engineers, low supervision fees, lack of effective communication systems; all these ensure that the supervision system does not work properly.

- Setting up of a database of performance to trace the performance of quality and performing an internal quality audit within the laboratories.
- The use of the external consultants. After establishing teams and management representatives for the implementation of ISO/IEC 17025, the laboratory may hire external consultants to help in developing the implementation process. Some laboratories may rely on their own qualified employees for this purpose and, before hiring consultants, a laboratory should consider their costs, qualifications, and previous experience. The work of consultants should be harmonized and co-ordinated within the laboratory and its culture, so that the quality system suits the normal routine of the laboratory.

Another contribution of this research is the presentation of a better understanding concerning the impact of government and society in the public sector especially in Arabic and Islamic countries. However, the major original contribution of this research is that it is the first empirical study to identify, analyse and understand the factors affecting the establishment of the new standard of ISO/IEC 17025 in Libyan chemical and petrochemical laboratories.

This study has been successful in identifying and investigating the factors that affect the establishment of laboratories' accreditation and may be relevant to manufacturing public sector laboratories in general. Having identified these factors, Libyan chemical and petrochemical manufacturing laboratories can now take them into consideration when starting to implement the QMS-ISO/IEC 17025, hopefully

implementing the standard successfully from the beginning. It will also give the local and foreign consultancy agencies a fuller picture regarding what kind of factors are needed to be overcome in order to help the laboratories to establish and implement an effective QMS from the beginning.

8.4 Future work direction

The first suggestion for further research is to start with a validation of this study. This research is the first to investigate the factors that affect the establishment of laboratories' accreditation in Libya according to ISO/IEC 17025.

In addition, the research design of this study was based mainly on quantitative tools to collect the data. Therefore, any further research might benefit from the use of a triangular approach using both quantitative and qualitative techniques. The latter could occur by interviewing respondents to obtain more in-depth, richer information, and thus to provide further explanation of the causes of variables.

The limitations of this study may constitute a basis for prospective research and further investigation. Such research might include ISO/IEC 17025 laboratories certified in the country to explore the differences that ISO/IEC 17025 might make between ISO/IEC17025 and non-ISO/IEC17025 laboratories. Since certain laboratories, such as the petroleum research centre, have already obtained ISO/IEC 17025, any future study could include the service industry in Libya.

Furthermore, any research on the take up of ISO/IEC 17025 in Libya might be in the form of a comparative study, such as between Libya and other Arab countries on the one side and Western industries on the other.

In addition, any further research on the laboratories accreditation in Libya or in any other developing countries might use the results of factor analysis that categorise the factors affecting laboratories accreditation into nine components.

Finally, the researcher suggests that other variables might be considered in any further research into ISO/IEC 17025. For instance, further research might also include any cultural, religious, political or legal aspects that might affect the establishment or implementation of ISO/IEC 17025.

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Appendix A: Questionnaire to Laboratories Employees

Questionnaire

Dear respondent...

Thank you for completing this questionnaire, your co-operation is greatly appreciated. The questionnaire aims to investigate the readiness of Libyan Laboratories sector for the implementation of accreditation, which will enable the Libyan laboratories to comply with the international standard ISO/IEC 17025. Also to identify and investigate the factors that affects the establishment of Libyan laboratories accreditation in order to influence decisions to implement laboratories accreditation. Accreditation provides confidence for consumers that every issue related to product or services is safe, and to minimize the risk of producing a faulty product. It is difficult to export low quality products or to compete against high quality products at low cost. Also now, environmental, safety and health subjects will determine the acceptability of products by the customer. The accreditation is the tool by which the product can penetrate foreign markets, because technical barriers to trade are reduced, quality increased and then exports improved.

Please answer all questions as honestly as possible. All information given will be treated confidentially and will be used for the purpose of this study only. Indeed, the result of the questionnaire will be kept confidential and the researcher guarantees that the identity of the respondent well not be disclosed to any other persons at any time. Please note that, the respondents are the laboratories employees, supervisors, technical managers, academic and/or clients. This is because the researcher would like to hear the views of the widest possible range of laboratory employees-so anyone can answer the questionnaire. So, if you need any help with this questionnaire, do not hesitate to contact me. Please return your questionnaire even if you are unable to answer all of the questions, as any information you provide will be of great use to the research

هذا الاستبيان يستهدف التعرف على مدى جاهزية هدا المختبر للاعتماد من منظمات عالمية والتعرف على ماهى العوامل التى قد تكون عائق على تطبيق بعض المواصفات والمعاير الدولية سواء من الناحية الاداريه او الفنية والتى من شانها ان تساعد متخدى القرارات فى اتخاد التدابير الضرورية اللازمة والتى من شانها ان تنهض بمستوى جودة المنتجات والخدمات الليبية فى السوق العالميه والتى تزيد من انتاجية هده الصناعات والخدمات ودلك من خلال تقليل والخدمات الاجنبية. العوائق الفنية التى تعترض هده المنتجات للتسويق فى الخارج ومنافسة الصناعات

نرجو منكم التكرم بالاجابة عن الأسئلة بأعلى قدر من الشفافية حيث يتعهد الباحث بعدم الإفصاح عن أي شخصية من العينة أو إظهار نتائجها الى إي طرف آخر .

أرجو اذا ما رغبتم في آي إيضاح يتعلق بالاستبيان فارجوا منكم مكالمة الباحث على الهواتف المرفقة أو الكتابة في آخر صفحة للملاحظة .

مع الشكر والتقدير لتعاونكم ولكم منى جزيل الشكر والاحترام

Thank you again for your co-operation.

The researcher
Taher Shihub
Research Institute for the Built and Human Environment
School of the Built Environment
The University of Salford, Manchester, England
00447756898677

Part One: Research Characteristics

الجزء الأول: خصائص البحث

Demographic characteristics:

This section in the questionnaire is about you

Please put a(√) in the categories that apply to you

يرجى قراءة الأسئلة آلاتية وإبداء رأيكم بوضع علامة (√) في المكان المخصص :

What is your occupation / profession?

ماهى الوظيفه التى تشغلها فى المختبر

مهندس / Engineer □ مدير/Manager □

Technician □ مشرف/Supervisor □

What is the highest level of your formal education?

(المستوى التعليمي) اعلى درجة علمية تحصلت عليها

High school /ثانوية تخصصية □ College/ دبلوم عالي □

BSc/بكالوريوس □ PhD / دكتواره □

MSc / ماجستير □ other/أخرى □

How would you classify the major users of your laboratory service?

من هى الجهات المستفيدة من الخدمات التى يقوم بتقديمها المختبر ؟

Local companies / شركات محلية□ foreign companies/ شركات اجنبية □

personal/ افراد □

What is your laboratory scope of work?

ما هو مجال عمل المختبر؟

Chemical / كيميائى □ □ Petrochemical / بتروكيميائى

Part Two: Investigating Dimensions of laboratory accreditation reddens)

الجزء الثاني : التحقيق والبحث في مدى جاهزية المختبر للاعتماد

Scoring System

1 [VD]	2 [D]	3 [N]	4 [S]	5 [VS]
Very Dissatisfied غير راضى جدا	Dissatisfied غير راضى	Neutral, Neither satisfied / Nor Dissatisfied غيرراضى و راضى	Satisfied راضى	Very Satisfied راضى جدا

Our aim in this section is to evaluate the laboratory knowledge and readiness to accreditation. Please put a "×" in the box that expresses your opinion based on the scoring system described above.

البيان الموضح يصف ظواهر متعددة متعلقة بامدى جاهزية المختبرات للاعتماد , لكل فقرة وضح كم أنت راضى وموافق أو غير راضى وموافق حول تلك الفقرة . ضع علامة (×) في الفراغ الذي يطابق شعورك

	Factor elements	VD	D	N	S	VS
Section A: Job management and rewards system						
A1	Clarity of job description مدى درجة وضوح الوصف الوظيفى للعاملين ف المخيبر					
A2	The quality of supervision نوعية الاشراف					
A3	Loyalty and respect towards employees مدى ولاء واحترام ادارة الموسسة و المختبر اتجاة العاملين به					
A4	Advancements and promotion is on the basis of job performance only هل الترقيات والتقدم الوظيفى يتم على اساس الاداء					
A5	Employees rewarding for developing new ideas هل يقوم المختبر بمكافاة العاملين لتطوير افكار و اراء جديدة					
A6	knowing and understand goals تفهم وتعى الاهداف العامة للمختبر وماهى واجباتك واهدافك					
A7	Clarity of long term goals to all employees ا لاهداف طويلة الاجل موضحة للعاملين والجميع يعمل على تحقيقها					
A8	Involvement of employees in decisions making تتم مشاركة الجميع فى اتخاد القرارات المتعلقة بالمختبر					
A9	The promotion opportunities فرص الترقيه					

	Factor elements	**VD**	**D**	**N**	**S**	**VS**
A1	The amount of payment you get قيمة المكأفاة الشهرية التى تتقضاها					
A11	Financial compensation تعويضات مالية					
A12	Happy and proud to work الافتخار بلعمل فى هدا المختبر					
A13	Daily attendances الحضورالیومی					
Section B: Culture Characteristics						
B1	The relation with authority العلاقه مع المسؤلين					
B2	The relation ship of individuals and group علاقة الموظف بالمجموعة العامله معه					
B3	The periodic meeting you attend حضورك للاجتماعات الدوريه					
B4	The people behaviours during meetings سلوك و تصرفات الموظفين خلال الاجتماعات					
B5	The events which are celebrated in this organizations الاحداث والمناسبات التى تحتفل بها المنظمة					
B6	In this laboratory changing is faster and immediate هل اى تغيرات تخص المختبر او العاملين فيه تتم حالاً وبسرعة					
B7	Adjustment to new requirements هل من السهل ان يتم التعديل فى المختبر لاى متطلبات جديدة					
B8	Effectiveness of team meetings هل الاجتماعات التى تعقد فعالة ودات جدوى					
B9	Time of talking informally to senior managers هل يخصص المديرين وقتاً للحديث بشكل غير رسمى مع الموظفين					
B10	Co-operation Between different departments هل هناك تعاون بين المختبر و مختلف الاقسام الاخرى					
B11	All employees acknowledge the need to change هل يسعى كل العاملين فى المختبر بالحاجة الى التغيير					
B12	Management looking and seeking new ideas هل تسعى الادارة بفاعلية وبشكل جدى الى وجود وابتكار افكار جديدة					
Section C: Technical factor: Laboratory facilities, accommodation and (Environmental Conditions)						
C1	Physical conditions at work (noise, air condition...etc.) الظروف الطبيعية للقيام بالعمل مثل النظافة , التهوية الضوضاء..					

	Factor elements	VD	D	N	S	VS
C2	Availability of time and resources to do your job properly وجود الوقت الكافى والموارد اللازمه للقيام بعملك كما ينبغى					
C3	Availability of space for doing all the activate such as space for sample storage...etc المساحة الكافية لعمل كل النشاطات مثل و جود مساحة كافية لتخزين العينات...الخ					
C4	Protection from undue internal and external pressures. استقلاليه فى اتخاد القرارات من غير اى ضغوط داخليه او خارجيه؟					
C5	Protestation of client's information confidential and proprietary rights حماية المعلومات السريه او اى حقوق خاصة بالزبائن؟					
C6	Availability and appropriates of utilities to use, such as electricity, water, instrument air...etc). المرافق العامة مثل الكهرباء وغيرها من المرافق متاحة و ملائمة للغرض					
C7	Availability of a policy and procedure for corrective action اجراءات تصحيحيه فى حالة وجود اداء غير مطابق لنظام الجودة					
C8	Investigation to determine root causes of problems. البحث عن الاسباب الاصليه للمشكله فى حالة وجود عدم تطابق؟					
C9	Availability of procedures for preventive actions يطبق المختبر اجراءات و قائيه ويتاكد من فعاليتها					
C10	Procedures for quality and technical records مراقبة السجلات التى تحتوى على معلومات فنيه او لها علاقه بالجودة					
C11	Security and confidentiality of records حفظ السجلات بامان وتحديد مسئولية افراد للقيام بهده المهمة					
C12	Schedule and procedure of periodic internal audits. هل يقوم المختبر بتنفيد عمليات تدقيق داخليه لنشاطاته بشكل دورى؟					
C13	Method proven to be fit for intended use. يقوم المختبر بالتحقق من صلاحية الفحص وتقديم دليل مادى لدلك					
C14	Existing of procedure to estimate uncertainty of measurements in testing and calibration. اجراءات لحسابات عدم التاكد للقياسات فى طرق الفحص والمعايرة					
C15	consideration given of all uncertainty components تؤخد الاجزاء المؤثرة فى الارتياب فى عمليات القياس بعين الاعتبار					
C16	Availability of the proper measurement and test equipment هل المختبر مجهز بجميع المعدات و الاجهزة اللازمة الاختبارات؟					

	Factor elements	VD	D	N	S	VS
C17	Capability and accuracy of equipment and software الاجهزه والبرمجيات المستخدمة قادرة على الحصول على الدقة الملائمة					
C18	Exiting identity of equipment such as, manufacture's name, and other related thing documented هل سجل المعدات يتضمن هوية الجهاز وكل مايتعلقبالجهاز؟					
C19	Establishment of procedures for equipment calibration معـايرة جميـع الاجهـزة التـى لهـا علاقـة بلاختبـارات قبـل اسـتعمالها					
C20	Existing procedure for calibration of reference standards هل هناك برنامج واجراءات لمعايرة المعاير المرجعية؟					
C21	Existing safe procedure for handling, transport, storage and use of reference standards and reference materials اجراءات امنة لنقل و تخزين و استخدام العينات و المعايير والمواد المرجعية					
C22	Sampling plans and procedure خطط واجراءات لاخذ العينات					
C23	Existing of procedures for the transportation, receipt, handling, protection, storage, retention and/or disposal of test and/or calibration items هل يتوفر اجراءات نقل واستلام ومناولة وحماية و تخزين و التخلص من العينات؟					
C24	regular using of certified reference materials and/or internal quality control by using secondary reference materials هل يستخدم المختبر مواد مرجعية مصدق عليها اى تحمل شهادة بانتظـام او يقـوم بـضبط جـودة داخليـة باسـتخدام مـواد مرجعيـة ثانويـة؟					
C25	Participation in inter-laboratory comparison or proficiency testing program هل يقو م المختبر بالمشاركة فى برامج المقارنة او اختبارات المهارة؟					
C26	Accurately, clearly, unambiguously, objectively, of reported results. هل يقوم المختبر بكتابة النتائج بدقة و بشكل واضح لالبس فيـــــة و بـــــشكل موضـــــوعى وفـــــق للطـــــرق المحـــــددة؟					
C27	Reports include information requested by client وجود تقرير تضمن المعلومات المطلوبه من الزبئن					
Section D: Communication and information						
D1	Communication is open in this laboratory يتبع هدا المختبر فى الاتصالات نظام الاتصالات المفتوح					

	Factor elements	VD	D	N	S	VS
D2	Communication with other team in the organization يمتللك هدا المختبر نظام اتصالات جيد مع الاقسام والفرق الاخرى فى المنظمة					
D3	Information and instructions comes from formal way كل المعلومات المهمه تاتى الى المختبر عبر القنوات الرسمية للاتصالات					
Section E: Training and knowledge						
E1	employees are trained to use a wide range of problems solving tools يتم تدريب الموظفين على استخدم عدة طرق وادوات لحل المشاكل					
E2	employees have opportunities to use their skills effectively in their job تعطى للموظفين فرصا لاستخدم مهاراتهم فى اداء و ظائفهم بفعالية					
E3	Managers trains employees to use their skills and talents يعمل المديرين على الاستفادة و استغلال كل المهارات والمواهب للعاملين					
E4	staff are involved in continuously reviewing and improving process كل الموظفين يشاركون فى مراجعة و تحسين العمليات					
Section F: Quality program						
F1	Emphasis on meeting customer needs when planning عند التخطيط هل يتم التركيز بشدة على تلبية احتياجات العملاء					
F2	Continuous quality improvement القيام بتحسين مستمر للجودة					
F3	Customers satisfaction is important for long-term success ارضاء الزبائن مهم لنجاح على المدى الطويل					
F4	Success in the market place depends on high quality products and services النجاح فى السوق يعتمد على جودة المنتجات					
F5	Employees understand customers requirement كل الموظفين يتفهمون الزبائن و متطلباتهم					
F6	Organization of laboratory to meet customer needs المختبرمؤهل و يساعد على تلبية الاحتياجات الحالية و المستقبلية لاحتياجات الزبائن					
F7	Quality is more important than volume of sales نوعية وجودة الخدمات لها اهميه اكثر من اهمية حجم المبيعات					
F8	Staff knowledge enough ISO/IEC 17025 كل المشرفين لديهم دريه و معرفة تامة عن متطلبات الايزو 17025					
F9	Commitment to excellent customer service يلتزم المختبر بتقديم خدمات ممتازة للعملاء					
F10	Continuous improvement ن ضمن اولويات المختبر التحسين المستمر					
F11	Awareness of cost conscious خصويدرك اهمية تكاليف القيام بلعمل					
F12	Established procedures are important اتباع الاجراءات اللازمة هامه جداً للقيام باى عمل فى المختبر					

	Factor elements	VD	D	N	S	VS
F13	Quality of equipment and resources to do the work هل يمتلك المختبر المعدات والموارد الضرورية للقيام بوظائفة					

Part 3: An investigation of the common barriers affecting accreditation

1 [C]	Critical factors (C) that you feel are critical and absolutely essential 1- عوامل حاسمه وهى التى تشعر وتعتقد انها عوامل حرجه وضروريه
2 [I]	Important factors(I) that you feel are important but not essential 2- عوامل مهمة وهى التى تشعر وتعتقد انها عوامل مهمة ولكنها ليست ضروريه جدا
3[M]	Minor important factors (M) that you feel are of minor importance 3- عوامل اقل اهميه وهى التى تشعر وتعتقد انها عوامل دات اهميه بسيطه

Our aim in this section is to investigate the difficulties to establish accreditation. Please put a "×" in the box that expresses your opinion based on the scoring system described above.

رتب وقدر كل من العوامل التاليه حسب مستوى اهميتها والتى قد تقف حائل امام اعتماد المختبرات ودللك بوضع علامة"×" في احدى المربعات عن طريق استعمال المعايئر التاليه

No	Factors	C	I	M
1	Employee Training and education قلة التعليم والتدريب للموظفين			
2	Top management commitment and involvement عدم التزام الادارة العليا			
3	Rapid and effective communication عدم وجود نظام سريع وفعال للاتصالات			
4	Technical expertise on ISO 17025 implementation ندرة وقلة الخبرة التقنية بمتطلبات الايزو 17025			
5	Time and resources قلة وندرة الوقت وندرة والموارد المتاحة			
6	Documentation process قلة وعدم الاهتمام بعملية التوثيق			

No	Factors	C	I	M
7	Cooperation and commitment of work force قلة التعاون واللالتزم من قبل العاملين			
8	International competition قلة المنافسة العالمية			
9	Pressure from customers قلة اى ضغوط من الزبائن			
10	Ready market and poor competitive environment جاهزية السوق وعدم وجود بيئة تنافسية			
11	Governmental support programs to accreditation قلة و ندرة الدعم الحكومى لبرامج الاعتماد			
12	Effective information قلة وندرة جودة المعلومات			
13	Bad peoples attitudes towards accreditation النظرة السئية للافراد اتجاة الاعتماد			
14	Experience amongst managers نقص الخبرة الفنية والاداريه لدى المدراء			
15	Resistance to new responsibilities مقاومة المسؤليات الجديدة			
16	Role of middle managers as motivators and transmissions عدم قيام المشرفين بدورهم على الوجه المطلوب فى تحفيز الموظفين			
17	Financial capacity to meet the accreditation cost عدم المقدرة المادية الكافية لسد مصاريف الاعتماد والمحافظه عليه			
18	Appropriate technical knowledge amongst workers قلة المعرفة الفنيه الملائمة لدى العاملين			
19	Awareness of accreditation at the management level قلة وعى باهمية الاعتماد على المستويات الاداريه			

Q 4.1-Does your laboratory have a quality system?

هل يوجد فى المختبر نظام لمراقبة الجودة؟

نعم / Yes □ لا /No □

If yes describe the system.....

ادكانت الاجابة بنعم صف لنا النظام المتبع باختصار

If No, why.....

ادكانت الاجابة بلا لماذ؟

Q4. 2-Do you have an official copy of ISO/IEC 17025?

هل توجد لديكم نسخة رسميه من الايزو 17025؟

Q 4 .3-Do you think that laboratory accreditation will improve the Libyan industry?

□yes □No, Why.....?

هل تعتقد ان اعتماد المختبرات سيحسن من مستوى التصنيع و الخدمات فى ليبيا ؟ □نعم □لا , لماذا.....

.....

Please use the following space if you have any other comments you would like to add.

أرجو استعمال الفراغ الآتي في إضافية اى ملاحظات اومعلومات أخرى .

.....

.....

.....

.....

Thank you very much for you time and cooperation.

الشكر والتقدير لتعاونكم ولكم منى جزيل الشكر والاحترام

Appendix B: Factor Analysis

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	25.895	35.965	35.965	13.415	18.632	18.632
2	4.058	5.636	41.600	6.565	9.118	27.750
3	2.787	3.871	45.471	5.859	8.138	35.888
4	2.341	3.251	48.722	4.394	6.103	41.992
5	2.024	2.811	51.534	3.514	4.881	46.872
6	1.779	2.471	54.004	3.089	4.290	51.162
7	1.675	2.326	56.331	2.579	3.583	54.744
8	1.544	2.144	58.475	2.273	3.157	57.902
9	1.487	2.065	60.540	1.900	2.639	60.540
10	1.345	1.868	62.408			
11	1.287	1.787	64.195			
12	1.199	1.666	65.861			
13	1.163	1.616	67.476			
14	1.124	1.561	69.037			
15	1.023	1.421	70.458			
16	.984	1.367	71.825			
17	.961	1.334	73.159			
18	.897	1.246	74.406			
19	.869	1.207	75.613			
20	.805	1.117	76.730			
21	.789	1.095	77.826			
22	.753	1.046	78.871			
23	.708	.984	79.855			
24	.691	.959	80.814			
25	.678	.942	81.756			
26	.637	.884	82.640			
27	.628	.872	83.512			
28	.600	.833	84.345			

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
29	.573	.795	85.141			
30	.545	.757	85.898			
31	.539	.748	86.646			
32	.487	.676	87.322			
33	.476	.662	87.983			
34	.448	.623	88.606			
35	.428	.594	89.200			
36	.425	.590	89.790			
37	.401	.558	90.348			
38	.396	.550	90.897			
39	.380	.528	91.426			
40	.367	.510	91.936			
41	.349	.485	92.421			
42	.336	.467	92.888			
43	.322	.447	93.335			
44	.317	.440	93.775			
45	.300	.416	94.191			
46	.285	.395	94.586			
47	.268	.372	94.958			
48	.266	.370	95.328			
49	.258	.359	95.687			
50	.243	.338	96.024			
51	.215	.299	96.323			
52	.199	.276	96.599			
53	.189	.262	96.861			
54	.186	.259	97.120			
55	.179	.249	97.369			
56	.175	.243	97.613			
57	.164	.228	97.840			
58	.160	.223	98.063			
59	.153	.213	98.276			

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
60	.142	.197	98.472			
61	.138	.191	98.663			
62	.125	.174	98.837			
63	.121	.169	99.006			
64	.109	.151	99.157			
65	.104	.145	99.302			
66	.094	.130	99.432			
67	.087	.121	99.553			
68	.076	.105	99.658			
69	.072	.100	99.758			
70	.064	.089	99.847			
71	.059	.082	99.929			
72	.051	.071	100.000			

Extraction Method: Principal Component Analysis.

Appendix C: Glossary

Quality system:

The laboratory shall establish, implement and maintain a quality system appropriate to the scope of its activities. The laboratory shall document its policies, systems, programmes, procedures and instructions to the extent necessary to assure the quality of the test and/or calibration results. The system's documentation shall be communicated to, understood by, available to, and implemented by the appropriate personnel.

Document control:

The laboratory shall establish and maintain procedures to control all documents that from part of its quality system (internally generated or from external sources) such as regulations, standards, other normative documents, test and/or calibration methods...etc.

Service to the client:

The laboratory shall afford clients or their representative's cooperation to clarify the client's request and to monitor the laboratory's performance in relation to the work performed, provided that the laboratory ensures confidentiality to other clients.

Corrective action:

The laboratory shall establish a policy and procedure and shall designate appropriate authorities for implementing corrective action when nonconforming work or departures from the policies and procedures in the quality system or technical operations have been identified.

Cause analysis:

The procedure for corrective action shall start with an investigation to determine the root causes of the problem.

Preventive action:

Needed improvements and potential sources of non-conformances, ether technical or concerning the quality system, shall be identified. If preventive action is required, action plans shall be developed, implemented and monitored to reduce the likelihood of the occurrence of such non-conformances and to take advantage of the opportunities for improvement.

Control of records:

The laboratory shall establish and maintain procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. Quality records shall include reports from internal audits and management reviews as well as records of corrective and preventive actions.

Internal audits:

The laboratory shall periodically, and in accordance with a predetermined schedule and procedure, conduct internal audits of its activities to verify that its operations to comply with the requirements of the quality system and this international standard. The internal audit programme shall address all elements of the quality system, including the testing and/or calibration activates.

Management reviews:

In accordance with a predetermined schedule and procedure, the laboratory's executive management shall periodically conduct a review of the laboratory's quality system and testing and/or calibration activities to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements.

Accommodation and environmental conditions:

Laboratory facilities for testing and/or calibration, including but not limited to energy sources, lighting and environmental conditions, shall be such as to facilitate correct performance of the tests and/or calibrations.

Validation of methods:

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

Selection of methods:

The laboratory shall use test and/or calibration methods, including methods for sampling, which meet the needs of the client and which are appropriate for the tests and/or calibrations it undertakes.

Estimation of uncertainty of measurement:

Laboratory's shall have and shall apply a procedure to estimate the uncertainty of measurement for all calibrations and types of calibrations.

Control of date:

Calculations and date transfers shall be subject to appropriate checks in a systematic manner.

Equipment:

The laboratory shall be furnished with all items of sampling, measurement and test equipment required for the correct performance of the tests and/or calibrations (including sampling, preparation of test and/or calibration items, processing and analysis of test and/or calibration data).

Measurement traceability:

All equipment used for tests and/or calibrations, including equipment for subsidiary measurements (e.g. for environmental conditions) having a significant effect on the accuracy or validity of the result of the test, calibration or sampling shall be calibrated before being put into service. The laboratory shall have an established programme and procedure for the calibration of its equipment.

Reference standards:

The laboratory shall have a programme and procedure for the calibration of its reference standards.

Reference materials:

Reference materials shall, where possible, be traceable to SI units of measurement, or to certified reference materials. Internal reference materials shall be checked as far as is technically and economically practicable.

Transport and Storage:

The laboratory shall have procedures for safe handling, transport, storage and use of reference standards and reference materials in order to prevent contamination or deterioration and in order to protect their integrity.

Sampling:

The laboratory shall have a sampling plan and procedures for sampling when it carries out sampling of substances, materials or products for subsequent testing or calibration. The sampling plan as well as the sampling procedure shall be available at the location where sampling is undertaken.

Handling of test and calibration items: