UNIVERSITY OF BIRMINGHAM

TPM Implementation in the UK and Libya

By

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A thesis submitted to the
University of Birmingham
For the degree of

Doctor of Philosophy

School of Mechanical Engineering
College of Engineering and Physical Science
The University of Birmingham

October 2014

Abstract

To date, no study has been found that investigates the relationship between Total Productive Maintenance (TPM) and Organisation Culture (OC) in the manufacturing sector in the Arab World in general or in Libya in particular. It was therefore felt to be beneficial to examine whether Libyan companies needed to develop a culture with a specific set of values and practices in order to implement TPM successfully. The purpose of this research was to encourage the use of such a programme by identifying possible cultural obstacles and suggesting ways forward.

The research was broken down into four phases. Firstly a wide literature search was undertaken to gain an understanding of TPM and to identify the issues involved with culture and OC. In order to better understand the relationship between OC and TPM, 10 factors were identified as being helpful to create a supportive environment and to be critical to the success of TPM implementation. They were: *top management*, *total employee involvement*, *communication and awareness*, *strategic planning* and *action plan*, *resource allocation* or *availability*, *recognition and empowerment*, *training and education*, *monitoring and evaluation*, *reward and incentives* and *teamwork*. The second phase comprised an empirical study. A questionnaire was distributed by post to 350 UK manufacturing companies to identify the influence of culture on TPM implementation and to identify the cultural characteristics that are most suitable for its success. The Competing Values Framework (CVF) was used for this purpose. Its structure is based on six OC dimensions (comprising *dominant characteristic, leadership style, management of employees, organisational "glue," strategic emphases, and criteria of succes*s), and four dominant cultures (i.e. group, developmental, hierarchical and rational).

The identified dimensions were used as a tool to assess the readiness of any organisation in terms of its existing culture prior to TPM implementation.

The findings indicated that the majority of UK manufacturing respondent companies were clearly dominated by group and rational values suggesting that their characteristics tend to be cooperative, coordinative; involve teamwork, unity and participation. Using the TPM approach in a group culture environment is helpful because the focus is on people's ability to improve communications between all employees and encourage teamwork activities. Results also revealed that *top management* was perceived to be the most important factor while reward and incentives was the least. The respondents recognised that commitment and support from top management determines the success of new change initiatives; focus on health, safety and environmental issues are necessary ingredients; the organisation treats all employees equally with regards to respect, performance and recognition; training and education are vital when adopting TPM and teamwork is important for achieving a TPM culture.

In the third phase, the same questionnaire that was sent to the UK companies was translated into Arabic and was sent to 350 Libyan manufacturing companies. The aim was to identify the differences in practises between the two countries. The results showed that a significantly positive relationship existed between the majority of the pairs of variables, the strongest being between training & education and management of employees. The results showed that there was a significant difference between UK and Libyan manufacturing companies' means on all the factors apart from *resource allocation* and *teamwork*.

The last part of the research comprised a comparison of the two empirical studies indicating that UK companies were better at adopting TPM programmes than those in Libya. The knowledge of TPM in Libya was found to be very limited but this research

highlighted that the awareness of TPM was increasing as the companies surveyed were beginning to recognise the potential benefits from developing an effective TPM approach. An interesting finding was that both countries operated within the same group and rational OC.

In response to this, and based upon the knowledge and understanding gained from the investigation and analysis, the researcher has proposed a set of recommendations to the Libyan government and companies to help encourage TPM in the country.

DEDICATION

To my late father and,

To my beloved Mother,

Wife and beautiful Sons,

Brother and Sisters,

I dedicate this thesis

With

Love and Respect

ACKNOWLEDGEMENTS

First and foremost, thanks are indeed due to Allah Almighty; worthy of all praise, without his help this research would not have been successfully completed.

I have been grateful in the preparation of this thesis to my original supervisor, Mrs. Elaine Aspinwall, for her patience and kindness, support, supervision and time throughout my study at the University of Birmingham. Your help and kindness will always be remembered and be deeply embedded in my heart. I would like to appreciate and thank Dr Andrew Tobias, for his great co-operation, immense assistance, guidance and his continued encouragement during the later stages of this study.

My gratitude also goes to the manufacturing companies in UK and Libya, especially those who have participated in the study. I would also like to thank the members of staff of the Cultural Affairs in the Libyan Bureau in London.

I am grateful to my beloved Father and Mother for their support and unlimited source of inspiration since I started this research, and to my brother and sisters for their help and support which was a great source of comfort and energy. I would like to thank my wife, Nesren, and my three children, Feras, Abdalla and Moad, who deserve my love, respect and my most sincere gratitude for enabling me to complete this work. I am sure that without their encouragement, patience and support, this work would not have achieved these results. Although my father is no longer with us, I hope that he is proud of me as he believed in the value of a good education. My many thanks go to my friend Rida who helped me with the translations and other colleagues for their help and advice.

Finally, I am thankful to the faculty, past and present, and to the contributions of the research office in the School of Mechanical Engineering, University of Birmingham, for their kind support throughout the period of my research.

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LIST OF ABBREVIATIONS

AM	Autonomous Maintenance
CBM	Conditioned Based Maintenance
CI	Continuous Improvement
CIA	Central Intelligence Agency
CIID	Centre for Industrial Information and Documentation
CM	Corrective Maintenance
CSF	Critical Success Factor
CVF	Competing Values Framework
FBS	Fuzzy Based Simulation
FTPM	Ford Total Productive Maintenance
GDP	Gross Domestic Product
IDEFO	Integration Definition for Function Modelling
IDV	Individualism
IMF	International Monetary Fund
JEII	Joint exploration through interactive interviewing
JIPE	Japanese Institute of Plant Engineering
JIPM	Japanese Institute of Plant Maintenance
JIT	Just In Time
KMO	Kaiser Meyer Olkin
MAS	Masculinity
MI	Maintainability Improvement

MP	Maintenance Prevention
MTBF	Mean time between failures
MTTR	Mean time to repair
OC	Organisational Culture
OCI	Organisational Culture Inventory
OCAI	Organisational Cultural Assessment Instrument
OEE	Overall equipment's effectiveness
PD	Power distance
PM	Preventive maintenance
PrM	Productive Maintenance
RCM	Reliability-centred maintenance
SPC	Statistical process-control
SME	Small and Medium-sized Enterprises
SPSS	Statistical Package for the Social Science
TQM	Total quality-management
TPM	Total productive-maintenance
TPS	Toyota Production System
5S	Japanese Visual Management Concept, Seiri (organisation), Seiton (orderliness), Seiso (cleaning-the act of), Seiktsu (cleanliness-the state of) and Shitsuke (discipline the practice of).
UA	Uncertainty Avoidance
UN	United Nation
WCM	World Class Manufacturing

CHAPTER 1: Introduction to the Research

1.1 Background

Manufacturing companies have experienced an amazing degree of change in the last three decades. Globalisation and economic instability have increased pressure on them to perform in cost efficient ways that are able to satisfy the ever changing need of their customers. In order to stay competitive, it is required for organisations to continuously enhance the effectiveness and efficiency of their production methods (Kaur *et al*., 2012).

Approaches such as Just in Time (JIT) and Lean Production require a high level of equipment availability which has resulted in maintenance gaining in significance as a support function for guaranteeing not only this but also quality products and workplace safety (Aspinwall and Elgharib, 2013). One of the recognised modern maintenance programmes adopted by organisations is TPM an innovative approach which helps to optimise Overall Equipment Effectiveness (OEE), eliminate breakdowns and encourages Autonomous Maintenance (AM) via daily activities involving all of a company's employees. The concepts of TPM have become key components in improving production (Konecny and Thun, 2011). Its major goal is to attain a reliable manufacturing system (Ahuja and Khamba, 2008b). Industrial maintenance plays a significant role in improving employee productivity, value added and competitiveness under growing international demands (Chinese and Ghirardo, 2010). Several manufacturing companies consider a concurrent implementation of these improvement programmes in order to attain synergic effects. The adoption of any new programme means more employee involvement and teamwork, which require more

responsibility and a greater level of skill and knowledge by the employees. This should be accomplished through proper, formal and systematic training and education (Seth and Tripathi, 2005). Depending on the needs of a particular organisation, training and education should cover all employees as part of an ongoing process and more attention should be attributed to maintenance management techniques and quality management issues (Nakajima, 1989).

Libyan companies represent the main industrial structure in which oil and gas is the main source of income in the country. They are facing a number of challenges including increasing competition and quality level, an inadequate employee training, and development and education in several fields; the new needs have been emerging as a result of the changes in the economic and social structure (Saleh, 2013). In spite of the fact that the government has financially supported the industrial sector, unfortunately the performance of the economy remains slow as a result of various problems faced by the Libyan public sector. Therefore the government has been persuading manufacturing companies to implement different approaches to ensure quality of products and services (Sampaio el al., 2009).

According to Aghila, (2000) the differences in cultures between nations and particularly between developed and developing countries should be recognised and furthermore understood, because of the effect of globalised economies in the world.

Currently, the concept of TPM in Libyan manufacturing companies is the critical missing concept to successfully achieving world class equipment performance; in addition it is a powerful new means for improving overall company performance.

The research presents a useful source of information to organisations worldwide and other developing countries, which are still lagging far behind when it comes to TPM programmes.

1.2 Study Motivation

The researcher (while working in a Libyan organisation) witnessed the waste of expensive resources, equipment deterioration, and scarcity of human resources, unqualified employees etc. Libyan industries have continued to loop in a vicious circle, while poorer developing countries (e.g. Malaysia, Singapore, India and Turkey) have made radical changes and are now able to compete in the global arena for better quality and productivity. In these countries TPM programmes have made an impact, so by encouraging such ventures in Libyan manufacturing companies should help to improve their knowledge, quality and productivity (Saleh, 2013). Also it would help Libyan managers to make significant changes in their management philosophy, attitudes and behaviour.

1.3 The research outline

1.3.1 Aims

The key aim of this study is to explore and understand the relationship between OC and TPM implementation and then to recognise the key factors that could affect how TPM is promoted in Libya.

1.3.2 Objectives

After identifying the challenges facing Libyan organisations, this research has a number of objectives related to OC and TPM implementation in both Libyan and UK manufacturing companies. These are:

- ✓ **Carry out detailed reviews of the available literature to identify:**
  - TPM implementation practices, Critical Success Factors (CSF), TPM frameworks, the benefits and limitations of TPM programmes.

- A valid means to measure OC profiles for TPM implementation.

✓ **Carry out a survey in the UK to identify:**

- The relationship between OC and TPM implementation. This will be achieved by identifying which elements of OC need to be considered or changed to facilitate and support TPM implementation.
- The results of the UK Survey will be used to identify culture that is ideal for successful TPM implementation.

✓ **Carry out a survey in Libya to:**

- Identify the differences between TPM practices in Libya and in the UK and determine deficiencies in the former.
- Investigate differences in the culture and provide general and suitable recommendations to help the Libyan government and companies to promote TPM in this specific location.

1.4 Significance of the Study

Libya is going through a transformation from a closed system (where there are poor policies and a clear lack of strategy, of knowledge of modern management approaches, of incentives, etc.) to an open on, where competition will be severe. Libyan organisations would not cope with the fast changing movement of international organisations that have already swept the local market (Abusa and Gibson, 2013; Sherif, 2010). Furthermore, there has been a growing demand in Libya and in the Arab World to adopt of a variety of maintenance strategies, and tactics such as TPM, Maintenance RCM, Total Quality Maintenance, Condition Monitoring programmes (CM), and Computerised Maintenance Management Systems (CMMS) (Saleh, 2013).

The focus of this research arose as a result of the researcher's personal experience, gained from working in a Libyan company. As highlighted previously, there are many difficulties facing Libyan manufacturing companies in today's competitive market. These include technical, financial, political and organisational factors. Libyan organisations should focus on quality improvement methods and values, as they are the crucial standards with which to measure success. It is vital to invest current resources through the use of good improvement programmes particularly in maintenance operations, where the effectiveness of people and equipment can provide high productivity and low expenditure.

The general purpose of conducting this research is to generate new knowledge and understanding and hence build upon existing quality management theories (in the maintenance area). The main aim is therefore to help encourage TPM in Libyan manufacturing companies by suggesting an ideal organisational culture and by providing appropriate recommendations to help implement and promote TPM.

1.5 Contribution of the research

This study is thought to be the first of its kind and that no literature had been found that investigated the cultural profile of Libyan manufacturing companies. As result, this research makes a contribution to these areas by adding to the limited work that does exist in the publications.

The results, discussions, and expected recommendations should assist top management in Libyan manufacturing companies to encourage the use of TPM programme by identifying possible cultural obstacles and suggesting ways forward. Similarly, it is expected that the research could benefit other organisations in developing countries that are seeking to improve their maintenance strategies.

1.6 Thesis Structure

The thesis consists of eight Chapters, which relate to the various research objectives and the adopted research design, each is briefly outlined below:

Chapter one presents an introduction to and the importance of, the research, outlining its aims and objectives. ***Chapter two*** covers the literature related to the study, including the fundamentals of the TPM philosophy, why such a strategy should be introduced, its implementation, CSF, OEE, TPM and Frameworks, concluding with the benefits and limitations of TPM. ***Chapter three*** reviews the literature that relates OC and TPM. Culture and OC are first defined, followed by culture change. The link between OC and TPM philosophies is presented, and aspects or dimensions/factors that might impact TPM implementation have been identified. The culture that supports TPM is discussed. Finally, the results of the literature review are presented, an analytical tool (the CVF) was used to help identify an ideal cultural profile that supports TPM implementation.

Chapter four describes the research methodology that has been applied in undertaking this research and to explain the steps followed and the methods employed by the researcher to collect the data. This chapter starts with an overview of the research methodology and paradigm. This is followed by a detailed description of the data collection methods adopted in this research including a justification for the research population and sample selection. This is developed to explain the procedures undertaken relating to questionnaire design and plan, pilot work, question types and format, the covering letter, translating the questionnaire, content of the final version of the questionnaire, administering the questionnaire, the respondents, checking for non respondent bias and reliability and validity evaluation are also discussed. Finally, the chapter concludes with a discussion and

justification of the statistical methods and techniques used in the data analysis in order to fulfil the objectives of the study. ***Chapter five,*** the transferability of TPM to Western countries is explained as well as its need and development in the UK. The findings of the empirical study in the UK, its limitations and assumptions are also detailed. The important role of OC on the implementation of a TPM programme is considered in ***Chapter six.***

The geographical, political, economical and industrial development of Libya is outlined in ***Chapter seven.*** The findings of the empirical study and the existing cultural profiles in Libya are presented. In addition the differences between the UK and Libya regarding TPM practices are explained. Finally, the limitations and assumptions of the research are briefly discussed. In ***Chapter eight*** the findings of the quantitative data are discussed by focusing on interpreting the key findings and their various implications. The conclusions of the research and contributions to the body of knowledge in the light of the specific research aims and objectives are presented in ***Chapter nine*** together with recommendations for the Libyan government and companies to help encourage TPM in the country.

CHAPTER 2: An overview on TPM & literature review

2.1 Introduction

Nowadays, new approaches in modern manufacturing industries such as JIT and Lean Production require a high level of equipment availability which has resulted in maintenance gaining in importance as a support function for ensuring not only this but also quality products and workplace safety. Organisations have learned that when they do not schedule time for maintenance their equipment will do it for them. To address this need, they are turning to TPM, which is an equipment management approach and the systematic implementation of maintenance by all employees companywide, enabling organisations to attain their objectives of zero defects, zero breakdowns, and zero accidents (Nakajima 1988 and Willmott, 1994) which in turn increases efficiency resulting in higher profits.

TPM is a world class programme to equipment management that engages all employees, working to enhance equipment effectiveness. Successful implementation involves shared responsibilities, full employee participation, and natural teamwork.

TPM is proven to play a significant role in improving maintenance and engineering performance in companies. It contributes strongly to an organisation's plan of action by ensuring that equipment and facilities are well maintained, so as to provide improved quality of products and services. The business strategy of a company very much depends on the way that its maintenance programme is planned, when it is handled as a strategic function, and carefully planned; the state of production and office equipment positively influences output, quality, cost, delivery, health and safety, and employee confidence (Ahuja and Khamba, 2008b; Eti *et al*., 2004).

This Chapter discusses the TPM philosophy starting with the meaning of TPM, its historical background, and its features. One of the most important factors in ensuring TPM adoption success is the formulation of a sound implementation framework prior to initiating a change process. A review of a sample of the existing frameworks follows. The focus then centres on how TPM was implemented in different manufacturing companies worldwide, its effectiveness, the practical aspects within and beyond basic TPM theory, the CSFs for its implementation, the difficulties and the problems encountered in both the adoption of the programme and during the implementation.

2.2 Total Productive Maintenance

In manufacturing companies, there is a real demand for proper maintenance of production facilities (Cholasuke *et al.,* 2004; Meulen *et al.,* 2008). The maintenance role is thus critical for sustainable performance of any manufacturing organisation. It is also partly responsible for technical system safety and to ensure the organisation is kept in good condition (Visser and Pretorious, 2003). Currently, effective TPM programmes are needed, which can carry on with the dynamic needs and determine the hidden but unused or underutilised resources (human skills and support, man-hours, and machine-hours). A TPM methodology has a positive and important relationship with the performance level of the organisations (Sharma et al., 2012).

One of the important objectives of a TPM programme is making excellent products by eradicating the causes of the generation of defectives due to equipment defects, through increasing and improving the awareness, skills and capabilities of the front-line operators running the process. Improving the working condition of the equipment and machines not only increases the capacity of production through increased production rates, but also

improves the quality of the product and decreases the chance of quality failures. Whereas TPM enhances productivity, it is also at the same time directly related to improvement of and maintenance of the quality of the product. In addition, it aims to vigorously encourage a culture in which operators build up ownership of their machines, learn more about them, and collaterally develop problem solving and diagnostic skills (Willmott, 1994; Majumdar and Manohar, 2012).

At present, the concept of TPM in some manufacturing industries is one of the important missing concepts in successfully attaining not only world class equipment performance, but also it is an influential new means in improving overall company performance.

2.3 The history of TPM

TPM is a philosophy, which has evolved from productive maintenance perceptions and methodologies. Suzuki (1992) stated that the origin of TPM traced back to the late 1940s and early 1950s. The objective was to improve the reliability and availability of production equipment. TPM was developed from Preventive Maintenance (PM) along with Corrective Maintenance (CM) and Maintenance Prevention (MP) concepts and methodologies. It originated and was developed in the USA.

In the 1970s, TPM developed into a strategy focused on achieving Productive Maintenance efficiency through a complete system based on total employee participation which was the basic concept of Total Quality Management (TQM). It was at this time that "Total" was added to Productive Maintenance as the challenges of strong international competition required companies to deal with systems in 'total'. Nippon Denso, a major supplier to the Toyota Motor Company, was the first company to establish plant wide PM in 1960. The idea

was that, operators produced goods using machines, and the maintenance employees was committed to the work of maintaining those machines including quality, yield and safety.

2.4 The concept of Total Productive Maintenance

TPM developed from a variety of maintenance philosophies and improvement strategies such as PM, TQM, World Class Manufacturing "WCM", and Reliability Centered Maintenance "RCM" that have been used in different industries. It is a world class process to equipment management that involves all employees, working to increase equipment effectiveness. Successful implementation requires shared tasks, full employee contribution, and natural work groups (Nakajima, 1989).

The development of TPM concepts and practices has progressed over the last four decades (see Figure 2.1) and can be divided into the following four development stages, (Venkatesh, 2006):

- The first prior to 1950 was described as reactive maintenance. Throughout this period slight attention was placed on determining reliability requirements or preventing equipment failures (Nakajima, 1988; Narender and Gupta, 2012).
- The second, PM, concerned an examination of current equipment to decide the best processes to avoid failure and to cut repair time. In this phase, assertion was placed on the economic efficiency of equipment replacements and maintenance as well as on developing equipment reliability to reduce the mean time between failures (Shirose, 1992; Narender and Gupta, 2012).
- The third, Productive Maintenance (PrM) was recognised during the 1960s as the significance of reliability, maintenance, and economic efficiency in plant design increased. PrM comprises three key elements:

- ✓ MP, which takes place during the equipment design stages.
- ✓ Maintainability enhancement, which is concerned with modifying equipment to stop breakdowns and smooth the progress of maintenance.
- ✓ PM, which includes regular inspections and repair of equipment (Ahuja and Khamba, 2008a; Attri *et al.*, 2012).

- The fourth most recent period, TPM, officially started in the 1970s in Japan. Seiichi Nakajima, vice-chairman of the Japanese Institute of Plant Engineers (JIPE), the precursor of the Japan Institute of Plant Maintenance (JIPM), endorsed TPM all over Japan and has become known as the father of TPM. Each year the JIPM award a prize to the best Japanese companies in recognition of their success in the application of TPM. Successful companies in various industry sectors include: automotive, metals, rubber, glass, chemical and food (Ahuja and Khamba, 2008a).

Figure 2.1: Journey of the Maintenance Concept

The concept of TPM has as many definitions as there are companies which adopt the philosophy. A conclusive and accepted definition does not exist, which in many ways reflects the uniqueness of the application of TPM within each company and the emphasis which is stressed by the company values (Davis, 1997; Ahmed *et al.*, 2005; Eti *et al.*, 2004).

2.5 Definitions of TPM

TPM is a methodical approach to understanding an equipment function, its association to product quality and the possible cause and frequency of failure of its essential components (Nakajima, 1989; Ahuja and Khamba, 2008b).

Nakajima (1989) described the word "total" in TPM as:

1) *Total effectiveness* - indicating TPM's pursuit of economic competence and productivity.
2) *Total prevention maintenance* including maintenance prevention and maintainability improvement (MI).
3) *Total participation* signifying contribution of all employees through small group activities, which incorporates AM by operators.

Nakajima (1989) and Lemma (2008) described the three components of TPM as Total approach - which deals with all sides of the facilities employed within all areas of an operating company and the people who operate, setup and maintain them. Productive action - a very realistic approach to the condition and operation of facilities, intended at continually improving output and overall business performance; and Maintenance - a very useful methodology for maintaining and enhancing the effectiveness of facilities and the overall safety of production operations.

In some research papers and books TPM has been divided into two different approaches, the Western and the Japanese approach, both having similarity. The main difference between these two is that the contribution of all employees (either working in teams or in small groups) is vital for success in the former, the relationship between the equipment and the

operator is the solution, in the latter. Bamber *et al.,* (1999) reviewed these two main approaches to defining TPM.

The Japanese approach was promoted by Nakajima (1989), the vice chairman of the JIPM who defined it as:

"*Productive maintenance involving the total participation of all employees through small group activity in addition to maximising equipment effectiveness and establishing a thorough system of a comprehensive planned maintenance system*"

He identified that the definition contained the following five points:

- The goal of TPM is to maximise use of equipment.
- It establishes a system for productive maintenance during the entire lifespan of the equipment.
- It should be realised in all divisions of a company, so that Engineering, Maintenance and Management divisions as well as the workers on the shop floor pull together.
- It involves all employees from top management down to shop floor workers.
- It promotes improved maintenance through small group AM activities (Nakajima, 1989).

The western approach was promoted differently. In some cases, the role of the team is emphasised and for others it is management of the technology (Ames, 2003).

The following examples reveal the differences in approach:

- Willmott, (1994) recognised the five point definition of the Japanese approach of TPM and as a result accepted this as being a precise and a true reflection of the main principles, yet he provided a definition more suited to Western manufacturing and added: "*TPM seeks to engender a company-wide approach towards achieving a standard of*

performance in manufacturing, in terms of the overall effectiveness of equipment, machines and processes, which is truly world class".

- Wireman (1991) suggested that TPM was maintenance that involved all employees in the company from top management to the line workers.
- Rhyne, (1990) considered TPM as a joint venture between maintenance and production personnel to develop product quality, cut waste and cost, increase equipment availability, and improve the company's general state of maintenance.

Although there is very little difference between the two approaches, the Western definition is more practical since it interprets TPM as a way of doing the job right. From the above listed definitions, it can be concluded that there are basically two elements that characterise TPM; Equipment Management and the participation and involvement of employees. Operators and Maintenance Technicians must realise that they both struggle for the same goal and consequently must cooperate and share a teamwork spirit.

2.6 Overall equipment effectiveness

An important performance measure in mass production environments is Overall Equipment Effectiveness (OEE). Established by Nakajima (1988) in the context of TPM, it is focussed towards equipment/machines. TPM maximises equipment effectiveness through two types of activity, quantitative and qualitative. The former relates to increasing the equipment's total availability and improving its productivity within a given period of operating time, while the latter refers to reducing the number of defective products, thereby stabilising and improving quality.

Huang *et al.,* (2003) stated that the concept of OEE was becoming increasingly popular and that it had been extensively used as a quantitative tool necessary for the measurement of

productivity in manufacturing operations. They stated that conventional metrics for measuring productivity, throughput and utilisation, were inadequate for recognising the problems and underlying improvements required to increase productivity. Accordingly, OEE attempts to discover production losses and other indirect and hidden costs, which are those that contribute to a large proportion of the total production cost. These losses are developed as a function of a number of mutually exclusive components (Huang *et al*., 2003), namely: availability (V), efficiency (P) and quality (Q).

In considering OEE, Wal and Lynn, (2002) and Chan *et al*., (2005) noted six large equipment losses:

1. Equipment failure/breakdown losses classified as time losses when output is reduced, and quality losses caused by faulty products.
2. Setup/adjustment time losses resulting from downtime and faulty products that happen when the production of one item ends and the equipment is adapted to meet the needs of another.
3. Idling and minor stop losses occurring when production is disrupted by a temporary breakdown or when a machine is idling.
4. Reduced speed losses which refer to the difference between the equipment design and the actual working speeds.
5. Reduced yield which occurs throughout the early phase of production from machine start-up stabilisation.
6. Quality defects and reworks i.e. those losses in quality caused by faulty production equipment.

As shown in Table 2.1 the first two are identified as downtime losses and are used to determine the *availability*, *V*, of a machine. The third and fourth are speed losses, which

calculate the supposed *performance* efficiency, P, of a machine, i.e. the losses that occur as a consequence of operating at less than the optimum conditions. The final two are assumed to be losses due to defects; the larger the number of defects, the lower the *quality* rate, Q, of parts inside the plant. OEE is calculated as:

$$V \times P \times Q$$

Where, $$V = \frac{loadingtime - downtime,}{loadingtime}$$

$$P = \frac{theoreticalcycletime \times processedamount}{operatingtime}$$

$$Q = \frac{processedamount - defectamount}{processedamount}$$

Huang *et al*., (2003) defined the following:

Loading Time*: the daily or monthly time available for operation minus planned stops*
Downtime*: total time for unscheduled stops (breakdowns, re-tools, adjustments)*
Theoretical Cycle Time*: theoretical minimum time to produce one piece.*
Operating time: *productive time available after "Down Time Losses" is subtracted.*
Processed amount*: refers to the number of items processed per time period.*
Defect amount*: represents the number of items rejected due to quality defects of one type or another.*

Nakajima (1988) recommended that ideal values for the OEE component measures are 90% or more for availability, 95% or more for performance efficiency, and 99% or more for the quality rate. At these base levels, the resultant OEE is 85% which is a benchmark value considered as world-class performance (Sharma *et al.,* 2012;Ahuja and Khamba, 2008a).The OEE measure can be applied at different levels within a manufacturing environment. Bamber *et al*., (2003) stated that, it could be used as a "benchmark" for measuring the initial

performance of a manufacturing plant in its entirety. Dal *et al*., (2000) stated that by using largely existing performance data, such as PM, material utilisation, accidents, labour recovery, absenteeism, conformance to schedule, set-up and changeover data, etc., the OEE measure could offer relevant information for daily decision making. However, the role of OEE goes far beyond the job of just checking and controlling.

It is a great tool to classify previously hidden manufacturing losses and inefficiencies. Following OEE scores and using them to make improvements in manufacturing processes is a critical step forward towards world-class lean manufacturing for companies of all sizes and types.

6 Process Losses	*Type of Loss*	*OEE Calculation*
Breakdowns	**Equipment Availability**	**Availability**
Setup and Adjustment	***(downtimes losses)***	×
Idling and Minor Stops	**Performance Efficiency**	**Efficiency**
Reduced Speed	***(speed losses)***	×
Process Defects	**Quality Rate**	**Quality**
Start-up Losses	***(defect losses)***	**= OEE**

Table 2.1 Six Process Losses and OEE (Source: Braglia *et al.,* 2009)

2.7 Foundation and Major Pillars of TPM:

There are several different descriptions of what makes up TPM. According to Yeomans and Millington (1997) the Western approach applies the following five pillars: (i) improved equipment effectiveness; (ii) AM; (iii) planned maintenance programme; (iv) training for operation and maintenance skills; and (v) early equipment management.

On the other hand, the JIPM proposed that eight pillars (shown in Figure 2.2) be applied in a systematic way to optimise plant and equipment efficiency (Ireland and Dale, 2001; Shamsuddin *et al*., 2005).

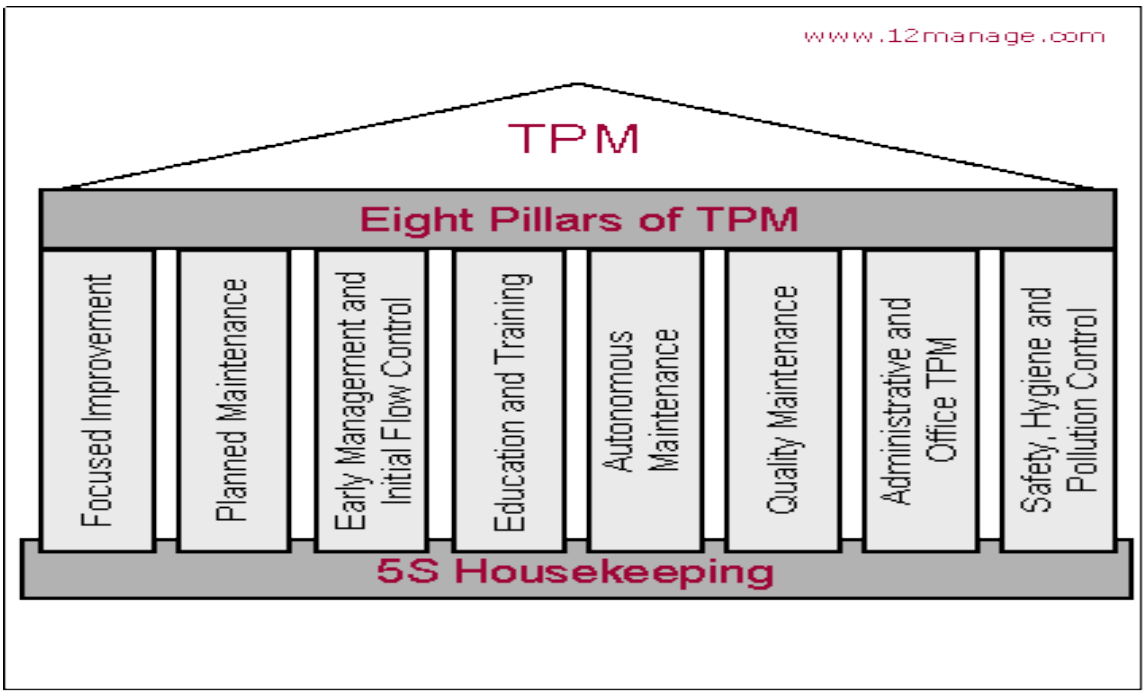

Figure 2.2: Pillars of TPM (Source: JIPM Solution, 2009)

Suzuki (1994) describes in details the JIPM fundamental pillars of TPM as:

1. *Focused Improvement:* This relates to the activities that maximise the OEE, processes and plants and improves the performance through total eradication of losses. It is intended at the equipment performing completely on the product manufacturing

task and is the duty of engineers, managers, operators, or technicians to take care of the machines in order to serve the purpose. The better equipment performance will lead to higher productivity on the shop floor then, making the business successful (Leflar, 2001).

2. *Planned Maintenance*: embraces three types: breakdown, periodic and predictive. By eliminating some of the daily maintenance tasks through AM, maintenance personnel can begin working on proactive equipment maintenance. Planned maintenance actions are scheduled to fix equipment and restore components before they fail. The Planned Maintenance pillar comprises concrete action incorporating planned education which allows all participants to rotate the Plan (P) Do (D) Check (C) Act (A) cycle and gain a great sense of satisfaction (Leflar, 2001).
3. *Early Management*: Early equipment management techniques should be initiated to prevent problems occurring during equipment start-up. It is an activity that encompasses the stages of planning, designing, manufacturing, trial run, start-up management, and stable operation run. One of the purposes of this pillar is to shorten the start-up period. The Maintenance Prevention (MP) design system naturally plays an important role in early equipment management.
4. *Education and Training*: TPM implementation is a continuous learning process, so this aspect is an important action in the process of implementation of TPM, since, the success of the entire programme depends on the degree to which the employees understand it and obtain desired operations and maintenance skills. The skills of operators and maintenance personnel must be improved if "AM" is to be successful. To implement TPM, a company must be willing to invest in training its employees in the use of its equipment (Nakajima 1989).

5. *Autonomous Maintenance (AM):* Nakajima (1988) described seven stages associated with this pillar.

- Carry out initial cleaning and inspection.
- Eradicate sources of contamination and inaccessibility.
- Develop and check provisional cleaning.
- Conduct general inspection autonomously. .
- Develop cleaning and lubrication standards.
- Workplace organisation and housekeeping.
- Fully implement an AM programme – this begins with the operators performing simple maintenance tasks like visual inspection, lubrication, tightening of loosened bolts, cleaning, but is gradually developed through pillar four, Training. This will assist more skilled maintenance personnel to take care of the more significant maintenance tasks, which create more added values. The intention is to keep machines in good condition.

6. *Quality Maintenance:* Through achieving zero defects, higher quality products and customer satisfaction are accessible. The focus is on equipment parts, which are critical for product quality. It supports a key objective of TPM i.e. guaranteeing reliability of equipment and processes so as to function correctly through their life cycle. Manufacturing technology, plant engineering and operating expertise all ensure that the quality is built in through the process and combine to create a final product of high quality (Suzuki, 1994).

7. *Office TPM*: Administrative and logistic processes should be implemented in order to increase efficiency and output in addition to identifying losses and elimination. Coordination and support functions have significant effect on Production and

Manufacturing. The effectiveness and productivity of a manufacturing system can be expanded by improving any activity that supports production. Many organisation losses are unmeasured and remain hidden (Suzuki, 1994).

8. *Safety, health and environment*: The aim of this pillar is to ensure a safe and appropriate working environment, eliminate incidents of injuries and accidents and present standard operating procedures.

2.7.1 TPM frameworks

2.7.1.1 Definition

Many authors and consultants in the field of TPM have used the term 'framework' without really defining it. Aalbregtse *et al*., (1991) defined it as being "a clear picture of the management goal for the organisation and should present key characteristics of the to-be style of business operations". It can also be referred to as a set of basic suppositions or essential principles of intellectual origin that supports the basic discussions and actions (Popper, 1994). The Collin Language Dictionary (2012) defines a framework as an "essential supporting structure or enclosing something else, especially a skeletal support used as the basis for something being constructed". Regardless of how it is defined it starts from the point that knowledge (know-how) is very important.

2.7.1.2 Frameworks for TPM

There have been numerous frameworks recommended by researchers for implementing TPM in different organisations having varying environments for acquiring manufacturing competencies in order to attain organisational goals and objectives (Ireland and Dale, 2001). Mishra *et al.*, (2008) stated that of the different TPM frameworks available, very few were

recommended by academicians. The majority were put forward by experts who established them on their experiences in different organisations. Yusof and Aspinwall (2000) explained the different between framework and models, it can be assumed that a model provides an answer to the question of 'what is TQM', with the overall concept or elements put together, whereas a framework answers 'how to' questions and provides an overall way forward. They added that if TQM is to be theoretically 'designed and constructed', the overall picture and structure for implementing, referred to as a framework, are required for carrying out relevant and important activities. The authors added that frameworks and models can be categorised into three broad types:

(1) Consultants / experts based; defined as *"those derived from personal opinion and judgement through experience in providing consultancy to organisations."*

(2) Awards based; those "*meant mainly for organisations seeking to be recognised as leaders in the quality management field."*

(3) Academic based; defined as "*those developed by academics and researchers mainly through their own research and experience in the field."*

This approach has been used to categorise the TPM frameworks (not models) found in the literature and is listed in Table 2.2.

Details of the compilation of each of those shown are given in Appendix I. As is inevitable their focus and elements tend to vary. Some merely characterised TPM without suggesting how to implement the elements, while others were intended to be used to facilitate the analysis of TPM practices rather than helping organisations to adopt them. It is worth noting at this point that the implementation of TPM differs from organisation to organisation even though the objectives are generally similar.

No.	Consultants / experts based	Award based	Academic based
1.	**JIPM "Nakajima"** 8 pillars	**Volvo Cars Gent** 13 pillars	**Yeomans and Millington** 5 pillars
2.	**Terry Wireman** 5 pillars	**Phillips 66** 6 pillars	**Society of Manufacturing Engineer** 5 pillars
3.	**Centre for TPM (Australasia)** 10 pillars		**Steinbacher and Steinbacker** 5 pillars
4.	**Cayman System** 8 pillars		**Society for Maintenance and Reliability Professionals** 6 pillars
5.	**TPM Club India** 8 pillars		
6.	**Strategic Work Systems Inc.** 6 pillars		
7.	**MAX International Engineering Group** 8 pillars		

Table 2.2 Categorised TPM Frameworks (Source: Mishra et al., 2008)

It was found that only a few of the frameworks listed in Table 2.2 were unique while others differed in the naming and the number of pillars/elements that they possessed. This is a problem for practitioners when they wish to choose a suitable TPM framework for implementation. Implementing TPM is by no means an easy task, however it does offer considerable strengths and opportunities to reach a competitive advantage. Although a number of frameworks have been suggested by practitioners and researchers for both Japan and the Western World, organisations world-wide are faced with the challenge of determining the right sequence of initiatives for effectively deploying TPM practices successfully, in the most effective manner. This awareness could be established in the same way as Nakajima (1988) did by consulting those who have successfully implemented TPM or any other maintenance method.

2.8 The need for TPM

In today's global economy, the survival of the company depends on its ability to quickly innovate and improve. Equipment is the key contributor to the performance and success of manufacturing companies (Ahmed *et al.,* 2005). It is important to develop suitable maintainability and reliability strategies for manufacturing equipment to certify that the organisations are capable of both producing a greater product quality at reasonable cost and ensuring a timely delivery of products to the customer (Madu, 2000). As a result, the need for a programme such as TPM is even greater, but more preparatory work will be required (Poduval *et al.,* 2013).

According to Shirose (1992) its introduction unites the whole company behind actually achieving a goal such as zero breakdowns and zero defects with the benefit of higher productivity and enhanced profitability. It has been recognised by different TPM experts over the years that its successful implementation has saved thousands of pounds reducing lost production (Nakajima, 1989).

Al-Hassan (2004) stated that TPM has the advantage of building quality into equipment and building an environment that stops equipment and tools from generating production or quality problems. This company-wide, team based effort, is at the heart of TPM. Suzuki (1992) stated that the three reasons that caused TPM implementation to spread so swiftly throughout Japanese's industry were that outstanding results were delivered, companies were transformed and a goal was provided towards which to strive. According to Poduval *et al.,* (2013) TPM is needed not only from an organisation viewpoint but also from that of an individual. It is no longer viewed merely as a continuous improvement tool to cut costs but is considered to be a critical tool for keeping lead times in check, which is absolutely

essential for survival in a world where customers demand low prices and rapid delivery. It is a continuous journey and will take some time for the benefits to be visible. But the effort is worth the pain experienced in the implementation process.

2.9 TPM Implementation

TPM, TQM, Six Sigma, Lean and the ISO (International Organisation for Standardisation) series of standards are together with the most well-known techniques employed by manufacturing organisations as Organisational Performance Improvement Techniques. Similarities, differences and the relationships between these programmes in terms of concept, objectives, procedures and range have remained confusing to industry (Kedar *et al*., 2008). Each of these programmes has its strengths and weaknesses and correspondingly the selection of one of these or a mixture of several has stayed a difficult issue for practitioners.

Konecny and Thun (2011) examined the effect of TPM and TQM on organisation performance and mainly the supporting role of employee participation programmes. The data was collected from the international research project High Performance Manufacturing that contained data for 238 sites. The conclusions showed that TPM and TQM, supported by Human Resource (HR) practices, had a significant possibility to improve organisation effectiveness. The study also indicated that organisations with a focus on TPM or TQM detailed practices as well as those practising a concurrent quality strategy showed a higher performance level than those lacking a specific quality focus. Seth and Tripathi (2005) examined the strategic implication of TPM and TQM in an Indian manufacturing company. Friedli *et al*., (2010) presented a complete model based on survey data collected from Swiss pharmaceutical manufacture companies in 2004 and 2009. The study was divided into four sub-systems: JIT, TQM, TPM, and the Management System. It revealed that the industry had

made progress towards "Excellence in Operations" between 2004 and 2009, but that most of the companies were still working on effectiveness (TQM and TPM) instead of focusing on efficiency (JIT). According to Kedar *et al*., (2008) Six Sigma provides a clear change of structure and is much more orientated on fast and concrete results in comparison to TPM, TQM, and Lean. Moradi *et al.,* (2011) studied the relationship between the pillars of TPM and 5S in one of the major Iranian food industries unit. The results asserted that all 5S principles affected TPM providing a better way to reduce the six big losses and consequently improve OEE. Furthermore they could encourage a collaborative culture in the plant in order to develop employees AM practices. Bamber *et al*., (2000) considered the possibility of merging some of the lean thinking tools, such as ISO 9001 with ISO 14001, and 5S and TPM. The results brought new aspects on how to integrate those mentioned, but there was not a particular connection between the ISO 9001 requirements and Lean tools.

2.10 Successful Implementations

Successful TPM programmes can be defined as those that have developed implementation plans, followed those plans through, and realised the expected benefits of their implementation. This does not necessarily mean that these "successful" projects have resulted in major financial savings. Some of these programmes had less ambitious goals, yet perceive them as successful if they met their stated goals (Lemma, 2008). One of the ways to evaluate TPM success is to adopt a holistic approach of assessing one's organisation. An example is the TPM excellence awards assessment approach. This is an international level award system assessed by JIPM to recognise organisations for achieving an excellence in their respective business (Sharma et al., 2006; Davis and Willmott, 1999).

As stated by Wireman (1991) "there is no single correct method for the implementation of a TPM practise". Bamber *et al.,* (1999) supported Wireman's statement and finished that there is "a difficulty and difference of TPM practices implemented throughout industry". Several companies across the world have implemented TPM and are successful and contented with the implementation. For instance, Ahuja and Kumar (2009) conducted a study at a precision tube mill into the improvements that successful TPM programmes made to competitive manufacturing. The results showed that TPM programmes could significantly help towards the enhancement of manufacturing performance in the organisation.

Ireland and Dale (2001) performed a study of three companies which had implemented TPM because of business problems they faced. Top management supported TPM and set up proper organisational structures to help its implementation. The companies had followed Nakajima's seven steps of AM, although different TPM pillars had been implemented, with common ones being Focused Improvements, Training, Safety and Quality Maintenance. They also used cost deployment to help focus improvement activities to the areas where the greatest benefits would be achieved. The main difference in the implementation process related to the use of the ABC machine classification system and the role of facilitators. ABC system prioritises machines for production and maintenance in which TPM activities were carried out on only the top ten, with comprehensive breakdown analyses and corrective measures.

Lixia and Bo (2011) successfully examined an effective way for Chinese organisations to implement TPM to reduce cost and increase efficiency in economic crisis. Ramnath and Bharath (2010) established a new framework identified as 'Fuzzy Based Simulation' (FBS) for determining the appropriateness of implementing TPM in a company in India. The

framework considered important issues like Quality, cost and delivery time. The authors concluded that TPM was appropriate and useful for the company.

2.10.1 Phases of a TPM programme

Various researchers have recommended their own description of a TPM implementation process, however, most is a variation of Nakajima's model which is a classic twelve-step TPM implementation programme that has been the foundation of TPM since 1984. These 12 steps maintain the basic developmental activities, which comprise the least requirements for the development of TPM. The implementation procedure steps in brief are shown in Table 2.3 (Nakajima, 1989).

Therefore, it has been recognised through the literature review that, although a number of models and methodologies have been proposed by experts and researchers for the Western World, organisations worldwide are faced with a difficult challenge of determining the right sequence of programmes for effectively implementing TPM programmes successfully, in the most effective way.

Distinction	Step	Implementation
The preparation phase	1. Pronounce top management decision to introduce TPM.	Announcement of the company, and published in internal publications or notice board.
	2. Start education and campaign to introduce TPM.	Carried out in agreement with other walks of life into the concept of TPM education.
	3. Create organisations to promote TPM.	Encourage the company of commissions, the functional division, the service Bureau and the set-up of TPM training teams
	4. Establish basic TPM policies and goals.	Reference point in the position of data collection and goal setting; estimate effects and events.
	5. Prepare master plan for TPM development.	Arranged from the introduction to fully implement; period of 3 to 5 years.
Preliminary implementation phase	6. Hold TPM kick-off.	Full participation and invite third party plant, affiliated companies and subcontractors.
TPM Implementation Phase	7. Improve effectiveness of each piece of equipment.	The project team to develop the activities of small groups; step up these methods and the analysis; improve safety; maintenance of skills enhance training.
	8. Develop an AM programme.	Develop best vertical start-up for products, processes, and equipment.
	9. Build up a scheduled maintenance programme for the maintenance department (periodic maintenance).	Set up, maintain, and control conditions for zero failures, defects, and accidents.
	10. Carry out training to improve operation and maintenance skills.	Support the production efficiency of various departments and improve administrative functions & environment.
	11. Improve early equipment management programme.	The establishment of systems for zero accidents and zero pollution environments.
Stabilisation Phase	12. Perfect TPM implementation and raise TPM levels (set higher scores).	Ask for higher targets, applying for PM awards prize

Table 2.3 Implementation Procedures Steps (Source: Nakajima, 1989)

2.10.2 Critical success factors of TPM Implementation:

Every organisation has a mission statement that translates the company's values into tangible goals that will progress it forward and make it perform to its optimum (Oakland and Porter, 1995). It reflects the organisation's unique values and vision; achieving it takes the involvement and skill of the entire employees.

The goals and objectives of each employee must be aimed towards the company's mission. In addition, the organisation must perform well in key areas unique to itself and to the industry in which it competes, on a consistent basis. These can be defined as the organisation's CSFs (Caralli, 2004). In using and applying them it should be borne in mind that success is not guaranteed even when some, but not all the relevant ones are in place. However the chances are enhanced when more of them are present (Stainforth and Staunton, 1996). In order to realise the true potential of TPM and ensure its successful implementation, TPM goals and objectives require to be fully incorporated into the strategic and business plans of organisations. The first step is to set up a strategic direction for TPM since the transition from a traditional maintenance programme requires a significant shift in the way that Production and Maintenance functions operate.

Authors such as Nakajima (1988), Patterson *et al*., (1995), Tajiri and Gotoh (1992) and Yeomans and Millington (1997), report that the CSFs of TPM implementation include aspects such as top management support, TPM teams, CI, cooperation and education of employees, although with different emphases in each case. A TPM manager can perform as a product champion who helps to train and roll out the programme to all levels of management. In addition prior management level training can help generate the necessary support and ensure that each has enough knowledge for active involvement in the

implementation process, which in turn helps to enhance the employees' commitment. Swanson (1997) recommended four important factors for the successful implementation of TPM, employee training, operator participation, teams and PM. Other factors that will facilitate smooth TPM implementation include committed management, strategic planning, cross-functional training, and employee participation. In order to capture the whole TPM programme, it is important to combine the practices recognised as pillars or elements with development activities. For the programme to be successful, the important processes must be recognised as helping both the organisation and the employees (Robinson and Ginder, 1995). There is also a requirement to encourage an environment for facilitating employees to smoothly implement the TPM practices of AM and planned maintenance.

As can be expected, some of the factors that have led to successful TPM programmes are basically the opposite of the obstacles to implementation. One significant factor is management's efforts to drive CI in a team environment. Building on trust through effective communication, acceptance of ideas, employee contribution in decisions, and regular feedback are incentives that make improvement through strategic TPM implementation programmes. Team Leaders must provide consistent messages; they should encourage their team members, facilitate and maintain order, and help with decision-making. This effort requires an "active organisation" (Yamashina, 2000).

According to Davis (1997) the leading consultant of Manufacturing Productivity Improvement Limited, practice of TPM implementation in the UK has shown that the key factors for success are to:

- Build a realistic plan and employ programme and project management principles;
- Appreciate that it will take a long time to spread across the organisation and to change the existing maintenance culture;

- Be determined to keep going;
- Organise in place, train and develop a network of TPM supervisors who will help and support the associated activities every day;
- Support the supervisors with the resources that they need, and give them senior level back up;
- Set a relevant measures of performance and constantly monitor and publicise benefits achieved in financial terms;

Davis (1997) added that it is very essential to evaluate performance as it allows managers to base their decisions on facts, rather than on say opinions. Fredendall *et al*. (1997) emphasised that a TPM development programme should typically emphasise, among other things, the leadership role of top management in its launch and implementation, the establishment of TPM policies and goals; the master plan which must be communicated to everyone in the organisation; and building a system for training and employee involvement. The top management commitment in preparing a suitable environment for TPM's introduction and in planning and organising for its implementation is considered vital to its success. Ahuja and Khamba (2008a) conducted a study intended to examine the implementation of TPM practises in Indian manufacturing industry. The authors listed the key enablers and critical factors for successful TPM implementation and classified them into six categories:-

1. Top management contributions.
2. Culture transformations.
3. Employee participation.
4. Conventional and proactive maintenance guidelines.
5. Training and Education.
6. Maintenance prevention and focused production system improvements.

The Fishbone diagram in Figure 2.3 represents the strategic issues associated to different TPM enablers and CSFs (Ahuja and Khamba, 2008a). It is strongly thought that the full adaptation of the laid out enablers and success factors can avoid the barriers to TPM implementation and can strategically lead an organisation to utilise competencies for continued competitiveness. The successful implementation of TPM requires top management support and commitment. Top management require to have a strong commitment to the TPM implementation programme and should go all-out for developing mechanisms for multi-level communication to all workers explaining the significance and payback for the whole programme, and whole heartedly propagating the TPM benefits to the organisation (Ahuja and Khamba, 2008a; Bakri *et al*., 2012). The main challenge for an organisation is to be able to make radical transformation to its culture for ensuring overall employee participation towards maintenance and manufacturing performance improvement through TPM initiatives. Several strategic programmes can also be successfully deployed in organisations for encouraging workers to the organisational goals and objectives of growth and sustainable development for meeting global corporate challenges, includes developing programmes for employees; recognition of efforts made by the employees; developing reward and incentive instruments; improving the skill and knowledge and encouraging cross-functionality between various organisation functions and departments(Ahuja and Khamba, 2008a).

Moreover, organisations need to build up standard work practices and secure operating procedures covering their entire range of production systems. They also need to guarantee total implementation of laid out procedures by motivated and capable employees, since it has been observed that most of the failures of TPM programmes can be credited to the

failure of the organisation to observe and maintain the standard operating procedures for production systems and other business functions.

Furthermore, Ahuja and Khamba added that organisations must make rigorous efforts to implement modern maintenance programmes like predictive maintenance and computerised maintenance management systems in order to enhance the manufacturing performance through contemporary proactive maintenance improvement initiatives. Finally companies need to develop and implement strategic TPM implementation initiatives for improving manufacturing performance. Initially, the true potential of TPM needs to be demonstrated by communicating the complete TPM policy and master-plan, establishing an organisation structure for TPM deployment, and focusing TPM initiatives on critical model machines, thereby creating an environment of suitability towards TPM practices (Ahuja and Khamba, 2008b).

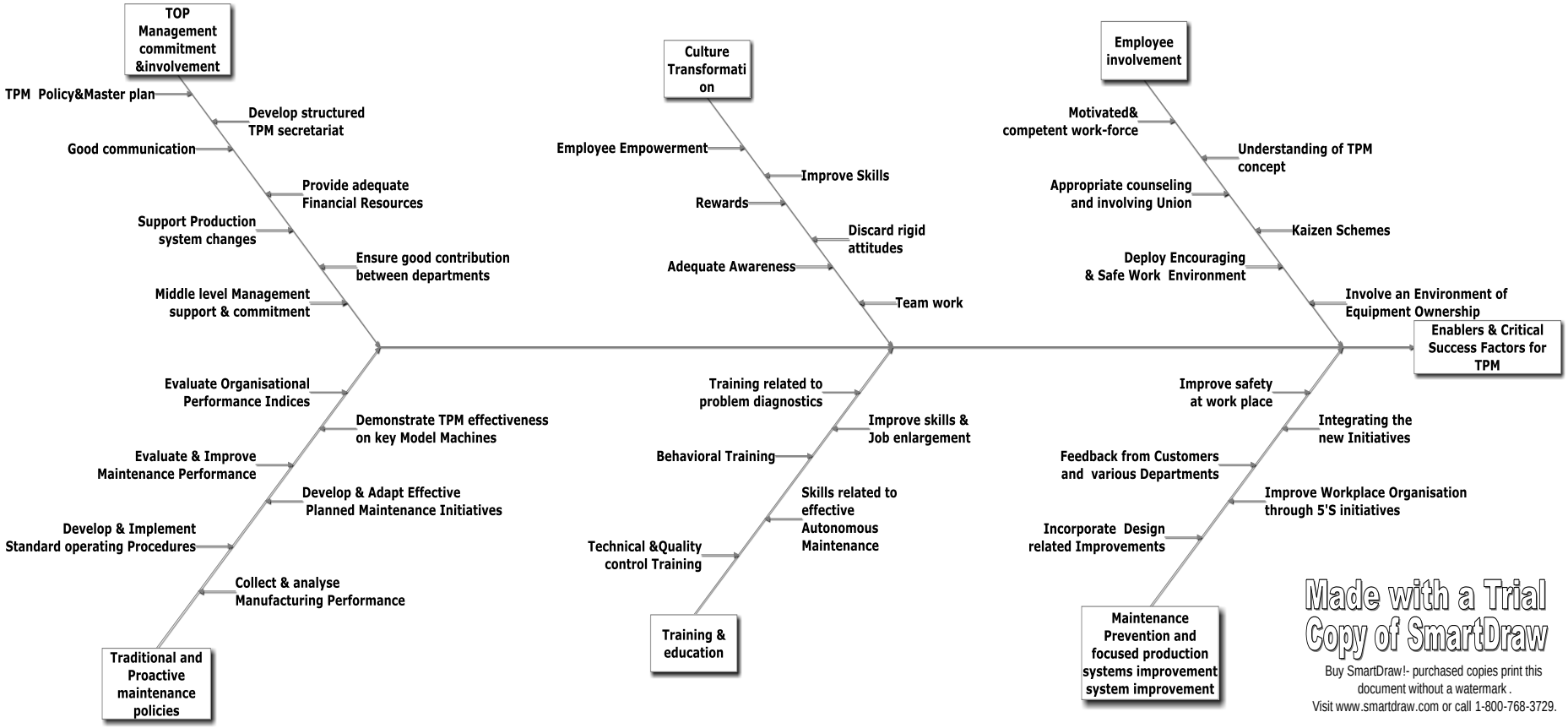

Figure 2.3 Enablers and CSFs for TPM Implementation (Source: Ahuja&Khamba, 2008a)

Bakri *et al.,* (2012) observed that there was a need for more study on the role of management in supporting and contributing in TPM programmes. Management has a specific influence to educate and deconstruct any decision within the organisation. Consequently, the extent of their understanding and commitment on the TPM practice needs to be carefully measured mainly on the intangible factors and hierarchical context. It is relevant to have an in-depth study to address this issue with a more comprehensive framework towards successful TPM.

Park and Han (2001) proposed a framework model for successful TPM implementation. They provided a checklist of factors that they considered critical for the successful implementation of TPM. They were classified as: Culture Transformation, Leadership Commitment and Support, Coordination, Communication and Cooperation. In addition, Park and Han identified two significant matters that are important to the successful implementation of TPM. Firstly organisations must have established their plan and their basis of competition, and have carried out systematic preparatory planning. Secondly, they should be conscious that the mere application of operational aspects of TPM, with little regard for underlying principles, will not ensure its full, long term benefits. There is no doubt that the long term benefits of TPM are the results of considerable investment in human resources development and management. Specifically, training for TPM and employee participation in maintenance-related decision making is critical to successful TPM adoption.

One *et al*., (2005) conducted a study aimed at identifying CSFs for TPM implementation in Malaysian manufacturing organisations. The study focused on two TPM operational strategies: Human-oriented and Process-oriented. The authors described the former as involving: Top Management Commitment and Leadership; Total Employee participation and Training and Education. The latter involved all kinds of technical approaches to

maximise the OEE through quantitatively increasing equipment availability and qualitatively eliminating all production losses that resulted from inefficient equipment (Nakajima, 1988). The findings showed that there was a positive relationship between the human-oriented strategy and the level of TPM implementation. The findings that training was a significant determinant of TPM implementation supports the work of Blanchard (1997) who pointed out that training and educational issues were critical to establishing successful TPM implementation. Hansson *et al.* (2003) put emphasis on effectively managing organisational change for enhancing an organisation's performance for strategic survival in a competitive environment. The success criteria for effective and efficient TPM implementation must include steps like following an established implementation process, committing management to it, integrating TPM with other continuous programmes (Lean Manufacturing, TQM, Six-Sigma, etc.), linking TPM activities directly to corporate business goals and objectives, documenting learning gained during TPM activities, and staying the course because TPM implementation does not always proceed smoothly; patience and determination is required (Ahuja and Khamba, 2008b).

Tripathi (2005) investigated the strategic implications of TPM and TQM in an Indian manufacturing company. He examined the relationship between factors effecting the implementation of TPM and TQM and business performance for TQM alone, TPM alone and both together. This was achieved by conducting an empirical survey on a sample of 108 manufacturing companies in which he identified two sets of factors critical for the effective implementation of TPM and TQM. Universally significant factors for all three approaches included top management, process management and strategic planning while approach-specific factors comprised equipment management and focus on customer satisfaction.

The need to understand the CSFs for successful TPM implementation is crucial in order to meet the purpose of this study.

No.	Critical success Factors	Authors
1.	Top management commitment	(Aspinwall and Elgharib, 2013; Bakri *et al*., 2012; Ng et al., 2011; Ahuja and Khamba, 2008a; Rodrigues and Hatakeyama, 2006; One et al., 2005; Seth and Tripathi, 2005; Hansson *et al.*, 2003; Park and Han, 2001; Bamber et al., 1999; Davis, 1997; Fredendall et al., 1997; Yeomans and Millington, 1997; Patterson *et al*., 1995; Tajiri and Gotoh, 1992; Nakajima, 1988).
2.	Total employee participation and involvement	(Ahuja and Khamba, 2008a; Arca and Prado, 2007; One et al., 2005; Park and Han, 2001; Yamashina, 2000; Bamber et al., 1999; Fredendall et al., 1997; Swanson, 1997; Nakajima, 1988).
3.	Communication and awareness	(Ng et al., 2011; Park and Han, 2001; Yamashina, 2000; Fredendall et al., 1997).
4.	Strategy planning and action plan	(Ahuja and Khamba, 2008a; Chan, 2005; Seth and Tripathi, 2005; Hansson *et al.*, 2003; Park and Han, 2001; Bamber et al., 1999; Fredendall et al., 1997; Swanson, 1997).
5.	Resources allocation & availability,	(Ng et al., 2011; Bamber et al., 1999).
6.	Recognition and empowerment	(Ahuja and Khamba, 2008a; Nakajima, 1988).
7.	Training and education.	(Aspinwall and Elgharib, 2013; Ng et al., 2011; Ahuja and Khamba, 2008a; Chan, 2005; Seth and Tripathi, 2005; One et al., 2005; Blanchard, 1997; Davis, 1997; Fredendall et al., 1997; Swanson, 1997).
8.	Monitoring and evaluation	(Ahuja and Khamba, 2008a; Seth and Tripathi 2005; Davis, 1997).
9.	Rewards and incentive mechanism	(Ahuja and Khamba, 2008a; Yamashina, 2000).
10.	Teamwork	(Rodrigues and Hatakeyama, 2006; Yamashina, 2000; Swanson, 1997; Nakajima, 1988).

Table 2.4 Summary of TPM CSFs

Different studies of TPM CSFs have been conducted by various researchers within all sectors of industry (Ng *et al.,* 2011; Ahuja and Khamba, 2008a; Seth and Tripathi, 2005; Hansson *et al.,* 2003; Bamber et al., 1999). Table 2.4 gives a summary of these CSFs. An in depth literature review indicated that numerous factors had been identified as important for accomplishing TPM. Although different researchers have used different terminologies to indicate these factors, they can be represented by generic themes. The common conclusion from these studies is that each organisation has a set of CSFs to which it must pay attention, and that the implementation process is firm-specific.

Based on the literature review (both from industry and academia), the researcher proposed the following 10 CSFs to form the basis for TPM adoption in manufacturing companies in different sectors: *top management*, *total employee involvement*, *communication and awareness*, *strategic planning* and *action plan*, *resource allocation* or *availability*, *recognition and empowerment*, *training and education*, *monitoring and evaluation*, *reward and incentives* and *teamwork*.

The ten factors are explained in more details below:

1. **Top Management Commitment:** commitment from management is the only way to implement and maintain the culture necessary for TPM. They act as a driver for TPM implementation by creating values, goals and systems to improve an organisation's performance. Most TPM experts and practitioners such as Ng et al., (2011), Ahuja and Khamba, (2008a), and Rodrigues and Hatakeyama (2006) agreed that top management is the single most important factor influencing the successful of TPM programmes.

   Many works verified that the lack of linkage between policy and the overall corporate strategy of manufacturing organisation leads to poor maintenance performance (Bakri et al., 2012; Ahuja and Khamba, 2008 b). The TPM programme

needs leadership throughout by top management who should understand and support its objectives and methodology. It is not enough for management to manifest his/her commitment verbally. It must be transparent throughout the whole company through adequate support, training and monitoring. Management should actively listen to their employees and check progress. In general, without appropriate leadership, TPM will not succeed only dynamic leadership can create the commitment to drive the TPM programme (Nakajima, 1989).

2. **Total employees participation and involvement:** successful TPM approach requires a committed and well-trained workforce that participates fully in improvement activities (Arca and Prado, 2007). TPM programme promotes employee involvement by preparing operators to become active partners with maintenance and engineering personnel in improving the overall performance and reliability of the equipment (Ahuja and Khamba, 2008a). The word 'Total' means all people are involved, including management and workers. In the TPM framework, the goals are to develop a maintenance free design and to involve the participation of all employees to improve maintenance productivity (One et al., 2005). The need for full shop floor involvement or participation is based on the belief that the involvement of production operators who have the most experience with the equipment since they are operating the machine everyday would benefit the maintenance activities of the organisation (Arca and Prado, 2007). As a result, TPM demands the involvement and participation of all production operators and maintenance staff in the form of small group activities in order to improve equipment effectiveness (Ahuja and Khamba, 2008b). According to Yamashina (2000) employee involvement can be characterised by the use of the following practices: *Knowledge*, employees should be provided with

knowledge and skills at all levels through their career to enable them to keep updated with their field of specialisation; *Sharing information* refers to the practice of informing employees about company and work group goals, as well as the sharing of performance feedback.

3. **Communication and awareness:** it plays a very important role in the implementation of TPM programmes, but it has often been found to be poorly managed in different organisations (Ng et al., 2011; Ahuja and Khamba, 2008b; Park and Han, 2001). Management feedback on the reports and the manner of feedback so that the employee can understand are also important; otherwise employees will be discouraged from further reporting of their concern on TPM (Park and Han, 2001).

   TPM can enhance communication, and hence safety culture. As described by McKone et al. (2001), TPM helps to improve the organisation's capabilities by enhancing the problem-solving skills of individuals and enabling learning across various functional areas. Ng et al., (2011) stated that companies need to build the skills of their workforce and develop worker participation in order to compete through WCM. TPM changes the structure of the organisation to break down traditional barriers between maintenance and production, fosters improvement by looking at multiple perspectives for equipment operation and maintenance, increases technical skills of production personnel, includes maintenance in daily production tasks as well as long-term maintenance plans, and allows for information sharing among different functional areas. The author also emphasise the importance of communicating and sharing improvement information among all the staff as a factor promoting the implementation of TPM programmes.

4. **Strategic planning and action plan:** according to Ahuja and Khamba (2008a) strategic planning is a systematic approach to setting quality goals, it's clear, to have successful implementation of TPM in any organisation, companies need to align of every employees effort with the aim of the organisation (Chan, 2005). It implies activities which link TQM, TPM and RCM to the organisation mission, vision and defined business strategy, and strategic priorities and goals. This gives a clear picture of how the improvement will benefit the organisation and promote desired achievements such as management and employees understanding.

   Benchmarking is another powerful management concept. It is seen within the context of TPM as an accelerator towards achieving TPM by learning from the best and so is viewed now as an inevitable step. Its processes provide a management tool for measuring and comparing parts of an organisation against the best which leads to excellent performance on a continuous basis (Seth and Tripathi, 2005).

5. **Resource allocation or availability:** TPM implementation requires investment by the top management in terms of resources. The main idea behind the maintenance is to make the parts and machine ready to do what are required within the time and sizes allocated and do it with fewer amounts of resources. To control the budget in organisations, downsizing is mostly adopted which reduces the availability of personnel for unscheduled work (Tripathi, 2005; Bamber et al., 1999). Furthermore next to the energy costs, maintenance costs can be the largest part of any operational budget. So timely maintenance actions are required which will minimise the incidence of such failures, and increases the reliability of machines and equipments through the effective management of maintenance function (Ng et al., 2011).

6. **Recognition and empowerment:** according to Ahuja and Khamba (2008 b) a well-designed staff and team recognition system is an effective factor in continuously encouraging and reinforcing the desired behaviour toward proposed changed, supporting morale and motivating employee involvement. They found that the associated staff rewards (in terms of certification and promotion) encouraged commitment in shop-floor workers and junior staff, giving them a sense of belonging and a feeling of pride. This finding is supported by One et al., (2006) found that recognition, respect and reward for a good job done were important factors in assuring effective implementation and maintenance of quality management systems in Chinese organisations. Similarly, Twati (2008) and Tripathi (2005) argue that employee empowerment, training and reward are important factors in implementing organisational improvements activities. Twati (2008) added that top management should reward and praise employees' initiatives. They should be rewarded and praised based on their contribution to the organisations, their skills and experience, irrespective of age, sex and any other considerations, which are unrelated to the function they perform. Nakajima (1989) suggests that following critical elements of empowerment leading to an improved organisational performance: provide the skills required to solve problems and make decisions; *and* define empowerment based on the mission of the organisation.
7. **Training and education**: is defined as the planned systematic development of the knowledge, understanding, skills, attitudes and behaviour patterns required by an individual in order to perform adequately a given task or job. The training and development of company employees is essential for organisational operation and advancement. Education and training can improve employees' knowledge and skills,

and can have an important influence on their development and lead to an increased sense of belonging (Yamashina, 2000; Nakajima, 1989). TPM encourages education and training through AM. As described by McKone et al., (2001), operators learn to carry out important daily tasks that maintenance people rarely have time to perform. These housekeeping tasks include cleaning and inspecting, lubricating, precision checks, and other light maintenance tasks and can be broken down into five 5's.

For training to be effective, however, regular reviews and improvements are made in the training system to accommodate changing requirements (Nakajima, 1989). It must be planned in a systematic and objective manner. Quality training must be continuous to meet not only changes in technology, but also changes involving the environment in which an organisation operates, its structure and most important of all, the people who work there (Ahuja and Khamba, 2008a).

8. **Monitoring and evaluation:** are the most critical elements in a successful implementation of TPM programmes (Ahuja and Khamba, 2008a; Tripathi, 2005; Davis, 1997). These implies activities such as obtaining measurable and quantified results and objectives, so as to have a clear scope and focus, and continually monitoring and following through the process. Appropriate data collection and analysis (e.g. OEE, uptime) is used by the facility to eliminate equipment -related losses. Employees have to see how they can personally benefit from the change, while management must see how it benefits the company (Nakajima, 1989). Monitoring and evaluation yields feedback on results that promote creation of a motivated management, which continuously provides resources and support for the implementation (Davis, 1997).

9. **Reward and incentives:** they are essential factor of TPM programme. For stimulating and enthusiasm and positive focus and maintaining it over the period motivation and recognition are necessary. Banners, signs, flags and notice boards that bear TPM slogans were displayed to create a positive environment and promote enthusiasm (Ahuja and Khamba 2008 a; Yamashina, 2000). The teams cleaned and improved their work place accordingly. Quality personnel will go around assessing the cleanliness of each line and team with the highest mark will be announced as the winner. Rewards in terms of monetary and certification will be given (Nakajima, 1989). Graisa and Al-Habaibeh (2011) observed that motivation awards to individuals and to shifts were given based on the criteria. An effective recognition and reward programme for employees who were actively involved in the process was observed. Efforts were done to boost operators 'morale and the commitment towards company's goals (Lazim and Ramayah, 2010).
10. **Teamwork:** teamwork among all employees in various departments in manufacturing companies can ensure better TPM implementation. Indeed, the complexity of getting commitment and involvement from employees is one of the implementation difficulties of TPM (Arca and Prado, 2008). The ownership of machines concept need to be enhanced to ownership of company as final goal is collective performance in any organisation. Activities like quality circles or TPM circles, CI, focused improvement groups, self-directed teams encourage teamwork and coordination. The small group activities being driving force in TPM implementation operators and executives at different levels were encouraged to form CI teams (Rodrigues and Hatakeyama, 2006; Nakajima, 1988). Ahmed *et al.*, (2005) observed in his study the formation of self-directed work teams which were given

problem solving responsibility, in addition to their regular job responsibilities. Lazim *et al.*, (2010) observed numbers of improvement activities were executed to create an on-going AM atmosphere. TPM small group activities aids better communication at all levels across all the departments and hence develops team working spirit healthy organisational requirements (Yamashina, 2000). Both operators and technicians express their ideas through the brainstorming session in order to solve all the recorded problems. Hence, there can be many suggestions for improving the equipment. From all the suggestions few of them contribute significantly to the improvement of the performance of the equipment can be classified as CI. Teamwork is needed to eliminate potential breakdowns and stoppages through total commitment. TPM teams should be supported by top management and should be given recognition and be an ongoing process (Nakajima, 1989).

Having enumerated the CSFs, a number of representative measurement elements were then carefully formulated on the basis of pertinent studies to reflect the meaning and scope of each. A total of 40 elements were assigned to them (details are provided in Appendix III-B). This resulted in a survey instrument for measuring the relevance of the CSFs for implementing TPM in manufacturing companies. This instrument was repeatedly checked and evaluated, and alterations were made before it was finalised. Its reliability and validity will be discussed later in Chapter Five.

2.11 Barriers and Obstacles to Successful TPM Implementation

Although there are success factors, there will be barriers and obstacles during implementation. For a successful implementation of TPM these obstacles should be studied carefully, understood, and possibly eliminated. Different authors note these as follows:

1. **Lack of management support** (Yamashina, 2000; Wang, 2006; Gupta *et al*., 2006; Rodrigues and Hatakeyama, 2006; Ahuja and Khamba, 2008a; and Lazim and Ramayah, 2010).
2. **Lack of understanding of TPM concepts** (Bamber et al., 1999; Ireland and Dale, 2001; Aspinwall and Elgharib, 2013).
3. **Lack of training and skills** (Bamber *et al*., 1999; Yamashina, 2000; Ahmed *et al*., 2005; Wang, 2006; Gupta *et al*., 2006; Rodrigues and Hatakeyama, 2006; Lazim and Ramayah, 2010 and Graisa and Al-Habaibeh 2011).
4. **Relationship between production and maintenance staff** (Chan *et al*., 2005).
5. **Heavy workload** (Cooke, 2000; Ahuja and Khamba, 2008a; Aspinwall and Elgharib, 2013).
6. **Ineffectiveness of planning and scheduling** (Ahuja and Khamba, 2008b, Aspinwall and Elgharib, 2013).
7. **Lack of TPM strategy** (Hartmann, 1992; Steinbacher and Steinbacher, 1993; Graisa and Al-Habaibeh, 2011).
8. **No finance commitments** (Ahuja and Khamba, 2008b; Aspinwall and Elgharib, 2013).
9. **Lack of human resources** (Lawrence, 1999; Yamashina, 2000).
10. **Workers show strong resistance to any change** (Cooke, 2000; Waeyenbergh and Pintelon, 2002; Aspinwall and Elgharib, 2013).

11. **Sufficient resources like people, equipment, time, etc. and assistance are not provided** (Davis, 1997; Aspinwall and Elgharib, 2013).
12. **Educational background of the employees** (Davis, 1997; Chan *et al.,* 2005; Aspinwall and Elgharib, 2013).

As can be seen from the above list, many are closely related to human factors. The implementation of TPM can cause fear and conflict among workers. It can be concluded therefore that TPM cannot be implemented in the same way in all organisations because of the differences in their culture, environment and structure.

2.12 Benefits for TPM implementation

Results from previous studies showed that TPM programmes provide higher productivity, higher safety and quality standards, fewer breakdowns, lower costs, higher delivery reliability, higher morale among the employees and a better working environment (Arca and Prado, 2007; Ahuja and Khamba, 2007; Ng *et al.*, 2011).

TPM has numerous benefits. One tangible benefit is the reduction of the maintenance force. By turning all of the PM activities over to Production, the maintenance personnel who were previously doing the preventive work are not needed (Van-Lane, 1991).

Suzuki (1994), stated that" Companies practicing TPM invariably achieve startling results, particularly in reducing equipment breakdowns, minimizing idling and minor stops, lessening quality defects and claims, boosting productivity, trimming labour and costs, shrinking inventory, cutting accidents, and promoting employee involvement". He also identified important intangible results of TPM implementation that include, enhancing the skills of the operators which increases problem solving abilities, improving the confidence of production employees, and improving the company image for customers.

Park and Han (2001) mentioned the following benefits and stated that they are less measurable: When employee participation increases, employee relations improve; as the quality of the product improves, so will customer satisfaction. When operators become more familiar with the tools and techniques used in the problem-solving process, the rate at which problems are resolved will increase; equipment becomes more reliable, and the process more repeatable, scheduling the flow of work through the process becomes easier.

According to Bernstein (2005) maintaining a successful programme depends on everything that supports those activities such as collection of accurate data, scorecards that show the significance of the data, clearly defined responsibilities for everyone involved and procedures that provide for on-going support of TQM efforts.

Leblanc (1995) stressed various initiatives for reaping benefits for TPM implementation such as:

1. A reduction in operation costs.
2. Cross-functional teams are integrated to enhance the value of TPM.
3. Reduce equipment breakdown and maximise equipment effectiveness.

Lycke (2003) preformed a case study in a Swedish company to investigate team building and team developments when implementing TPM. One of the biggest benefits the company gained was the communication channels between employees especially between Production, Maintenance and Engineering; the cooperation between these departments had increased significantly.

The author conducted four case studies in large & medium size UK manufacturing companies to determine how TPM had been implemented, focusing on the effectiveness of the programme and different aspects of the implementation. Two benefits achieved by the four companies were an improvement in the availability and performance of the equipment

inside the company and enhanced communication between employees. Other benefits were financial improvement, cut-price on energy cost and improved employee self-esteem and job satisfaction (Aspinwall and Elgharib, 2013).

2.13 Summary

Maintenance is an important function in manufacturing especially in today's competitive environment. Hence maintenance strategies have evolved over a period of time. TPM is a company-wide strategy to increase the effectiveness of the production environment so that machines and processes are available whenever needed and able to produce the right product with the required quality. For TPM to succeed in any organisation, both management and the employees must address issues strategically while operating in an environment of trust and organisation. The improvement process must be recognised as benefiting both the company and the employees. The responsibility for the success or failure of TPM programmes rests more with management than with the plant floor employees (Nakajima, 1989).

In this chapter, an overview of maintenance was provided to identify how the maintenance systems/practices have evolved over time. The concept of TPM programmes was described from both the Western and Eastern perspective. The chapter also covered the fundamentals of the TPM philosophy, why such a strategy should be introduced, its implementation, CSFs, OEE, TPM and Frameworks concluding with the benefits and limitations of TPM. In addition, the chapter indicated how TPM provides specific tools that can be used to improve equipment performance, improve work areas around the equipment, and change the habits of the people who are responsible for buying, designing, installing, operating, and maintaining the equipment. To successfully implement and sustain TPM practices,

manufacturing organisations must be predisposed to nurture an atmosphere that is willing to fortify the TPM programme and its resultant workplace changes (Bakri et al., 2012). The contribution of top management is found to be one of the highly decisive factors for successful TPM implementation (Ahuja and Khamba, 2008a).

The literature shows that the main TPM Structure is divided into eight pillars (suggested and promoted by Nakajima, 1988) and the activities involved are; *focused improvement, planned maintenance, early equipment management, education and training, AM, quality maintenance, office TPM, and Safety, Health and Environment.* They are the most common ones for implementing TPM effectively and efficiently. When properly implemented, they form the foundation that will support any successful TPM effort (Bernstein, 2005). Nakajima developed the classic twelve-step TPM implementation programme (Nakajima 1988; 1989) that has been the foundation for TPM implementation since 1984. A detailed implementation process for each of the twelve steps is further described in details in Appendix II.

The literature review showed that there are many frameworks for implementing TPM, which will vary from organisation to organisation even though the objectives are mostly similar. It is clear from the chapter that manufacturing organisations worldwide are facing many challenges to achieve successful implementation of TPM. Important lessons gained from the literature review were highlighted. Every individual case presents significant insights into how TPM is being applied in practise.

From the literature review and in particular in sections 2.12 and 2.13, the researcher has generated the most common CSFs of TPM implementation and that have been mentioned by many authors. Those CSFs were concluded and summarised by the researcher in Table 2.55. They were: *top Management, total employee involvement, communication and awareness, strategic*

planning and action plan, resource allocation or availability, recognition and empowerment, training and education, monitoring and evaluation, reward and incentives and *Teamwork*. Addressing the ten CSFs as part of the quality management process in Libyan manufacturing companies will increase their chances of success.

It is evident that TPM programmes take time, effort, human resources and financial costs but the benefits that are achieved from the implementation far outweigh the difficulties (Aspinwall and Elgharib, 2013).

Before dealing with the problem of studying the suitability or transferability of TPM to one of the developing countries (LIBYA), an important subject has to be discussed, namely the link between OC and TPM concepts. It is well known that TPM is considered a 'culture sensitive' subject and in fact many of its basic elements are related to issues of OC. The next Chapter will discuss in more detail, the issues surrounding OC and TPM implementation.

CHAPTER 3: Organisation Culture (OC) and TPM

3.1 Introduction

Many researchers consider that culture acts as a main driver for the success (Al-Khalifa and Aspinwall, 2001) or failure of TQM and TPM (Elgharib and Aspinwall, 2013) adoption and implementation. In order to introduce such initiatives successfully, an organisation's employees should have a clear understanding of, and an agreed approach to achieving their goals. TPM is a maintenance programme which involves a focused, defined concept for maintaining plants and equipment. Its goal is to increase not only production but also employee morale and job satisfaction. It closely resembles the familiar TQM programme. For instance, just as with TQM, total commitment to the programme by upper level management is required. Moreover, employees must be empowered to start corrective action. Changes in the employees' attitude toward their job responsibilities must happen, which means a change in culture is required. As with any programme that requires a culture change, TPM may take a year or more to implement and is an on-going process (Wireman, 1991).

Studies that have dealt with the implementation of concepts such as TPM, TQM, Condition-Based Maintenance (CBM) and RCM identify rather similar forces and obstacles (Park and Han, 2001; Tsang and Chan, 2000; Yusof and Aspinwall 2000). The driving forces are mainly concerned with good management, information, communication, and assigning the necessary resources to the change. The same applies to the obstacles with the addition of cultural aspects. Therefore, it is important to not only understand how culture is defined

and what its elements are but also to be familiar with the source elements that give it the capacity to provide sustainable competitive advantage.

This chapter reviews the literature that relates organisational culture and TPM. It will start with a brief meaning of culture and OC and then go onto culture change. The link between OC and TPM philosophies is presented, and aspects or dimensions/factors that might impact TPM implementation have been identified. The idea that a certain amount of the variability of OC can be explained by differences in national culture is explored (it is known that Arab cultures have distinct characteristics). Finally, the culture that supports TPM will be discussed.

3.2 The Importance of defining "Culture"

During the history of successful, multinational companies Worldwide, there have been many attempts to study what makes these companies great; in most cases it is their culture. Studies have shown that the main patterns of culture are: the sum of the values, customs, traditions, and meanings that make a company unique (Want, 2003; Hofstede, 2001). Most significantly, the way in which an organisation invests in its network of executives to achieve the corporate culture defines how management manages (Schein, 2004). The literature offers many differing points of view on defining the types of culture. It is important to understand its definition, its types, and which of these are ideal for a particular organisation or nation.

The word 'culture' can be used in two different ways. The first is in the sense of national culture whilst the second refers to organisational culture. It is the ideas, beliefs and customs that are shared and accepted by people in a society or it refers to the underlying values, beliefs and codes of practice that make society what it is (Schermerhorn, 2002). Williams

(1998) lists three different definitions, thereby accounting for scientific disciplines (e.g. philosophy and sociology):

- ***Ideal***, indicate that culture is a state or practice of human excellence, in terms of certain absolute or universal values. The analysis of culture, if such a definition is accepted, is essentially the discovery and description, in lives and works, of those values that can be seen to compose a timeless order, or to have permanent reference to the universal human condition.
- ***Documentary***, indicate that culture is the body of intellectual and creative work, in which, in a comprehensive way, human thought and knowledge are recorded.
- ***Social***, indicate that culture is a description of a particular way of life, which communicates certain meanings and values not only in art and learning but also in organisations and normal manners (Williams, 1998).

Culture can be described as the way of life of a group of people, which includes beliefs, law, morals, customs, and any capabilities and behaviours obtained by a man as a member of society, and enables people to communicate with others, provides the awareness and skill needed, and expects how others in society are likely to react to certain actions (Miroshnik, 2002). It is as difficult to define as many other concepts describing human social life. Hofstede (2001) defined culture as: "the collective programming of the human mind that distinguishes the members of one human group from those of another. Culture in this sense is a system of collectively' held values". Hofstede says that as almost every person belongs to a number of different groups and categories of people, at the same time, people inevitably carry several layers of mental programming within themselves, corresponding to different levels of culture. He illustrated that **culture** should be perceived from human nature on one side, and from an individual's personality on the other as shown below in Figure (3.1).

Human nature, in Hofstede's opinion, is what human beings have in common: the capability to feel fear, anger, love, joy, sadness, the need to associate with others, the facility to observe the environment and talk about it with other humans. How a human expresses these feelings is however, modified by culture.

On the other hand, Hofstede believes that **personality** is based upon traits which are partly inherited, with the individual's unique set of genes, and partly customised by the influence of culture and the unique personal experiences (Hofstede and Hofstede, 1997).

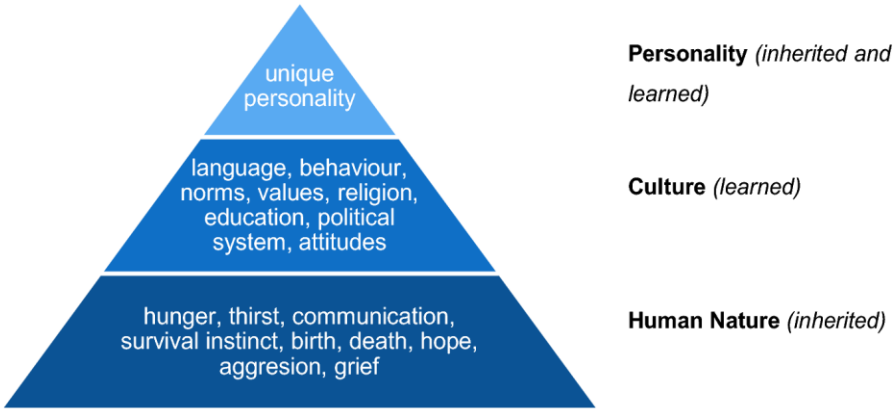

Figure 3.1 Hofstede's Pyramid of Human Uniqueness

[Source: Hofstede and Hofstede, 1997],

Different organisations may contain cultures subgroup, but there will often be common assumptions shared all over the organisation, particularly throughout times of crisis. For this study, culture is defined as a group's shared basic assumptions which in turn establish how the group understands and solves problems (Hofstede, 2001).

Considering which types of culture are ideal provides information on which cultures are most likely to promote a successful TPM implementation and will aid top management in choosing if implementing the programme will be beneficial to their organisation.

3.2.1 Organisational Culture

The concept of OC has become one of the most important topics in organisation science. It is generally agreed that it is complex and hard to penetrate. Jones *et al.*, (2005) suggested that defining it was the hardest part of studying it while other researchers opted out of offering a definition altogether 'since culture appears to include virtually everything in an organisation and therefore any definition must do the same' (Wilson, 1992).

Schein (2004) defined OC as a pattern of shared basic assumptions that was educated by an organisation as it resolved its problems of external adaptation and internal integration that has worked well enough to be considered valid and, thus, to be educated to new members as the correct way to observe.

Definitions from Hofstede (2001), Schein (2004), and Cameron and Quinn (2006), suggest that OC is a pattern of shared basic assumptions and implicit values within an organisation which allow it to work. To recognise the individuals' perceptions of their working environment, Quinn (1988) suggested that motives, values and problem-solving styles could reflect four ideas of organising, which appear as a close parallel to four information processing orientations, to form the basis of a CVF.

One of the key roles of OC is to differentiate the organisation from others and give a sense of identity for its associates. OCs do not necessarily have to always be rational or consistent; in fact, they rarely are and can appear quite haphazard and chaotic to the outsider. They can also have subgroups with different cultures and with varying agenda (Schein, 2004). There are several different types of culture that define the organisational, understanding the different types are important. Some of these types irrelevant to this study (Appendix III-A1) but it helps to give organisations a better understanding of ideas, beliefs and values that it experience every day. Some are strictly hierarchical and are aimed at control, stability, and

internal efficiency. This is a type of culture and not just an organisational scheme because it reflects and enforces the manner in which employees interact, the values of the company, and the particular way that the company is built to achieve its goals.

Want (2003) identifies seven types of culture - predatory, frozen, chaotic, political, bureaucratic, service, and new age each described as follows:

1. *Predatory*: has a temporary focus and is not able to predict the results of its actions. The predatory organisation does not focus on the needs of its partners or stakeholders and reacts only when a crisis requires it to.
2. *Frozen*: are characterised by their reluctance to risk-taking and improvement. Strict devotion to the chain of command is required.
3. *Chaotic*: are characterised as sustainable plan and more energy is spent on internal politics than on external customers.
4. *Political*: are characterised by internal competition for resources, position, and job improvement. Regulations and implicit limits do exist to referee the political manoeuvring, but resources are again focused more on internal in-fighting than on external customers.
5. *Bureaucratic*: in which the needs of the organisation are valued before those of the customer.
6. *Service*: places a main concern on satisfying client needs to be able to serve the organisation's needs.
7. *New age*: are characterised by their mixture of innovation with awareness to the needs of their customers and employees.

Schein (1996) had a little different viewpoint on the types of culture that exist. He argued that there are three types within any organisation; they are operator, engineering and

management. The "*operator"* culture is founded on human relations. The workers on the shop floor find that they need to work together to complete their goal. The remaining two "*engineering"* and "*management"* cultures both have roots outside of the organisation, in the general functional culture of their business. They see people as resources that only create problems. In addition, they view people as a means to attain competence and productivity, not as a source that can be used to help attain these objectives. Chatman and Cha (2003) describe an ideal culture as "strong", i.e. one that has high levels of conformity among its members. They added that an example of a culture fitting the description of strong may be found at Toyota organisation. Research conducted by Spear and Bowen (1999) concluded that the Toyota Production System (TPS) depended on a shared sense within the organisation of what an ideal system would be. None of the rules are written down. The System flourishes by remaining adaptable, flexible, and requiring employees to contribute in the learning process while constantly improving every feature of the organisation. Hofstede (2001) concluded that differences in these cultural dimensions across organisations and countries provide an underlying explanation for different organisational structures, and given these cultural differences, the resultant structures in a culture are logical to members of the same culture.

Hofstede and Hofstede (1997) offered different approaches and viewpoints on culture at both national and organisational level. They argued that OCs should be distinguished from national ones. The latter differ mostly at the values' level, while the former differ at the symbols', heroes' and rituals', together labelled 'practices'. The authors added that different national cultures have different chosen ways of building organisations and different patterns of employee incentive. For instance, they limit the choices for performance

evaluation, management by objectives, strategic management and humanisation of work (Hofstede, 1997).

Other researchers stated that an organisation's structure is a determinant of its culture (Schein, 1996; Handy's, 1991) i.e. specific structures create specific types of culture, as reflected in Handy' s (1991) work as described in Appendix III-A1.

3.3 The need for culture change

Change can be described as a transfer from one case to another through transitional stages. It is impacting on organisations as never before, due to worldwide competition (Tsoukas and Chia, 2002).

The biggest challenge that an organisation faces is to be able to make a radical transformation to its culture for ensuring overall employee participation in maintenance and manufacturing performance improvement through TPM initiatives (Ahuja and Khamba, 2008a). Ahuja and Singh (2012) also revealed that the success of any other company initiatives deployed in the organisation needs to align the employees with the organisation's goals and objectives of growth and sustainable development in meeting today's global manufacturing operations challenges. These include a mechanism for employee empowerment, recognition of the efforts of employees in the company's performance, providing a rewards and incentive mechanism to all employees, making effort to improve the skills, knowledge and promoting cross functionality across the various departments.

Panneerselvam (2012) stated that TPM implementation process requires an implementation team impelled by a change agent who is responsible for managing change within the organisation throughout the process. Hence, the top management has to make concerted efforts to enhance motivation within the organisation by creating awareness about the true

potential of the TPM philosophy and effectively communicating to the employees regarding the direct benefits of TPM to the workforce. Furthermore, organisations should effectuate union buy-in by involving the union representatives during the planning and execution phases of TPM implementation which as a resultant addresses most of the employees' behavioural barriers towards successful TPM implementation.

Change in organisation would, in the long run, lead to change in the OC. So, to challenge the 'resistance to change', it need to initially put effort into actions to transform human behaviour or fixed mindset through improved environment, working conditions and then set mission and vision to implement any new concepts which is based upon cultural change (Soni, 2013).

Hatum and Pettigrew (2006) identified the following five determinants of organisational flexibility as a set of organisational and managerial capabilities that enabled companies to adapt quickly in a highly competitive environment:

- Characteristics of the dominant coalition,
- Centralisation and formalisation of the decision making process,
- Low macro culture embeddedness,
- Environmental scanning,
- Strong organisational identity.

Yelton (2005) stated that realising cultural change within an organisation is a continuous process comprising planned, intentional steps that include:

1. **Knowledge and awareness**: by direct evaluation of the current culture; development of baseline data and vision of desired state.
2. **Recognition and reward**: by support and incentive for desired behaviours and outcomes and assurance of the decision-making procedure (who, how, what, when).

3. **Communication:** by improvement of an organisational communication scheme delivery of consistent messages throughout the organisation**,** honest discussion of tough issues that are often avoided.
4. **Systems, structures and linkage:** by adjustment of top management and with the organisation's core values issues, determination of core competencies to support the desired culture description of goals including "stretch" goals for management and connection of behaviours, goals and achievements to compensation (Yelton, 2005).

Yelton added that the use of established tools and techniques such as the "Change Acceleration Process" for quick decision-making, "Work-Out" when you know the problem, but not the answer, and "Lean Six Sigma" to modernise processes and reduce variation, can give employees a solid structure for dealing with issues they confront on a daily basis.

Rubrich (2010) argued that TPM is the hardest of all the "lean tools" to implement in organisations for two reasons. Firstly, TPM implementation needs the greatest amount of culture change from different groups of people within the organisation almost concurrently. Secondly, of all of the areas of possible lean process improvement within the four walls of an organisation, the maintenance of the equipment is the area which is the furthest behind. He added that the benefits from this implementation in terms of on-time delivery, reduced scrap, enhanced productivity and improved employee morale is probably greater than any of the other lean tools (Rubrich, 2010).

The author believes that although the tools and the techniques may be present and the change strategy implemented with dynamism, the fundamental culture of the organisation; the values; managerial style and ways of thinking remains the same.

Therefore, an ideal culture for TPM takes a long time to develop. The ultimate goal is to accomplish a best fit between strategy, technology, and the OC.

3.4 The relationship between OC and TPM

TPM signifies a major shift in the way an organisation approaches the maintenance function and implementation typically requires a considerable change in OC. Most researchers on TPM recommend a variety of ways to support this cultural change, including the commitment of top management, training and changes in reward systems. Regardless of these efforts, many organisations still find it difficult to create the required change in culture. For some the old culture may be too deeply embedded and for others, the conventional approaches to changing culture may have been overused (Lawrence, 1999). Maintenance goes from being the duty of the maintenance department to being everyone's duty. Such change is often resisted by both production and maintenance employees. Production employees and managers are unwilling to accept responsibility for maintenance activities due to concerns about whether or not such employees have the necessary skills and/or time to perform maintenance tasks. Another reason that adds to employee scepticism about and resistance to TPM is general movement on the part of businesses to try to do more with less (Park and Han, 2001).

TPM can be perceived as an effort to make production employees do more work so that the organisation can get by with fewer maintenance personnel. In addition, production and maintenance employees simply fear the unknowns that such a change in their work environment will bring. One of the difficult aspects of implementing TPM is conquering this resistance and bringing about the needed change in OC. Many TPM programmes fail because companies are unable to change the existing culture (Patterson et al., 1995).

Park and Han (2001) stated that planning for TPM implementation includes creating a good environment for effective change. It is a significant cultural change, will require major

adjustments by everyone involved and requires employee empowerment, with total contribution of the entire work force. For TPM to be successful, management responsibility must be pushed to the bottom levels of the hierarchy. Park and Han added that achieving a shift in the beliefs and assumptions that support culture is both a difficult and long-term responsibility. Change is generally inspired by altered situations such as a crisis or a challenge to the procedures and is management driven. For change to be acknowledged by individuals in the organisation, its meaning must be clear in their daily experience. Managing cultural change for TPM normally involves:

- A clear meaning of the business task that is owned throughout the organisation and is relevant to the market.
- Set up an organisation in which analysis, preparation, and manage are balanced with informality and the freedom to question, challenge, and experiment.
- The support of a visible top management, flat unified structures, a team organisation, and outstanding communication.

Wireman (1991) proposed that TPM is a maintenance improvement programme that involves all personnel in the organisation and includes everyone from top management to the line employee, and covers all departments including, Maintenance, Operations, Design Engineering, Project Engineering, Plant Management, and Accounting Finances. Bamber *et al.*, (1999) listed a generic model indicating factors affecting the successful implementation of TPM in UK manufacturing SMEs which include the existing organisation, time allocation for implementation, management commitment, the involvement of people, an implementation plan, alignment to mission, the motivation of management and workforce, measures of performance, and knowledge and beliefs. Davis and Willmott (1999) suggested two important enablers for the successful implementation of TPM programmes in manufacturing

organisations: (i) a planned programme which uses a number of tools and techniques to achieve highly effective companies and production equipment and to measure its effectiveness and (ii) a philosophy which is based upon the empowerment and encouragement of plant floor-based employees from all areas. Ahuja and Khamba (2008b) classified the key CSFs for successful implementation of TPM in Indian manufacturing industry into six categories: top management support, employee participation, traditional and practical maintenance policies, training and education, cultural change, maintenance prevention and focused production system improvements. Tsang and Chan (2000) identified the importance of management leadership, employee contribution, strategic planning, education & training and communication.

Based on a comprehensive literature review of OC and TPM, 10 critical success factors have been identified, each containing a different number of elements to measure (see Table 3.1). They comprise a mixture of culture, climatic and organisational characteristics. The factors were suggested from the previous discussions in the literature review, and in particular in sections 2.10, 2.11, 2.12 and 2.13, it has been empirically examined and proven by many researchers such as: Konecny and Thun (2011); Friedli *et al*., (2010); Ahuja and Khamba (2008a); Ireland and Dale (2001); Bamber *et al*., (2000); Yeomans and Millington (1997), Nakajima (1989). Hence, a survey will be conducted in the UK to test them.

Culture Factors	Areas to address
F1.**Top Management**	A. Commitment and support determines the success of new change initiatives. B. Encourages employee involvement in TPM activities. C. Pays significant attention to improving maintenance. D. Has a clear understanding of the scope of maintenance missions. E. Ensures employees are well supported through times of change. F. Focuses on health, safety and environmental issues.
F2 **Total Employee involvement.**	A. Employees are encouraged to make and implement suggestions. B. TPM involves every single employee, from top management to workers on the shop floor. C. Employees are routinely involved in some organised form of continuous improvement (Kaizen). D. Production employees have accepted that autonomous maintenance is their responsibility. E. Employees have easy access to information on productivity.
F3 **Communication and awareness.**	A. There is effective communication between teams transcending every level of hierarchy in the company. B. Employees are well informed of the current company employee development policies. C. Employees are regularly given feedback on environmental issues, safety incidents and their corrective actions.
F4 **Strategic planning and action plan.**	A. Detailed roles and responsibilities are well-defined, communicated, updated and understood plant-wide. B. The organisation has a good housekeeping system (5-Ss). C. The organisation has developed a process to evaluate the efficiency and effectiveness of maintenance performance. D. The organisation uses benchmarking to identify the needs for change.
F5 **Resource allocation or availability**.	A. Equipment is made available for maintenance, when scheduled, plant-wide. B. Machine availability on the shop-floor is visible and understood by everyone. C. There is a system of making modifications to the existing equipment for improving equipment availability. D. There are processes in place to analyse breakdowns and the root causes are identified and permanently fixed. E. Resources allocated for TPM are not compromised for other initiatives such as TQM.

F6 **Recognition and empowerment**.	A. Employees' suggestions are regularly evaluated and implemented. B. The organisation treats all its employees equally with regards to respect, performance and recognition. C. Operators do basic maintenance and inspect their machines daily. D. All the TPM teams are empowered to take responsibility for their decisions.
F7 **Training and education**	A. Training and education are vital elements when adopting TPM. B. Safety and environmental training programmes are provided for team members and other personnel. C. Regular reviews and improvements are made in the training system to accommodate changing requirements. D. TPM team leaders are experienced and have leadership qualities.
F8 **Monitoring and evaluation**	A. Appropriate data collection and analysis (e.g. OEE, uptime) is used by the facility to eliminate equipment -related losses. B. The company follows a schedule of planned maintenance of the equipment. C. Condition monitoring has improved the reliability of the machinery in production areas.
F9**Reward and incentives**	A. People are encouraged to improve their knowledge and skills at work. B. There is a system of linking recognition and rewards to the company's improvement goals as set out in its improvement strategy.
F10 **Teamwork**	A. Shop floor workers are organised into TPM teams for problem solving and the team objectives are aligned with departmental objectives. B. Teamwork is important for achieving a TPM culture. C. TPM improves teamwork between production and maintenance departments. D. Sufficient numbers of skilled engineers/technicians are employed in the production area.

Table 3.1 Cultural Factors Expected to Influence TPM Implementation

3.5 The impact of national culture on TPM

Every organisation has its own culture; it can be positive or negative, strong and unique or weak and indifferent. Al-Khalifa (2000) stated that the national culture represented by the shared values of a society/country influences OC and, therefore influences TPM implementation. Al-Khalifa (2000) compared the most important cultural values of the US, Japan and Arab countries (see Table 3.2). As can be seen there is a great deal of variation between them. This can affect managerial attitudes, employees' performance, and technology transfer.

US	Japan	Arab countries
1. Freedom. 2. Independence. 3. Self-reliance. 4. Equality. 5. Individualism. 6. Competition. 7. Efficiency. 8. Time. 9. Directness. 10. Openness	1. Belonging. 2. Group harmony. 3. Collectiveness. 4. Age/seniority. 5. Group consensus. 6. Cooperation. 7. Quality. 8. Patience. 9. Indirectness. 10. Go-between.	1. Family security. 2. Family harmony. 3. Parental guidance. 4. Age. 5. Authority. 6. Compromise. 7. Devotion. 8. Patience. 9. Indirectness. 10. Hospitality.
Note: "1" represent the most important culture value "10" the least		

Table 3.2 Priorities of Culture Values (Source: Al-Khalifa, 2000)

3.5.1 The characteristics of National Arab cultures

Hofstede (1980) conducted a study based on a comparative analysis of 53 samples covering countries from the five continents. The sample included Libya, Saudi Arabia, Egypt, Iraq, Kuwait, Lebanon and the UAE. Four universal national culture dimensions were proposed. The first was measured by Power distance (PD), the extent to which members of a society

accepted that power in institutions and organisations is and should be according to (Hofstede, 1980) distributed unequally. The Arab countries scored a PD value of 80, and received the seventh highest score of the 53 countries/regions, indicating a high level of unfairness of power and wealth with the society. The second was measured using Uncertainty Avoidance (UA), the extent to which members of a society feel uncomfortable with uncertainty and ambiguity, and support beliefs promising certainty and institutions protecting conformity. The result for the Arab countries was 68, indicating the society's low level of tolerance for uncertainty. In an effort to reduce this level of uncertainty, firm rules, laws, policies, and regulations must be accepted and implemented. The third, Masculinity (MAS) focused on how much the society enforces rules, or not. A high MAS ranking indicates a high degree of gender differentiation. A score of 52 was achieved by the Arab countries. This was slightly higher than the average of 50.2 for all the countries and the 23rd highest score. It indicates that women in these countries are limited as far as their rights are concerned, however this may be due more to the Muslim religion than to a cultural paradigm. The fourth measure Individualism (IDV) focused on the degree to which its society reinforces individual or collective achievement and interpersonal relationships. The Arab countries scored 38, compared to a world average ranking of 64. This translates into a collectivist society as compared to an individualist culture and is manifested in a close long-term commitment to the member "group," that being a family, extended family, or extended relationships.

Hofstede and Hofstede (2005) noted that national culture refers to shared values, beliefs and the way of life of a society, a country or a nation where people live together. In the same way, those people who work in organisations live in an OC which is related to their beliefs,

values, perceptions and what is accepted or not within the organisation. Therefore, in order to understand them one must understand their societies.

3.5.2 Culture that supports TPM

TPM requires good management to be effective from the start. Without effective leadership that associates TPM efforts to the business and holds people responsible for performing "highly specified work," equipment performance and reliability will maintain to decline and TPM programmes will be short lived (Williamson, 2000).

The role of management should not solely be to control but also to give support and encouragement. Decisions on generally based issues, such as the implementation of TPM and RCM or the introduction of a new incentive system for workers, are made only after the management has entered into a dialogue with those affected. The managers will provide overall direction for the work that is clearly targeted and engaging. Their duties will be those of experts, advisers and coaches to help the employees avoid unnecessary waste of effort so that they can: (i) enhance their task-relevant knowledge and skills and (ii) define creative, unique and appropriate performance strategies that generate synergistic process gains. They should also be accountable for answering requests from employees to ensure that the assets needed for increasing performance are available when required (Eti *et al.*, 2004).

Eti and others added that TPM is predicated by the challenge of seeking to do things better therefore dealing effectively with change needs to become a way of life within manufacturing organisations. The motivation of workers within an organisation to accept “change” for the better is an essential requirement for successfully implementing TPM. Their degree of enthusiasm to embrace “change” determines the rate of progress towards

that goal. TPM can only succeed in an organisation that is committed to provide the essential training and time to monitor the success or failure of the resulting improvement programmes (Eti *et al.,* 2004).

The most approachable culture for TPM implementation is one where people at all levels understand the business environment in which they function, why they are there, the mission of the company, and what kind of levels of competition they are facing or expect to face. If the employees are prepared to make the changes necessary in terms of their work habits to ensure the long-term survival of their organisation, an ideal TPM culture is defined. Once into TPM an ideal culture is one in which those closest to the equipment have assumed the basis of "ownership" of their equipment much as they care for and respect their own property (Williamson, 2000; Wireman, 2004).

3.6 The impact of OC on TPM success

OC has an increasing significance because of its impact on employee performance and satisfaction. Understanding it helps to increase an organisation's effectiveness and development (Subrahmanian, 2012).

Much attention to date has focused on the technical side, on tools and techniques rather than on the ability to build a self-sustaining culture where change is seen as the norm and where resistance to change is never an option. Companies worldwide operate in their own ways i.e. each has got its own way of doing things and express it in its own particular way. The suppositions, morals and behaviours that an organisation showed can be viewed as its culture. A particular type of culture is developed through management actions and is reflected in the vision and mission statements of the organisation. Moreover, its culture

arises through the development of norms and values that help it to survive and prosper in these environments ((Murphy, 2010, Khan, 2006; Eti *et al*., 2004).

Many organisations that attempted to implement TPM programmes have experienced difficulties and are unable to gain the anticipated benefits. The lack of success of an organisation to successfully implement TPM has been attributed to a variety of obstacles including behavioural, organisational, cultural, departmental, operational and financial barriers (Panneerselvam, 2012). Aspinwall and Elgharib (2013) who conducted case studies in four UK manufacturing companies found that the difficulties fall into the following groups: management, cultural, implementation and technical problems, all of which are related with each other. Cultural change was highlighted as the most significant issue when implementing TPM which means that successful programmes require true top management support to conquer any resistance to change which can come from both workers and middle managers. Therefore, Management should ensure the development of an OC that comprises openness, collaboration, trust, autonomy, pro-activity and experimentation, which are interconnected and essential for every organisation for its development. Moreover, management can take suitable steps to overcome these issues by providing the necessary awareness, incentive systems, motivational actions etc. (Suresh, 2012). These issues address the following questions:

- Can OC be managed and changed?
- What are the ideal cultural characteristics of an organisation that can help assist and maintain TPM implementation?

3.7 Some Tools for measuring OC

OC can be positive or negative, strong and unique or weak and indifferent. In general, an organisation needs a positive one to support its growth and development or at least to avoid failure. On the other hand, OC cannot be shaped to the desired direction in every case (Schein, 2004). In order to help, understand and measure OC, several studies were explored. Few models of OC have found application within the organisational development research. As Burnes (2000) stated in his review of evaluation research on organisational change, one reason for this lack of integration might have been the lack of valid instrumentation for measuring OC, and a reluctance to introduce quantitative measures into a research area often closely linked to qualitative, ethnographic methods.

The Denison OC survey (Denison 1990) provided an instrument to determine the sensitivity to organisational change. This instrument measures OC along four basic cultural traits; Involvement, Consistency, Adaptability and Mission, which are represented by certain organisational dimensions. The instrument consists of 60 items, which are used to measure them. The approach offers a quantitative multi-dimensional assessment which has also been correlated with organisational performance measures of the main organisational cultural traits. Denison (1990) argued that the approach allowed for the assessment of the ways in which organisations (or sub-groups within organisations) dealt with seemingly contradictory or paradoxical goals and demands (Fisher and Alford, 2000).

3.7.1 Integration Definition for Function Modelling (IDEFO)

The use of this technique in improving productivity and communications in computer integrated manufacturing systems and as a tool for business process reengineering efforts

are widely documented. Also Colquhoun *et al.,* (1993) suggested its use, to develop manufacturing systems, implement organisational change, or manage projects. There are many different IDEFO methods that can be classified into two categories; modelling and descriptive. The former is based on the Structured Analysis and Design Technique (SADT) developed by Douglas Ross and SofTech, Inc. Models are frequently created with a hierarchical structure that provides a useful tool for understanding a system. Colquhoun *et al.,* (1993) stated that the model has the following benefits:

- It is a great instrument to model the functions (activities, processes, actions, operations) of a wide selection of systems or subject areas to any level of aspect.
- Its modelling system is accurately defined.
- It is well-tested and confirmed, through many years of use.
- It improves communication between all people involved in a project or subject area.
- It provides a concise description of systems.

They (Colquhoun *et al.,* 1993) also list the following weaknesses:

- IDEFO models might be so concise that only the domain experts can understand them.
- IDEFO models are sometimes misinterpreted as representing a sequence of activities.
- One of the disadvantages is the constraints put on the user by the technique.
- The network of boxes and arrows, along with the size of some models, can cause many users to reject the model.

3.7.2 Organisational Culture Inventory (OCI)

This tool has been used in a wide variety of business, government, not-for-profit and educational organisations throughout Australia and New Zealand (Cooke and Szumal,

2000). The tool was initially examined and promoted by Cooke and Lafferty (1987). It provides profiles of an organisation's operating culture in terms of the behaviours that members consider are necessary to 'fit in and meet expectations' within their organisation.

The OCI looks at culture through four lenses, cultures mainly concerned with task, people, basic human needs (such as security), and higher order needs (such as relationships and self-esteem). It measures 'how things are done around here'. The OCI examines how members of an organisation experience its operating culture. Through members' answers, the OCI measures twelve (12) distinct patterns or styles of behavioural norms and expectations that members of an organisation might be expected to adopt in carrying out their work and interacting with others. The 12 patterns are also used to measure an organisation's culture in terms of its orientation with some patterns being distinctively related to the 'People orientation' such as Self-actualising, Humanistic encouraging, Affiliative and dependent while others are related to the 'Task orientation' such as Competitive and Achievement. Combined OCI scores are then transferred to a circular graph to form a visual profile, or picture, of an organisation's current culture. In turn, these behavioural norms have a significant impact on the organisation's ability to solve problems, adapt to change, and perform effectively. OCI results are plotted on profiles that illustrate individual normative beliefs (when the perspective of only one member is considered) or the shared behavioural expectations that operate within the organisation and represent its culture (when the perspectives of multiple members are combined). The OCI is used widely and is a thoroughly researched tool for measuring OC (Cooke and Szumal, 2000).

Lawrence (1999) proposed an additional means to help bring about the cultural change necessary to make TPM work. He introduced mathematical modelling. Its use in the maintenance function is certainly not new, and there are some reviews available of the

different models that have been developed and used (Al-Sultan and Duffuaa, 1995; Valdez-Flores and Feldman, 1989).

3.7.3 Competing values framework (CVF)

Another approach that has shown promise for application is the CVF which has been applied to issues ranging from leadership development to organisational change (Quinn, 1988). Cameron and Quinn (2006) stated that the CVF has been shown to be a helpful framework for assessing and profiling the dominant cultures of organisations because it helps individuals identify the underlying cultural dynamics that exist in their organisations. It helps to raise the awareness of cultural attributes. It was established in the early 80s as a result of studies of organisational effectiveness (Quinn, 1988). This framework has been named as one of the 40 most important frameworks in the history of business (Ten *et al*., 2003). It has been studied and tested in organisations for more than 25 years by a group of leaders from leading business schools and corporations (Quinn, 1988; Cameron and Quinn, 2006).

The CVF proposed and tested by Denison and Spreitzer (1991) has been selected to identify types of OC and explore underlying dynamics of culture practices. Its framework has been developed through empirical research on organisational effectiveness. According to this theory, organisations can be examined along two dimensions (see Figure 3.2) a focus on internal processes versus one on external processes and focus on control versus one on flexibility. Simultaneously, these two dimensions form four quadrants from which four dominant culture types emerge.

In a culture where hierarchy values are dominant, procedures govern what people do and stability, predictability and efficiency are considered to be long-term concerns of the

organisation. An organisation with a dominant rational culture values productivity and competitiveness by strongly emphasising external positioning and control. The workplace is highly result-oriented. The group culture values cohesion, participative, teamwork and commitment. The developmental culture has the fostering of adaptability, flexibility and creativity as a major goal. Readiness for change is advocated (Cameron and Quinn, 2006).

To understand how the CVF can be used at all these levels and in so many different organisationally relevant areas it is important to have a strong foundational understanding of the framework (Denison and Spreitzer, 1991).

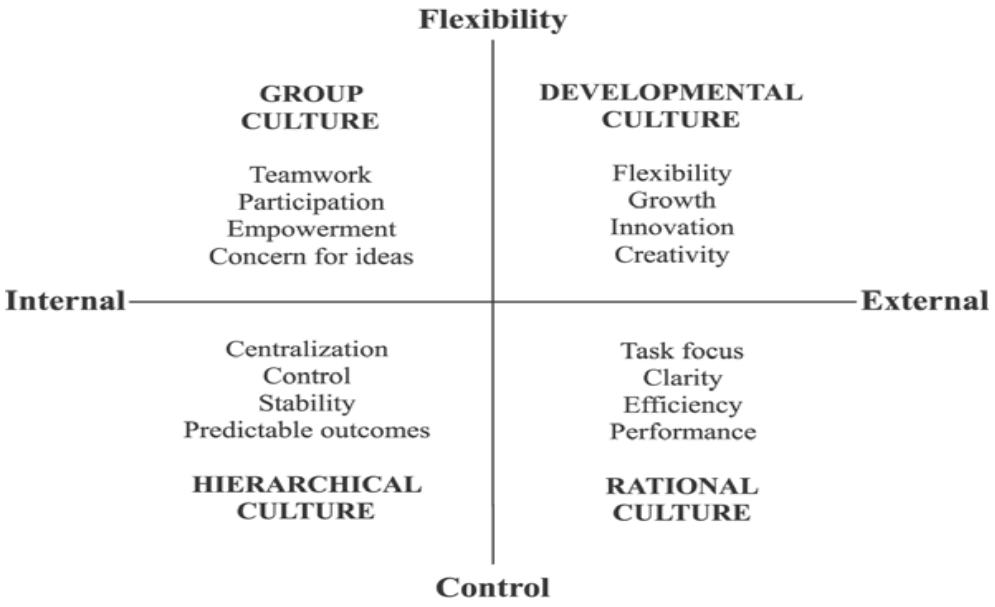

Figure 3.2 CVF of OC (Source: Denison and Spreitzer, 1991)

CVF is a useful Framework for organisations to adopt in taking a system's perspective of their business and to plan and manage major change. It has certain features that make it a desirable tool for investigating the cultural change necessary for successfully implementing TPM. The method of presenting data as organisational or individual profiles is quite modern and unique. Interpretation of the results quickly becomes implicit. This allows discussions to

focus on interpreting the organisation, rather than the data, thus providing an understanding of the existing state of the OC.

The CVF has been widely used not only to assess OC but also to examine the relationship between OC and other organisational phenomena including organisational effectiveness (e.g. Cameron and Quinn, 2006, Zammuto and Krakower 1991, Smart and St. John 1996), and TQM implementation (e.g. Al-Khalifa and Aspinwall, 2000). Lund (2003) examined the impact of OC types on job satisfaction in a survey of marketing professionals in a cross-section of companies in the USA. The CVF was utilised as the conceptual framework for the analysis. The findings indicated that job satisfaction was positively related to group and developmental cultures, and negatively related to rational and hierarchy cultures. All these empirical studies have validated the CVF as a powerful instrument to assess OC. Cameron and Quinn (2006) established the Organisational Cultural Assessment Instrument (OCAI), which is based on the CVF and provides a practical toolkit for change managers to help change agents and to help scholars understand, diagnose and facilitate the change of an organisation's culture to improve its effectiveness. Cameron and Quinn (2006) established the Organisational Cultural Assessment Instrument (OCAI), which is based on the CVF and provides a practical toolkit for change managers to help change agents and to help scholars understand, diagnose and facilitate the change of an organisation's culture to improve its effectiveness. Every organisation has its own mix of these four types of OC, which is determined by the completion of a questionnaire. The OCAI structure is based on six OC dimensions (Cameron and Quinn, 2006) which are integrated by the CVF framework into the four culture types (group, developmental, hierarchical and rational). The characteristics used to classify culture types result in an informative organisational profile related to six

"cultural aspects" apparent in every organisation. According to Cameron and Quinn (2006) these criteria include:-

1) *Dominant organisational characteristics*: the degree of teamwork and sense of belonging, level of creativity and dynamism, focus on goals and competition, reliance upon systems and emphasis on efficiency.
2) *Organisational leadership*: leadership style and approach that permeates the organisation. The roles identified were mentor, facilitator, innovator, broker, producer, director, coordinator, and monitor.
3) *Management of employees*: How employees are treated, degree of consultation, participation and consensus, working environment.
4) *Organisational glue*: bonding mechanisms that hold the organisation together such as cohesion and teamwork, loyalty and commitment, entrepreneurship and flexibility, rules and policies, goal orientation and competitiveness.
5) *Strategic emphasis*: organisational strategy drivers; long term development of human capital, innovation, stability and competitive advantage, growth and acquisition, achievement of goals.
6) *Criteria for success*: how is success defined and who gets rewarded profits, market share and penetration, sensitivity to customers and concern for people, development of new products and services, dependability and optimum cost.

Kwan and Walker (2004) noted, the CVF had then become the dominant model in quantitative research on OC.

3.7.4 Joint exploration through interactive interviewing (JEII)

The different measurement tools and processes reflects the variety in perspectives on the dimensions, levels, content and development of OC which finally dictate what needs to be revealed or measured and who need to be involved in the process. For instant, Schein (2004) developed a ten-step technique, which he described as a **(JEII).** The technique was based on the dispute that the pattern of assumptions that underlie what people value and do in an organisation are the basic cultural essence of that organisation. This idea led to his next dispute that you have to discover the hidden assumptions in an organisation to reveal its cultural paradigm. Consequently, he developed a ten-step method, which he described as a **(JEII).** The technique involved is listed below:

1. Access and focus on surprises
2. Regular inspection and examination
3. Discovering a motivated insider
4. Unveiling the surprises, confusion
5. Shared investigation to find explanation
6. Formalising assumptions
7. Regular checking and integration
8. Pressing to the level of assumptions
9. Permanent recalibration
10. Official written description

The underlying cultural assumptions, around which the cultural paradigm of an organisation forms, are assessed by its positions on specific dimensions. Description of the steps together with a detailed guide to interviewing methodology, analytical methods to be used in group discussion, examples of what questions to be asked, what to observe, to check and to look for within each step and in relation to each specific dimension are provided. The results obtained from the whole process are compiled, synthesised and analysed to give a description of the assumptions of a given organisational culture. The assumptions are tested to show how they relate to each other in a meaningful pattern – to articulate the paradigm.

This technique is based on a process consultation approach. It is mainly a qualitative tool, a theory-based examination of artefacts, adopted principles and shared basic assumptions using a selection of semi-structured procedures and empirical methods (Schein, 2004).

3.8 Summary

Culture is a crucial factor when employing any kind of organisational change. A culture that does not value innovation and flexibility may find it difficult to accept the principles of lean (Alavi, 2003). Project failures which have been attributed to OC are significant to study as they offer important information on the challenges facing organisations when implementing lean. Although culture is often overlooked in favour of management fads or quick fix strategies, it is a key component of every organisation's success (Want, 2003).

Some consider that TPM initiatives affect cultural characteristics and suggest that implementation failure is affected by a mismatch with OC. Much of the TPM literature has specified that a TPM culture will be created through management support, training in the elements of TPM and in the use of its tools. It is also understood that different TPM activities and tools influence the organisational agenda in a culture change approach to TPM implementation (Aspinwall and Elgharib, 2013).

The review of the literature however also stresses that a change process such as the implementation of TPM concepts is not an easy one as it involves a process of implementing new concepts and tools that will normally require a change in the company's organisational culture. It is important for a company to analyse its OC prior to embarking on the implementation process as it will help to determine its strengths and weaknesses. It is

however important that the method used for assessing a company's OC is aligned to the company's initial state and required outputs.

The researcher believes that the existing OC has a great influence on an organisation's activities and practices, and that a TPM programme also affects the existing culture. Nevertheless, it will certainly improve the success of TPM, if an organisation considers its current cultural practices and tries to create a supporting environment before implementing such a programme to avoid any possible resistance to change. Part of the implementation planning should be devoted to clearly recognising the necessary OCs. This comprises existing and future roles and duties for the people affected by the proposed process changes. These changes need to be communicated to the organisation, and the appropriate training needs to be provided, to make the process change a smooth transition. Several researchers conclude that managers of worldwide companies should understand cultural differences in countries in which they operate because many management behaviours and attitudes are embedded in culture (Miroshnik, 2002; Douglas *et al.*, 2007).

It appears that very little research has focused on cross-cultural studies in Arab and North Africa countries in particular. There is a lack of research addressing the impact of organisational culture on TPM implementation and comparing Western cultures (developed countries) such as the UK with non-Western cultures (developing countries) and with North Africa in general and Libya in particular.

The CVF is one of the many frameworks that have been developed to help organisations understand their culture and its impact on their success. In highlighting the difference in cultural types between the existing profile and that of an ideal TPM culture an organisation can communicate the change needed to reach the required status.

Furthermore, the CVF can be an effective tool in training and education and for helping organisations to better understand themselves (Cameron and Quinn, 2006). Having considered the options available, the author decided that the CVF was the most appropriate to use as an assessment tool for OC in this thesis and so bring about the changes needed to reach a desired ideal culture.

Finally, the study reveals that culture change and TPM implementation does not yield overnight success. It takes good planning and a focused plan, assisted by top management through absorbing organisational cultural improvement over a significant period of time to realise the true outcomes from the complete implementation of TPM.

Chapter 4: Research Methodology

4.1 Introduction

Tranfield *et al.,* (2003) defined research methodology as a series of specific regulations and actions on which the research is based so that practical results can be recognised. This means that the rationale of the methodology should go further than the application of regulations and actions to involve the process of facilitating the scientific communication between researchers, as well as creating simple and demonstrable systematic rules. In this research, the research methodology centres on the basic principles as a source of strategies, means and techniques.

This chapter describes the methodology that has been applied in undertaking this research and to explain the steps followed and the methods employed by the researcher to collect the necessary data. An overview of the methodology and concept is followed by a detailed description of the data collection methods including a justification for the research population and sample selection. The procedure undertaken relating to questionnaire design and plan, pilot work, question types and format, the covering letter, content of the final version of the questionnaire, administering the survey form, choice of respondents, checking for non-respondent bias and reliability and validity evaluation are also discussed. Finally, the chapter concludes with a discussion and explanation of the statistical methods and techniques used in the data analysis in order to fulfil the objectives of the study.

4.2 Research Design

Leedy and Ormrod (2005) refer to research as the methodical process of collecting and analysing information and data in order to increase the understanding of the observable fact of concern or interest. It involves a series of well-planned and carefully executed activities to find solutions to research problems including:

- Recognising the need for the research,
- Reviewing the related literature,
- Developing the objectives and the research questions,
- Identifying the appropriate strategies to answer these questions.

It also includes the tools used for collecting, analysing and presenting the data and information (Sekaran and Bougie, 2010). Collis and Hussey (2003) believe that the research methodology refers to the approach adopted by the researcher towards the entire process of the research study. In other words, the research methodology applied determines how the research study is conducted.

The design was constructed, step by step, to link the whole research together, see Figure 4.1.

4.3 Research Approaches

There are two approaches from which a research methodology can be derived, quantitative and qualitative (Saunders et al., 2007). The distinction between the two may not be that clear cut since even a method that does not involve the quantification of data may still be guided by a positive understanding of the problem (Saunders, et al., 2007).

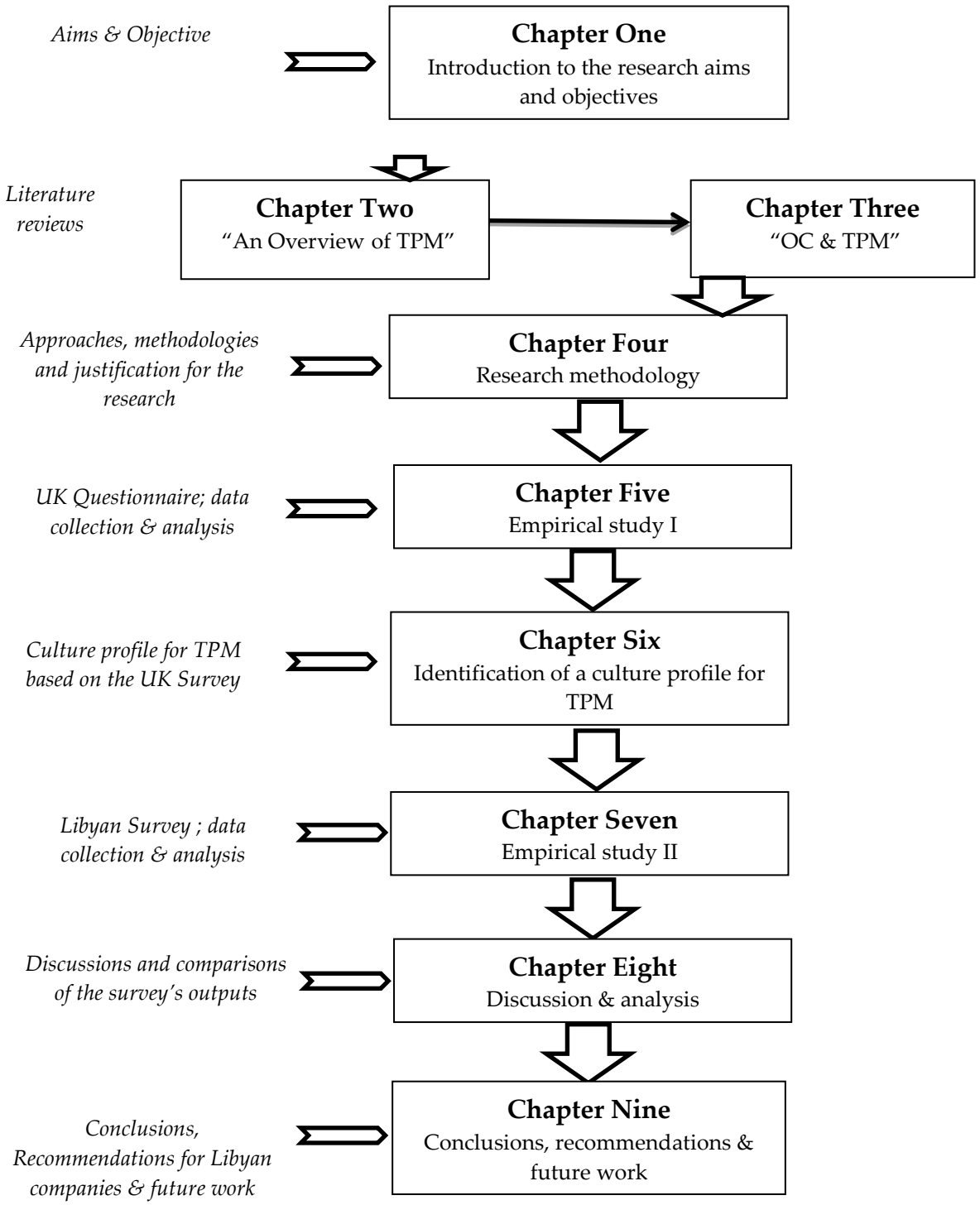

Figure 4.1 Research Flow Chart

Several researchers introduce both methods into a single study (for example, Konecny and Thun, 2011; Sherif, 2010, Butler, 2009), while others advocate choosing one method, and staying with that for the duration of the study (Aspinwall and Elgharib, 2013; Abusa and Gibson, 2013; Graisa and Al-Habaibeh, 2011). Nevertheless, regardless of the philosophical debate, most researchers clearly state the approach they have adopted. The former is known as the scientific empirical tradition and the latter the naturalistic phenomenological approach (Burns, 2000). The choice of which to use depends on a particular research paradigm (Sale et al., 2002; Yauch and Steudel, 2003). Saunders et al., (2007) summarise the features of the two approaches as shown in Table 4.1.

The quantitative approach looks for the facts or causes of social phenomena, with little regard to the subjective state of the individuals and therefore logical reasoning can be applied to the research. In this way accuracy and objectivity can be accomplished when studying research problems and explaining the results.

Table 4.1 lists the key features of the two main paradigms that indicate to the research process (Saunders, *et al*., 2007). Some researchers prefer a primarily inductive approach to the relationship between theory and research whereby theory is the outcome of the research. In other words, the process of induction involves drawing generalisable inferences out of observations (Pellisier, 2007; Saunders, *et al.,* 2007). It is clear that, whereas deduction entails a process in which: theory leads to observations/findings; induction entails a reversed process where observations/findings lead to theory development (Saunders, *et al.,* 2007).

Difference	Quantitative	Qualitative
The observer	must be independent	is part of what is being observed
Human interests	should be irrelevant	are the main drivers of science
Explanations	must demonstrate causality	causality aims to increase general understanding of the situation
Research process	through hypotheses and deductions	gathering rich data from which ideas are induced
Concepts	need to be operationalised so that they can be measured	should incorporate stakeholder perspectives
Units of analysis	analysis should be reduced to simplest terms	may include the complexity of 'whole' situations
Generalisation through	statistical probability	theoretical abstraction
Sampling requires	large numbers selected randomly	small numbers of cases chosen for specific reasons

Table 4.1 Differences between the Two Approaches (Source: Saunders *et al*., 2007)

Explanation, establishing possible relationships between the variables and linking them to an integrated theory (Saunders, *et al*, 2007) is used where large populations are studied at once and is the most cost effective way to collect data. A questionnaire comprising structured questions is distributed to a large number of the targeted population and the responses statistically analysed (Pellisier, 2007).

In contrast to address criticisms levied at the quantitative approach, the qualitative approach makes use of in depth one-to-one interviews and focus groups. Qualitative research usually emphasises words rather than quantification in the collection and analysis of data.

Each of the two main methodologies has its advantages and disadvantages. Table 4.2 provides a summary of some of their strengths and weaknesses.

Approaches	Strengths	Weaknesses
Quantitative	• They can provide a wide coverage of a range of situations • They can be fast and economical • Where statistics are aggregated from large samples, they may be of considerable relevance to policy decisions	• The methods used tend to be rather inflexible and artificial • They are not very effective in understanding a process or the significance that people attach to action • They are not very helpful in generating theories • Because they focus on what is, or what has been recently, they make it hard for policy makers to infer what changes and actions should take place in the future
Qualitative	• Data gathering methods are seen as natural rather than artificial • Ability to look at the change process over time • Ability to understand people's meaning • Ability to adjust to new issues and ideas as they emerge • Contribute to theory generation	• Data collection can be tedious and require more resources and takes more time • Analysis and interpretation of data may be more difficult • Harder to control the pace progress and end-points of the research process • Policy makers may give low credibility to results from a qualitative approach

Table 4.2 Strengths & Weaknesses of Quantitative & Qualitative (Source: Saunders, *et al.*, 2007)

The choice of methodology depends on the size and depth of information to be collected as well as available resources and the geographical spread over which the data is to be generated (Yousef, 2001). In this work it was decided to follow a quantitative research method. This is because the empirical study is intended to look at the relationship between particular variables, and to find out the answers to questions in the form of what and why rather than how. Furthermore, the quantitative approach involves collecting numerical data that can be charted, graphed, tabulated, and analysed using statistical methods.

4.4 Questionnaire Design and Data Collection

Yin (2003) acknowledged five ways of collecting and analysing empirical data in business research. They are experiments, questionnaires, analysis of archival information, histories and case studies. Each has its own advantages and disadvantages, which have to be evaluated in order to suit the circumstance in which each method is employed (see Appendix III-A which summarises the advantages and disadvantages of various data collection techniques). Questionnaires have been widely used to assess the impact and contribution of TPM in a number of studies (Graisa and Al-Habaibeh, 2011; Friedli *et al.*, 2010; Batumalay and Santhapparaj, 2009; Alsyouf, 2009).

In this research, a questionnaire was chosen as the data collection tool because it offered a realistic solution to the problem of distance between subjects and the researcher and also a postal survey was reasonably cheap to manage and a practically effective method for data collection from a large and different geographical area (Sekaran, 2003). Respondents also have time to think about answers without the influence of an interviewer. Welman and Kruger (1999) summarised the advantages and disadvantages of questionnaires as a data collection tool (see Table 4.3).

N.	Advantages	Disadvantages
1.	Better possibility of anonymity.	Anonymity complicates the following-up of questionnaires.
2.	Reasonably cheap method and provides reliable information.	Possibility of low response rate.
3.	It is confidential and respondents enjoy a high degree of freedom in completing the questionnaires.	It can only be used for short surveys with mainly closed questions.
4.	Saves time, the information can be gathered within a short time.	The clarification and description of concepts are not possible and respondents can misunderstand questions, have limited skills.

Table 4.3 List of Advantages and Disadvantages of Questionnaires
(Source: Welman and Kruger, 1999)

The researcher intended to send questionnaires to organisations in both the UK and Libya. The main purpose of the UK survey was to identify the relationship between OC and TPM implementation. The results would be used to identify an "ideal culture" for successful TPM implementation. The same survey would then be conducted in Libya to enable differences to be determined between TPM practices here and in the UK and highlight deficiencies in their OC. It was considered appropriate for a high-ranking Manager to complete the questionnaire and so the Managing Director was generally the addressee.

The layout of the questionnaire is essential, in order to obtain the right information. Within the structure lies the potential of excluding or adding specific questions depending on previous answers. The clarity and the language used to construct the questions must be carefully considered. Several versions of the questionnaire were produced and critically reviewed and evaluated by the author, the author's supervisor and colleagues at the University.

This resulted in a six page questionnaire divided into three sections: general information; measurement of TPM and classification of the ideal culture for successful TPM implementation (Appendix III-B). It comprised both closed and open ended questions; its general layout is shown in Table 4.4.

Section	Topic of section	No. of questions
1	General information	5
2	Measurement of TPM	40
3	Classification of the ideal culture for TPM	24
	Total number of questions	**69**

Table 4.4 Format of the Questionnaire

The main function of the questions, used in the questionnaire, is to gather enough required data to achieve the aim and objectives of the research. When designing individual questions researchers do one of the following (Saunders et al., 2007):

- Adopt questions used in other questionnaires.
- Adapt questions used in other questionnaires.
- Develop their own questions.

The researcher has used a mixture of all three approaches. The researcher closely examined previous research using questionnaires conducted in the area of maintenance and TPM, such as Konecny and Thun (2011); Lazim and Ramayah (2010); Batumalay and Santhapparaj (2009); Alsyouf (2009); Ahuja and Khamba, 2008b, and Seth and Tripathi (2005). These researchers developed their questionnaires for data collection based on their own research purpose. None of these questionnaires fully met the requirements of this research. It was useful in giving the researcher guidance for the general structure of the questionnaire.

Furthermore, the literature review is the main source of forming the questions, thus, the researcher has generated and developed the questions of the questionnaire in the light of related topics such as; barriers, difficulties, critical factors and variables that affect the quality in maintenance within an organisation found in the literature review. The questions of the questionnaire were specifically devised from the elements of the following sections (see 2.10, 2.11, and 2.12). The developed questions were appropriate to get the required data from the respondents' organisations, and all relevant issues covered. To enhance validity and reliability issues, the researcher's supervisor who has quality and maintenance expertise reviewed the questions of questionnaire. His comments were taken into consideration. Furthermore, to support the validity and reliability issues, feedback from the pilot study resulted in some of the questions being modified and changed.

Although using metric statistics is common practise among researchers who use rated questionnaires, this is not always the most appropriate way of analysing this type of data. Rated scales are, typically, non-metric ordinal scales, and the correct statistical indicators in this case are median, frequency and quartiles, rather than the average and standard deviation (Kinnear and Taylor, 1996; Hair et al., 2006). However, if one assumes that the differences between any two consecutive points of the scale are equal, then the results can be treated as metric data from an interval scale (Jacinto and Aspinwall; Tabachnick and Fidell, 1989). This assumption was made in this study to facilitate the analysis.

The questionnaire content was split into the following three main sections: Section One: "general information", the respondents were asked five questions, which would provide information, such as group categories, role within the company, ownership of the organisation, number of employees, and types of product they manufacture. The main aim of the questions was to obtain the background details of respondents who participated in this study. This is very important for obtaining high quality information.

The questions contained in section two related to the 10 cultural factors and their 40 related statements (see Table 3.1). A Rensis Likert scale was used to measure the level of agreement or disagreement by respondents to a question (Fink, 2002). Five points were used: "strongly disagree (SD), disagree (D), uncertain (U), agree (A) and strongly agree (SA)". The following scoring scale was used: 1 = strongly disagree = very low; 2= disagree = low; 3 = Uncertain = moderate; 4 = agree = high; and 5 = strongly agree = very high (Field, 2005). Streiner and Norman (2003) argued that the minimum number of categories should be in the region of five to seven. The respondents rated scales with five and seven response categories as relatively easy to use. Scales with two, three or four response categories were rated as relatively quick to use. However, seven scales are not widely used possibly because of the

difficulty of finding suitable adjectives when seven all-point defined scales are used. A five point Likert-scale was chosen for rapidity of data collection and to constrain responses to set criteria. It provides a reasonable compromise between sensitivity, reliability and ease of use. It always has a middle neutral point. This gives the respondents more room to think about which side and to what degree he/she would take in answering the question.

As demonstrated in Chapter three (Section 3.7.3) the CVF provides a valid means of understanding OC. The third section uses the same 24 statements provided by the CVF framework to assess the respondents company's organisational cultural features. The characteristics used to classify cultural types result in an informative organisational profile. These criteria include:

1. *Dominant characteristics* which identify whether an organisation is (a) A very personal place like a family (b) Entrepreneurial and risk taking (c) Competitive and achievement oriented (d) Controlled and structured.
2. *Organisational leadership style*, which can be described as (a) Mentoring, facilitating, or nurturing (b) Entrepreneurial, innovative, or risk taking (c) No-nonsense, aggressive, results oriented (d) Coordinating, organising, efficiency oriented.
3. *Management of employees*, which emphasises (a) Teamwork, consensus, and participation, (b) Individual risk taking, innovation, freedom, and uniqueness (c) Competitiveness and achievement, (d) Security, conformity, predictability.
4. *Organisational glue*, consisting of (a) Loyalty and mutual trust, (b) Commitment to innovation and development, (c) Emphasis on achievement and goal accomplishment (d) Formal rules and policies.

5. *Strategic emphasis on* (a) Human development, high trust, openness, (b) Acquisition of resources and creating new challenges, (c) Competitive actions and winning, (d) Permanence and stability.

6. *Criteria for success,* defined as (a) Development of human resources, teamwork, and concern for people, (b) Having the most unique and newest products and services, (c) Winning in the marketplace and outpacing the competition, (d) Dependable, efficient, and low cost.

The identified dimensions were used as a tool to assess the readiness of any organisation in terms of its existing culture prior to TPM implementation.

4.5 Sample selection and piloting of Questionnaire

Sampling defines a population as the entirety of units or people about whom the researcher needs to acquire information. A population is seen to be a complete group of people that comprise a community, a society, an organisation, or anything that may have some common features or criteria (McDaniel and Gate, 2002). Sampling is the procedure of selecting units such as employees, Managers, Companies, etc. from a population of interest. Its size must be large enough to give a good representation of the population and small enough to be manageable. The researcher decided that the best strategy would be to choose larger manufacturing companies for the studies, as they would be more likely to have implemented TPM and may be keener to help. 350 questionnaires were sent to Manufacturing Companies (from all manufacturing sectors), randomly chosen from the UK (University of Birmingham's FAME database) and from Libya (Centre for Industrial Information and Documentation directory).

According to Saunders *et al.,* (2007) a questionnaire should always be piloted to ensure that respondents will have no problems in answering the questions and there will be no problems in recording the data. The questionnaire was therefore sent initially to two UK automotive companies and two to Senior Lecturers at two UK universities. As a result minor revisions were made to the questionnaire before distribution.

The first version of the research questionnaire was in English but since the common language in Libya is Arabic, it was necessary to translate it before distribution. Professionals from a University and from companies in Libya undertook this. It was then back-translated to English by another lecturer and revised and modified by the researcher. A third English-Arabic translator was then employed to produce the final version. The full Arabic version of the questionnaire is shown in Appendix IV-C.

In the covering letters and accompanying questionnaires (see appendix III-C), the aim of the research was briefly explained and the confidentiality of the responses was guaranteed. The covering letters were addressed to the Managing Directors of each company, since these were felt to be the most suitable for responding. The questionnaires were forwarded to an alternative manager to complete. The assumption made by the Researcher was that each respondent was the best suited to answer the questions.

4.6 Statistical analysis

The SPSS (Statistical Package for the Social Sciences, Version 19.0) software programme package was used to examine the responses. The reason for this was the familiarity of the author with the software and the features of the software that allow the data to be articulated in different ways. Having decided that the data collected would be analysed using this package, the responses to the questionnaire were prepared in a manner that

facilitated its analysis. The questionnaires were coded and pre-numbered in order to identify the respondents who returned the questionnaires. The analysis was divided into three parts as follows:

1. the measurement and understanding of TPM among UK respondent companies (follows in this Chapter),
2. the classification of an ideal culture profile for TPM (discussed in Chapter 6)
3. Presentation of the study in Libya and its comparison to the UK study (see Chapter 7).

Reliability and validity are very significant topics to consider when planning and carrying out any type of research. Reliability refers to the ease with which research could be duplicated by another individual whereas validity refers to how clear the purpose and method are in terms of results achieved and whether these measure what was anticipated (Fink, 2002).

4.6.1 Statistical Analysis Technique

This section presents a brief outline of the statistical and descriptive methods that were used to analyse the data.

The latter included frequency, means, and standard deviations used on the demographics and survey responses to provide a general description of the data collected. The statistical methods focussed generally on factor analysis and "t" tests.

Cross-tabulation enables researchers to see whether or not there is a relationship between two variables. It is a very practical way of generating tables showing the relationship between two or more variables and of gaining insights into the key variations

and trends (Field, 2005). It will be used in the questionnaire in section one, two and three to display and compare the results).

Correlation (a measure of the linear relationship between two or more variables or sets of data) was used in section two of the questionnaire to investigate culture and TPM factors in the UK sample, in the Libyan sample and in both samples together. Pearson's Product Moment correlation Coefficient (r) is the most often used in and the most practice coefficient (Field, 2005).

Factor analysis was used to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. It is used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables. It can also be used to generate hypotheses regarding causal mechanisms or to screen variables for subsequent analysis (Sekaran, 2003).

Factor analysis explores the underlying correlations among a large number of variables (e.g. questionnaire responses) in order to combine them into a smaller set of dimensions that have a common relationship, known as factors. There are two factor models referred to as principal component analysis and common factor analysis. The latter is also known as exploratory factor analysis.

Principal component analysis is typically appropriate when the aim is to reduce the original set of variables into smaller sets of combined variables, whereas common factor analysis is used when the primary concern is about identifying the underlying common dimensions in the original variables (Hair et al., 2006).

Although there has been a considerable debate over which factor model is the more appropriate, empirical research usually brings similar results and solutions (Hair et al., 2006; Field, 2005). In this context, Field (2005) argued that the differences between a principal

component analysis and that of common factor arise largely from the calculation and may be difficult to conceptualise to non-statisticians. In addition, principal component analysis tends to be more stable and by far the most commonly used model in business research (Hair et al., 2006). Thus, principal component analysis (hereafter referred to as factor analysis) was chosen for the purposes of in this research.

Burns (2000) introduced four methods for reliability measure: test-retest method, alternate forms method, split-half method and internal consistency method. The most popular test of internal consistency or homogeneity among the items is ***Cronbach's coefficient alpha*** (**α**) (Sekaran, 2003; Bryman and Bell, 2007; Saunders et al., 2007). It measures how well a set of variables or items measures a single, one-dimensional latent aspect of individuals (Rungasamy *et al.,* 2002). However, when items are used to form a scale they need to have internal consistency. The items should all measure the same thing, so they should be correlated with one another. A commonly-accepted rule of thumb is that an alpha of 0.7 (some say 0.6) indicates acceptable reliability and 0.8 or higher indicates good reliability (Nunnally, 1978). Very high reliability (0.95 or higher) is not necessarily desirable, as this indicates that the items may be entirely redundant. These are only guidelines and the actual value of Cronbach's alpha will depend on many things. E.g. as the number of items increases, Cronbach's alpha tends to increase too even without any increase in internal consistency. For this reason the coefficient is also called the internal consistency or the internal consistency reliability of the test (Saunders et al., 2007). It was used in this study to ensure that the reliability of the survey responses.

An ordinary comparison t-test is appropriate to compare the means of two groups (Kinnear and Gray, 1997). It was therefore used in this study to identify the differences between the UK and Libyan cultures in terms of implementing TPM programmes.

A decision had to be made in the research process as to how to measure OC. A common question in research is whether to use an already existing research instrument or to construct a new one, while hardly any standard rules exist (Sekaran, 2003). The author relied on an established instrument in the academic literature instead of creating a new one. Researchers have developed a variety of models and scales to measure OC. Primary among these, are: CVF & OCAI (Cameron and Quinn, 2006); IDEFO (Colquhoun, 1993); OCI (Cooke and Szumal, 2000); and the JEII (Schein, 2004). Compared to these latter models and scales, the CVF and its matched scale OCAI have the following advantages:

- Few dimensions but broad implications: The CVF includes only two dimensions whereas the OCAI incorporates the essence of eight commonly accepted dimensions (Ralston *et. al.*, 2006).
- Empirically validated in cross-cultural research: a large amount of empirical studies have established the reliability and validity of the CVF and OCAI (e.g., Howard, 1998; Ralston *et. al.*, 2006).
- Most succinct: The OCAI questionnaire includes only 24 items thus it is very convenient for practical operations (Ralston *et. al.*, 2006).

In conclusion the CVF and its matched scale OCAI were very suitable for this research study, especially for studying OC change and for identifying of culture types related to organisational effectiveness.

4.7 Summary

The research design and approach have been outlined in this Chapter. In deciding on the choice of data collection methods, issues such as the facilities available, time, costs and resources associated with gathering data should be (Saunders et al., 2007) and were, taken into account. A questionnaire was used as the main method of data collection. This was explained and justified. A pilot study was carried out prior to the distribution of the final version of the questionnaire; several drafts were made and amended in response to the feedback received from this. The questionnaire design and layout, question types and format, contents of the final version of the questionnaire (English and Arabic) were discussed in this Chapter. The statistical methods used to address the relationship between OC and TPM implementation were also discussed.

CHAPTER 5: An Empirical Study I

5.1 Introduction

For a long time, developing countries planned their economic strategies based on models copied from successful western countries with the aim of enjoying the same degree of economic success (Goncalo et al., 2012). However, globalisation and international trade, along with advances in information technology have now dramatically increased competition worldwide. To compete in a global market, firms need to be equipped with new technology, up to date information, skilled employees, and enhanced managerial skills. The concept of TPM was developed and propagated as the result of intense global competition (Ahuja and Singh, 2012).

Despite globalisation, the implementation of improvement programmes has not occurred at the same pace in different regions of the world. While early implementation started in Japan, the US, and Europe, followed by South East Asian countries, those in the Middle East have lagged behind. To compete in the global market, countries in the Middle East such as Libya need to implement quality management practices, tools, and techniques within all sections of their industries.

Many companies across the globe have implemented TPM programmes and are successful and satisfied with the implementation (Aspinwall and Elgharib, 2013). Table 5.1 shows different examples of TPM implementation around the world.

Author & Year of Publication	Study	Sample size	Country	Methodology used
Batumalay and Santhapparaj (2009)	OEE through TPM practices in Malaysian industries	400	Malaysia	Questionnaire
Ahuja and Kumar (2009)	TPM implementation	One	India	Case Study
Aspinwall and Elgharib (2013)	TPM implementation	Four	UK	Case Study
Konecny and Thun (2011)	An empirical analysis of a conjoint implementation of TQM and TPM on plant performance	238 plants	Germany	Questionnaire
Seth and Tripathi (2005)	Relationship between TQM and TPM implementation factors and business performance in Indian context	460	India	Questionnaire
Alsyouf (2009)	Maintenance practices	1440	Swedish	Questionnaire
Lemma (2008)	TPM implementation	Two	Ethiopia	Case Study
Moradi et al., (2011)	The effect of the implementing 5s on TPM	One	Iran	Case Study
Rodrigues and Hatakeyama (2006)	Analysis of the fall of TPM in companies	one	Brazil	Case study
Bamber et al., (2000)	TPM implementation	One	UK	Case study
Cooke (2000)	TPM implementation	Four	UK	Case study
Lazim and Ramayah (2010)	Maintenance strategies in Malaysian manufacturing companies	1000	Malaysia	Questionnaire
Arca and Prado (2007)	TPM implementation	Seven	Spanish	Case study

Table 5.1 Examples of TPM Implementation around the World

The UK was chosen as a benchmark for the following reasons:

- No language problems associated with the UK compared to others in the listed table.
- Insufficient detail about TPM practices in other countries was available from the literature.

- No publications were found about TPM practice in a country similar to or near to Libya.
- Information could be more readily obtained from UK companies.
- The researcher is based in the UK.
- Several acclaimed global giants such as Ford, Jaguar, Land Rover, Sun, BPB, Cadbury Lear, Airbus and GKN have successfully implemented TPM.

This chapter presents the data collected from UK manufacturing companies responding to the survey, it consists of a comprehensive discussion of the analysis of the results from the questionnaire survey as a further phase of the research. Finally, the limitations and assumptions of the study will be discussed in brief. Prior to this the transferability of TPM to Western countries will be considered as well as its need and its development in the UK. A postal survey was conducted to address these issues and the results / findings are examined.

5.2 TPM and UK

The main event that brought TPM to the attention of UK manufacturers and academics in the late 80's was the announcement of Nakajima's book 'Introduction to TPM' that was interpreted into English and published by Productivity Press. Though the concepts of the methodology had been developed in Japan in the early 1970s the book was not published there until 1984 (Davis, 2011).

Davis noted that the list of JIPM and TPM prize winners for the 2 years prior to 2011 appeared to show that there were very few examples of UK companies that had implemented and sustained a complete TPM programme in spite of its being extremely popular in the early to mid-1990s.

Davis concluded that the first two pillars of TPM linked to OEE and PM systems, were the least difficult to implement and that was why several organisations had embraced them. The other three pillars relating to people issues such as motivation, employees' participation and culture change are much more difficult and took longer to implement.

5.3 The cultural transferability in Western World

Organisations worldwide implement global best practices to secure a competitive advantage. Those that do not change and adapt to the new competitive environment will be overpowered in the marketplace by those that do and will disappear (Raymond, 2002). Each society has its own work principles that are generally influenced by peoples' backgrounds and attitudes which in turn manipulate their views. Hofstede (2001) introduced a selection of factors, which contribute to cultural differences between nationalities such as a dominant language, national armed forces, national education system, common mass media, and national political system. Perhaps one of the major sources is differences in religion.

Roney (1997) identified different issues that exist between national cultures, such as -the way individuals view the world; - the degree to which people are integrated into groups; - how information is processed; - how individuals establish relationships with others; - how they deal with uncertainty and the concept of time. All of these exist in each culture and even within a given individual, but cultural norms and expectations are generally based on a dominant shared value. Therefore, signs of appropriate manners, for example, are based on the dominant values within a given culture. Additionally, organisational associates share expectations that policies will be consistent with these dominant values.

5.4 Objectives of the Study

The focus of this research was firstly, to measure the level of understanding of TPM implementation in the UK (covered in this Chapter) and in Libyan manufacturing companies (discussed in Chapter Seven) and secondly to identify an ideal culture for successfully implementing TPM (see Chapter Six). The findings of this research are intended to help improve the Libyan industry, to increase its productivity and profitability and to be aware of the cultural differences and thereby implement the programme successfully. Based on the objectives of the study and the points discussed above, the following steps were taken and discussed in detail below:

1. Design of a questionnaire.
2. Selecting the samples in the UK and in Libya and distributing the survey.
3. Conducting the appropriate statistical analysis based on the survey data.

5.5 Response rate

The questionnaires were sent out together with the covering letter, at the beginning of January 2011. A total of 84 were returned, but 17 were found to be invalid for the analysis (reasons for not taking part included, 'company moved, in the process of re-structuring the business and 'Ceased Trading). A reminder letter was sent eight weeks after the initial mail to those who had not yet responded (see Appendix III-D). Several companies had either moved to another location, or closed their manufacturing businesses. 111 Completed questionnaires were received representing a response rate of 32% which can be considered good. Previous studies revealed response rates of 9.1% for Shamsuddin *et al.*, (2004), 18.7% for Brah and Chong (2004), 26.3% for Seth and Tripathi (2005), 43% for Kaur *et al.*, (2012),

and 49% for Ahuja and Khamba (2008). Since generally responses to questionnaires have decreased in number over the recent years. In order to deal with non-response bias early and later responses were compared according to Armstrong and Overton (1977). No significant differences were found to exist at the significance level of 0.05. A summary of the survey response rate of the UK questionnaire can be found in Appendix III-E).

5.6 Reliability and Validity

Reliability of the research findings relates to decreasing the risk of gaining wrong answers, this includes two key features of the research design, reliability and validity (Saunders *et al.,* 2007). It provides a signal about the consistency of the instrument. It is mainly a matter of stability. The most commonly used measure of reliability is internal consistency assessed by Cronbach's coefficient alpha (α) (Saunders *et al.,* 2007) which correlates each item with every other one. Its value ranges from 0 to 1. Items with weaker correlations can be removed to leave an instrument with a high degree of homogeneity. When a scale has a Cronbach's alpha value of 0.7 or higher, it can be considered as reliable (Pallant, 2007).

Validity is used to assess the accuracy of the results, and refers to the degree to which an item measures what was intended. Different ways are proposed for assessing the validity of measurements the two commonly used are content and construct validity. Content validity is a qualitative method which ensures that the measure includes a sufficient and representative set of items that represent the concept (Sekaran, 2003). Construct validity is a quantitative method which measures how well the results obtained fit the theories around which the test is designed to investigate the correlation between the measures (Sekaran, 2003). It is carried out to make sure that each construct is factor rather than multi-factorial.

The instrument used to identify or to measure validity in this study was construct validity. Responses in sections two and three were subjected to "principle components" analysis. The "Kaiser Meyer Olkin" (KMO) indicator was determined to measure sample size competence.

5.7 Results of the survey

5.7.1 General information

The first section of the questionnaire, dealt with general information about the respondent and the company: employment category, role within company, ownership, number of employees and industry sector. The intention of asking such questions was to get enough information about the tested companies that may help the researcher for his study and further analysis.

It was pleasing to see that more than half (57.7%) of the respondents held top management positions (General Directors, Assistant Directors), in their companies, indicating that the survey was taken seriously in the participating organisation. 30.6% of the respondents were from middle management (General Managers, Manufacturing Managers, Production Managers, Maintenance Manager), 9.9% from Supervisory Inspectors (Line Managers, Inspectors, Quality Control, Technical Officers). The remainder classified as other, recorded 1.8% who contribute in daily activities to implement the programme of improvement (Engineers, Trainers and Senior Technicians). A detailed table in Appendix III-F has shown the distribution of the role within the respondent companies.

The majority of the respondents (78.4%) were from the private sector, 13.5% from partnership/joint ventures and 5.4 % from the government-owned companies (see Figure 5.1).

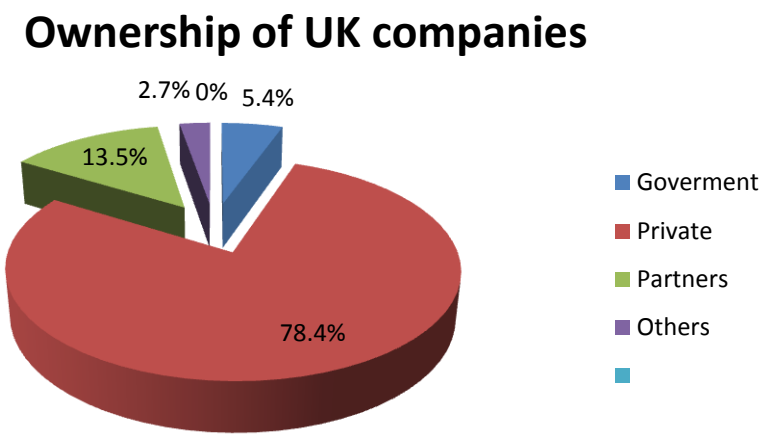

Figure 5.1 Ownership Within the UK Respondent Companies

Of the respondent companies 9.9% had less than 50 employees, 39.6% had between 50 and 249 and 50.5% had more than 250.

Figure 5.2 shows the breakdown of the industrial sectors to which the respondent companies belong. As can be seen a high percentage came from the automotive sector. The group "Others" which included the manufacturing of paper, wood and glass and also the printing industry was the next largest.

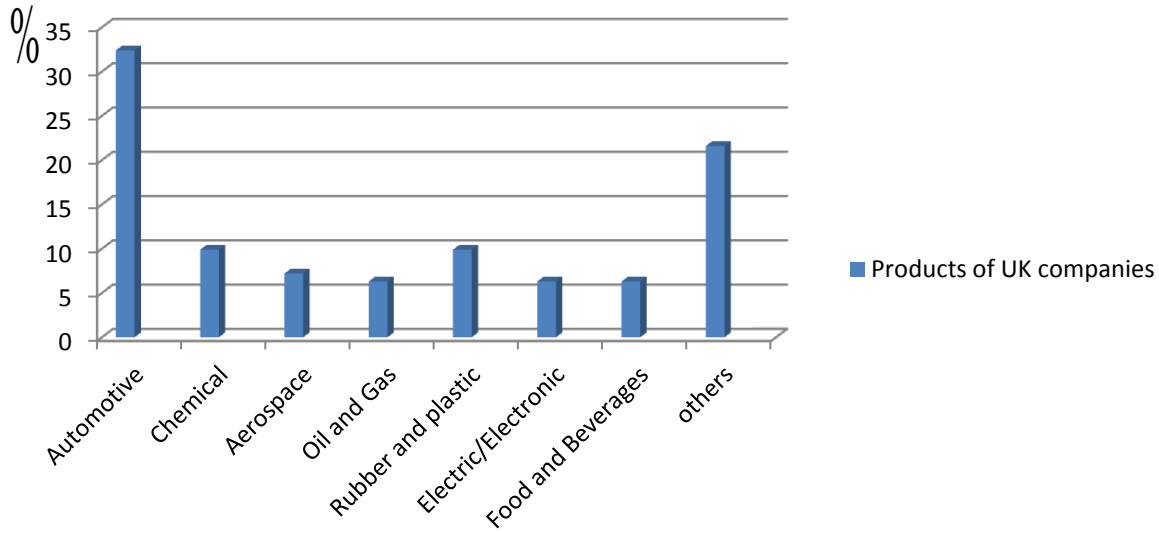

Figure 5.2 Distributions of Respondent Companies by Sectors

5.8 Reliability and Validity

5.8.1 Reliability analysis:

As stated before, the most common method for assessing the reliability of a scale is to examine its internal consistency by calculating Cronbach's alpha (α).Normally, alpha values greater than 0.7 are regarded as high enough to show reliability (Nunnally, 1978), although a value of 0.6 was used by Antony *et al.,* (2002) and Rungasamy *et al.,* (2002).

Table 5.3 shows the results of evaluating the internal consistency of the 'measurement of TPM' using the 40 items or elements in the 10 cultural factors. The reliability (Scale of Variance) ranged from 0.600 for *Monitoring and Evaluation (F8)* to 0.855 for *Top Management (F1).* All the Cronbach's alpha values exceeded 0.5 which is generally considered adequate for exploratory work (Sakakibara *et al.,* 1997).

Regardless of this, certain items were deleted from the factors to further improve the internal consistency. Referring to Table 5.3, one example of the deletion of items is 1.5, "Focuses on health, safety and environmental issues" from the *Top Management* factor "F1", increasing its alpha level to 0.858. The final Cronbach's values after deleting items, ranged from 0.613 to 0.858 (example of analysis outputs is provided in Appendix III-G). Thus, the constructs had satisfactory reliabilities.

Factors	Items listed	Scale Variance if Item Deleted	Item deleted	Final Cronbach's Alpha
F1	6	0.855	**1.5**	**0.858**
F2	5	0.685	None	0.685
F3	3	0.761	None	0.761
F4	4	0.721	**4.1**	**0.726**
F5	5	0.722	None	0.722
F6	4	0.777	None	0.777
F7	4	0.813	**7.2**	**0.838**
F8	3	0.600	**8.2**	**0.613**
F9	2	0.702	None	0.702
F10	4	0.600	**10.1**	**0.623**

Table 5.2 Results of Reliability Analysis

5.8.2 Results of correlation analysis

As a preliminary step in the analysis, the relationships between the 10 factors and the 6 OC dimensions were investigated using correlation analysis (see Table 5.3).

No.	Variables
D1	Dominant characteristics of the organisation.
D2	Organisational leadership.
D3	Management of employees in organisation.
D4	Organisation glue.
D5	Strategic emphasis of the organisation.
D6	Success within the organisation.

Table 5.3 6 OC Dimension variables

This is 'a measure of the linear relationship between variables' (Field, 2005). Field added, a positive correlation signifies that a linear relationship exists between variables (if one

increases, the other one increases). A negative correlation signifies an inverse linear relationship between them (if one increases the other one decrease). Pearson's Product Moment Coefficient (r) is the most often used and most precise coefficient (Field, 2005). The results of this analysis are presented in Table 5.4.

It was clear that a significantly positive linear relationship existed between most pairs of variables. This supports the emphasis in the literature on the vital role of an OC in TPM. Based on the findings in Table 5.4, the strongest relationship was found between F1 (*Top management*) and D6 (r=.783). This was expected for UK companies, since top management plays a critical role in promoting training and education in the company and it could affect all of the other variables to improve productivity and quality. In general, without appropriate leadership, TPM will not succeed; only dynamic leadership can create the commitment and support to determine the success of new change initiatives.

N=111	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**
D1	.432**	.586**	.631**	.211*	.401	.631**	.615**	.322*	.247**	.237*
D2	.509*	.633**	.421*	.442	.318	.667**	.634**	.521**	.322*	.429*
D3	.421**	.423**	.395**	.439**	.501*	.678**	.344**	.366**	-.114	.625**
D4	.613**	.411**	.644**	.259*	.554**	.619**	.599**	.541**	.082	.588**
D5	.662**	.513**	.601**	.328*	.272**	.599**	.617**	.341*	.401**	.592**
D6	.783**	.494**	.369**	.153	.396*	.673**	.512**	.377**	.511**	.633**

**Correlation is significant at the 0.01 level (1-tailed).
*Correlation is significant at the 0.05 level (1-tailed).

Table 5.4 Pearson's Correlations between the Variable

The second highest correlation was between F6 (*recognition and empowerment*) and D3 (r=.678) and also F6 and D6 (r=.673). The intention for implementing an improvement programme within an organisation is to change performance and practice. In most UK companies' manufacturing operations, the maintenance activities depend largely on human input. Nakajama stated that TPM is a programme that focuses on productive maintenance programmes, which in turn, focus on involving every single employee from top management to shop floor workers and empowering employees to initiate corrective activities (Nakajama, 1989).

The next highest correlation was between F6 (*recognition and empowerment*) and D2 (r=0.667). This shows that managers understand the TPM principles and methods, since *recognition and empowerment* are very important factors in successfully adopting TPM programmes or any other quality management systems (Aspinwall and Elgharib, 2013).

Reward & incentives (F9) is negatively correlated with D3. The weakest correlations were between (F9 and D4; F9 and D3; F4 and D6).

5.8.3 Validity Analysis

According to Nunnally (1978) validity refers to the extent to which the instrument measures the concept that the researcher wants to measure. He stated that there is no single way of determining this but there are three different types of validity that are generally considered and these are: Content, Construct and Criterion.

In this study, the researcher believes that the tool used for measuring TPM implementation in UK manufacturing companies has construct validity since it is based on the previous studies of Shamsuddin *et al.,* (2004), Brah and Chong (2004) and Seth and Tripathi (2005). Construct validity is a quantitative technique (measured using factor analysis) to ensure that

each factor has the theoretical construct that it was designed to measure (Sekaran, 2003). Its main function is to condense or summarise the key features of a large number of variables for further analysis. The principal components procedure of factor analysis was used in this case to test whether the elements belonged to the factor as allocated or should be removed.

Table 5.6 illustrates factor analysis results for each of the 10 OC. As can be seen, all items have a high loading for their factor, with the exception of item 40 "Shop floor worker". The analysis proved that the factors were unifactorial apart from "Teamwork" (F10). In this case one of the items; the "shop floor worker" had a low loading value of 0.481. This was possibly due to the fact that it was associated with softer/human issues whereas the other

Factors	**Items listed**	**Component matrix for factor**	**Eigenvalue**	**% Variance explained by factor**
Top management	6	.840 .826 .824 .808 .641 .630	3.528	58.797
Total employee	5	.744 .709 .660 .654 .554	2.227	44.541
Communication	3	.866 .834 .765	2.031	67.707
Strategic planning	4	.846 .759 .722 .607	2.181	54.525
Resource allocation	5	.781 .760 .718 .601 .583	2.406	48.121
Recognition	4	.828 .768 .764 .741	2.408	60.190
Training	4	.901 .880 .756 .660	2.594	64.851
Monitoring	3	.865 .695 .667	1.676	55.863
Reward	2	.878 .878	1.543	77.141
Teamwork	4	.809 .740 .633 **.481***	1.834	45.859

*Value below 0.6 criterions.

Table 5.5 Factor Analysis Results for Each of the 10 OC Factors

items measured the physical condition of the workplace. It was decided to maintain this item rather than to split the factor into two since the other two items do have an effect on the morale of the workers; it does sit comfortably in this factor. Statistically valid measures again provide support to the structure of this tool and to the factors as independent indicators, see Appendix III-H. Table 5.6 shows the total variance for factor *Top Management* "F1". The results of factor analysis showed only one component with an Eigen value greater than one for each factor. The percentage of variance 58.797 means that the identified factor 58.79% of the data total variance. The percentage means that the 6 original variables can be reduced to a single factor variable. The new factor ought to explain a minimum of 58% of the data's original variance, which complies with Jensen et al. (2006).

Component	Initial Eigenvalues			Extraction Sums of Squared Loading		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.528	58.797	58.797	3.528	58.797	58.797
2	.922	15.364	74.160			
3	.496	8.271	82.431			
4	.477	7.952	90.383			
5	.317	5.285	95.668			
6	.260	4.332	100.00			

Table 5.6 Total Variance Explained for F1

Table 5.7 shows that the entire set of variables has high factor loadings (≥ 0.630) on the suggested factor. This output is especially used when several factors are suggested, in order to determine the variables calculated affiliation towards the factors.

	Component 1
Ensures employees are well supported	.840
Pays attention to improving maintenance	.826
Clear understanding of missions	.824
Commitment and support	.808
Encourages employee involvement in TPM	.641
Focuses on health, safety	.630

Extraction Method: Principal Component Analysis

Table 5.7 Component Matrix for factor "F1"

Additionally, Bartlett's test of Sphericity indicated statistical significance (sig values ≤ 0.001) for all cases. Table 5.8 shows an example of KMO and Bartlett's test values for *Top Management (F1).*This means that enough correlations exist among the variables to proceed (Hair et al., 2006). The KMO measure of sampling adequacy is an index used to examine the appropriateness of factor analysis. A value between (0.5 and 1.0) indicates that factor analysis is appropriate (Field, 2005; Chow, 2004).

Factors	Items listed	KMO Value	Bartlett's Test of Sphericity
Top management	6	0.830	637.393
Total employee	5	0.669	199.925
Communication	3	0.668	183.735
Strategic planning	4	0.704	193.103
Resource allocation	5	0.743	228.740
Recognition	4	0.775	243.500
Training	4	0.712	404.036
Monitoring	3	0.523	95.154
Reward	2	0.500	81.160
Teamwork	4	0.553	128.476

Table 5.8 KMO and Bartlett's Test for Factor Analysis

Since the number of factors were identified, they should be interpreted based on the factor loading, which is the correlation between each of the original items. Factor loading is a measure of the relative importance of each item in representing that factor. Thus, the larger the absolute size of an item loading, the more important it is in interpreting and naming the factor. The results of running a factor analysis are shown below in Table 5.9. The KMO value here of .830 is not only above the minimum requirement but is also regarded as a good value

according to Field (2006). Bartlett's Test of Sphericity is highly significant (Sig. = .000). Thus, factor analysis is appropriate for this study's data.

Kaiser-Meyer- Olkin Measure of Sampling Adequacy.		**.830**
Bartlett's Test of Sphericity	**Approx. Chi-Square**	**637.393**
	Df	**15**
	Sig. Prob	**.000**

Table 5.9 KMO and Bartlett's Test for Factor "F1"

5.8.4 Descriptive statistical analysis

Section two of the questionnaire was designed to measure the factors of TPM as well as the companies understanding of the programme. Appendix III-I, shows how the respondents rated each of the 10 factors and their 40 related elements. The first column in each lists the elements' column. Each subsequent column gives the percentage of responses based on the Likert scale.

All the elements in the *Top Management* factor received strong support with between 75% and 99% of all respondents at least agreeing with the statements. It can be seen that management's focus on health and safety was a really important issue for the respondent companies with scores of 56% SA and 36% A while only 8% were uncertain. They are possibly those in less experienced manufacturing companies who are often unclear about what they need to do to meet their legal obligations.

The results of *total employees' involvement* revealed somewhat higher levels of involvement and were better than expected. Nearly 87% of the respondents (54% A and 33% SA) agreed that TPM involves every single employee, from top management to shop floor

workers. This sense of ownership is a significant issue that support TPM's success with every operator being responsible for the cleanliness and maintenance of their own machines is clean and maintained. It comprises the employees to have a common understanding of the basic concepts of TPM (One *et al.,* 2005). 63% of the respondents accepted that AM is their responsibility to improve equipment reliability, maintainability and productivity. About 69% of respondents asserted that employees have easy access to the information on productivity, while only 10% had no easy access to the information.

Based on the responses for the *communication and awareness* factor, 25% of the companies disagreed or were uncertain that there was effective communication between teams, while 75% of the respondents were agreed that there was an effective communication between teams. Top management use effective communication to procure the support of their employees towards achieving an organisation's objectives. Numerous studies noted that effective communication influence the organisation to move systematically towards employees' involvement and improves organisation performance (Ng *et al*., 2011; Ahuja and Khamba, 2008b; Yusuf *et al*., 2007; Park and Han, 2001).

Strategic planning and *action plan* was included in this research to specify the level of how important these capabilities are to the company when developing their strategy.

75% of the respondent companies agreed that detailed roles and responsibilities are well-defined, communicated, updated and understood plant-wide. This supports the finding from literature that manufacturing companies today are more prepared for the changing market conditions. More than 12% of the respondent companies disagreed or were uncertain about using benchmarking in their organisation. This is possibly because some organisations consider it as spying on the competition where others believe it could be expensive (Wilson and Pitman, 2000; Besterfield *et al*, 2003).

More than 92% of the respondents agreed that there was no shortage of main resources in the form of methods and analysis tool, furthermore the availability of machines on the shop-floor was visible to and understood by over 80% of the respondents. 73.9% of respondents agreed that there was a system in place for making modifications to existing equipment for improving equipment availability. Daily maintenance checks on equipment are carried out by production workers in about 87% of respondent companies and approximately 78% of these companies indicated that their employees carry primary responsibility for their decisions.

94% of the respondents agreed that their organisation treated and respected them equally; only 6% disagreed and were not happy with their treatment within their companies. *Training and educationa*l aspects had become one of the crucial factors to establish successful TPM implementation, where appropriate education starts as early as during the introduction and initial preparation stages. The majority of the respondents indicated that training and education were vital elements when implementing TPM. More than 91% of the respondents agreed that training was an important factor for TPM adoption, furthermore 92% agreed that safety and environmental training were provided for team members and personnel. A lack of training programmes was confirmed by 18% of the respondents who asserted that there were no regular reviews or training programmes to accommodate changing requirements. 32% of the respondents disagreed that team leaders were experienced and had leadership quality. This is perhaps because team leaders are not machine operators or maintenance technicians, who must believe in regulation, responsibility and open communication, and are able to instruct the team into taking ownership of the machine, provide team training before TPM implementation and encourage the team to make TPM more smooth and successful (Lixia and Bo, 2011).

Regarding *monitoring and evaluation*, about 15% of the respondents confirmed that their organisations had not developed appropriate data collection and analysis systems, while 85% agreed that their organisation followed schedule or planned maintenance of equipment.

Employee encouragement such as *rewards and recognition incentives* inspires employees to perform. In excess of 84% of the respondents agreed that they were encouraged to improve their knowledge and skills at work. In line with this the findings of Yusuf *et al.,* (2007) reported that employee encouragement is positively related with organisation performance.

84% of the respondents agreed that TPM improved teamwork between production and maintenance departments. This is a good result and reflects a strong trust that TPM improves teamwork and manufacturing performance. This is by far one of the most important aspects of TPM.

5.8.5 Extent of practise

The objective of this second section of the questionnaire was to measure each statement relative to the success of TPM. The statements were a wide range of important issues concerning TPM programmes such as the actual philosophy, techniques, training. Appendix III-J tabulates the mean and rank score for each statement. Several important points are instantly apparent. The respondents recognise that:

1. Commitment and support from top management determines the success of new change initiatives.
2. Focus on health, safety and environmental issues are necessary ingredients.

3. The organisation treats all employees equally with regards to respect, performance and recognition.
4. Training and education are vital when adopting TPM.
5. Teamwork is important for achieving a TPM culture.
6. Operators do basic maintenance and inspect their machines daily.

In contrast, there is some uncertainty as to their level of success with regards to the following points:

1. Shop floor workers are organised in TPM teams for problem solving and the team objectives are aligned with departmental objectives.
2. There is a system for linking recognition and rewards to the company's improvements goals.
3. Resources allocated for TPM are not compromised for other initiatives such as TQM.

In view of the fact that the mean value is low in the "resources allocated for TPM", companies have to improve productivity by utilising resources like machinery, men, and material as optimally as possible. This will provide companies with a stable foundation to pursue innovation and growth. The 40 statements structure the basis of measurement of TPM understanding and as such can form a tool to assign a "score" to companies. It could possibly be interpreted as the higher the score, the better the understanding but not necessarily the better the practice.

The overall mean for each factor is shown in Table 5.10. The values range from 3.776 to 4.345. "*Top management*" was perceived to be the most important factor while "*Reward and incentives*" was the least.

The four highest scoring factors were top management, training & education, recognition & empowerment, and monitoring & evaluation, which show that companies in the UK believe these TPM factors are still extremely important elements of competitive advantage.

Factor	Description	Mean	Rank
F1	Top management	4.345	1
F2	Total employee involvement	3.946	5
F3	Communication and awareness	3.913	6
F4	Strategic planning and action plan	3.890	9
F5	Resource allocation or availability	3.902	8
F6	Recognition and empowerment	4.073	3
F7	Training and education	4.173	2
F8	Monitoring and evaluation	4.066	4
F9	Reward and incentives	3.776	10
F10	Teamwork	3.908	7

Table 5.10 Mean Score for Each Factor

5.9 Limitations of the study

No major problems were encountered while conducting the study. However, one limitation was that the research was limited to manufacturing organisations. Moreover the questions addressed the principles and concepts of TPM rather than its implementation. Including some open-ended questions, thereby allowing participants to record their own answers may have provided an insight into the practise of TPM, although this was not the intention of the survey.

Another limitation was self-reporting bias. The researcher is dependent on the data reported by the top managers of the respondents manufacturing companies. This is a familiar problem when data are collected from managers about their organisations, since they are the overseers of their companies' operations and are likely to be the ''thought'' leaders of TPM. For example, the factors of *total employee involvement*, *recognition & empowerment*, *training & education and reward & incentives* could be assessed more positively because it is completed by a manager. Multiple responses from different individuals in each company can reduce this bias.

Finally, one of the critical limitations was the difficultly in identifying companies with the appropriate functional background knowledge about TPM practices.

5.10 Summary

An overview of the steps in the research process was presented in this Chapter.

A questionnaire was used as the main method for data collection. This was explained and justified. The population and sample respondents were randomly chosen from the University of Birmingham's FAME database, and the questionnaire was designed to ensure that the largest possible response rate was received. Data collection and sampling were discussed. The questionnaire was piloted prior to the distribution of the final version; (several drafts were made and modified in response to feedback received from experts). The questionnaires were sent to 350 UK manufacturing companies and generated a 32% response rate which is considered as good for this kind of research.

Relevant analysis was carried out using SPSS software (Ver.19). Internal Consistency was measured by calculating a statistic recognised as Cronbach's coefficient alpha; a correlation coefficient was used to point out the strength of association between TPM factors. The issues

of reliability and validity of the results has been discussed. The results of the correlation presented in Table 5.5 showed that a significantly positive relationship existed between most the majority of the pairs of variables. The strongest being F1 (*Top management*) and D6 (*Success within the organisation*) (r=.783).

Another aspect investigated in the questionnaire was the level or extent of practice of each factor of TPM programme. *Top management, Training and education* and *Recognition and empowerment* were the highest ranked factors, while *reward & incentives* and *Strategic planning & action plan* was in the lowest rated.

The next Chapter uses the competing values framework (CVF) to determine an ideal culture to implement a TPM programme in UK manufacturing companies.

CHAPTER 6: Identification of an ideal culture profile for TPM

6.1 Introduction

Using the results of the survey discussed in the previous Chapter, it is now possible to identify an ideal cultural profile, based on UK companies, that supports TPM implementation. The findings will also be used in Chapter six to help Libyan industries identify the changes needed to reach the desired TPM culture.

6.2 Results & Findings of the Survey

6.2.1 An ideal cultural profile based on the UK Survey

Based on the findings of the literature review and Chapter four, the same questionnaire was used in this chapter but only section three. The aim of section three of the survey was to help identify an ideal cultural profile that would assist TPM implementation (based on data provided by the UK's respondents) and the suitable environment for ensuring its success. It comprised of 24 statements composed into six parts with four descriptions in each part as described previously (Cameron and Quinn, 2006). The four descriptions matched the definitions of each of the four culture types (i.e. hierarchy, group, rational and developmental). The respondents were asked to state their level of agreement to each of the statements using the Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The cultural profile in the UK was investigated for all respondent companies by averaging the respondent's rating for each cultural type across the six dimensions. This attained six values, one for each of the developmental, group, rational and hierarchical

cultures (see Table 6.1). The respondent score was then obtained by averaging the six dimensions' scores across each culture type. The average score values for all the respondent companies are also shown in Table 6.1.

OC dimensions	Group	Developmental	Hierarchical	Rational
Dominant Characteristics	3.77	3.15	3.66	3.55
Organisational leadership	3.77	3.33	3.36	3.86
Management of employees	3.99	2.91	3.63	3.76
Organisation glue	4.09	3.70	3.54	3.52
Strategic	4.05	3.89	3.86	3.99
Success	4.23	4.28	3.95	3.88
Average of 6 dimensions UK Cultural profile	3.98	3.54	3.66	3.76

Scales as follows: 1= SD, 2= D, 3= U, 4= A and 5= SA

Table 6.1 Scores of Each Culture Type

The identification of each of the six dimensions representing an ideal culture for TPM is shown in Figures 6.1a, b, c, d, e and f.

The results indicate that the dominant characteristic of an ideal TPM organisation should be group culture which is described as a family-type of organisation where shared values and goals, unity and participation are important elements (see Figure 6.1a). The workforce is considered as an extended family. The group is encouraged to suggest improvements associated with their work and is rewarded as a team.

The valued effectiveness lies in the employees shared common goals and values that assist to quickly react to rapid environmental changes (Cameron and Quinn, 2006). However, in terms of organisation leadership style, the results indicate that rational culture is the most dominated culture in the UK companies (see Table 6.1). According to Cameron and Quinn (2006) leadership style tends to be participative, supportive and considerate, demanding and

facilitate their interaction through teamwork. This is also apparent from Figure 6.1b. Organisational leadership in the goal-oriented rational culture is strong and demanding in achieving competitiveness, and tends to develop clear objectives and aggressive strategies to drive practices and behaviours leading to productivity and profit- ability (Denison and Spreitzer, 1991). The respondents agreed that TPM organisations are very friendly places in which to work people share ideas and work in a CI environment. The management of employees should be characterised as teamwork, participation and harmony. Individual initiative, innovation and freedom are still, however, considered valuable (see Figure 6c). Effective implementation of TPM programmes requires an environment that encourages open communication and employee involvement to facilitate changes and provides the necessary resources for CI. In this kind of situation, employees are not only encouraged to take part in CI teams and are rewarded for their participation to better quality, but they also get the training and education to be successful in their jobs. The 'glue' that holds such organisations together is group (4.09), with its emphasis on loyalty, tradition, collaboration and commitment. This culture type is found to be important for overall TPM implementation (see Figure 6.1d). When the employees feel that their ideas and opinion will be appreciated by management, they will then be more eager to make efforts in recognising and solving problems and taking more obligations in improvement projects. As far as the strategic emphasis inside an ideal TPM organisation is concerned, it was a mix of the four types with group culture being scored slightly higher than the others (4.05) see Figure 6.1e. The final and the sixth dimension is criteria of success. An ideal TPM organisation should be characterised by gaining unique and new products or services, and adapt quickly to new opportunities, see Figure 6.1f.

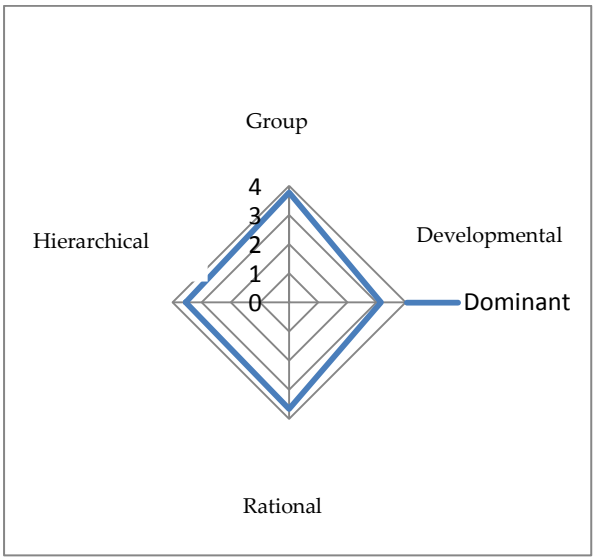

Figure 6.1 (a) Dominant Culture Characteristic

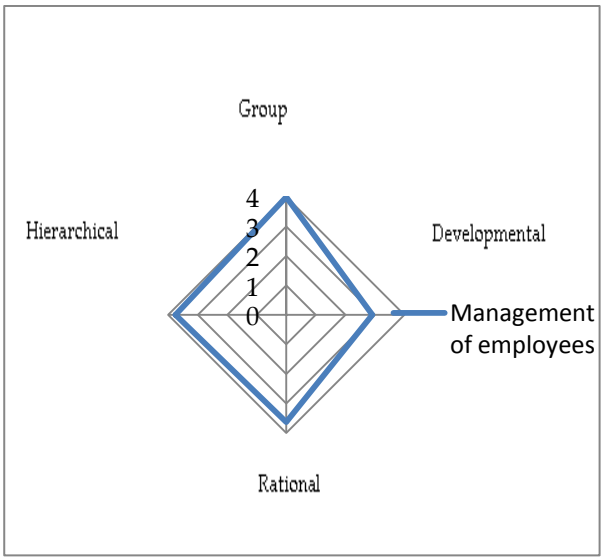

Figure 6.1 (b) Organisational Leadership

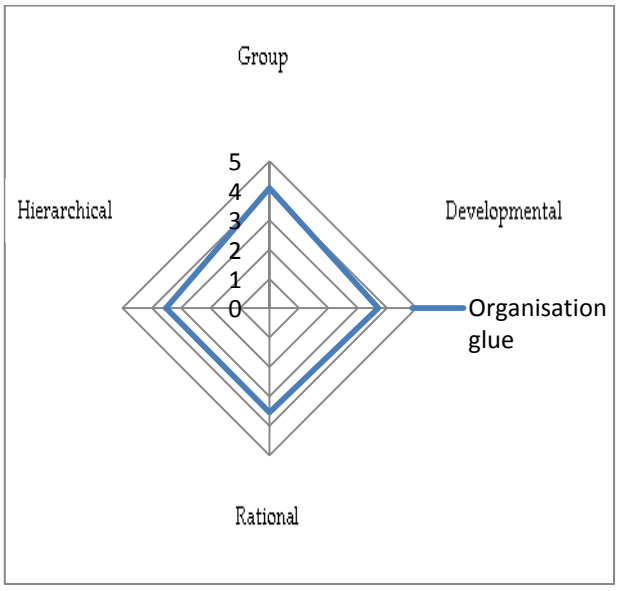

Figure 6.1 (c) Management of Employees

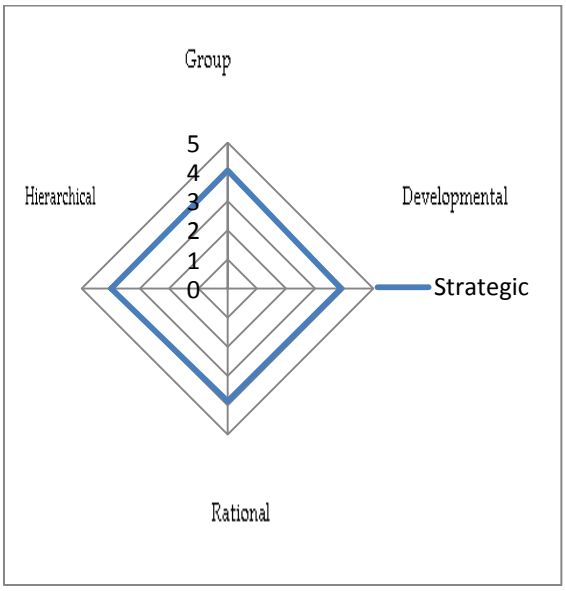

Figure 6.1 (d) Organisation Glue

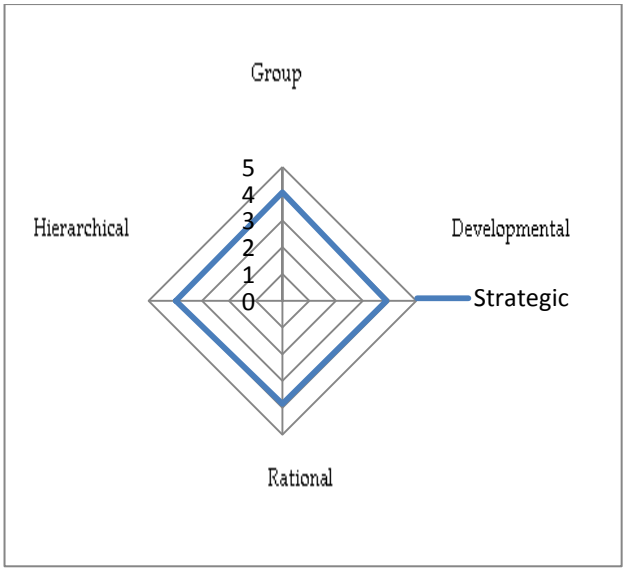

Figure 6.1 (e) Strategic Emphases

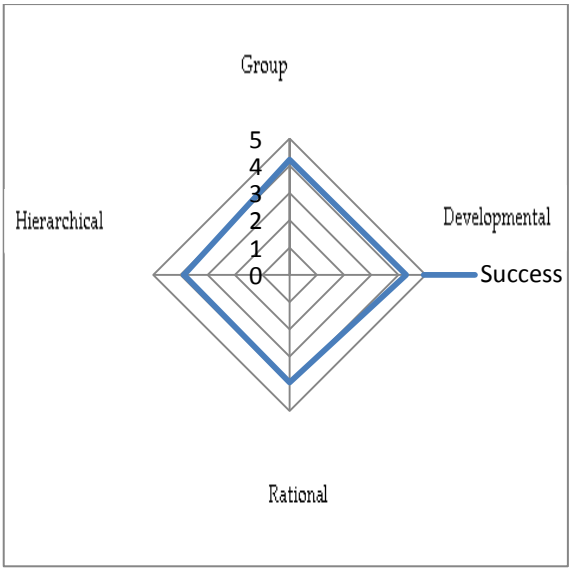

Figure 6.1 (f) Criteria of Success

Figure 6.1 Six OC Profiles

The average scores for each culture type show that the majority of the OCs of the respondent companies are clearly dominated by group, with the highest average compared to others (see Figure 6.2). The overall culture profile diagram (Figure 6.2) is almost square in shape indicating that the four values attained for each culture type were similar. However, they do differ as is showing in Table 6.1 with the group culture showing the highest value. According to Cameron and Quinn (2006) a square profile shape, sometimes simply indicates that a company does not realise its own culture, strengths, or unique capabilities, and that the culture is well developed in each quadrant. It should be noted that the author has used a simple average to calculate the profile. Typical characteristics of group culture are supportive; involve teamwork, and fewer management levels. The respondent companies with a group culture are characterised as a friendly workplace, with shared values, beliefs, goals, unity and participation. This sort of culture emphasises flexibility and change, with a strong internal focus on organisational improvement (Cameron and Quinn, 2006).

Implementing TPM in an organisation with such a culture would be preferable because the focus would be on the employee's capability to enhance communications between themselves, to be empowered and to improve commitment, participation and loyalty.

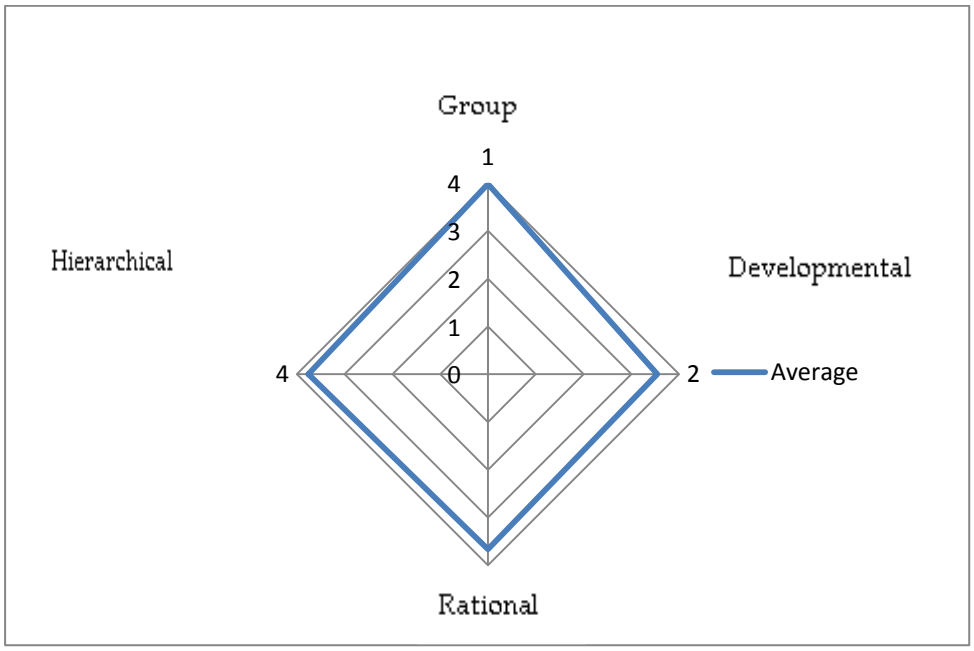

Figure 6.2 Overall Cultural Profile in UK

When considering the results, it should be borne in mind that the scores were based on only one response per organisation, generally from top or middle management. In most cases, the overall profile specified by the respondents was a mixed culture. A low score was gained for developmental and hierarchical values, a high one for group and a moderate one for rational. According to Cameron and Quinn (2006) many successful organisations simultaneously emphasise group culture with rational or hierarchy with developmental. This could be a sign of weakness as much as a sign of strength. The authors give an example of earlier research conducted by Cameron (1986), in which he found that organisational effectiveness in institutions of higher education was highest in those that emphasised

innovation and change (developmental) and simultaneously stability and control (hierarchical). In addition, he found that successful organisations were supportive of and developed their employees (group) but also demanded output and achievement (rational). He concluded that successful organisations were able to behave in flexible and sometimes contradictory ways and they can encourage hard-driving productivity and accomplishment, yet also empower employees and maintain an enjoyable and informal climate.

This study has identified the cultural profile in UK companies. The literature has suggested the importance of OC variables in TPM adoption and identifying the presence and relevance of these was undertaken using the OCAI. A point to note is that the respondents were from a range of different "ownership" types i.e. government-owned, private, and partnership/ joint venture, with possibly some variation associated with the different mindsets and different industry sectors to TPM adoption.

6.3 Summary

Implementing TPM generally requires a change in the OC of an organisation and in existing behaviours of all employees including top-level management. The process has been dogged with barriers and pitfalls. It is therefore important that companies understand their OC profiles when embarking on a TPM programme.

The main challenge facing an organisation is to be able to make a drastic change in its culture thereby guaranteeing overall employee involvement across the maintenance and manufacturing performance improvement through TPM programmes. Preparing for TPM implementation comprises creating a positive environment for effective change. Management should communicate the concepts of TPM to its entire workforce by forming the policies and through training and education (Attri *at el*, 2012).

The CVF is one of many frameworks that has been developed to help organisations understand their culture and its impact on their success. In highlighting the differences in cultural characteristics between the existing profile and that of an ideal TPM culture an organisation can communicate the change needed to reach the desired state. Furthermore, the CVF can be an effective tool in training and education and for helping organisations to better understand themselves (Cameron and Quinn, 2006).

In applying the OCAI method, the results indicated that the respondent companies from the UK have a dominant group culture (see Figure 6.2). This result is consistent with previous studies by Inam and Anastassia (2011), Huang (2007), and Al-Khalifa and Aspinwall (2001) who pointed out in their studies that people working in organisations with a "group culture" are characterised by respecting traditions and morals, closely related to human relations, but at the same time are competitive, coordinative, and involve teamwork. Cameron and Quinn (2006) pointed out that most organisations progress from an initial group culture to a hierarchical one.

In this study, it was found that the "group" and "rational" cultures whose core values are reliable with TPM programmes such as investment in employee training and education, employee involvement and contribution, and performance. It has highlighted the important role of OC on the implementation of a TPM programme. The study will also assist managers in determining where to strive to help improve employee's participation and performance and provide companies with the necessary advantages to continue and be successful in the worldwide marketplace.

A constraint of this study is that its results were based on investigations in the UK only. Obviously, generalising the results to different cultural or economic contexts should be made with care.

The focus of Chapter "Seven" is to analyse and evaluate current practices and the level of knowledge of TPM programmes in Libyan manufacturing companies to recognise the problems faced and to suggest a way forward for them.

CHAPTER 7: An Empirical Study II

7.1 Introduction

There reasons for choosing Libya and the UK as places in which to conduct this research. Importantly, Libya is the motherland of the researcher, which means that the researcher is able to collect the necessary information without any difficulty regarding the language, cultural difference etc. The other important reason is that there is a shortage of empirical studies concerning TPM in developing countries, including Libya, also, concerning TPM and OC relationships. This is therefore the first attempt to recognise the level of understanding of TPM implementation in Libyan manufacturing companies. It will also provide a better understanding of TPM programmes in an environment having a different cultural, social, and economic system.

Finally, the results of this study should contribute to the knowledge of TPM with particular emphasis on Libyan manufacturing companies. The research could also be of benefit to other organisations in developing countries that are seeking to improve their maintenance system.

7.2 Overview of Libya

7.2.1 Background

Libya is a developing country located in the middle of the northern coast of Africa. Geographically it is the fourth largest country in Africa with an area of 1,759,540 sq km. It is approximately half the size of Europe or a quarter of that of the USA. It is bordered by the

Mediterranean Sea to the north, Egypt and Sudan to the east, Tunisia and Algeria to the west, and Chad and Niger to the south, see Appendix IV-A (Otman and Karlberg, 2007). This location gives Libya great strategic importance and, therefore, it has a high profile in the region. The significance of its location lies in the fact that Libya stands as a vital link between Europe, Africa and Asia (Salama and Flanagan, 2005). The results of a general census reported that the Libyan population in 2010 was 6,461,545 people, with a growth rate of 2.11% per annum (CIA, 2010). Islam is the religion of Libya and Arabic is its official language although English and Italian are used in the major cities (Garcia *et al*., 2009).

From a historical perspective, Libya has been colonised by several foreign powers, with the Phoenicians setting a colonisation trend that saw the Greeks, the Romans, the Ottomans and more lately the Italians followed by the British and the French guardianship (Otman and Karlberg, 2007). Libya was granted independence by a UN resolution in 1951 and became a kingdom following the British model (NAID, 2003). The country has undergone a number of changes; in 1969 it became a republic which lasted until 2011.

In line with the latest revolutions in the region (Arab spring), a major political protest began in Libya against the regime on 17thFebruary 2011; the Libyan Interim National Transitional Council (LINTC) was then established and became the revolutionary government. The LINTC succeeded early on in controlling many of the coastal cities in the east and southeast areas. On 24 October 2011 the official announcement of the liberation of Libya was made by the LINTC in Benghazi (LINTC, 2011).

7.2.2 Economic development

Having summarised and explained some of the geographical, historical and political aspects of Libya, it is useful to review its economic situation and the most important economic

resources in the country. According to the International Monetary Fund IMF (2003), the Libyan economy depends heavily on the oil sector and remains largely state controlled and regulated. Prior to the discovery of oil in 1959, agriculture was the primary sector. The national oil corporation was established in 1970 and dominates Libya's oil industry, along with a number of smaller subsidiaries, which combined account for approximately half of the country's oil output (Zahari and Shurbagi, 2012). It carries out reconnoitring and production operations with other companies under petroleum investment agreements, and markets oil and gas locally and overseas (Sasi, 2008). The Libyan economy is heavily dependent on the exports of crude oil for export receipts and government revenue- more than 96% of exports and more than 60% of the national Gross Domestic Product (GDP) (Kridan and Goulding, 2006).

Porter and Daniel (2006) noted that oil in Libya has a direct impact on the performance of the overall economy and influences the quality of the country's business environment in many ways, including investment and motivations for non-energy sector activities. They assert that oil can provide two major returns: first, oil wealth if distributed effectively to the population can have a positive effect on individual prosperity and, therefore, the standard of living of all Libyans; secondly, it can offer an important source of investment capital for other industries and economic development initiatives (Porter and Daniel, 2006). Moreover, Libya has quantities of natural resources, such as iron, phosphate and other minerals. Unfortunately, these are not exploited because of under investment; there is a need for foreign investment and this is being sought by the Libyan government.

Ten years ago, competitive business environments were being challenged to improve performance to ensure that organisations maintain a position in the marketplace within changing business environments and the increasing influences of globalisation (Hokoma *et*

al., 2008). For this reason, organisations are seeking to develop their employees' skills within the work environment (Fouche, 2006).

Libya is currently one of the world's leading oil and gas producers, effecting real change to the Libyan society and economy. Sanctions forced on the Libyan economy by both the United Nations (UN) and the USA were recently lifted, opening up the market for foreign companies to invest. Other sectors of the Economy such as Agriculture, Manufacture and Services failed to provide a reliable alternative for oil to drive sustainable economic development (Zahari and Shurbagi, 2012).

7.2.3 Industrial developments

The use of technology in Libya is somewhat limited, in spite of its being one of the richest countries in Africa. After the discovery of oil in 1959, Libya changed completely from a poor country to a rich one, recording the 9th highest oil reserves of any country in Africa (Arab Net, 2002). Non-oil sectors such as Manufacturing and Construction have expanded to include Petrochemical, Food, Textile, Electrical & Electronic, Mineral (such as iron, steel and cement) and Aluminium products. Agricultural output is limited by the climate and soil, and Libya still imports about 75% of its food (East-West Debt, 2004).

Manufacturing was a development challenge that was to be unquestionably accepted and tackled in order to find alternative resources for oil as a source of public revenue. However, the manufacturing sector in Libya has not fared well with regard to quality and standardisation. It has not been successful in mobilising resources and efforts for the research and development of quality awareness of products or services (Libyan Commercial Industrial and Agricultural Chamber 2002). According to Graisa and Al-Habaibeh (2011)

and the Centre for Industrial Information and Documentation (CIID, 2007) the following problems faced the industrial sector:

1. There are gaps between target and actual production levels, signifying that Libyan manufacturing companies have always faced difficulties in terms of achieving their planned capacity production.
2. Only a small percentage of the planned training programmes were successfully accomplished and most were in-house especially those related to maintenance and inspection procedures.
3. Despite the fact that the Libyan manufacturing sector is comprised of different sub-industries, their contribution to the total achieved production capacity varied greatly. The highest percentage of 43% across the Libyan industry was achieved by the mineral sector while the lowest of 1% was recorded by the textile and furniture industry.
4. There was a lack of focus on maintenance strategies and training at the start of production. This was needed to keep the plant to the right standard.
5. There is no clear system in place to measure pollution and no health-related monitoring programme for personnel.
6. Salaries are poor and workers sometimes take on external work to improve their income.
7. Raw materials are available but they contain impurities as there is no clear plan for testing them.
8. The Libyan private ownership in general and SMEs especially, lack business experience and face problems of economies of degree, and poor managerial, financial and marketing competences.

9. There is no effective management in place. Some at top level do not have a suitable qualification and sufficient experience to carry out their jobs effectively as Al-Zamany *et al*., (2002) stated "…unqualified managers (middle management in public owned organisations), are appointed by political decision. These managers can work as another barrier to performing the job effectively and improving it."
10. Maintenance data are not recorded and training is required.

In spite of the above difficulties facing manufacturing companies, the government have recently placed a greater emphasis on achieving better quality in order to compete in both domestic and foreign markets through the implementation of quality management systems. This is crucial because gradually more foreign buyers have become frustrated having to verify the quality of Libyan goods that they purchase, a costly and time consuming process (Sampaio *el al.,* 2009).

7.2.4 Libyan social and cultural aspects

As an Arab country Libya shares common language, religious, cultural and other social values. Most of those suggested for the culture that supports TPM such as, honesty, trust, justice, reliability, equality, and teamwork are strongly emphasised in daily Muslim practices. This makes it easy for top management in any organisation in Islamic countries to encourage employees to practice such values in their daily activities in order to improve their working environment.

Islam has a significant part in forming Libyan cultural values (Vandewalle, 2006). It is considered a complete religion covering communal and political aspects as well as devotion of the soul and the moral principles of people's behaviour (Twati and Gammack, 2006).

According to Islamic work principles, hard work and the respect of people in the workplace are considered virtues. Therefore, social relations at work between employees' are also encouraged for achieving successful communication (Yousef, 2001).

Aghila (2000) indicated that Libyan families operate as small societies, with their members being appointed to a ranked order, according to age and generation. Power and leadership are the preserve of the father, grandfather or eldest son. Libya is described by the extended family, clan, tribe and village, which play an important role in the society's life and individuals' dealings with each other (Ahmed, 2004). It is one of a number of Arabic countries included in Hofstede's (1997) cultural study, along with Egypt, Iraq, Kuwait, Lebanon, Saudi Arabia, and the United Arab Emirates. Although Arab countries have many related common characteristics (i.e. language, religion and socio-cultural), they do differ from each other in other ways. Hofstede (1997) stated that, for example, the Saudis are more collectivist than some other Arabs.

Comparisons of culture values between Arab countries and others have been reported (Hofstede, 1997). The former scored higher levels of power distance, uncertainty avoidance, and collectivism than several Western Countries such as the UK and the USA. These dimensions have been found to have a considerable relationship with individuals' ethical decision making processes (Cherry *et al*., 2003; Christie *et al*., 2003; Fleming *et al*., 2010).

7.2.5 The cultural transferability

Several organisations in developing countries have valued the importance of implementing new technologies to improve their economies and the overall efficiency of their business, manufacturing, and processes. There are, however, many issues to consider when undertaking such a strategy, including lack of organisational readiness for adoption;

insufficient support for the required change; lack of alignment with strategic change; poor support and user participation; and unrealistic expectations (Twati, 2008). Aghila (2000) stated that the direct transfer of Western theory to developing countries like Libya, without understanding cultural differences, may face difficulties regarding their organisational and managerial practices. Hence, the differences in cultures between nations and particularly between developed and developing countries should be recognised and understood due to the effect of globalised economies in the world. For example, TPM usually requires changes in employees' attitudes and values, which take time to absorb. As a result, it demands long term and careful planning. Immediate, company-wide performance gains should not be expected during the start of implementation. However, at this early stage, top management must demonstrate their total commitment to TPM by allocating the necessary resources to create and sustain the cultural changes necessary and to provide relevant training to employees in order to achieve success (Eti *et al*., 2004). Furthermore, the human resource aspect is a very important function. It is therefore necessary to look at how manufacturing programmes can be linked to people behaviour and how they can relate to them.

7.3 Response rate

The questionnaires were despatched, together with the covering letter at the beginning of August 2012. They were pre-numbered in order to identify the respondents who returned the questionnaires; this was only used in the follow-up process. A total of 103 forms were returned but 8 were found to be invalid for analysis for different reasons including: the confidentiality of the information required, some had ceased operation prior to the time of the study, the post-war crisis and other security reasons.

Five weeks after of the initial mailing, the second batch of questionnaires was sent to those who had not then responded. The reminder letter was included in each package as well as a questionnaire. This generated a further 32 returned questionnaires of which three were incomplete due to the inability to respond because of insufficient knowledge of the subject matter. Regarding non response bias, both early and later responses were compared according to Armstrong and Overton (1977) and no significant differences were found to exist at the 0.05 significance level. The survey generated a response rate of 35% which like the UK study can be considered good. Details of the survey response rate can be seen in Appendix IV-D.

7.4 Results of the Survey

The software package used for the analysing the data from the usable responses was again SPSS for Windows-Version 19.0. The following sections focus on processing the collected quantitative data and producing statistical results. These will be linked back to the findings from the literature and in Chapter 8, compared to the UK data. The results have been expressed in both narrative and graphic forms, with references to specific questions when necessary.

7.4.1 General Information about Respondents

The first section in the questionnaire related to general information about the respondents. 36% of the respondents held top management positions comprising General Directors and Assistant Directors indicating that the study was taken seriously in the participating companies. 32% were from Middle management comprising General Managers, Manufacturing Managers, Production Managers, and Maintenance Managers; and 19% from

Supervisory Inspectors including Line Managers, Inspectors, Quality control, Technical Officers). The remainder were classified as "Others".

Category	Frequency	Percent
Top Management	45	36.3
Middle Management	39	31.5
Supervisory	23	18.5
Others	17	13.7
Total	124	100.0

Table 7.1 Job Category in Libyan Participating Companies

The ownership type of the participating companies is presented in Figure 7.1. As can be seen the majority of respondents (48%) were from Government-owned companies, but 25% were from private companies, showing the effect of the country moving from a social economy to a free one (Younes *et al*., 2013). 61% of the respondent companies employed more than 250 employees, 27% had between 50 and 249 and the remainder less than 50.

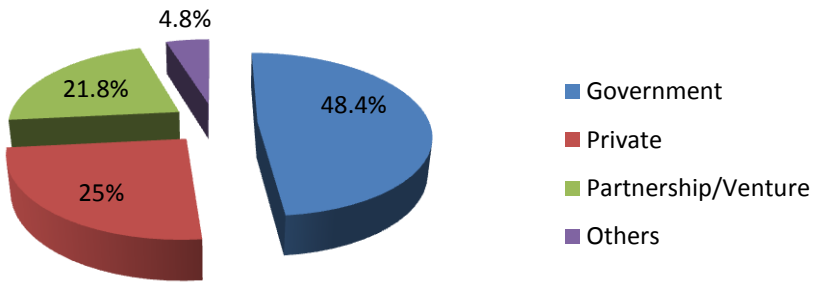

Figure 7.1 Ownership of Libyan Respondents Companies

Figure 7.2 shows the distribution of the industrial sectors to which the respondent companies belong. As can be seen a high percentage come from the Oil & Gas sector, with Electric & Electronic being the second largest.

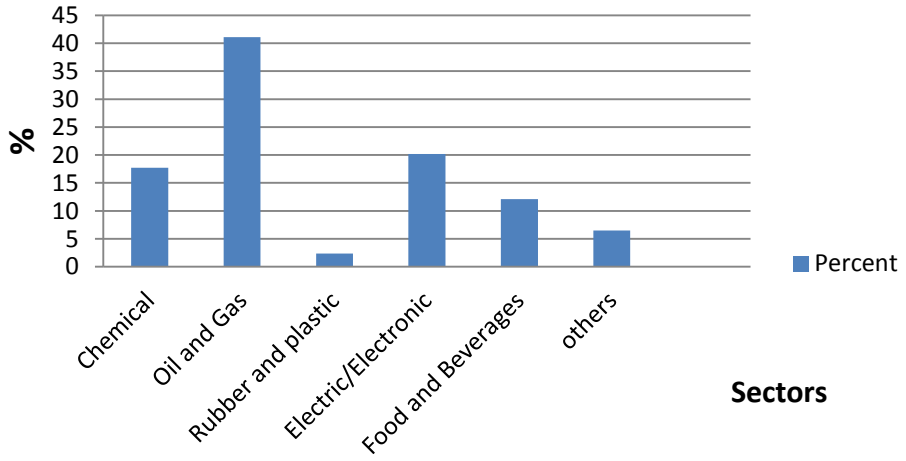

Figure 7.2 Distributions of the Respondent by Companies by Sector

It was felt by the author that the sample was sufficient to achieve the objectives of this study since there was a reasonable spread of different sized organisations, representing a variety of manufacturing sectors and types of ownership.

7.4.2 Descriptive statistical analysis

Section two was concerned with the factors of TPM as well as the companies' perception of their practices. Appendix IV-B, lists how the respondents rated each of the 10 factors and their 40 related elements. The first column lists the elements while subsequent ones give the percentage of responses based on the Likert scale.

All the elements in the top management factor showed good support with between 68% and 82% of all respondents at least agreeing with the statements. Health and safety is really important and it is clear from the results that most respondent companies are highly

dedicated to provide a healthy, safe environment in the workplace. Somewhat lower levels of involvement in terms of "production employees' accepting AM" were found. Nearly 60% of the respondents disagreed or were uncertain about both AM being accepted and their responsibility to improve equipment reliability and maintainability. 52% of the respondents disagreed or were not certain that they had easy access to information regarding productivity, while 48% agreed that they did. The responses related to the communication and awareness factor indicated that in general there was effective communication between teams and that top management communication communicated well with employees to secure their support towards attaining the organisation's objectives.

With regard to the strategic planning and action plan factor, 71% of the respondent companies agreed that these were in place. Figure 7.3 shows the different responses regarding the resources allocation or availability factor. Equipment availability, analysing breakdowns, and resources allocated for TPM all scored highly.

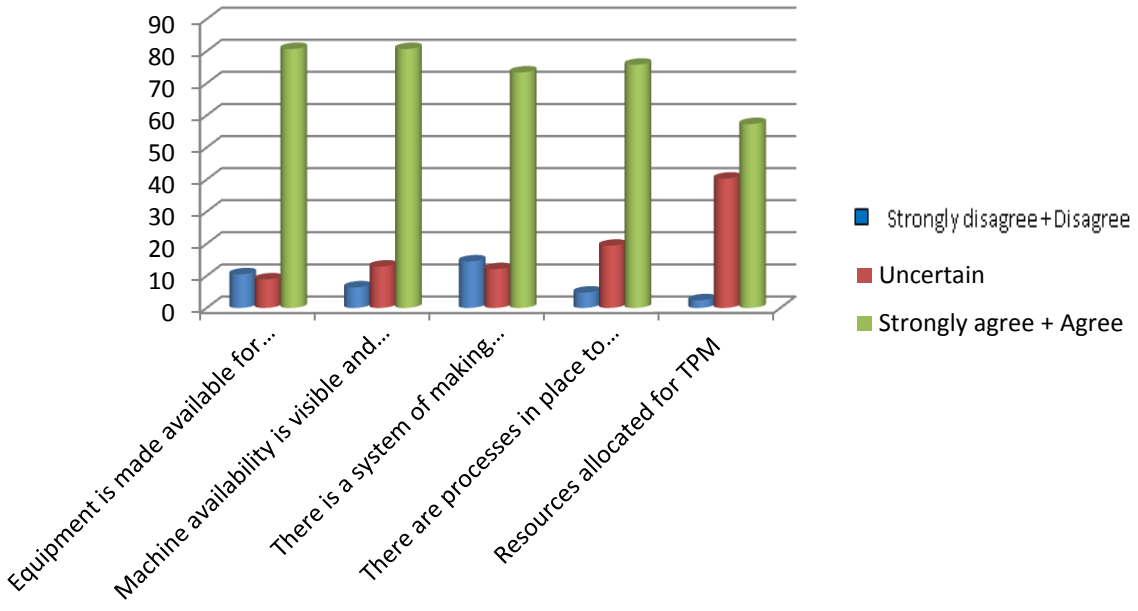

Figure 7.3 Resource Allocations / Availability Factor

The responses for the "recognition and empowerment" factor reveal that, in the majority of cases, operators do contribute to routine PM tasks such as cleaning, lubricating, adjustments and inspections, although 35% of the respondent companies disagreed or were uncertain.

In 65% of the respondent companies operators do carry out AM tasks like minor PMs. So clearly in most of the organisations, operators have undertaken cleaning, lubricating, adjusting and inspection, and few of them need to work aggressively to achieve operator competence to carry out AM. 71% of the respondent companies agreed that their employees' suggestions were evaluated and implemented but approximately 40% of these specified that they do not empower TPM teams to take responsibility for their decisions. The results showed that only 4% of companies do not have a training programme for employees, while 92% do provide training and have safety and environmental programmes for team members and personnel.

There was good support for the monitoring and evaluation factor, between 59% and 88% of all respondents at least agreeing with the statements. Another notable finding was the relatively high percentage (70%) of respondents that agreed that they were encouraged to perform and improve their knowledge and skills at work. With regard to the statement of the "system of linking recognition and rewards", 55% agreed that there was a system linked to the company's improvement goals as set out in their improvement strategy.

84% of the respondent companies agreed that TPM improved teamwork between production departments while 9% disagreed or were uncertain that it was important for TPM.

7.4.3 Level of implementation and knowledge of TPM

The level of implementation and success of TPM practices was the focus of the next section. The statements were wide ranging, incorporating important issues concerning TPM practises such as the philosophy, techniques and training programmes.

Appendix IV-E shows the mean and standard deviation scores for each statement. The following observations can be made:

1. Safety and environmental training programmes are provided for team members and other personnel.
2. Condition monitoring has improved the reliability of the machinery in production areas.
3. There are processes in place to analyse breakdowns and root causes are identified and permanently fixed.
4. Teamwork is important for the TPM culture.

On the other hand, there is some uncertainty as to their implementation level and success of the programme with regard to:

1. Reward and encouragements.
2. Employees have easy access to relevant information.
3. All TPM teams are empowered.

The overall mean for each factor was computed to look at the level of understanding and knowledge of TPM. As can be seen in Table 7.2, these range from 3.50 to 4.04. "*Training and education*" was recognised to be the most important factor while "*Reward and incentives*" was the least.

Factor	Description	Mean	Rank
F1	Top management	3.94	3
F2	Total employee involvement	3.54	9
F3	Communication and awareness	3.82	6
F4	Strategic planning and action plan	3.65	7
F5	Resource allocation or availability	3.93	4
F6	Recognition and empowerment	3.63	8
F7	Training and education	4.04	1
F8	Monitoring and evaluation	3.96	2
F9	Reward and incentives	3.50	10
F10	Teamwork	3.89	5

Table 7.2 Mean Score for Each Factor

This could indicate that the companies are not fully succeeding in their implementation of TPM. In fact, the ranking of the mean scores puts the factor *employee involvement* ninth and the factor *recognition & empowerment* eighth. Indeed for TPM to succeed, companies must focus on people which are the basic parameters for implementing and sustaining TPM. Without them the programme will almost certainly fail.

7.4.4 The cultural profile in Libya

The aim of this section was to identify the existing / current cultural profile of companies operating in Libya. Section three of the questionnaire, comprising the same 24 statements as used in the UK survey. The participants were asked to state their level of agreement with each of the statements using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

To investigate the cultural profile the respondents' rating for each cultural type across the six OC dimensions was averaged. An organisational profile score was then obtained by

averaging the six scores within each culture type. The results for all the participating companies are shown in Table 7.3.

OC dimensions	Group	Developmental	Hierarchical	Rational
Dominant characteristics	3.48	3.20	2.80	3.40
Organisational leadership	3.14	3.31	3.55	3.73
Management of employees	3.80	3.24	3.46	3.70
Organisation glue	4.14	3.75	3.77	3.90
Strategic	3.52	3.69	3.85	4.06
Success	4.22	4.18	3.80	3.04
Average of 6 dimensions Libyan Cultural profile	3.72	3.56	3.53	3.63

Table 7.3 Scores of Each Culture Type

The results indicate that the 'dominant characteristics' of the participating companies portrayed a group culture (having the highest average) which is described as an extensive family-type with shared values, beliefs, goals, unity and participation. Core values for group culture includes co-operation, consideration, agreement, fairness and social equality (Cameron and Quinn, 2006). Cameron and Quinn (2006) pointed out that the workforce in this type of culture is considered as extended family members who work in teams, are encouraged by the organisation to suggest improvements associated with their work and are rewarded as a group. TPM practise in a group culture would be beneficial because it focuses on teamwork, people's capability to enhance commitment and effective communications between employees and top management. The findings also indicate that *Organisational Leadership* (D2), *Management of Employees* (D3) and *Strategic emphasis* (D4) were a mix of the four types with rational culture generally scoring higher than the others. The

leaders of the rational culture are hard drivers, producers and competitors. The 'Organisational glue' that holds TPM organisations' together displayed both group (4.14) and rational cultures (3.90), the key being commitment to experimentation and goal accomplishment. As far as 'Strategic emphasis' inside the TPM organisation was concerned, it was a mix of a rational and hierarchical culture. The leaders of this type of organisation consider themselves as being good coordinators, competitors and organisers. Maintaining a smooth running organisation is important. The long-term concerns are stability, predictability and efficiency. The final dimension is criteria of success where leadership style should be characterised by teamwork, participation and consensus, (see Appendix IV-G).

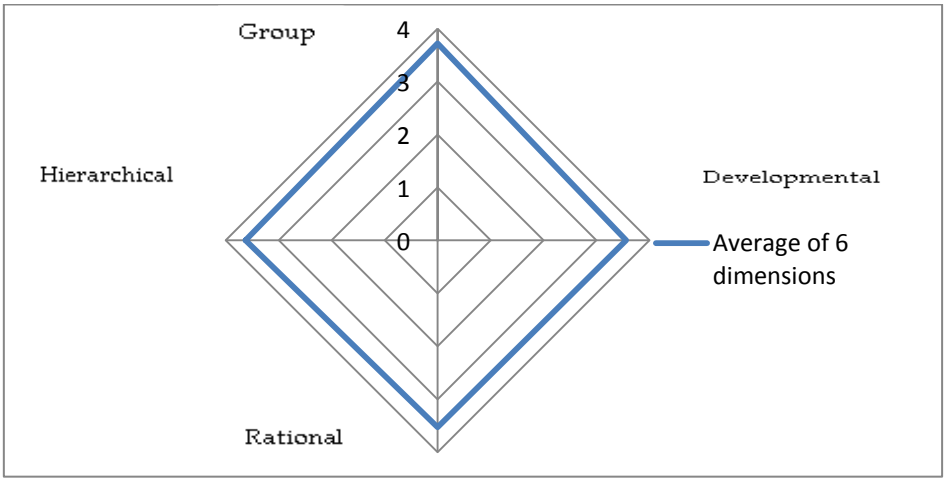

Figure 7.4 Overall Current Cultural Profiles

The average score profile for TPM implementation in the Libyan manufacturing companies is shown in Figure 7.4. As stated earlier, the respondents perceived their OC type to be mainly group culture. It should be clarified that "dominant"is a term used in the OCAI literature to rate the highest average of profiles even if it is small. Respondents identified rational culture as the next in their companies, followed by developmental and last by the hierarchical. This is consistent with previous studies that reported many sub-cultures in an

organisation to be the rule and unitary culture the exception (Cameron and Quinn, 2006; Igo and Skitmore, 2006; Thomas *et al.*, 2002; Al-Khalifa, 2000). An important point that needs to be clarified is that the difference between the six dimensions of the companies profiles and the overall average profile suggests that the companies are trying to respond to differing demands made upon them. Typically in engineering, these could result from specific customer requirements to industry wide behavioural shifts. The company may need to operate simultaneously in two or more quadrants to satisfy the particular demands of a customer or project scope (Igo and Skitmore, 2006).

This study has identified a group culture type as dominant, which in turn is appropriate for an organisation where people treat each other almost like members of a family. The literature has suggested the importance of OC variables in TPM adoption and identifying the presence and relevance of these was undertaken using the OCAI. Cameron and Quinn (2006) stated that most organisations progress through different cultures, starting with group; then moving to developmental then to rational and finally to hierarchical after they have been established for some time.

7.5 Results of correlation analysis

As a preliminary step in the analysis, the relationship between the 10 factors and the OC dimensions (see Chapter 5, Table 5.5) were investigated. The results of this analysis are presented in Table 7.4. It was found that a significantly positive linear relationship existed between most pairs of variables. This supports the emphasis in the literature on the vital role of an organisation's culture in TPM. However, there was no significant relationship with some of the elements.

The strongest relationship was found between F7 (*training & education*) and D3 (*management of employees*) (r=.671). This was expected since Libyan companies are currently trying to improve productivity and quality. Providing training and education for the people involved in the programme ensure that they have the necessary information, knowledge and skills to improve their existing job or to learn something new. The second highest correlation was between F8 (*monitoring & evaluation*) and D5 (*strategic emphasis of the organisation)* (r=.664). This element indicates the role of organisations in the implementation and evaluation of their TPM programmes. Finally, the third highest correlation was between F6 (*recognition & empowerment*) and D3 (*management of employees*) (r=0.659). This was expected for Libyan companies since the top management operates as a driving force in recognising employees' suggestions, morals and to empower the employees to make decisions and to solve problems in their workplace.

N=124	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**
D1	-.174	.379**	.161	.311**	.258**	-.19**	.361**	.114	-.025	.239**
D2	.501**	.252**	.336**	.481**	.504**	.361**	.514**	.588**	-.084	.277**
D3	.276**	.287**	.491**	.512**	.622**	.659**	.671**	.506**	.293**	.465**
D4	.272*	.472**	.486**	.431**	-.429	.611**	.298**	.393**	.152	.521**
D5	.321	.262**	.432	.429**	.440**	.502**	.318**	.664**	.276**	.300**
D6	.101	.272**	.279**	.163	.271**	.306	.313**	.341**	.159	.380**

**Correlation is significant at the 0.01 level (1-tailed).
*Correlation is significant at the 0.05 level (1-tailed).

Table 7.4 Pearson Correlations between the Variables

7.6 Knowledge and Understanding of TPM Programme

Having analysed the Libyan data, a comparative study needs to be conducted in order to identify similarities and differences between the UK and Libyan respondent companies in terms of understanding and knowledge of TPM programme. The comparison in this section will be centred on the 10 factors. The mean scores for each factor are shown in Table 7.5. The idea behind the score was the higher the score, the better the understanding. As can be seen, the means for the Libyan respondents are lower than those of the UK in every case except F5. The values for the UK range from 3.77 to 4.34, where as those for Libya range from 3.50 to 4.04, (*with a standard error of 0.1 would be significant different*) which equate to a `moderate' level of practice". *Training and education* and *Top management* were the two highest TPM factors, while *reward and incentives* was lowest in both. The results could indicate that UK companies are better at implementing TPM or have a better understanding of the programme.

Factor	Description	Mean Libya	Rank	Mean England	Rank
F1	Top management	3.94	3	4.34	1
F2	Total employee involvement	3.54	9	3.94	5
F3	Communication and awareness	3.82	6	3.91	6
F4	Strategic planning and action plan	3.65	7	3.89	9
F5	Resource allocation or availability	3.93	4	3.90	8
F6	Recognition and empowerment	3.63	8	4.07	3
F7	Training and education	4.04	1	4.17	2
F8	Monitoring and evaluation	3.96	2	4.06	4
F9	Reward and incentives	3.50	10	3.77	10
F10	Teamwork	3.89	5	3.90	7

Table 7.5 Mean Score for Each Factor for UK & Libya

The highest 3 factors according to the UK companies were '*top management* ', '*training and education* 'and '*recognition and empowerment* ', while the bottom 3 were '*reward and incentives'*, '*strategic planning and action plan*' and '*resource allocation or availability*'. With regards to the Libyan , '*training and education'*, '*monitoring and evaluation'* and '*top management'* are the highest, while '*reward and incentives'*, *total employee involvement'* and '*recognition and empowerment'* were the least critical. This could indicate that the companies are not fully succeeding in their implementation of TPM. Top management need to ensure active participation of all their employees in a TPM programme.

To determine whether there was any similarity between the mean ranks of the UK and the Libyan respondent companies, Spearman's rank correlation coefficient was used. Its value was 0.561, thus providing 'moderate' evidence that both groups were in part agreement.

The results show that the largest difference between the two groups was 'recognition and empowerment' which was ranked eighth by the Libyan respondents and third by the UK ones. As can be seen there are some similarities between the two groups. For example, '*training and education'*, and '*top management'* were the two most critical factors. On the other hand, '*communication and awareness'*, and '*reward and incentives'* were the least important.

7.7 Differences in TPM Practices

Another aspect of this study was to identify any differences between the two cultures in terms of implementing TPM programmes. The findings of this study indicate that UK companies are more successful at adopting TPM programmes. Their mean scores for all the TPM factors were generally slightly higher than those of the Libyan respondent companies (see Appendix IV-F). This is possibly because the UK companies have been involved TPM programmes for longer than the Libyan ones. The results show that in 86% (*See appendix III-I,*

statement number 8, result is total of A and SA) of UK respondent companies top management through to workers on the shop floor are involved in TPM.

In addition, the three TPM factors, rewards (F9); employees' participation (F2) and empowerment (F6) in particular, had the smallest means for the Libyan group. A strong focus on "employees' involvement" is critical to a TPM programme in Libya where companies are bureaucratic, function based and have an individualistic work culture. Recognising the variety of human skills, their creativity and entrepreneurship to capture these valuable human attributes will reinforce TPM efforts. By focusing on the above points, Libyan manufacturing companies will be able to compete more effectively. t-tests were then conducted for each of the 10 TPM factors. The results of the tests are presented in Table 7.6.

Factors	F	P-Value	t	Results
Top management	7.972	0.005	4.516	Sig.
Total employee involvement	7.436	0.007	4.788	Sig.
Communication and awareness	19.269	0.000	.786	Sig.
Strategic planning & action	17.191	0.000	2.677	Sig.
Resource allocation	.791	0.375	0.022	Not sig.
Recognition and empowerment	40.124	0.000	4.613	Sig.
Training and education	5.825	0.017	1.295	Sig.
Monitoring and evaluation	5.242	0.023	1.055	Sig.
Reward and incentives	28.265	0.000	2.157	Sig.
Teamwork	3.601	0.059	0.057	Not sig.

Table 7.6 Summary of Paired Sample statics for UK & Libyan Companies

The test involved a paired comparison t-test. It showed that there was a significant difference between UK and Libyan manufacturing companies' means on all the factors at the 0.05 significance level apart from F5 "*resource allocation*" and F10 "*teamwork*".

The explanation of this could rest on the fact that both groups were already familiar with the two factors and could relate to what was being learned in their training programmes. This finding is aligned with that of other researchers such as Chan *et al*., (2005), Ravikumar and Bhaskar (2008), and Ahuja and Khamba (2007) who stated that TPM helps to increase the value of the OEE, improve equipment availability, enhance equipment performance, reduce equipment unscheduled downtime and boost throughput by providing a structure to help the measurement of the equipment losses and then give priority and improvements to deal with all the six big equipment losses. Moreover, the result also supports the discussion in the literature relating to the role of TPM in achieving manufacturing performance, where teams are considered as an important component in achieving high availability, production efficiency and better quality. Such organisations with a team based maintenance strategy will perform better (Sharma *et al*., 2006). A teamwork approach needs honesty, communication and a suitable environment for criticising and suggesting ideas for updating and improving the current status within the organisation (Hokoma *et al*., 2008).

Lazim and Ramayah (2010) emphasised the importance of maintenance staff in which team members need to have sufficient knowledge and skills to improve performance, also, the focus should be directed towards efforts to develop the life cycle, reliability and efficiency of equipment. This means that middle management should look directly at the TPM team and pay extra attention to utilising TPM team members.

7.8 Limitations of the study

No major constraints were found while conducting the study. However, the research was limited to manufacturing organisations only. Moreover, the survey could have included open-ended questions in order to provide further insight into TPM implementation, although this was not the intention of the survey. Another limitation was the translating of the questionnaire into the Arabic language, especially the technical and language aspects, so it took a considerable time.

It was difficult to identify respondent companies in Libya with the appropriate functional background and knowledge regarding TPM practices. Further, the generalisation of results remains limited to this study, and its extension to other environments may be misleading.

Finally this study should be of great benefit to many manufacturing companies in Libya and will encourage the momentum for future studies aimed at helping them.

7.9 Summary

This Chapter has outlined some of the major aspects of the Libyan environment in relation to: geographical, political, economical and industrial development. It has also included an overview and background of the population, social and cultural aspects. Regardless of the efforts towards diversification, the Libyan economy still depends heavily on the Oil Sector and remains largely state controlled and regulated. In terms of industrial aspects, the country is facing a variety of problems including planning, maintenance strategies, health and safety, training and effective management. Implementation of TPM in Libyan companies would enhance productivity and overcome the difficulties mentioned, thus increasing their competitiveness to succeed in World markets. To be able to build a

competitive industry the government needs to play a major role in preparing the right environment and the ground nationwide.

With respect to the social and cultural context, Libya is characterised by the extended family, clan, tribe and village, which plays a significant role in the society's life and individuals' relationships with each other. With regards to cultural transferability, Aghila (2000) stated that the direct transfer of Western theory to developing countries like Libya, without understanding cultural differences, may face difficulties in implications of the organisational and managerial practices in these countries.

An overview of the methodology used in this research study, driven mainly by the research objectives was presented. The same questionnaire as used in the UK study was used as the main method of data collection. Data from the responses received were analysed using SPSS software (Ver.19).

Translating and piloting the questionnaire was done prior to distribution of the final version as several drafts were made and modified in response to feedback received from experts on translation from English to the Arabic Language. It was decided to use the same questionnaire to ensure the study's validity and reliability and enable comparisons of the results to be made with those of the UK survey. The questionnaires were distributed to 350 Libyan manufacturing companies chosen from the CIID Libyan directory. A 35% response rate was achieved.

The survey results have raised some important and interesting issues. The overall current cultural profiles in the Libyan respondents' organisations is similar to previous studies that have reported many sub-cultures in an organisation to be the rule and unitary culture the exception (Cameron and Quinn, 2006; Igo and Skitmore, 2006; Thomas *et al.*, 2002; Al-Khalifa, 2000). The difference between the six dimensions of the companies' profiles and the

overall average profile suggests that the companies are trying to respond to differing demands made upon them. Typically in the engineering industry, these demands could result from the project specific customer requirements through to industry wide behavioural shifts.

The CVF results showed that many organisations in Libya were not characterised by just one cultural kind. The findings in fact, indicated that the culture types tend to be biased towards group and hierarchical while an ideal cultural profile that supports TPM implementation should have the characteristics of both group and rational dimensions as shown by the UK study. These results were again not a major surprise due to the government and control cultures in Libya. The cultural profile recognised in this Chapter could be used as a benchmark tool for national organisations that are practising TPM organisations also could be used to further examine connections between OC and TPM success for non-TPM organisations.

The results of the correlation presented in Table 7.5 showed that a significantly positive relationship existed between most the majority of the pairs of variables (the strongest being between F7 (*training & education*) and D3 (*management of employees*) (r=.671).

Another aspect investigated in the questionnaire was the level or extent of practice of each factor of TPM programme. *Training and education* and *Monitoring and evaluation* were the two highest ranked factors, while *reward and incentives* was the lowest rated. The next lowest of the Libyan companies was *total employee involvement* then *recognition and empowerment*. This could indicate that the companies could still be struggling to implement TPM successfully. In fact, the ranking for both countries, shown in Table 7.2, puts *Reward and incentives* at the end.

The t test was used to determine whether there were significant differences between the means of UK and Libyan respondent companies. Significant differences between most of the means were found at the 5% significant level those for F5 and F10 were the exceptions. Some limitations were acknowledged in relation to this study and in the interpretation of the findings, including the translating of the questionnaire into the Arabic language.

The benefits of TPM are now recognised across virtually all industries worldwide. The findings of the study provide strong, substantial evidence that OC is positively related to TPM programmes and to their benefits. This study provides new quantitative data on TPM programmes in major Libyan manufacturing companies and the benefits of such approaches.

The next chapter provides a discussion and interpretation of the major findings and the contribution of the study. A comparison of these research findings and those of previous studies that have been addressed in the literature review chapter will be presented. Furthermore, implications of the research findings will be clarified and demonstrated.

CHAPTER 8: Discussion and Implications

8.1 Introduction

Having carried out an empirical study to determine the relationship between OC and TPM implementation in both UK and Libya, this Chapter will centre on a discussion of the similarities and the differences found.

It is organised between two sections. In the first, the results are discussed in terms of a descriptive of analysis of the level of TPM implementation, the relationship between TPM and OC and the differences in TPM practises. In the second section a comparison is made between the existing (Libyan) culture profile and the 'ideal' formulated from the UK study.

8.2 Discussion of Key Findings

8.2.1 Descriptive analysis findings

The respondent companies in Libya were found to have a reasonable level of TPM awareness 69% (*See appendix III-B, statement number 8, result is total of A and SA*) compared to those in the UK of more than 86% (*See appendix III-I, statement number 8, result is total of A and SA*). These indicate that the level of knowledge of the programme is quite low according to above results. Nakajima (1989) stated that the success of TPM implementation very much depends on the employees' total involvement and empowerment, with the top management effectively cascading this to the lowest levels of the organisation. Although it is encouraging to see that the level of awareness of TPM in Libya is quite high, the level of understanding is in fact very low. The reasons could be because of a lack of proper training, lack of a top

management strategy and personal development. This is apparent from the large gap that exists between the number of respondents who are aware of TPM and those who correctly understand what it is. An understanding of TPM is only a start; the key to progress should be an understanding of its concept and processes. As highlighted by Ahuja and Khamba (2008b), the failure of companies to successfully harness the true potential of TPM can also be accredited to uncertainty over what it exactly comprises, understanding the importance of knowledge, and both inconsistent and unclear expectations. The authors concluded that due to a lack of knowledge of TPM, employees fear that the only drive is to improve production efficiency, reduce labour, and increase employees' workloads.

With regard to total employees' involvement, the findings from the Libyan study revealed somewhat low levels with regard to "production employees accepting AM". Approximately 60% of the respondents disagreed or were uncertain that AM was practised in their organisations and that it was their responsibility to improve equipment reliability and maintainability. 51.6% of the respondents disagreed (or were not certain) that they had easy access to information regarding productivity. This is in line with Ahuja and Khamba (2008b) and Cooke (2000) who asserted that companies which have experienced failure in TPM implementation programmes have often ignored the total employee involvement aspect. In TPM, maintenance is everyone's responsibility rather than being that of the maintenance department only. Such a change is often resisted by both production and maintenance employees. Production employees and Managers are reluctant to accept responsibility for maintenance activities due to concerns about whether or not production employees have adequate skills or the time to carry out maintenance tasks.

It is apparent from the Libyan respondent companies that "*communication and awareness*" in general is effective between teams (70% agree or strongly agree) and top management use

constructive communication to secure the support of employees towards attaining the organisation's objectives. This finding is consistent with Kheng and Yusof (2003), Subrahmanian (2012), Haddad and Jaaron (2012), Graisa and Al-Habaibeh (2011) and Tsarouhas (2007) who confirmed that appropriate communication skills encourages employees to improve their attitudes and knowledge. A strong focus on communication using an awareness campaign, and an emphasis on training for all employees is needed for the successful implementation of TPM. 76% of the UK agreed that there was effective communication between teams. Yusuf *et al.*, (2007) noted that effective communication influences the organisations to move systematically towards employees' involvement and improves organisation performance.

According to the strategic planning and action plan factor, 71% of the Libyan respondent companies had agreed that these were in place. A similar score of 75% was received from the UK respondent companies. This supports the finding from the literature that manufacturing industry today is more prepared for changing market conditions. Top management have to implement a master plan for achieving TPM with a policy and related objectives. Some of the latter can comprise the reduction of scheduled and unscheduled down time, and the development of flexible operators for operating and maintaining equipment (Suresh, 2012).

With regard to resources allocation, more than 92% of the UK respondents agreed that there was no shortage of methods and analysis tools available, furthermore over 80% agreed that there was a system in place for making modifications to existing equipment for improving equipment availability. According to the Libyan respondents, top management deal with maintenance issues, in terms of the availability of resources. It was recognised that there was a shortage in resources related to maintenance such as equipment, spares and

funds. The maintenance tasks focused on sorting out breakdowns as opposed to preventing them.

In spite of the fact that most of the Libyan respondents agreed that there were some training and education programmes in place, their maturity was very poor. The reason perhaps is that the respondents do not have a good 5s background. According to the results, more than 50% of the respondents disagree or are uncertain that there is a good 5s practice in place (see appendix IV-B-16). If properly conceived and followed, 5S could be revolutionary towards greater productivity and quality in any manufacturing and service industry (Ahmed et al., 2005). This is consistent with Graisa and Al-Habaibeh (2011) who found that there was a need for using the 5s methodology in Libyan manufacturing companies to focus on, cleanliness and standardisation to improve profitability, efficiency, service and safety. Another reason perhaps is that the respondent companies have only recently started to adopt TPM. Therefore, they do not have a sufficient educational background and the experience upon which to build the training programmes. According to Sun *et al*., (2003) the educational background of the members selected will impact the speed of the TPM implementation. Ireland and Dale (2001) noted that managers must be trained in TPM to provide the strong TPM drive from top management down to the shop floor. A pleasant and safe working atmosphere is required (Kulkarni and Dabade, 2013). In addition, TPM specific training should be conducted to clarify the role of the programme. This finding is consistent with Poduval *et al*., (2013), Ahmed *et al*., (2005), and Cua *et al*., (2001) who stated that new employees who join organisations should be taken through TPM training as part of induction; also as part of the training, middle management should ensure that employees make regular visits to different plants that are successful with their TPM programmes to help understand the principles and secure the benefits.

Employee support such as rewards and recognition incentives inspires employees to perform. The results showed that the UK respondents strongly empower their employees, build their organisations around teams, and develop human resource capability at all levels. Hence, managers at all levels and employees are committed to their work and feel that they are part of the organisation. On the other hand, 45% (*See appendix IV-B, statement number 36, result is total of SD, D and U*) of the Libyan respondents do not provide their employees with any work incentives or motivations. Based on the results 29% (*See appendix IV-B, statement number 35*) disagreed or were uncertain that "People are encouraged to improve knowledge". The reasons could be one of the following: low salary, lack of recognition and rewards, inequality between employees, uncertainty of work future, instability. This finding is consistent with Graisa and Al-Habaibeh (2011) who identified the major issues related to Libyan manufacturing companies to be lack of incentives for improvements in personal development, and of financial gains.

Based on the researcher's personal experiences, an important difference found between the respondent companies in Libya and the UK relates to human abilities and flexibility. In the former employees' abilities are often believed to be just fixed and limited. Accordingly job progress through training is less noticed, while in the UK organisations tend to emphasise flexibility, creativity and unlimited capacity of their employees. Thus the internal working culture in Libya relies more on applying the theory and pattern of traditional management. But in the UK the theory of human relations and a participatory management pattern are more suitable.

Several studies (Sharma *et al*., 2006; Ahmed *et al*., 2005; McKone *et al*., 2001; Ireland and Dale, 2001) revealed that the successful implementation of TPM programmes can enhance manufacturing performance, leading organisations to achieve competitive

advantage and bring a wide range of benefits. The differences between companies and countries may affect the implementation process, but the key critical success factors remain constant and similar especially with TPM implementation in manufacturing industry.

8.2.2 Level of implementation of TPM programme

One of the major objectives of this research was to determine whether Libyan industry had the 'ideal' cultural profile (identified by the UK study) to be able to successfully implement TPM. However, this study needs to be interpreted with care, for two reasons. Firstly, the visions and views of the respondents comprising top and middle management and experts in the field of TPM, are ideal but may not truly reflect reality. Lastly, UK companies tended to be in the main, from different industries from those of Libya. In addition the economic status of both countries is very different

It was thought, by the author, that the 10 TPM factors identified from the literature review would help to create a supportive environment for TPM and could influence the success of its transformation into Libyan industries. They were: *Top Management* (F1), *Total employee involvement* (F2), *Communication and awareness* (F3), *Strategic planning and action plan* (F4), *Resource allocation or availability* (F5), *Recognition and empowerment* (F6), *Training and education* (F7), *Monitoring and evaluation* (F8), *Reward and incentives* (F9) and *Teamwork* (F10). The results are shown in Figure 8.1. The values range from 3.50 to 4.34, which equate to a `moderate' level of practice. The Libyan respondent companies ranked *training & education* (F7) as the most important issue to consider and improve with a mean score of 4.04 (this was rated the 2nd most important issue by the UK participant companies with a standard error of 0.1 would be significant different). However, it should be noted that the difference may be due to the fact that in UK companies training & education and human resource issues are

not as problematic or under-developed as compared to those of Libya. Top management should support their workforce since people are the greatest asset of any organisation. Thus, they must adopt a long-term view and develop their human resources through education, on-the-job training and improvement and awareness programmes.

The *top management* factor (F1) was only rated third in the Libyan study with a score of 3.94 compared to the highest rating of 4.34 given by the UK companies with a standard error of 0.1 would be significant different. This factor is crucial if TPM is to have any chance of success. It is essential that it is visible to the whole company by means of adequate support through time, human resources, monitoring, coherence and priority being given to quality. As reported in the literature review (Chapter two), which included many examples of empirical studies and was supported by experts and consultants, total commitment of both top and middle management should provide way and support for the individuals working in maintenance. Moreover, they should make better efforts to connect the maintenance strategy to the overall manufacturing and business strategy. There is a need to show the influence of maintenance on a company's performance (Bakri *et al*., 2012; Attri *et al*., 2012).

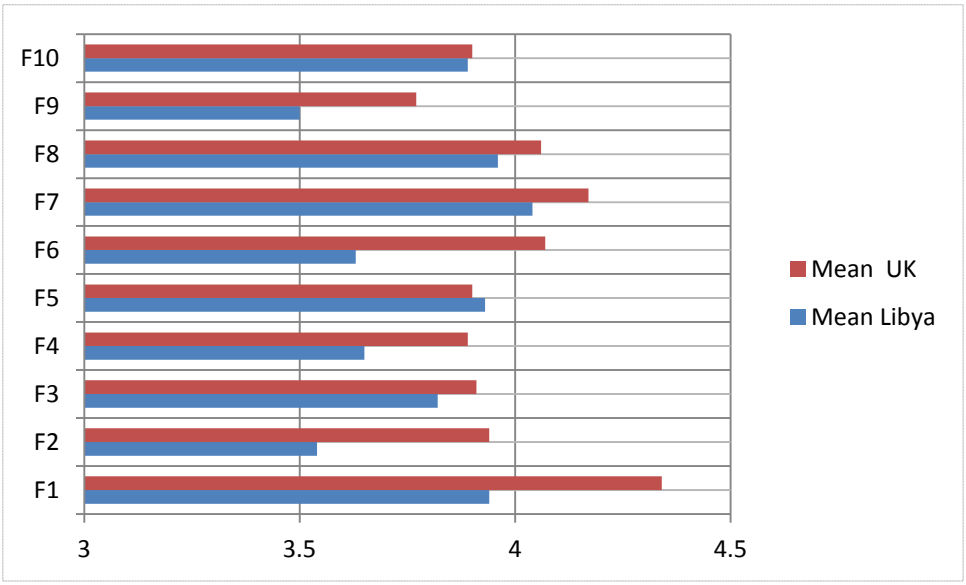

Figure 8.1 Different in Ranking for TPM 10 Factors

With regard to *total employees' involvement* (F2), the mean score by the Libyan respondents was 3.54. This indicates a low level of employee involvement in TPM activities, since they do not (i) have easy access to information (3.2), (ii) accept AM (3.31), (iii) suggest system implementation (3.59), and (iv) are not routinely involved in CI (3.66). The researcher believes that one of the reasons for the low levels of employee participation in Libyan companies is the resistance to change their behaviours and attitudes. UK manufacturing companies on the other hand scored a higher mean of 3.9, demonstrating a good level of awareness in terms of accepting AM and their responsibility to improve equipment maintainability. The finding is consistent with Davis (2011) who concluded that in UK manufacturing companies, small group activity concerning production and maintenance has improved and despite they are not always referred to as autonomous TPM teams, almost completely that is exactly what they are. Davis added that more emphasis is placed on the importance of workplace organisation and cleanliness in many companies who run 5S activities and perform regular shop-floor based audits and improvement activities.

The largest difference was found in the "*recognition & empowerment* "factor (F6) which was rated 3rd by UK companies compared to 8thby the Libyan ones. The UK companies surveyed strongly recognise and empower their employees, build their organisations around teams, and develop human capability at all levels. Therefore, managers, and employees are committed to their work and feel that they are part of the organisation. Employees at all levels feel that they have at least some influence into decisions that will make their work effective, and that their work is directly connected to the goals of the organisation. Furthermore, employees also feel that they have been treated fairly and equally *i*n the workplace (see Figure 8.2).

The Libyan companies scored 3.63 for F6 which concurs with the study by Graisa and Al- Habaibeh (2011) ensuring that employees understand what is expected from them and giving them the freedom to become proactive within the company. It is believed that the lack of self-satisfaction and a reward system could be the main shortcomings to productivity improvement.

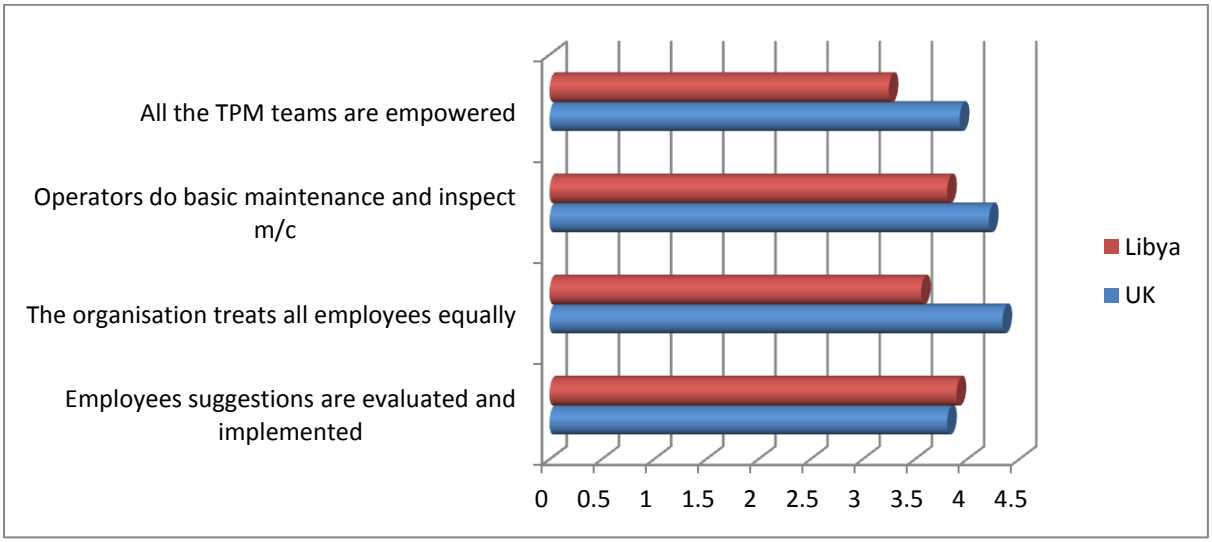

Figure 8.2 Mean Scores for Recognition and Empowerment (F6)

The lowest scoring factor for the two groups was *reward & incentives* (F9) with a mean score of 3.77 for the UK respondents compared to 3.50 for the Libyans with a standard error of 0.1 would be significant different. Graisa and Al-Habaibeh (2011), in their study, concluded that there was a lack of reward incentives for employees and the majority had to work extra hours to satisfy their financial needs. In this situation, it is hard for employees to be sufficiently motivated to do the required work.

TPM implementation is a focused job demanding specific skill sets. For this reason employees should be publicly appreciated by middle management for their efforts. A

suitable reward instrument should be established to encourage a sense of inclusiveness for employees (Poduval *et al.,* 2013; Kulkarni and Dabade 2013; Graisa and Habaibeh, 2011). Although the study has identified large differences between Libya and the UK in terms of culture, productivity, and environmental awareness, both *lack reward & recognition systems*. More importantly, the results indicated that because of the lack of motivation and recognition companies could be in danger of losing their experts and engineers who are not pleased with their salary, motivation and recognition (Poduval *et al*., 2013; Graisa and Habaibeh, 2011).

Although the mean scores were similar another large variation in terms of ranking was found in "*resource allocation and availability*" (F5). Top management believes that TPM is an unnecessary cost and a drain on the company's resources, thus resisting a call for its implementation and finding ways and means not to allocate resources for its implementation (Poduval *et al.,* 2013). The findings reflect that there is a shortage of skills, methods, analysis tools, etc. The reason for that shortage is due to the lack of top management support for maintenance and the unclear vision of the company. According to Poduval *et al.,* (2013) the lack of methods and analysis tools is because organisations do not have sufficient knowledge in the quality field.

More importantly, TPM is a resource-based programme where all workers are accountable for contributing to preventing equipment deterioration, breakdowns, failures and stoppages. Communication and awareness between production, maintenance employees and engineers is very essential, and in TPM these individuals jointly work together and interact with each other (Witt, 2006).

In accordance with the findings of this research, top management is still not sufficiently aware and does not fully recognise the need for making employees

knowledgeable and more aware of TPM. Neither is it committed to improve the stability of such programmes if they existed. The possible implication is that some top or middle managers are not sufficiently loyal to the company as they are not possessors or sharers. In this case, they obviously recognise that they would not be asked about their responsibility if the companies failed to achieve the desired objectives.

Finally, from all the findings discussed in this section, the level of TPM implementation among UK and Libyan manufacturing companies has been explained. By examining the summary of the Libyan mean scores, it is seen that these range from 3.50 to 4.04, which is, to some extent, lower than the extent of TPM implementation by Malaysian manufacturing companies, which ranges from 3.60 to 4.12 (Ramayah *et al.*, 2002). Although the five TPM factors employed in the Malaysian study were not precisely the same as those proposed in this study, some, including management commitment, training and education, employee empowerment, team culture, and companies policies and goals, were comparable elements. This indicates that the level of TPM implementation in companies may be influenced by the advancement level of a country's economy in addition to the length of time of TPM implementation. The results from the studies performed in the research show that TPM practices in Libya manufacturing companies have a good future, as the respondents agreed that all the practices were at high levels. The results help to provide suggestions on the extent of achievement for Libyan companies in their journey towards excellence. The study has indicated and identified crucial issues for organisations to consider, especially in areas found lacking in implementation.

8.2.3 Relationship between TPM and Organisational Culture

One of the critical factors to reach successful TPM is to have good leadership and top management support. The findings show that in UK top management is stronger than in Libya. The strongest relationship was found between F1 (*Top management*) and D6 (Success within the organisation). The responsibility of top management is vital to make sure those TPM objectives and goals are aligned with the overall goals of the business. Most of the UK respondents believed that top management were strongly committed to and involved in achieving success within the organisation. Therefore, top management commitment is the basic requirement in TPM implementation. This is in line with Nakajima (1989) who stated that the responsibility of top management is to actively promote motivation, ability and a favourable work environment for the workers.

In Libya the situation is completely different. The results indicated that top management was negatively correlated with the dominant characteristics of the organisation (D1). This is not surprising because of the lack of knowledge of modern quality approaches especially at top management level, making it difficult for Libyan organisations to have long term planning, strategies, goals and objectives. This indicates that top management are still not sufficiently aware of, and did not recognise the necessary need for educating employees and making them more aware of TPM. This result is also consistent with that of Youssef (2006) who concluded that the bureaucratic management styles in Libya were impeding a more participatory and quality conscious organisational culture. The author agrees with Mohamed (2005) who stated that one of the reasons why top management are not successful in Libyan organisations is that the wrong people are in the wrong position by the criteria of qualification and experience, which results in ineffective leadership. Also, the lack of top

management support was reported as another reason. It shows, therefore, that the major problem in moving along the TPM journey is not financial but is related to both the required knowledge based around TPM and the need to convince the government institutes, in the case of public sector organisations and/or top management of the benefits surrounding the TPM philosophy.

According to UK respondents, the results are however different with regard to *recognition & empowerment* (F6). It is clear that UK companies have a good relationship between F6 and the *management of employees in the organisation* (D3). Therefore, managers and employees are committed to their work and feel that they are part of the organisation. This is consistent with Nakajima who stated that TPM is a programme which focuses on involving every single employee from top management to shop floor workers and empowering employees to initiate corrective activities (Nakajima, 1989). This is also consistent with the finding of Bamber *et al.,* (1999) who found that motivation of middle management and the workforce was a factor affecting successful TPM implementation. On the other hand, the findings of the Libyan companies revealed that there was not enough recognition & empowerment. The Libyan companies empower their employees with high control that reduces team work and capability of their employees. This is consistent with that of Youssef (2006).

Based on the correlation results there was a positive relationship of all OC dimensions in both the UK and Libyan companies. It is apparent that UK respondent companies benefit a great deal from TPM team leaders who provide a communication channel between employees especially between Production, Maintenance and Engineering. It is believed that regular reviews and improvements are made during the training to accommodate changing requirements. Appropriate training for safety and environmental

programmes were developed and deployed for employees throughout the respondent companies. The finding agrees with that of Aspinwall and Elgharib (2013) who concluded that TPM programmes should be implemented through a procedure of well established learning, and not be used as a quick fix solution to a problem. They added that all workers should be taught in the fundamentals of quality as described by the company's goals and objectives. Training & education positively influences the extent of TPM implementation, in efforts to improve performance. Moreover, AM for instance, needs proper and systematic TPM strategy implementation, particularly training and education for all workers. However, Gebauer *et al*., (2008) stated that Chinese manufacturing companies should focus on TPM and predictive maintenance in order to improve performance. The finding is consistent with Brah and Chong (2004), Arumugam *et al.,* (2008), and Panneerselvam (2012) who emphasised that operators must be exposed to systematic training and education programmes and ought to be able to report any problems detected quickly to line supervisors or technicians for corrective action. In this regard, it is the middle management's duty to identify training needs, set targets for training, develop training packages, and ensure effective execution of the training programme followed by an evaluation process to understand its effectiveness.

From the findings (Table 7.5, F2, F4, and F6), it is clear that training programmes, timing, duration and processes were not well planned to cover the real training needs and was undertaken with no real solid objectives to fulfil. In order to successfully implement TPM, companies must have top management support, understanding and commitment, along with training, recognition, and empowerment of everyone in the organisation (Fredendall, et al., 1997; Davis and Willmott, 1999; Wireman, 1991; Nakajima, 1989). Yusof and Aspinwall (2000), recommend that organisations examine implementation problems

first and then provide suitable training to remove them. They suggest that top management should in the beginning focus on behaviours, such as classifying and resolving problems and team working to support improvement. The company should complete a "needs assessment" first, from which companies could decide what is correct and what is incorrect, and then start the training programme to tackle the problem areas so that employees can do their jobs more professionally and efficiently (Yusof and Aspinwall, 2000). The researcher feels that one of the reasons for these bad decisions associated with training plans is related to in particular, the immaturity of quality systems, which normally Libyan companies advocated they had just started to adopt in their organisations. This is not a surprising finding, since quality progress in developing countries has a short history and has had very little success (Hokoma *et al.,* 2008).

There was no significant relationship between *Reward & incentives* and *management of employees in the organisation* (D3) for the UK manufacturing companies (See Table 5.5). This is consistent with the findings of Graisa and Al-Habaibeh (2011), Cholasuke *et al.,* (2004) and Bamber *et al.,* (1999) who stated that the factors affecting the successful implementation of TPM include lack of training (operational and maintenance), lack of incentives for improvements, and lack of a personal development system.

Furthermore, the correlation analysis in the Libyan scenario revealed that the weakest correlation was between F9 and D1; F9 and D2; F1 and D6 (See Table 7.4). Moreover, *teamwork* (F10) showed a positive correlation with all the other OC dimensions indicating that they were important for TPM implementation. The weakest for the UK were between F9 and D4; F9 and D3; and F4 and D6 (See Table 5.4). The findings showed that all TPM factors were equally important in participating to the success of the TPM programme. Top Management should emphasise to all workers the continual requirement to enhance

equipment condition and to stay a focused on increasing performance. In conclusion top management's task is to guarantee that TPM objectives and goals are associated with the overall goals of the company. Most of the TPM factors showed a convincing correlation with each OC which supports the findings of others (Poduval *et al.*, 2013; Aspinwall and Elgharib, 2013) indicating the alignment between TPM and OC.

8.2.4 Differences in TPM practises

As was shown in Chapter 6 there was a significant difference between UK and Libyan manufacturing companies' means on all of the factors apart from "*resource allocation*" and "*teamwork*". The results also revealed that the UK respondents showed a better performance the than Libyan ones in terms of "*top management*", "*training and education*" and "*recognition and empowerment*". However, the differences were not significant. The findings indicate that leadership, training and education, and employee involvement are important for the implementation of TPM. The factors, "*rewards*" (F9); "*employees' participation*" (F2) and "*empowerment*" (F6), had the smallest means for the Libyan group, while "*rewards*" (F9); "*strategic planning*" (F4) and "*resource allocation*" (F5) had the smallest for the UK.

The results suggest that to improve the implementation of TPM, managers al all levels in Libyan companies need to focus on: *top management support, employees' involvement, training and education,* and *recognition and empowerment*. The findings indicate that successful implementation of TPM is the effect of improvement of OC. The implication for Libyan companies is that success and higher revenues are achieved when the implementation of TPM has been improved.

Finally, according to the findings of the comparison of section 7.2.1, 7.2.2, 7.2.3, and 7.2.4 in general and the results of the factors F2 "*total employee involvement*", F4 "*strategic planning*

and action plan", and F7 *"Training & education"* in particular, the respondent UK companies create a long term strategy with strong and different objectives, whereas those in Libya have a shorter term strategic plan due to their lack of experience and knowledge. This is consistent with previous studies in the UK (Davis, 2011; Done et al., 2011), and in Libya (Abusa, and Gibson, 2013, Al Habaibeh, 2011).

8.3 Comparison between the existing Libyan cultural profile and that of the desired / UK

Using the results from the UK survey, an "ideal" cultural profile was determined and is shown in Figure 6.2. Both countries share the same group and rational OC, the dominant cultures that direct shared values, assumptions and interpretations, whereas the hierarchy culture is the least common for Libyan respondent companies and developmental for the UK ones. These findings were expected, given the special nature of the work culture in such organisations. It is characterised by respecting traditions and morals, feeling a sense of family, but at the same time being competitive and achieving superiority. It was no surprise to find the hierarchical culture as the least common type in Libyan organisations. All employees, regardless of their positions are guided and controlled by governments. In addition, the work culture cannot be described as creative adaptable and flexible so a developmental culture is also not common in Libyan organisations. The hierarchical culture is not sufficient to ensure successful TPM implementation as it is not the predominant one of TPM adopters. These findings are consistent with those of Cameron and Quinn (2006) whose hierarchy means were generally rated the lowest, in contrast to those found by Zu *et al*., (2010) who investigated the relationship between OC and quality practices related with Six

Sigma implementation in US manufacturing companies. Their findings suggested that OC normally has a considerable effect on quality management and different cultural orientations influence different quality practices. They also confirmed that "Group" and "Developmental" dimensions support Six Sigma. It appears that not only does an emphasis on the flexibility and people oriented cultural orientations (i.e., group and developmental culture) but also an emphasis on the control-oriented cultural orientation (i.e., rational culture) lead to a higher implementation level of quality practices.

As stated by Cameron and Quinn (2006) most organisations go through different cultures as they develop. They start in a group culture, then move to developmental, then to rational and finally to the hierarchy after they have been established for some time. The characteristics of the above organisations are, stability and control, and a focus more on the internal issues to keep the organisation going; therefore, they may not be willing to change. This is especially relevant since there is no competition between organisations in Libya, where almost everything is owned by the government.

Organisational Leadership (D2), Management of Employees (D3) and Strategic emphasis (D4) were a mix of the four types with "Rational culture" generally scoring higher than the others. The leaders of the "Rational" type are hard drivers, producers and competitors. The 'Organisational glue' that holds TPM organisations together should be both group and developmental cultures the key being innovation and adaptability. Unlike rational or hierarchy, developmental does not have a centralised power or an authority relationship. Instead, power flows from individual to individual or from task team to task team, depending on what problem is being addressed at the time (Cameron and Quinn, 2006). Figure 8.3 shows the Libyan (current) culture profile superimposed on that of the UK, both showing a clear preference towards Group and Rational cultures. This is in accordance with

what the research has revealed about organisations that possess strong cultures; they are associated with having homogeneity of effort, clear focus, and higher performance in environments where unity and common vision are required (Cameron and Quinn, 2006).

Figures 8.4 and 8.5 show the two respondent groups in terms of "Strategic emphasis" (D5) and "Success" (D6) respectively.

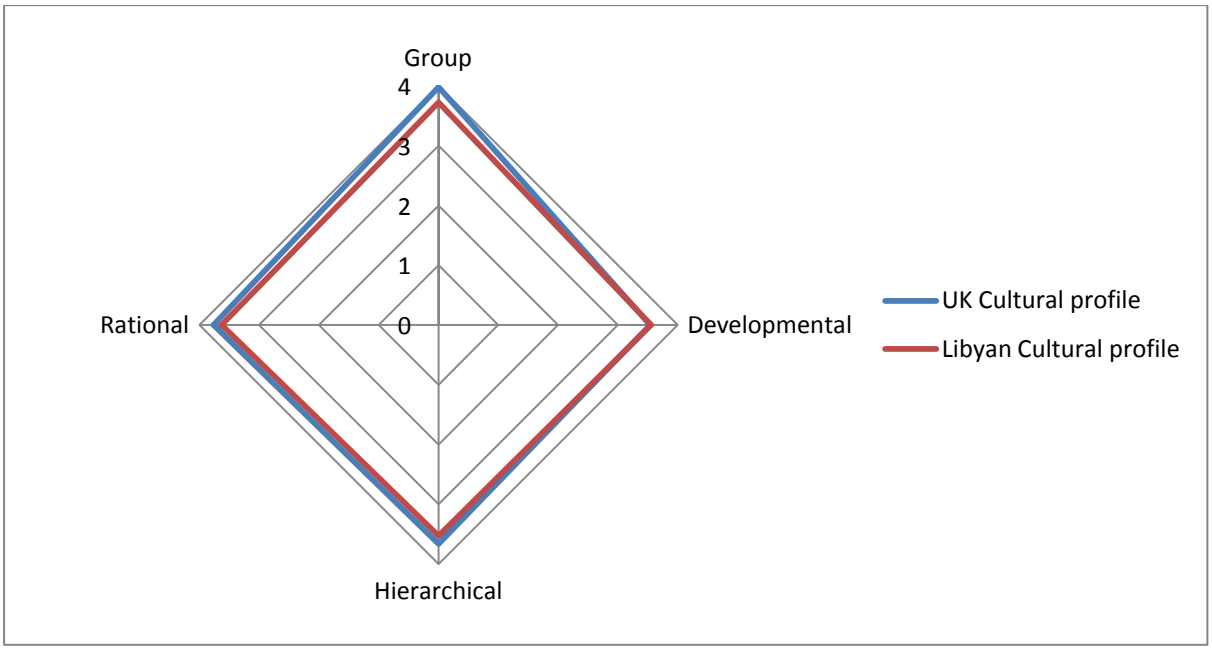

Figure 8.3 Comparison between UK's and Libyan's Culture Profile

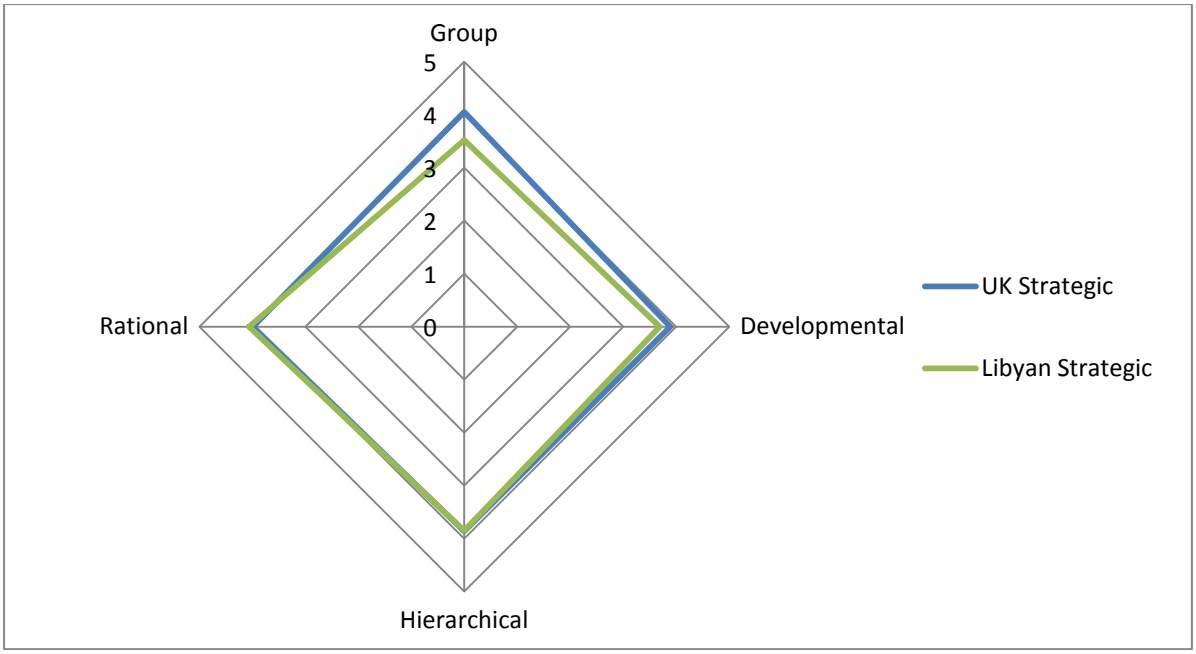

Figure 8.4 Strategic Emphasis Profile (UK & Libya)

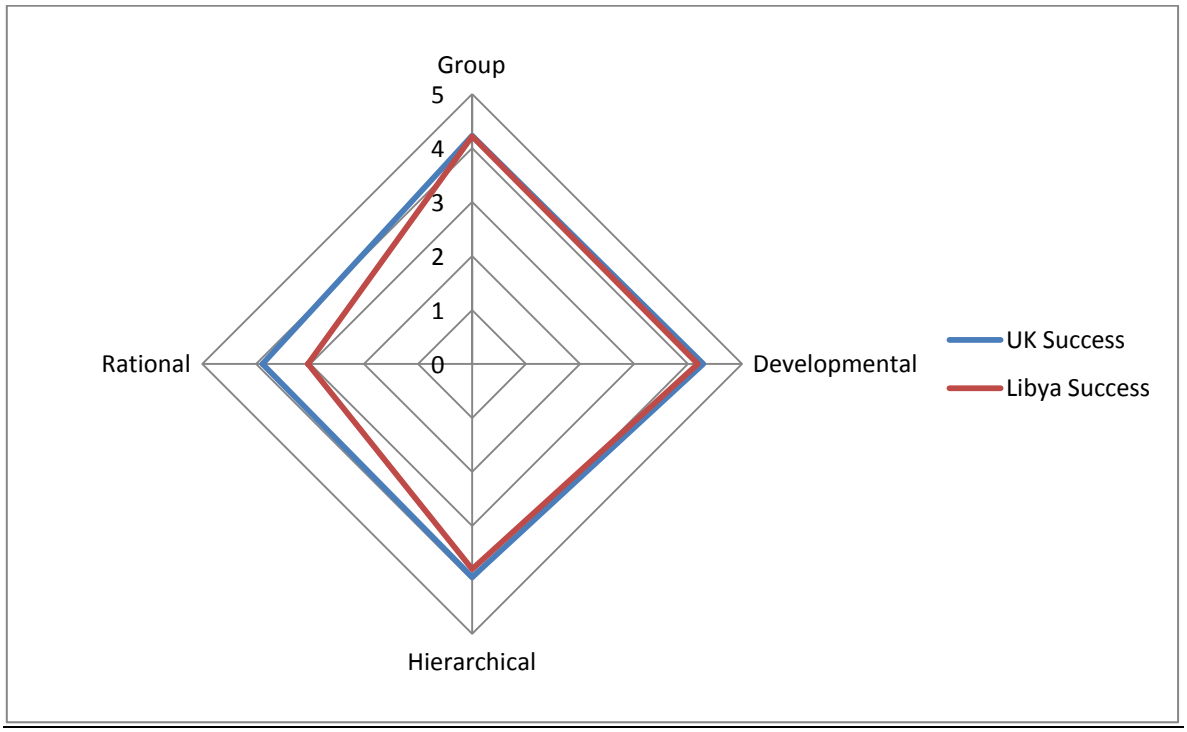

Figure 8.5 Criteria of Success Profile (UK & Libya)

In terms of the former the UK respondent companies are supported by both the group and rational cultures while rational and hierarchical dominate the Libyan ones. It is interesting to

note that both respondents group embraced the rational culture for regulating the use of quality tools and techniques for achieving higher quality levels in organisations. The need of the group culture was highlighted in the UK study for maintaining a teamwork atmosphere in the organisation to support the cooperation between departments particularly required in product design and process improvement projects. This is consistent with the findings of Zu *et al*., (2010) who stated that successful implementation requires a company to provide employees with the necessary skills to engage in creative and effective CI activities, while at the same time encouraging the use of a problem-solving approach to use quality tools to control its systems and processes.

The UK and Libyan respondents indicated that the *criteria of success* inside a TPM organisation could be a mix of group and developmental culture types with group culture being rated slightly higher for the Libyan companies (see Figure 8.5). Developmental organisations are believed to be original workplaces (rather than management oriented) where people take risks whereas in a group culture leaders are known as entrepreneurial and innovative (Cameron and Quinn, 2006).

Although ahead of many of the undeveloped countries in the region, Libya is not yet ready to accept and implement TPM because of a lack of infrastructure. Top management are not keen to be involved in implementing TPM programmes due to the lack of education and skills, and the fear of anything which is new and uncertain. As a result, to implement TPM, it is advisable for an organisation to understand the dominant culture that exists within it, since it will provide more reliable data for managing the implementation process and identifies priorities for action.

The OC characteristics in Libya tend to emphasise the development of human resources with the aim of bringing goal clarification and direction. People in most of the organisations

are expected to follow rules that outline what they should do and for that reason they expect job security. They develop an environment which stresses human relationships where managers empower their staff and facilitate them to participate and commit. Managers will need to form teams to face new challenges. The characteristics of Top Managers should be more visionary, innovative and they should take calculated risks to make significant gains. Building teamwork, opportunities for growth and development and decentralised decisions are important factors for the desired culture.

It is clear that not all of the respondent companies have Group and Rational cultures only but tend to have a mix of four, three, or two of the types in the CVF instrument. If TPM is to succeed the OC has to change towards a more flexible and customer-oriented one.

The results of these OC studies are consistent with those of Ebeid and Gadelrab (2009) who conclude that, to achieve a developmental culture, one needs teamwork, participation, cohesiveness, loyalty, interpersonal relationships and commitment (characteristic of group), creativity, adaptability, flexibility and working toward innovation (characteristic of developmental), and at the same time, goal achievement, goal orientation and production are necessary.

In addition, companies which adopted group or rational culture types were more likely to describe their cultures as team builders and mentors or hard-driving and competitors. The lack of a developmental culture profile in the Libyan respondent companies may be one reason why they do not have long-term strategic plans nor are they adequately prepared for a TPM environment which demands a lot of changes to the way in which business is approached. Hence, the findings suggest that to attain the full benefits of implementing TPM, companies should put emphases on at least three cultural dimensions, i.e., group, developmental, and rational.

OC differences and similarities between UK and Libya can perhaps be further observed in the light of Hofstede's (1997) remarks that national cultures are about values and OCs are about organisational and managerial practices. It can be argued that industry cultures which are similar to national ones, promote certain values (Gordon, 1991). Top management in the respondent companies of both countries would find it difficult to spend long hours with each employee to develop relationships. In particular, when working in a team based organisation, managers may smooth the progress of team proactive activities more quickly by developing a supportive OC offering adequate justification, with honesty, respect and propriety.

Evidence from these studies support the authors' earlier arguments that the implementation of TPM may end in disappointment in many companies operating in Libya due to their current working culture. TPM needs an enormous change in the social behaviour of employees and their technological knowhow. Top management and leaders in the region have to understand that a fundamental change is required if TPM is to be implemented. The essential philosophy must be effectively communicated to employees, rather than adopting a packaged version from other cultures, consultants or societies.

8.4 Summary

This Chapter discussed the UK and Libyan manufacturing companies in relation to OC and its suitability for implementing a TPM programme. Several findings have been discussed beginning with the descriptive analysis of the respondent companies, through all the TPM factors to the responses received from the two surveys. Analysing the results has shown the extent of achievement for Libyan manufacturing companies in the direction of excellence. Having studied the relationship between TPM and OC, most of the TPM factors showed a

convincing correlation with each OC, indicating their alignment (agreeing with the published research and expectations). With regard to TPM practises, the results indicated that UK companies were better at adopting TPM programmes, the mean scores for each of the factors were generally slightly higher than those of the Libyan ones. Comparing the existing (Libyan) culture profile and the (desired) UK one, it was found that both groups operate within the same group and rational OC. A further finding was that in order for a TPM programme to be successful an organisational change, dependent on the OC, is necessary.

The overall conclusions of the research and the recommendations for Libyan organisations are presented in the next Chapter. Suggestions for future research in the area are also included.

CHAPTER 9: Conclusions, Recommendations and Future Research

9.1 Conclusions

To be successful and to achieve WCM status, companies must possess both efficient maintenance and effective manufacturing strategies. TPM is a maintenance approach that focuses on processes and people (Ahuja and Singh, 2012). It has received a great deal of interest from industrial companies worldwide since its evolution and consequently a large number of manufacturing companies have implemented TPM programmes, particularly in developed and industrialised nations (Muthu *et al*., 2000). In this Chapter, the research process will be summarised and the conclusions of the work presented.

The literature review emphasised that a change process such as the implementation of TPM is not an easy one as it involves a process of introducing new concepts and tools that will normally require a change in the company's OC. Thus it is important for an organisation to analyse its OC before embarking on an implementation process. This will help it determine its strengths and weaknesses and help it build a successful strategy of implementation.

It was evident from the Libyan survey that there was a lack of employee awareness and a difficulty in understanding the rationale of TPM programmes. Some organisations may be better than others at comprehending their systemic nature and the need to ensure that these new practices fit consistently with how their organisation works. Possibly some are more effective at implementing these programmes and managing change or that particular cultural factors and circumstances make it more likely that companies in the UK

achieve better in these areas than do their counterparts in Libya. As a result, employees could see little benefit since it required significant effort and work on their part.

Libya, like most developing countries, lacks the skills and qualifications, to overcome these problems; top management must identify the importance of TPM programmes and be prepared to communicate this effectively, before they commit themselves. Management/Leaders need to educate not only themselves but their employees as well. Failure to believe such values could lead to serious outcomes because of the increasing levels of competition from international companies, who have already successfully implemented TPM, and are looking to invest in Libya.

Furthermore, it is essential for top management to always support changes in the organisation, to reduce resistance to change, should there be a need to implement fundamental changes. But in doing so, a number of elements have to be considered in order to make the initiative a success. Top management has to provide support and the necessary tools and facilities to change leaders who are the change agents. They with management support and commitment and through other factors such as teamwork, employees' involvement and support, recognition and empowering employees, providing continuous training and education develop strategic planning and all issues concerning HR can increase the extent of TPM implementation.

To date no study has been found to investigate the relationship between TPM and OC in the manufacturing sector in the Arab World in general or in Libya in particular. An important result of this study was therefore to identify the relationship between OC on the implementation of TPM, and to identify an ideal culture necessary for successful TPM implementation in the context of both UK and Libyan companies. The research was carried out in four systematically connected parts. The first part entailed carrying out a survey in

the UK to identify the relationship between OC and TPM implementation. This was achieved by first carrying out an intensive literature review of TPM as well as culture and OC to identify which elements needed to be considered or changed to facilitate and support TPM implementation. The second was to identify an ideal culture necessary for successful TPM implementation, and then to carry out a survey in Libya to identify the differences between TPM practices here and in the UK and determines deficiencies. The last aspect was to investigate differences in the culture and to provide general and suitable recommendations to help the Libyan government and companies to promote TPM in this specific location.

In the first part, it was clear that much of the TPM literature emphasised that long-term management commitment is necessary to its success. Top Management must improve the relationship between employees and provide a consistent direction and support. Culture and knowledge of the programme are believed to be critical factors to successfully implementing TPM (Aspinwall and Elgharib, 2013; Panneerselvam, 2012). Another important factor found in the literature reviews was that employee education and training were fundamental to implementing TPM. Mistake-proofing and problem solving are two competences that undermine TPM and must be emphasised throughout training programmes. TPM programmes should be implemented during a process of well established learning, and not be used as a quick fix solution to a problem. Moreover, all workers should be trained in the essentials of quality as defined by the company's goals and objectives. They should also be given updated training when new techniques are introduced.

Ten factors that were thought by the researcher would help to create a supportive environment and were critical to the success of TPM implementations were used to help

understand the relationship between OC and TPM. They were: *top Management, total employee involvement, communication and awareness, strategic planning and action plan, resource allocation or availability, recognition and empowerment, training and education, monitoring and evaluation, reward and incentives* and *Teamwork*.

The second part (an empirical study centred on these factors) was conducted in the UK to determine an ideal culture necessary for successful TPM implementation. The CVF was deemed to be the most appropriate tool to use for this based on the responses received. It is a tool that is sensitive to creative and innovative aspects of organisational power. It consists of twenty-four statements to support a TPM philosophy and facilitate its implementation.

The majority of the UK manufacturing respondent companies were clearly dominated by a group culture. The typical features of this are cooperative, coordinative; involves teamwork, and fewer management levels. Companies with a group culture are characterised as having a friendly workplace, with shared values, beliefs, goals, unity and participation. This type of culture focuses on internal issues, flexible values and care rather than looking for stability (Cameron and Quinn, 2006). Using a TPM approach in organisations with this culture would be helpful because it focuses on improving communications between all employees and encouraging teamwork activities.

Results from the UK survey revealed that the *top management* factor was perceived to be the most important while "*rewards and incentives*" was the least. The respondents recognised that: commitment and support from top management determined the success of new change initiatives; focus on health, safety and environmental issues are also necessary ingredients; the organisation treats all employees equally with regards to respect, performance and

recognition; training and education are vital when adopting TPM and teamwork is important for achieving a TPM culture.

However, there is some doubt as to the level of success with regards to: "shop floor workers are organised in TPM teams for problem solving" and "the team objectives are aligned with departmental objectives"; "there is a system for linking recognition and rewards to the company's improvement goals" and "resources allocated for TPM are not compromised for other initiatives such as TQM".

The same survey was performed in Libya to enable differences to be determined between TPM practices here and in the UK and highlight deficiencies. The results showed that a significantly positive relationship existed between the majority of the pairs of variables, the strongest being between training & education and management of employees. The t test showed that there was a significant difference between UK and Libyan manufacturing companies' means on all the factors apart from resource allocation and teamwork. This designated that the mean perceived by UK companies were better than the mean extent of Libyan companies. With respect to the resource allocation and teamwork factors, both the UK and the Libyan respondent companies were focusing on the same elements. The justification of this could rest on the fact that both groups were already familiar with the two factors, and could relate to what was being learned in their training programmes.

Usually, training without education is not successful. The significance of "education first" and "training second" is the golden role. The introduction and implementation of TPM, or other systems may need years of preparing a foundation based on cultural and psychological education and training. When working in different cultures, it is even harder to mentally educate people to follow certain standards. Where different classes of people

exist and carelessness and unawareness are in existence, the goal of education and training seems even more difficult to attain.

In order to sustain competitiveness, Libyan companies need to change their bureaucratic style of management to a high value added and practical one. For such a transformation the adoption of successful practices is considered as one of the crucial factors. Therefore, to employ the correct tools for TPM programmes one has to differentiate, where and when these training strategies can be implemented. The implementation of TPM programmes can have totally different meanings in different cultures. In some cultures the employees might think that these are managerial means of disciplinary control while in another they may believe it to be a strategic weapon for improving manufacturing performance.

The successes of TPM as an organisational change mechanism depends on OC. Libyan companies need to recognise that part of the implementation planning should be dedicated to explicitly identifying the necessary organisational changes. This includes current and future roles and responsibilities for the individuals affected by those proposed. These need to be communicated to the organisation, and the appropriate training needs to be provided, to make the process change a smooth transition.

The CVF analysis showed that both countries operate within the same group and rational OC. The similarities that were noted between the UK organisations and those in Libya are due to those shared values. An important point should be noted with regard to the cultural profile shapes.

Frameworks have been suggested by researchers, consultants and academics for implementing TPM programmes in various organisations having varying environments for garnering manufacturing competencies in order to accomplish organisational aims and objectives (Ireland and Dale, 2001). Some have merely characterised what TPM is without

suggesting how to implement it, while others are meant to be used to facilitate the analysis of an organisation's practices rather than helping it to adopt the framework. Another important point is that the implementation of TPM will differ from organisation to organisation even though the objectives are mostly similar.

To implement TPM programmes successfully in Libyan manufacturing companies, the researcher recommends using Nakajima's framework (see Figure 2.2). It provides a road map and emphasises CI, empowering the employee, teamwork and standardising every activity to minimise the time of execution and consists of eight pillars (*Focused Improvement, Planned Maintenance, Early Management, Education and Training, Autonomous Maintenance, Quality Maintenance, Office TPM and Safety, health & environment).* It is described in detail in Chapter two (Section 2.7).

According to Nakajima (1989) a TPM programme can be implemented using four major phases. Phase 1, *preparation*, consists of steps to overcome the initial resistance to change. Phase 2, *preliminary implementation*, is designed to involve operators in maintenance activities.

Phase 3, *TPM implementation*, focuses on improving equipment effectiveness and overcoming resistance to TPM. Phase 4, *TPM stabilisation*, involves perpetuating the TPM programme.

In the *preparation phase*, top management has the primary responsibility of preparing a suitable environment for TPM's introduction. This is done by first announcing the decision to introduce TPM and beginning TPM education. Here, top management demonstrates its commitment by first educating the managers. This includes visiting other plants using TPM and conducting other activities such as reward systems to overcome resistance. Typically management uses a small central TPM committee to both promote and coordinate the TPM

implementation. The committee ensures that autonomous small groups are established at every level. The committee also creates basic TPM policies and attainable, quantifiable goals for upper-level groups. After establishing these goals it ensures that each group below it develops consistent goals. As these groups are being established the TPM committee helps top management formulate a master plan for TPM development. This includes reducing the six big equipment losses (equipment failure, setup and adjustment, idling and minor stoppages, reduced speed, defects in process, reduced yield) and creating an AM programme, a plan for quality control, one for maintenance by the maintenance department and one for education and training to improve maintenance skills (Nakajima, 1989).

Phase 2, preliminary implementation, is the "kick off" of the TPM programme. In this phase, the individual worker begins to experience TPM through training activities aimed at eliminating the six big losses. To do this, the TPM committee identifies the initial tasks to be assigned to the operators and coordinates the development of carefully detailed procedures. The actual writing of the procedures may be done by the maintenance technicians with oversight and support from management (Nakajima, 1989). This is an important phase of implementation that needs to be monitored carefully. Management needs to ensure that the operators receive training to learn the skills and that the maintenance technicians cooperate and support the operator's efforts.

Phase 3 is full TPM implementation. This concentrates on improving equipment effectiveness by using a variety of common quality improvement techniques to focus efforts on the equipment that have chronic losses. Visible success in eliminating chronic losses helps to overcome resistance to change and develops an impetus for further change. Up to the point of starting AM many companies can implement TPM without any major changes in their maintenance practices. As soon as all the equipment operators are involved in the

AM programme, there may be some increased resistance to change since the traditional separation between the operators and maintenance is being reduced as operators become responsible for their own equipment (Nakajima, 1989). Active top management leadership may be required to successfully overcome resistance to change by operators and maintenance personnel. Management must carefully consider the skills required and the current capabilities of its operators. They must provide adequate training for the operators to enable them to work efficiently.

Phase 4, stabilising and perpetuating TPM, is where the TPM groups begin a cycle of continuously improving their TPM results. Managers at all levels focus on improving TPM skills by diagnosing each group's performance at conducting the standardised maintenance programme. In this phase, maintenance considerations are incorporated into each of the company's functions to change the interaction of people and equipment (Nakajima, 1989). This requires that the company includes some maintenance goals in its business strategy to create an impetus to make the necessary culture changes and to focus the company on maximizing equipment availability and reliability. These goals help direct the company away from the old paradigm of minimising maintenance costs towards the new one of maximising the benefits from maintenance investments. The implementation procedure steps are shown in detail in Appendix II.

Finally, this piece of research is thought to be the first of its kind and will help to improve the understanding of both TPM and the role of OC in Libyan industry. The findings and recommendations should help top management in Libya to recognise the problems brought about by their interventions and control.

9.2 Recommendations for helping TPM implementation in Libyan Companies

This research presented information about the success of TPM and the barriers to its successful implementation together with its relationship with OC in UK and Libyan manufacturing companies. The recommendations are based upon the literature review and the findings of the case studies that were performed. The researcher recommends that the following points be addressed if Libyan organisations are to successfully implement and sustain TPM:

- As suggested in Section 6.5 a completely new management style is needed for successful TPM programmes implementation. A greatly different process is required, and collecting data on the current status can assist a company to recognise its current focus, and will help as a starting point for improvement (see also Chapter Seven, section 7.2.3).
- An overall plan is necessary to implement a TPM programme. It needs a systematic, incorporated, reliable, and organisation-wide approach, and this can only be attained through total planning (see Sections 6.5.2, 7.2.2, and 7.2.3).
- Consistent with the literature review (Section 2.12), and based on the findings of (Sections 6.7, and 7.2.1) top management must fully understand the philosophies of a TPM programme that they are looking to implement.
- Extensive training is needed particularly in the areas of problem identification and solving skills in order to realise the benefits of TPM implementation (Sections 6.6, 7.2.1, 7.2.2, and 7.2.3).

- Regular reviews and audits to address the elements of all the TPM systems should also provide a solid basis to improve manufacturing performance (Section 6.6, and 7.2.3).
- Benchmarking research to compare TPM implementation in Libyan manufacturing companies with similar organisations in other neighbouring countries is a useful tool which will enable them to learn from the experience of others (Section 6.5.2).
- To be successful Libyan companies must promote CI and have an effective learning environment. This can be achieved by adopting and developing a culture of learning within the organisation (Sections 2.13, and 6.6).
- The government must help to support the need to develop a good strategy for certified companies to provide internal and external training on quality practises and health and safety programmes (Section 6.10).
- The development of TPM implementation needs to be reviewed on a regular basis. It is suggested that a TPM steering committee be formed. This should comprise TPM facilitators, Production Managers and Maintenance Managers. The committee's duties should include setup TPM teams, reviewing the progress of TPM initiatives, looking at ways to promote TPM throughout the company and ensuring that TPM efforts are continued (Sections 6.6, 6.8, and 7.2.3).
- It is necessary that employees at all levels in the manufacturing organisation are included from the start in the evolution, progress and maintenance of the TPM programme and that the driving force behind them should be a combination of maintenance, production and quality (Section 6.5.3).
- Libyan manufacturing companies need to implement OEE as a performance indicator to track the efficiency of equipment in order to achieve higher targets.

Production line supervisors and equipment technicians should periodically keep statistics of key equipment's availability, performance and quality and set up the goal of OEE to help equipment efficiency management (Sections 2.6, and 6.8).

- TPM teams should be rewarded for achieving certain performance goals (Sections 2.13, and 6.5.3).
- Libyan companies should motivate all employees particularly if they offer suggestions and ideas for improvement (Sections 6.5.3, 7.2.1, 2.2.2, and 7.2.3).
- Early equipment management can be achieved by considering failure causes and the maintainability of equipment from the early stages of design, manufacturing installation and commissioning (Sections 2.7, 6.5.2, and 6.5.3).
- Libyan companies should be encouraged to communicate information to employees and to give them direct access to information on productivity through the various communication channels adopted (Section 6.5.3).
- Initiating a TPM programme based on a solid foundation (such as equipment cleaning; lubrication; correct operation; and regular inspection) will guide Libyan manufacturing companies to attain a sustainable TPM programme (Sections 2.10, and 6.5.2).
- Finally, it is vital that the obstacles to implementation be taken seriously at the outset of the whole TPM implementation process and plans be put in place to overcome them (Section 2.8).

A copy of the recommendations will be sent to a group of the top leaders in the Ministry of Industry, manufacturing sectors and to the Universities to be considered as guidelines to help support and promote TPM in Libyan organisations. They should understand that to

implement such programmes, requires a detailed knowledge of the requirements of the programme.

It is very important that Libyan companies realise the development and influence of OC on TPM implementation, particularly in view of their current ineffective management processes, lack of skills, poor quality, inappropriate structure and poor team work etc. Each type of organisation faces its own unique challenges, most of which are related to cultural issues (Aspinwall and Elgharib, 2013).

9.3 Further research

From the findings of this study, it is clear that Libyan manufacturing companies are still in the early stages of their TPM journeys which have required huge research activities in different aspects of TPM. There was a clear lack of understanding and awareness of TPM features and tools which will provide a good research opportunity. Urgent need to propose key areas of research for the development of the industry in Libya as follows:

- The development of an effective training programme for manufacturing companies in Libya.
- Further empirical studies are required to investigate TPM programmes in Libya, in terms of private and public sectors.
- It is suggested that the role of employees be investigated for their impact on TPM.
- It is furthermore suggested that empirical research be carried out in future to explore the shared features of the situation-based problems in various manufacturing industries.

In addition, an ideal cultural profile that is supposed to help TPM implementation could be used in further studies. In addition, investigate whether organisations with different

dominant culture types have significantly different levels of success in their implementation of TPM. Moreover, the results show that the highest average starts with group then rational and ends with hierarchy. The period of time that companies have established their business was not mentioned in the questionnaire. Therefore, there is a need for further investigation to find out if there are any differences between the early established companies and the new ones in terms of their OC profile.

The researcher believes that TPM implementation is necessary in Libya, would be a good investment. If it is implemented correctly, with a strong belief and commitment, TPM can certainly lead Libyan companies on their way to improvement, to achieve a quality culture, and to enable them to survive and compete in the developed market.

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APPENDICES

11.1 APPENDIX I- Details of TPM frameworks

A. Consultants / experts based type:

1. JIPM "Nakajima"

1. Focused improvement 2. Autonomous maintenance
3. Preventive maintenance 4 .Training and education
5. Maintenance prevention 6. Quality maintenance
7. Administrative TPM 8. Safety and environmental management

2. Terry Wireman

1. Maximise equipment effectiveness
2. Improve maintenance efficiency & effectiveness
3. Train to improve the skills of all people involved in TPM
4. Involve operations personnel in daily maintenance of equipment
5. Manage equipment in order to prevent maintenance

3. Centre for TPM (Australasia)

1. Safety and environmental 2. FI & process improvement
3. Work area management 4. Operator equipment management
5. Maintenance excellence management 6. Logistics & support improvement
7. New equipment/product management 8. Education and training
9. People support systems improvement 10. Process quality & innovation management

4. Cayman System

1. Autonomous maintenance 2. Quality maintenance
3. Planned maintenance 4. Individual improvement
5. Training, people development 6. Environment Health and Safety
7. Early equipment management 8. 5S's

5. TPM Club India

1. Individual improvement
2. Autonomous maintenance
3. Planned maintenance
4. Education and training
5. Development management
6. Quality maintenance
7. Office TPM
8. Safety, health and environment

6. Strategic Work Systems Inc.

1. Improving equipment effectiveness by targeting the major losses
2. Involving operators in daily runtime maintenance of their equipment
3. Improving maintenance efficiency and effectiveness
4. Training for everyone involved
5. Life-cycle equipment management and maintenance prevention design
6. Winning with teamwork focused on common goals

7. MAX International Engineering Group

1. Small group activities to eliminate the major equipment losses
2. Feedback process for product, process and equipment improvement
3. Integrated maintenance system
4. Planned maintenance system
5. Improving education and skills
6. Quality maintenance system
7. Administrative system
8. Safety, hygiene & environmental system

B. Award based frameworks

1. Volvo Cars Gent

1. Customer-ordered production
2. Individual improvement
3. Autonomous management
4. Planned maintenance
5. Quality management
6. Early product management
7. Early equipment management
8. Logistics
9. People management
10. Office management
11. Safety and environment
12. Supplier support
13. Integration in society

2. Phillips 66

1. Team running maintenance
2. Focused improvement
3. Planned maintenance
4. Support, service and training
5. Total quality conditions
6. Teamwork

C. Academic based frameworks

1. Yeomans and Millington

1. Increase equipment effectiveness
2. Training
3. Autonomous maintenance
4. Early equipment management
5. Planned preventive maintenance system

2. Society of Manufacturing Engineer

1. Improve equipment effectiveness
2. Involve operators in daily maintenance
3. Improve maintenance efficiency and effectiveness
4. Education and training
5. Designing and managing equipment for maintenance prevention

3. Steinbacher and Steinbacker

1. Maintenance prevention
2. Predictive maintenance
3. Autonomous maintenance
4. Corrective maintenance
5. Preventive maintenance

4. Society for Maintenance and Reliability Professionals

1. Restoring equipment to a new like condition
2. Operator involvement in maintaining equipment
3. Improving maintenance efficiency and effectiveness
4. Training people to improve their job skills

5. Equipment management & maintenance prevention

6. Effective use of preventive & PM technology

11.2 APPENDIX II - Four Phases of a TPM programme

TPM can be implemented using the following four major phases according to (Nakajima, 1989):

1. **Preparation:** This first stage is concerned with the necessary steps to take any initial resistance to change. Top Management has the major responsibility of preparing a suitable environment for TPM's introduction. This is accomplished by first announcing the decision to introduce it and to begin the education process. Top Management demonstrates its commitment by first educating Managers, and Group Leaders. This includes visiting other companies that successfully implemented TPM. Typically a small central committee is purposefully set up to both promote and coordinate the TPM implementation. It ensures that autonomous small groups are established at every level, and also creates basic TPM policies and attainable goals for "upper-level" groups. After these have been established the committee ensures that each subordinate group develops consistent goals.
2. **Preliminary implementation:** This is the "kick off" of the TPM programme, at which the detailed preparation is formally announced together with the start of the implementation. Park and Han (2001) point out at this stage, individual workers begin to experience TPM through training activities aimed at eliminating the six big losses. The TPM committee identifies the initial tasks to be assigned to the operators and coordinates the development of carefully detailed procedures; these may be carried out by the maintenance technicians with supervision and support from management.
3. **TPM Implementation:** The focus at this stage is directed towards improving equipment effectiveness especially those associated with chronic losses through the use of a variety of common quality techniques. Visible success here helps to overcome resistance to change and develops momentum for further change. As soon as all the equipment operators are involved in the AM programme, there may be some increased resistance to change since the traditional separation between the operators and maintenance is being reduced as operators become responsible for their own equipment. Active top management leadership required to successfully

overcome resistance to change by operators and maintenance personnel (Nakajima, 1988). The operation of both an operator certification procedure and a reward system is crucial to the success or failure of TPM (McCarthy, 1995). The certification process is necessary to ensure that the operator has actually gained the skills required to conduct autonomous machine maintenance. One of the simplest certification methods is to have the maintenance staff evaluate the operator's skills. McCarthy stated that the most important outcome of the task transfer is that the operator becomes the "owner" of the equipment and assumes responsibility for its care. Top and mid-level managers must carefully diagnose implementation progress to determine what types of training are needed and to ensure that the skills are mastered (McCarthy, 1995).

4. **Stabilisation**

Stabilising and maintaining TPM is the stage where the TPM groups begin a cycle of continuously improving their results. By now the TPM implementation activities would have reached maturity stage. Now is the time to apply for preventive maintenance award.

11.3 APPENDIX III-A: Advantages and disadvantages of various data collection techniques

Technique	Advantages	Constraints
Observing	• Gives more detailed and context related information • Does not rely on people's eagerness to provide information • Directly see what people do rather than relying on what they say they do.	• Susceptible to observer bias • Hawthorne effect – people usually perform better when they know they are being observed • Does not increase understanding of why people behave the way they do
Interviewing	• Has a higher response rate than written questionnaire. • Useful for gaining insight and context into a topic • Is suitable when used with both educated and uneducated people.	• Reports of events may be less complete than information gained through observations. • Time consuming and expensive compared to other data collection methods • Could be invasive to the respondent
Case studies	• Fully describing people's experience in programme input, process, and results • Great way of showing programme to outsiders	• Time consuming to collect information • Signifies depth of information rather than breadth.
Survey &Questionnaires	• Is less expensive • Many people are familiar with surveys • Some respondents feel more comfortable responding to a survey than taking part in an interview • Tabulation of closed-ended responses is an easy and straightforward process • Does not require research assistants.	• Respondents may not complete the survey resulting in low response rates. • Good survey questions are hard to write and they take a considerable time to develop. • Size and diversity of sample will be limited by people's ability to read • Given lack of contact with respondent, never know who really completed the survey
Using Available Information	• Allows examination of trends • Is less expensive because the information is already there	• Information may be incorrect or incomplete. • Data is not always easily accessible.

[Source: (Finn and Jacobson, 2008)]

11.4 APPENDIX III-A1: Types of Culture

Types of culture, as reflected in Handy's (1991) work as follows:

1. **Role Culture**: This is explained as a building supported by columns and beams, each having a precise task in supporting the building. It is possibly the most well-known and widespread of all the cultural types. It is based around the job or role rather than the personalities and is summarised by what one tends to think of as the traditional hierarchical structure (Figure 3.2).

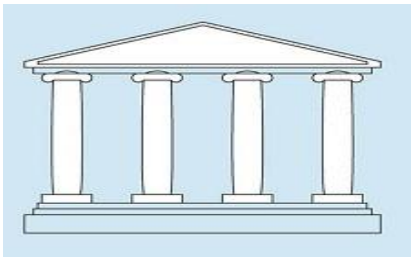


Figure 3.2 Role Culture (Source: Handy, 1991)

2. **Task Culture**: In this type, administration is mainly concerned with the continuous and successful solution to problems. Achievement is judged in terms of results and problems solved. Some of the threads of the net are thicker or stronger than others, and much of the power and influence is situated at the top of the net, at the knots. Task culture relies on teamwork to produce results. Teams, project teams or task forces are shaped for a specific purpose and can be re-formed, continued or abandoned (Figure 3.3).

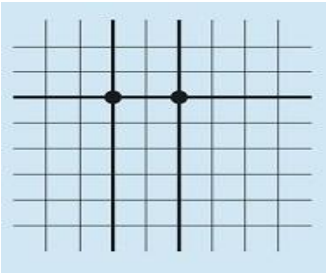


Figure 3.3 Task Culture (Source: Handy, 1991)

3. Power Culture: This is illustrated as a spider's web (see Figure 3.4). This type of culture, power obtained from the top person, and a special relationship with that individual matters more than any formal title or position. The dominant influence of the centre results in a structure that is able to move quickly and respond to change and outside threats. This culture is often established in small commercial organisations and political groups.

Figure 3.4 Power Culture (Source: Handy, 1991)

4. Person (Star) Culture: It is not found in many organisations although many people support some of its values. It is illustrated by a loose cluster or a constellation of stars (see Figure 3.5). The person is the central point. If there is a structure, it exists only to serve the individuals within it. The culture only exists for the people concerned; it has no super-ordinate reason. Although not a ordinary culture on which an entire organisation should be based, it is none the less found in small areas of large organisations (Handy 1991).

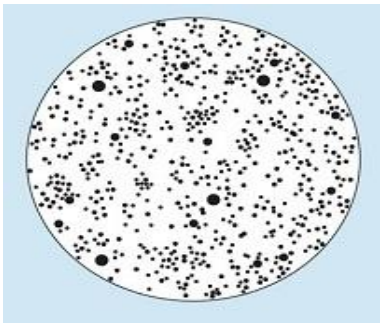


Figure 3.5 Person Culture (Source: Handy, 1991)

Hill and Rothaermel (2003) and Schultz *et al.,* (2003) agreed that companies which have managed to remain successful over a period of time have generally tended to be those with a strong OC that is also an adaptive culture which has been successful in adapting to the demands of the business environment. The ability of a company to have this type of OC is however easier said than done as in general the stronger the OC the more difficult it is to change over a short period of time (Hill and Rothaermel, 2003).

Although the concept of OC is generally used to assist the study of management and organisations there are those who question its value, for example, Willmott (1993) emphasised the dark side of culture by drawing attention to what he regards as the "subjugating and totalitarian" implications of culture and suggests that the success in ensuring commitment is at best partial and that employees can become trapped in a vicious cycle of cynicism and dependence. Other researchers have emphasised cultural fragmentation rather than unity. They have gone on to put concepts such as instability and ambiguity at the centre of their analysis of organisational culture.

The researcher believes that the above definitions of OC in general, share several common factors regardless of how the term is defined including: beliefs, norms, patterns, customs, rites, rituals, value systems, behavioural norms, expectations, and ways of doing business.

11.5 APPENDIXIII-B- UK Questionnaire

UNIVERSITY OF BIRMINGHAM

ORGANISATIONAL CULTURE AND TOTAL PRODUCTIVE MAINTENANCE

Introduction

Culture change acts as a main driver and barrier for successful TPM adoption and implementation. TPM has proven to significantly enhance the competitiveness and profitability of companies throughout the world, and some have been transformed into organisations that are characterised as World-Class; however, far too many companies have fallen short in developing the programme. This questionnaire addresses the relationship between organisational culture and TPM implementation. I would very much appreciate your taking part in the survey as the success of this research depends upon your response.

Instructions

Please read the questions carefully and indicate your answer with a tick in the boxes provided. If there is an option "others" please specify your answer in the space provided

.

Section one: General Information

1.In which group are you employed?

Top management ☐ Middle management ☐ Supervisory ☐ Others (Please specify) ☐.....

2 - What is your role within the company? .....

3. What is the ownership of your Organisation?

Government ☐ Private ☐ Partnership/Joint Venture ☐ Others (Please specify) ☐.....

4. What is the approximate number of employees in your company?

Less than 50 ☐ 50-249 ☐ More than 250 ☐

5. What type of products does your company manufacture?

- ○ Automotive.
- ○ Chemical.
- ○ Aerospace.
- ○ Oil and Gas.
- ○ Rubber and plastic.
- ○ Electrical/electronic.
- ○ Food and beverages
- ○ Others (please specify).....

Section Two: Measurement of Total Productive Maintenance

Listed in the following table are ten organisational culture factors that are believed to affect the success of TPM. Indicate the extent to which you agree or disagree with them by putting an X in the appropriate box. Please indicate your answer using the following scale:

1 2 3 4 5

Strongly disagree, disagree, uncertain, agree, and strongly agree.

	Factors	1	2	3	4	5
F1.	**Top Management :**					
	A. Commitment and support determines the success of new change initiatives.	☐	☐	☐	☐	☐
	B. Encourages employee involvement in TPM activities.	☐	☐	☐	☐	☐
	C. Pays significant attention to improving maintenance.	☐	☐	☐	☐	☐
	D. Has a clear understanding of the scope of maintenance missions.	☐	☐	☐	☐	☐
	E. Ensures employees are well supported through times of change.	☐	☐	☐	☐	☐
	F. Focuses on health, safety and environmental issues.	☐	☐	☐	☐	☐
F2	**Total employee involvement.**					
	A. Employees are encouraged to make and implement suggestions.	☐	☐	☐	☐	☐
	B. TPM involves every single employee, from top management to workers on the shop floor.	☐	☐	☐	☐	☐

	C. Employees are routinely involved in some organised form of continuous improvement (Kaizen).	☐	☐	☐	☐	☐
	D. Production employees have accepted that autonomous maintenance is their responsibility.	☐	☐	☐	☐	☐
	E. Employees have easy access to information on productivity.	☐	☐	☐	☐	☐
F3	**Communication and awareness.**					
	A. There is effective communication between teams transcending every level of hierarchy in the company.	☐	☐	☐	☐	☐
	B. Employees are well informed of the current company employee development policies.	☐	☐	☐	☐	☐
	C. Employees are regularly given feedback on environmental issues, safety incidents and their corrective actions.	☐	☐	☐	☐	☐
F4	**Strategic planning and action plan.**					
	A. Detailed roles and responsibilities are well-defined, communicated, updated and understood plant-wide.	☐	☐	☐	☐	☐
	B. The organisation has a good housekeeping system (5-Ss).	☐	☐	☐	☐	☐
	C. The organisation has developed a process to evaluate the efficiency and effectiveness of maintenance performance.	☐	☐	☐	☐	☐
	D. The organisation uses benchmarking to identify the needs for change.	☐	☐	☐	☐	☐
F5	**Resource allocation or availability**.					
	A. Equipment is made available for maintenance, when scheduled, plant-wide.	☐	☐	☐	☐	☐
	B. Machine availability on the shop-floor is visible and understood by everyone.	☐	☐	☐	☐	☐
	C. There is a system of making modifications to the existing equipment for improving equipment availability.	☐	☐	☐	☐	☐
	D. There are processes in place to analyse breakdowns and the root causes are identified and permanently fixed.	☐	☐	☐	☐	☐
	E. Resources allocated for TPM are not compromised for other initiatives such as TQM.	☐	☐	☐	☐	☐
F6	**Recognition and empowerment**.					
	A. Employees' suggestions are regularly evaluated and implemented.	☐	☐	☐	☐	☐
	B. The organisation treats all its employees equally with regards to respect, performance and recognition.	☐	☐	☐	☐	☐
	C. Operators do basic maintenance and inspect their machines daily.	☐	☐	☐	☐	☐

	D. All the TPM teams are empowered to take responsibility for their decisions.	☐	☐	☐	☐	☐
F7	**Training and education**.					
	A. Training and education are vital elements when adopting TPM.	☐	☐	☐	☐	☐
	B. Safety and environmental training programmes are provided for team members and other personnel.	☐	☐	☐	☐	☐
	C. Regular reviews and improvements are made in the training system to accommodate changing requirements.	☐	☐	☐	☐	☐
	D. TPM team leaders are experienced and have leadership qualities.	☐	☐	☐	☐	☐
F8	**Monitoring and evaluation**					
	A. Appropriate data collection and analysis (e.g. OEE, uptime) is used by the facility to eliminate equipment - related losses.	☐	☐	☐	☐	☐
	B. The company follows a schedule of planned maintenance of the equipment.	☐	☐	☐	☐	☐
	C. Condition monitoring has improved the reliability of the machinery in production areas.	☐	☐	☐	☐	☐
F9	**Reward and incentives**					
	A. People are encouraged to improve their knowledge and skills at work.	☐	☐	☐	☐	☐
	B. There is a system of linking recognition and rewards to the company's improvement goals as set out in its improvement strategy.	☐	☐	☐	☐	☐
F10	**Teamwork**					
	A. Shop floor workers are organised into TPM teams for problem solving and the team objectives are aligned with departmental objectives.	☐	☐	☐	☐	☐
	B. Teamwork is important for achieving a TPM culture.	☐	☐	☐	☐	☐
	C. TPM improves teamwork between production and maintenance departments.	☐	☐	☐	☐	☐
	D. Sufficient numbers of skilled engineers/technicians are employed in the production area.	☐	☐	☐	☐	☐

Section Three: Classification of the ideal Culture for TPM

In completing this section, you are providing information that will be used to obtain a better understanding of your organisation's culture and values. It is **NOT** a test; the results will be used to help identify an ideal culture necessary for Total Productive Maintenance.

Please indicate the extent to which you agree or disagree with the following statements by putting an X in the appropriate box. The categories are;

1 2 3 4 5

Strongly disagree, disagree, uncertain, agree, and strongly agree.

	Dimensions	1	2	3	4	5
D1.	**Dominant characteristics of the organisation- It is** A. A very personal place. It is like an extended family. People seem to share a lot of themselves	☐	☐	☐	☐	☐
	B. A very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.	☐	☐	☐	☐	☐
	C. Very results oriented. A major concern is getting on with the job. People are very competitive and achievement oriented.	☐	☐	☐	☐	☐
	D. A very controlled and structured place. Formal procedures generally govern what people do.	☐	☐	☐	☐	☐
D2	**Organisational Leadership** A. Is generally considered to be mentoring, facilitating or nurturing.	☐	☐	☐	☐	☐
	B. Is generally considered to exemplify entrepreneurship, innovation or risk taking.	☐	☐	☐	☐	☐
	C. Is generally considered to be a practical, aggressive, result-oriented focus.	☐	☐	☐	☐	☐
	D. Is generally considered to be coordinating, organising.	☐	☐	☐	☐	☐
D3	**Management of employees in the organisation-** ***the management style in the organisation is characterised by*** A. Teamwork, consensus and participation.	☐	☐	☐	☐	☐
	B. Individual risk-taking, innovation, freedom and uniqueness.	☐	☐	☐	☐	☐
	C. Hard-driving competitiveness, high demands and achievement.	☐	☐	☐	☐	☐

	D. Security of employment, conformity, predictability and stability in relationships.	☐	☐	☐	☐	☐
D4	**Organisation Glue- *that holds the organisation together is:***					
	A. Loyalty and tradition. Commitment to the organisation runs high.	☐	☐	☐	☐	☐
	B. Commitment to innovation and development. There is an emphasis on being at the cutting edge.	☐	☐	☐	☐	☐
	C. Formal rules and policies. Maintaining a smooth-running organisation is important.	☐	☐	☐	☐	☐
	D. The emphasis on achievement and goal accomplishment. Aggressiveness and winning are common themes.	☐	☐	☐	☐	☐
D5	**Strategic emphasis of the organisation**					
	A. High trust, openness and participation persist.	☐	☐	☐	☐	☐
	B. Is dynamism and willingness to meet new challenges. Trying new things and prospecting for opportunities are valued.	☐	☐	☐	☐	☐
	C. Competitive actions and achievement. Also, is placed on beating the competition.	☐	☐	☐	☐	☐
	D. Permanence and stability, efficiency, control and smooth operations are important.	☐	☐	☐	☐	☐
D6	**Success within the organisation is on the basis of:**					
	A. Development of human resources, teamwork, employee commitment and concern for people.	☐	☐	☐	☐	☐
	B. Efficiency. Dependable delivery, smooth scheduling and low cost production are critical.	☐	☐	☐	☐	☐
	C. Winning in the marketplace and the competition. Competitive market leadership is the key.	☐	☐	☐	☐	☐
	D. Having the most unique or the newest products. It is a product leader and innovator.	☐	☐	☐	☐	☐

❖ ❁ ❖

Thank you for your participation in this survey.

All responses will be treated in the strictest confidence and used only for research purposes.

Please reply to:

Maged Elgharib
Research student (Room G47M)
School of Mechanical Engineering

11.6 APPENDIXIII-C- Sample letter

<Company'> **<Date>**

<Job title>

<Address>

Survey Questionnaire sample letter

Dear <Managing Director>,

I am a PhD student in the School of Mechanical Engineering at the University of Birmingham. My research project addresses the relationship between organisational culture and TPM implementation related to both the UK and a certain developing country. To help with this aspect I have compiled a short questionnaire divided into three sections which I have enclosed. The first includes the background aspects of the respondent company such as number of employees and type of industry. The second section includes several organisational culture dimensions that I believe could influence the success of TPM and create a supportive environment for its implementation. The last one is aimed at identifying an ideal cultural profile for TPM.

It would be very much appreciated if you could complete the questionnaire since the success of my project depends upon a good level of response. It is anticipated that this should take no more than 20 minutes. You have my assurance that any information provided will be treated in the strictest confidence and that participants will not be individually identifiable in resulting reports, publications or other related research. I would like to thank you in anticipation of your help and look forward to hearing from you at your earliest convenience.

Yours sincerely,

_____

Mr. Maged Elgharib

Mrs. Elaine Aspinwall
Head of Quality Research Group

11.7 APPENDIXIII-D- Sample of reminder letter

<Company'> **<Date>**

<Address>

The Managing Director

Dear Sir,

I recently sent you a questionnaire related to organisational culture and TPM. To date I do not appear to have received your response. Although I have had several completed surveys returned, the number is insufficient for me to draw valid conclusions.

I am aware that you have a very busy schedule and that you must receive many requests of this type, but the success of the survey and hence the research work carried out in the future very much depends on a high level of response. I would therefore be grateful if you could spare some time completing the questionnaire (a copy of which I have enclosed) and returning it to me.

Thanking you in anticipation.

Yours sincerely,

Maged Elgharib

11.8 APPENDIXIII-E- Responses of the UK Questionnaire

1. Details of Initial Survey Posting

Details of Reponses	First batch	Second batch	Total
Date of Despatch	11/1/2012	13/1/2012	
Number sent	153	197	350
Positive responses	25	59	84
Refusal to participate	5	12	17

2. Follow up

Detail of responses	One batch
Date of sending Q	12/3/2012
Questionnaires sent	249
Positive responses	27
Refusal to participate	8

The Total Responses

Details of Reponses	Total	Percentage
Positive responses	84+27=111	32%
Refuse to participate	17+8=25	

11.9 APPENDIXIII-F- Roles within the companies

		Frequency	Percent
Valid	CEO	2	1.8
	Chief Chemist	1	.9
	Facility Manager	3	2.7
	Financial Director	4	3.6
	General Manager	4	3.6
	Head of Development	2	1.8
	Health and safety	1	.9
	HR Director	1	.9
	HR Manager	2	1.8
	Industrial Engineering	3	2.7
	Industrial Manager	2	1.8
	Maintenance Manager	3	2.7
	Managing Director	40	36.0
	Manufacturing Director	7	6.3
	Manufacturing Engineer	1	.9
	Manufacturing Manager	8	7.2
	Manufacturing Operation	1	.9
	Mechanical Engineer	1	.9
	Operation Director	5	4.5
	Process develop leader	1	.9
	Product Development	1	.9
	Product Development	6	5.4
	Production Director	1	.9
	Production Maintenance	1	.9
	Quality and Control	1	.9
	Quality Inspector	1	.9
	Quality Inspector	1	.9
	Quality Inspector	1	.9
	SFS	1	.9
	Team Leader	5	4.5
	Total	111	100.0

11.10 APPENDIXIII-G - Example of Reliability Analysis outputs

```
RELIABILITY
  /VARIABLES=F1ClearUnder      F1CommSupp      F1EncourEmplo      F1EnsureEmp
F1FocusHealth F1PaysAttent
  /SCALE ('ALL VARIABLES') ALL
  /MODEL=ALPHA
  /STATISTICS=SCALE
  /SUMMARY=TOTAL.
[DataSet1] E:\Maged\Maged_data.sav
```

Case Processing Summary

		N	%
Cases	Valid	235	100.0
	Excluded[a]	0	.0
	Total	235	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.855	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	**Cronbach's Alpha** if Item Deleted
Clear understanding of missions	20.88	11.545	.716	.816
Commitment and support	20.46	11.369	.709	.817
Encourages employee involvement in TPM	20.59	13.859	.495	.855
Ensures employees are well supported	20.77	11.599	.740	.812
Focuses on health, safety	20.59	12.517	.509	.858
Pays attention to improving maintenance	20.66	12.284	.709	.820

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
24.79	17.066	4.131	6

11.11 APPENDIXIII-H – Factor Analysis

Factor Analysis (F1)

Communalities

	Initial	Extraction
Clear understanding of missions	1.000	.679
Commitment and support	1.000	.653
Encourages employee involvement in TPM	1.000	.411
Ensures employees are well supported	1.000	.706
Focuses on health, safety	1.000	.397
Pays attention to improving maintenance	1.000	.683

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.528	58.797	58.797	3.528	58.797	58.797
2	.922	15.364	74.160			
3	.496	8.271	82.431			
4	.477	7.952	90.383			
5	.317	5.285	95.668			
6	.260	4.332	100.000			

Extraction Method: Principal Component Analysis.

Component Matrixa

	Component
	1
Ensures employees are well supported	.840
Pays attention to improving maintenance	.826
Clear understanding of missions	.824
Commitment and support	.808
Encourages employee involvement in TPM	.641
Focuses on health, safety	.630

Extraction Method: Principal Component Analysis.

Factor Analysis (F2)

Communalities

	Initial	Extraction
Employees are routinely involved in CI	1.000	.503
Employees encourages to implement suggestions	1.000	.307
Employees have easy access to information	1.000	.554
Production employees accepted AM	1.000	.427
TPM involves every single employee	1.000	.436

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.227	44.541	44.541	2.227	44.541	44.541
2	.990	19.808	64.349			
3	.810	16.194	80.543			
4	.509	10.183	90.726			
5	.464	9.274	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
Employees have easy access to information	.744
Employees are routinely involved in CI	.709
TPM involves every single employee	.660
Production employees accepted AM	.654
Employees encourages to implement suggestions	.554

Extraction Method: Principal Component Analysis.

Factor Analysis (F3)

Communalities

	Initial	Extraction
Effective communication between teams	1.000	.750
Employees are well informed of the current policies	1.000	.696
Employees are regularly given feedback	1.000	.585

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.031	67.707	67.707	2.031	67.707	67.707
2	.592	19.722	87.430			
3	.377	12.570	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
Effective communication between teams	.866
Employees are well informed of the current policies	.834
Employees are regularly given feedback	.765

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Factor Analysis (F4)

Communalities

	Initial	Extraction
A detailed roles and responsibilities	1.000	.369
The organisation evaluates the efficiency, effectiveness	1.000	.715
The organisations has good 5s	1.000	.521
The organisation uses benchmarking	1.000	.576

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.181	54.525	54.525	2.181	54.525	54.525
2	.802	20.061	74.585			
3	.617	15.415	90.000			
4	.400	10.000	100.000			

Extraction Method: Principal Component Analysis.

Component Matrixa

	Component
	1
The organisation evaluates the efficiency, effectiveness	.846
The organisation uses benchmarking	.759
The organisations has good 5s	.722
A detailed roles and responsibilities	.607

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Factor Analysis (F5)

Communalities

	Initial	Extraction
Equipment is made available for maintenance	1.000	.610
Machine availability is visible and understood	1.000	.578
There are processes in place to analysis breakdowns	1.000	.516
Resources allocated for TPM	1.000	.340
There is a system of making modifications	1.000	.361

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.406	48.121	48.121	2.406	48.121	48.121
2	.872	17.439	65.560			
3	.706	14.119	79.679			
4	.596	11.926	91.605			
5	.420	8.395	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
Equipment is made available for maintenance	.781
Machine availability is visible and understood	.760
There are processes in place to analysis breakdowns	.718
There is a system of making modifications	.601
Resources allocated for TPM	.583

Extraction Method: Principal Component Analysis.

Factor Analysis (F6)

Communalities

	Initial	Extraction
Employees suggestions are evaluated and implemented	1.000	.590
Operators do basic maintenance and inspect m/c	1.000	.685
The organisation treats all employees equally	1.000	.583
All the TPM teams are empowered	1.000	.549

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.408	60.190	60.190	2.408	60.190	60.190
2	.591	14.787	74.977			
3	.577	14.434	89.412			
4	.424	10.588	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
Operators do basic maintenance and inspect m/c	.828
Employees suggestions are evaluated and implemented	.768
The organisation treats all employees equally	.764
All the TPM teams are empowered	.741

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Factor Analysis (F7)

Communalities

	Initial	Extraction
Regular reviews and improvements	1.000	.813
Safety and environment training programmes	1.000	.435
TPM team leaders are experienced	1.000	.775
Training and education are vital for TPM	1.000	.572

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.594	64.851	64.851	2.594	64.851	64.851
2	.829	20.721	85.572			
3	.332	8.291	93.863			
4	.245	6.137	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
Regular reviews and improvements	.901
TPM team leaders are experienced	.880
Training and education are vital for TPM	.756
Safety and environment training programmes	.660

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Factor Analysis (F8)

Communalities

	Initial	Extraction
Appropriate data collection and analysis	1.000	.748
Condition Monitoring has improved reliability	1.000	.444
The company follows schedule of planned maintenance	1.000	.483

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.676	55.863	55.863	1.676	55.863	55.863
2	.869	28.977	84.840			
3	.455	15.160	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
Appropriate data collection and analysis	.865
The company follows schedule of planned maintenance	.695
Condition Monitoring has improved reliability	.667

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Factor Analysis (F9)

Communalities

	Initial	Extraction
People encouraged to improve knowledge	1.000	.771
There is a sys for linking recognition and rewards	1.000	.771

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.543	77.141	77.141	1.543	77.141	77.141
2	.457	22.859	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
There is a sys for linking recognition and rewards	.878
People encouraged to improve knowledge	.878

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Factor Analysis (10)

Communalities

	Initial	Extraction
shop floor workers are organised in TPM teams	1.000	.873
Sufficient numbers of skilled engineers/technicians	1.000	.702
Teamwork is important for TPM culture	1.000	.560
TPM improves teamwork between production and maintenance	1.000	.721

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.834	45.859	45.859	1.834	45.859	45.859
2	1.023	25.566	71.425	1.023	25.566	71.425
3	.714	17.852	89.277			
4	.429	10.723	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component	
	1	2
Sufficient numbers of skilled engineers/technicians	.809	
TPM improves teamwork between production and maintenance	.740	-.417
Teamwork is important for TPM culture	.633	
shop floor workers are organised in TPM teams	.481	.801

Extraction Method: Principal Component Analysis.

11.12 APPENDIX III-I - Samples of the Questionnaire Responses in Percentage

No.	Statements	SD	D	U	A	SA
1	Commitment and support	0	0	.9	20.7	78.4
2	Encourages employee involvement in TPM	0	1	10.8	41.4	46.8
3	Pays attention to improving maintenance	0	1.8	7.2	47	44
4	Clear understanding of missions	0	8.2	17.1	41.4	33.3
5	Ensures employees are well supported	0	0	12.6	46	41.4
6	Focuses on health, safety	0	.9	7.2	36	55.9
7	Employees encourages to implement suggestions	0	.9	11.7	54.1	33.3
8	TPM involves every single employee	0	7.2	6.3	49.5	37
9	Employees are routinely involved in CI	.9	10.8	11.7	55	21.6
10	Production employees accepted AM	0	9	27.9	44.1	19
11	Employees have easy access to information	1.8	9	20.7	46	22.5
12	Effective communication between teams	.9	8.1	15.3	58.6	17.1
13	Employees are well informed of the current policies	.9	3.6	26.1	46	23.4
14	Employees are regularly given feedback	.9	2.7	19	46.8	30.6
15	A detailed roles and responsibilities	1.9	8.1	15.3	41.4	33.3
16	The organisations has good 5s	.9	6.3	11.7	53.2	27.9
17	The organisation evaluates the efficiency, effectiveness	3.6	8.1	9	60.4	18.9
18	The organisation uses benchmarking	.9	12.6	12.6	63.1	10.8
19	Equipment is made available for maintenance	0	3.6	3.6	60.4	32.4
20	Machine availability is visible and understood	0	4.5	14.4	56.8	24.3
21	There is a system of making modifications	0	7.2	18.9	59.5	14.4
22	There are processes in place to analysis breakdowns	4.5	4	11	52.3	28.2
23	Resources allocated for TPM	3.6	10.8	32.4	37	16.2
24	Employees suggestions are evaluated and implemented	0	6.7	24.3	51	18.0
25	The organisation treats all employees equally	0	.9	5.4	52.3	41.4
26	Operators do basic maintenance and inspect m/c	0	1.8	10.8	52.3	35.1
27	All the TPM teams are empowered	3.6	1.8	16.2	55.0	23.4
28	Training and education are vital for TPM	0	.9	7.2	45.0	46.8
29	Safety and environment training programmes	0	0	7.2	46.8	46
30	Regular reviews and improvements	1	2.7	14.4	49.5	32.4
31	TPM team leaders are experienced	3.6	4.6	24.3	44.1	23.4
32	Appropriate data collection and analysis	3.6	2.7	9.0	53.2	31.5
33	The company follows schedule of planned maintenance	1.8	1.0	13.5	39.6	44.1
34	Condition Monitoring has improved reliability	2.7	1.8	17.1	60.4	18.0
35	People encouraged to improve knowledge	0	2.7	12.6	47.7	37
36	There is a system for linking recognition and rewards	3.6	18.9	29.7	33.3	14.4
37	shop floor workers are organised in TPM teams	4.5	17.2	34.2	28.8	15.3
38	Teamwork is important for TPM culture	.9	2.7	1.8	56.8	37.8
39	TPM improves teamwork between production and maintenance	0	5.4	9.9	55.0	29.7
40	Sufficient numbers of skilled engineers/technicians	0	14.5	8.1	47.7	29.7

11.13 APPENDIXIII-J- Mean score for each statement

No.	Statements	Mean	Rank
1.	Commitment and support	**4.77**	1
2	Encourages employee involvement in TPM	4.34	5
3	Pays attention to improving maintenance	4.20	12
4	Clear understanding of missions	4.00	23
5	Ensures employees are well supported	4.29	7
6	Focuses on health, safety	**4.47**	2
7	Employees encouraged to implement suggestions	4.20	13
8	TPM involves every single employee	4.16	15
9	Employees are routinely involved in CI	3.86	29
10	Production employees accepted AM	3.73	36
11	Employees have easy access to information	3.78	34
12	Effective communication between teams	3.83	30
13	Employees are well informed of the current policies	3.87	28
14	Employees are regularly given feedback	4.04	19
15	detailed roles and responsibilities	4.02	20
16	The organisations has good 5s	4.01	21
17	The organisation evaluates the efficiency, effectiveness	3.83	31
18	The organisation uses benchmarking	3.70	36
19	Equipment is made available for maintenance	4.22	10
20	Machine availability is visible and understood	4.01	22
21	There is a system of making modifications	3.81	33
22	There are processes in place to analysis breakdowns	3.96	24
23	Resources allocated for TPM	3.51	38
24	Employees suggestions are evaluated and implemented	3.81	34
25	The organisation treats all employees equally	**4.34**	6
26	Operators do basic maintenance and inspect m/c	4.21	11
27	All the TPM teams are empowered	3.93	25
28	Training and education are vital for TPM	**4.38**	4
29	Safety and environment training programmes	**4.39**	3
30	Regular reviews and improvements	4.10	16
31	TPM team leaders are experienced	3.82	31
32	Appropriate data collection and analysis	4.06	18
33	The company follows schedule of planned maintenance	4.25	9
34	Condition Monitoring has improved reliability	3.89	27
35	People encouraged to improve knowledge	4.19	14
36	There is a system for linking recognition and rewards	3.36	39
37	Shop floor workers are organised in TPM teams	3.33	40
38	Teamwork is important for TPM culture	**4.28**	8
39	TPM improves teamwork between production and maintenance	4.09	17
40	Sufficient numbers of skilled engineers/technicians	3.93	26

11.14 APPENDIX IV-A- location of Libya

11.15 Appendix IV-B - Samples of the questionnaire responses in percentage

No.	Statements	SD	D	U	A	SA
1	Commitment and support	8.9	3.2	7.3	46.8	33.9
2	Encourages employee involvement in TPM	0	2.4	15.3	54.8	27.4
3	Pays attention to improving maintenance	2.4	1.6	15.3	49.2	31.5
4	Clear understanding of missions	.8	10.5	21.0	40.3	27.4
5	Ensures employees are well supported	3.2	12.1	10.5	51.6	22.6
6	Focuses on health, safety	5.6	7.3	12.9	33.9	40.3
7	Employees encourages to implement suggestions	5.6	8.9	27.4	37.1	21.0
8	TPM involves every single employee	.8	7.3	21.8	40.3	29.8
9	Employees are routinely involved in CI	0	13.7	24.2	44.4	17.7
10	Production employees accepted AM	1.6	21.8	35.5	25.8	15.3
11	Employees have easy access to information	3.2	35.5	12.9	32.3	16.1
12	Effective communication between teams	1.6	16.9	11.3	29.0	41.1
13	Employees are well informed of the current policies	4.8	19.4	17.7	31.5	26.6
14	Employees are regularly given feedback	.8	11.3	12.1	38.7	37.1
15	A detailed roles and responsibilities	.8	.8	27.4	37.9	33.1
16	The organisations has good 5s	.8	11.3	38.7	33.1	16.1
17	The organisation evaluates the efficiency, effectiveness	8.1	13.7	28.2	25.0	25.0
18	The organisation uses benchmarking	1.6	22.6	21.0	24.2	30.6
19	Equipment is made available for maintenance	1.6	8.9	8.9	48.4	32.3
20	Machine availability is visible and understood	3.2	3.2	12.9	56.5	24.2
21	There is a system of making modifications	0	14.5	12.1	54.0	19.4
22	There are processes in place to analysis breakdowns	.8	4.0	19.4	36.3	39.5
23	Resources allocated for TPM	.8	1.6	40.3	31.5	25.8
24	Employees suggestions are evaluated and implemented	1.6	15.3	12.1	33.9	37.1
25	The organisation treats all employees equally	5.6	16.9	20.2	30.6	26.6
26	Operators do basic maintenance and inspect m/c	.8	14.5	19.4	33.9	31.5
27	All the TPM teams are empowered	0	21.0	39.5	33.1	6.5
28	Training and education are vital for TPM	10.5	1.6	1.6	41.9	44.4
29	Safety and environment training programmes	.8	3.2	4.0	44.4	47.6
30	Regular reviews and improvements	.8	7.3	21.8	33.1	37.1
31	TPM team leaders are experienced	11.3	6.5	9.7	41.9	30.6
32	Appropriate data collection and analysis	.8	10.5	29.8	27.4	31.5
33	The company follows schedule of planned maintenance	4.8	8.9	11.3	46.8	28.2
34	Condition Monitoring has improved reliability	1.6	1.6	8.9	45.2	42.7
35	People encouraged to improve knowledge	12.1	8.1	9.7	46.8	23.4
36	There is a system for linking recognition and rewards	10.5	18.5	16.1	29.8	25.0
37	shop floor workers are organised in TPM teams	11.3	10.5	32.3	27.4	18.5
38	Teamwork is important for TPM culture	.8	.8	7.3	55.6	35.5
39	TPM improves teamwork between production and maintenance	.8	4.0	11.3	52.4	31.5
40	Sufficient numbers of skilled engineers/technicians	4.0	.8	12.9	62.9	19.4

11.16 APPENDIXIV-C - Questionnaire in Arabic

جامعة برمنجهام

استبيان حول الثقافة المؤسسية وبرنامج الصيانة الإنتاجية الكاملة TPM

مقدمة:

يعتبر التغير الثقافي المحرك الأساسي لتبني وتطبيق برنامج الصيانة الإنتاجية الكاملة TPMالذي أظهر تحسنا كبيرا في التنافسية والربحية للشركات في جميع أنحاء العالم مما أدى إلى ارتفاع تصنيف بعضها، ومع ذلك فإن الكثير من تلك الشركات لم تتمكن من تطوير هذا البرنامج . يستعرض هذا الاستبيان العلاقة بين الثقافة المؤسسية وبرنامج الصيانة الإنتاجية الكاملة ونأمل منكم الإجابة عليه حيث يعتمد نجاحه على مدى تجاوبكم معه.

الإرشادات:

اقرأ الأسئلة بعناية وضع علامة ✓ أو تحديد الإجابة الخاصة بكم في المكان المخصص:

الجزء الأول: معلومات عامة

1- المستوى الوظيفي

إدارة عليا ☐ إدارة وسطى ☐ إشراف ☐ أخرى .....

2- ما هو دوركم داخل المؤسسة؟ .....

3- ملكية المؤسسة

حكومية ☐ خاصة ☐ مشاركة ☐ أخرى .....

4- عدد العاملين بالمؤسسة تقريبا

أقل من 50 ☐ 249-50 ☐ أكثر من 250 ☐

5- نوع المنتج المصنع

آليات ☐ كيميائي ☐ فضاء ☐ نفط وغاز ☐ لدائن ومطاط ☐ كهربي/الكتروني ☐

مأكولات ومشروبات ☐ أخرى .....

الجزء الثاني: مقياس الصيانة الإنتاجية الكاملة

يحتوي الجدول التالي على قائمة تتكون من عشر عناصر للثقافة المؤسسية التي يعتقد أنها تؤثر على نجاح هذا البرنامج. نأمل منكم توضيح مدى موافقتكم أو عدم موافقتكم على هذه العناصر بوضع علامة في الصندوق المخصص لذلك باستخدام إحدى الخيارات الآتية:

1- غير موافق بشدة 2- غير موافق 3 - غير متأكد 4- موافق 5- موافق بشدة

	العناصر	1	2	3	4	5
1	**الإدارة العليا** - الالتزام والدعم يحدد نجاح مبادرات التغيير الجديدة	☐	☐	☐	☐	☐
	- تشجيع العاملين على المشاركة في الصيانة الإنتاجية الكاملة	☐	☐	☐	☐	☐
	- الاهتمام البالغ بتحسين الصيانة	☐	☐	☐	☐	☐
	- الفهم الجيد لمهام الصيانة	☐	☐	☐	☐	☐
	- التأكيد على الدعم الكامل للعاملين أثناء فترة التغيير	☐	☐	☐	☐	☐
	- التركيز على الصحة والسلامة وقضايا البيئة	☐	☐	☐	☐	☐
2	**المشاركة الكاملة للعاملين** - تشجيع العاملين على تقديم وتنفيذ مقترحاتهم	☐	☐	☐	☐	☐
	- إشراك كافة العاملين في البرنامج من الإدارة العليا إلى العمال على أرض المصنع	☐	☐	☐	☐	☐
	- إشراك العاملين بشكل روتيني في بعض أشكال التحسن المستمر والمنظم (كايزن)	☐	☐	☐	☐	☐
	- تقبل عمال الإنتاج لتحمل مسؤوليتهم للقيام بالصيانة الذاتية	☐	☐	☐	☐	☐

	- سهولة حصول العاملين على المعلومات حول الإنتاجية	☐	☐	☐	☐	☐
3	**التواصل ودرجة الوعي** - هناك تواصل فعال بين فرق العمل عبر مختلف المستويات بالهيكل التنظيمي بالمؤسسة	☐	☐	☐	☐	☐
	- لدى العاملين دراية جيدة بالسياسات الحالية لتطوير العمال	☐	☐	☐	☐	☐
	- يتم تزويد العمال بمعلومات حول قضايا البيئة والحوادث المتعلقة بالسلامة وطرق تصحيحها	☐	☐	☐	☐	☐
4	**التخطيط الإستراتيجي وخطة العمل** - الأدوار والمسؤوليات محددة وواضحة ويتم تحديثها واستيعابها من قبل كافة العاملين بالمصنع بشكل جيد.	☐	☐	☐	☐	☐
	- لدى المؤسسة نظام جيد للنظافة للترتيب المنزلي (5-Ss)	☐	☐	☐	☐	☐
	- قامت المؤسسة بتطوير آلية لتقييم فاعلية الأداء لعمليات الصيانة	☐	☐	☐	☐	☐
	- تستخدم المؤسسة نظام للقياس لتحديد احتياجات التغيير	☐	☐	☐	☐	☐
5	**تخصيص الموارد ومدى توفرها** - توفير المعدات للصيانة ضمن برنامج معد في كل أنحاء المصنع	☐	☐	☐	☐	☐
	- توفر ألألأت في الأماكن المخصصة بشكل واضح ومفهوم للجميع	☐	☐	☐	☐	☐
	- يوجد نظام للقيام بالتعديلات للمعدات الموجودة وذلك لتحسين عملية توفرها	☐	☐	☐	☐	☐
	- توجد آلية لتحليل الأعطال والأسباب الأساسية يتم تحديدها وإصلاحها بشكل دائم	☐	☐	☐	☐	☐
	- تخصيص الموارد لبرنامج الصيانة الإنتاجية الكاملة وألا تحل مبادرات أخرى مثل (TQM) محل هذا البرنامج	☐	☐	☐	☐	☐
6	اعتماد مقترحات العاملين وتفعيلها - تقييم المقترحات وتطبيقها بشكل منتظم	☐	☐	☐	☐	☐
	- المساواة بين العاملين على أساس الاحترام وحسن الأداء	☐	☐	☐	☐	☐
	- يقوم المشغلون بالصيانة الأساسية وفحص ألألأت يوميا	☐	☐	☐	☐	☐
	- يتم دفع فرق برنامج TPM لتحمل مسؤوليات قراراتهم	☐	☐	☐	☐	☐
7	التدريب والتعليم - يعتبر التدريب والتعليم عنصرا أساسيا لتبني نظام TPM	☐	☐	☐	☐	☐

	- توفير برامج تدريبية حول البيئة والسلامة لفرق العمل والموظفين	☐	☐	☐	☐	☐
	- القيام بالمراجعة وإدخال التحسينات بانتظام لمواكبة الحاجة للتغيير	☐	☐	☐	☐	☐
	- لدى القياديين بنظام TPM الخبرة ومهارات القيادة	☐	☐	☐	☐	☐
8	المراقبة والتقييم - يتم استخدام نظام جمع وتحليل معلومات مناسب للتخلص من فقدان المعدات	☐	☐	☐	☐	☐
	- تتبع المؤسسة جدول منظم لصيانة المعدات	☐	☐	☐	☐	☐
	- نظام المراقبة يرفع من اعتمادية ألألأت بمواقع الإنتاج	☐	☐	☐	☐	☐
9	الحوافز - يتم تحفيز العاملين لزيادة المعرفة والمهارة	☐	☐	☐	☐	☐
	- يوجد نظام يربط بين التحفيز وأهداف تحسين الأداء ضمن استراتيجية المؤسسة	☐	☐	☐	☐	☐
10	العمل الجماعي - يتم تقسيم العمل على أرض المصنع كفرق عمل نظام TPM لحل المشاكل بتوافق اهداف الفرق مع أهداف القطاع	☐	☐	☐	☐	☐
	- يعتبر العمل الجماعي عنصرا هاما لتحقيق ثقافة TPM	☐	☐	☐	☐	☐
	- نظام TPM يرفع من اداء العمل الجماعي لأقسام الإنتاج والصيانة	☐	☐	☐	☐	☐
	- يوجد عدد كاف من المهندسين والفنيين المهرة بمواقع الإنتاج	☐	☐	☐	☐	☐

الجزء الثالث: الثقافة المؤسسية والمناخ المؤسسي

العبارات الآتية تصف أنماط القيم السائدة التي قد توجد في مؤسستك. يرجي توضيح المدى الذي عنده تقوم كل عبارة بوصف مؤسستك. يرجى ملاحظة أنه لا يوجد وصف أفضل من الأوصاف الأخرى ولكنها أوصاف مختلفة عن بعضها فقط.

1- غير موافق بشدة 2- غير موافق 3 - غير متأكد 4- موافق 5- موافق بشدة

	العناصر	1	2	3	4	5
1	**الخصائص البارزة في المؤسسة**	☐	☐	☐	☐	☐
	- إنها مكان شخصي جدا وكأنها أسرة كبيرة يشارك الناس فيها بعضهم البعض	☐	☐	☐	☐	☐
	- إنها مكان مفعم بالحركة والإبتكار والإرادة لخوض التجربة ومواجهة المخاطر	☐	☐	☐	☐	☐
	- الإهتمام الرئيسي بأداء المهام وتحقيق النتائج, وإعتماد التنافسية والإنجاز	☐	☐	☐	☐	☐
	- يتم العمل وفق آلية وهيكلية محددة وضمن الإجراءات الرسمية.	☐	☐	☐	☐	☐
2	**اسلوب قيادة المؤسسة**	☐	☐	☐	☐	☐
	- تتصف عموما بالمراقبة وتسهيل تنفيذ المهام	☐	☐	☐	☐	☐
	- تتصف عموما بالمبادرة والإبتكار وركوب المخاطر	☐	☐	☐	☐	☐
	- تتصف عموما بالعملية والجدية والتركيز على حصد النتائج	☐	☐	☐	☐	☐
	- تتصف عموما بأنها تنسيقية وتنظيمية	☐	☐	☐	☐	☐
3	**متانة (تماسك) المؤسسة**	☐	☐	☐	☐	☐
	- ارتفاع الولاء والتقاليد والإلتزام	☐	☐	☐	☐	☐
	- الإتزام بالإبتكار والتطويروالتركيز على تكون الأولى في منتجاتها / خدماتها	☐	☐	☐	☐	☐
	- السياسات والقوانين الرسمية والحفاظ على سير العمل بشكل سلس أمر مهم	☐	☐	☐	☐	☐
	- هناك تركيز على تحقيق الهدف والمهمة . وهناك تشارك في توجيه الإنتاج والإنجاز	☐	☐	☐	☐	☐

4	**المناخ داخل المؤسسة** - مريح ويدعو إلى المشاركة. فيه ثقة عالية واتفاق على المتطلبات	☐	☐	☐	☐	☐
	- يركز على الديناميكية والإستعداد لمواجهة تحديات جديدة, ويحاول طرقا جديدة مع التعلم عن طريقة التجربة والخطأ	☐	☐	☐	☐	☐
	- يركز على الأداء والإستقرار والتوقعات بإجراءات واضحة ومعززة	☐	☐	☐	☐	☐
	- المنافسة والمواجهة والتركيز على الفوز	☐	☐	☐	☐	☐
5	**معايير النجاح في المؤسسة** - تعتمد على أساس تطويرها للموارد البشرية والعمل الجماعى واهتمامها بالعاملين	☐	☐	☐	☐	☐
	- تعتمد على المنتجات/الخدمات الفريدة أو الجديدة وهي مبتكرة ورائدة من حيث إنتاجها	☐	☐	☐	☐	☐
	- تعتمد على الفاعلية وأداء المهام في وقتها مع إنخفاض تكلفة الإنتاج	☐	☐	☐	☐	☐
	- التنافس على الصدارة والقيادة في السوق	☐	☐	☐	☐	☐
6	**أسلوب إدارة المؤسسة** - يتسم بالعمل الجماعي والمشورة والمشاركة	☐	☐	☐	☐	☐
	- يتسم بالمبادرات والإبتكارات والحرية والتمييز الفردي	☐	☐	☐	☐	☐
	- يتسم باستقرار العاملين وطول مدة بقائهم في المراكز الوظيفية مع توقع ما يحدث في المؤسسة	☐	☐	☐	☐	☐
	- يتسم بكثرة الواجبات من أجل المنافسة والإنتاج والإنجاز	☐	☐	☐	☐	☐

نشكركم على المشاركة ونؤكد لكم بأن إجاباتكم ستعامل بسرية تامة وأنها سوف تستخدم لأغراض البحث فقط.

11.17 APPENDIX IV-D- Responses of the Libyan Questionnaire

Details of Reponses	First batch	Second batch	Total
Date of sending questionnaire	01/08/2012	02/08/2012	
	200	150	350
Positive responses	75	20	95
Refuse to participate	5	3	8

Reminder letter

Detail of responses	One batch
Date of sending Q	05/9/2012
Questionnaire sent	247
Positive responses	29
Refuse to participate	0

The total responses as follows

Details of Reponses	Total	Percentage
Positive responses	95+29=124	35%
Refuse to participate	8	

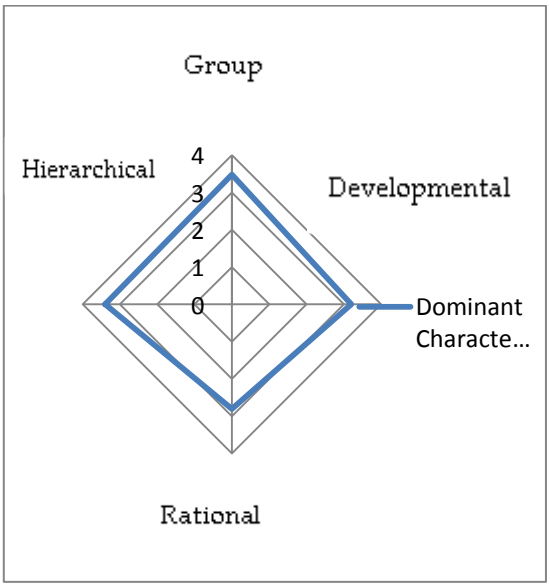
11.18 APPENDIX IV-E- Mean score for each statement

No.	Statement	Mean	SD	Rank
1	Commitment and support	3.94	1.160	15
2	Encourages employee involvement in TPM	4.07	.723	7
3	Pays attention to improving maintenance	4.06	.868	8
4	Clear understanding of missions	3.83	.977	21
5	Ensures employees are well supported	3.78	1.032	24
6	Focuses on health, safety	3.96	1.158	13
7	Employees encourages to implement suggestions	3.59	1.090	31
8	TPM involves every single employee	3.91	.937	17
9	Employees are routinely involved in CI	3.66	.927	28
10	Production employees accepted AM	3.31	1.031	37
11	Employees have easy access to information	**3.23**	1.188	**40**
12	Effective communication between teams	3.91	1.162	18
13	Employees are well informed of the current policies	3.56	1.212	32
14	Employees are regularly given feedback	4.00	1.012	11
15	A detailed roles and responsibilities	4.02	.846	9
16	The organisations has good 5s	3.52	.924	34
17	The organisation evaluates the efficiency, effectiveness	3.45	1.232	35
18	The organisation uses benchmarking	3.60	1.189	30
19	Equipment is made available for maintenance	4.01	.958	10
20	Machine availability is visible and understood	3.95	.891	14
21	There is a system of making modifications	3.78	.924	26
22	There are processes in place to analysis breakdowns	4.10	.905	5
23	Resources allocated for TPM	3.80	.874	23
24	Employees suggestions are evaluated and implemented	3.90	1.118	19
25	The organisation treats all employees equally	3.56	1.212	33
26	Operators do basic maintenance and inspect m/c	3.81	1.064	22
27	All the TPM teams are empowered	3.25	.861	39
28	Training and education are vital for TPM	4.08	1.214	6
29	Safety and environment training programmes	4.35	.776	**1**
30	Regular reviews and improvements	3.98	.979	12
31	TPM team leaders are experienced	3.74	1.274	27
32	Appropriate data collection and analysis	3.78	1.032	25
33	The company follows schedule of planned maintenance	3.85	1.082	20
34	Condition Monitoring has improved reliability	4.26	.815	2
35	People encouraged to improve knowledge	3.61	1.267	29
36	There is a system for linking recognition and rewards	3.40	1.325	36
37	Shop floor workers are organised in TPM teams	3.31	1.219	38
38	Teamwork is important for TPM culture	4.24	.691	3
39	TPM improves teamwork between production and maintenance	4.10	.811	4
40	Sufficient numbers of skilled engineers/technicians	3.93	.848	16

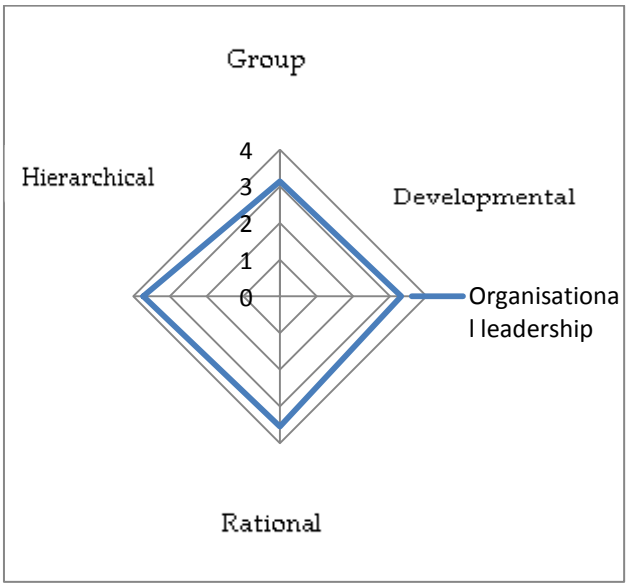
11.19 APPENDIXIV-F- Group statistics

	country conducting questionnaire	N	Mean	Std. error	Std. Dev
F1	UK	111	4.34	.1002	.837
	LIBYA	124	3.94	.0711	.986
F2	UK	111	3.94	.0903	.853
	LIBYA	124	3.54	.0851	1.034
F3	UK	111	3.91	.1028	.838
	LIBYA	124	3.82	.0768	1.128
F4	UK	111	3.89	.0974	.895
	LIBYA	124	3.65	.0826	1.047
F5	UK	111	3.90	.0928	.838
	LIBYA	124	3.93	.0919	.910
F6	UK	111	4.07	.01032	.756
	LIBYA	124	3.63	.0651	1.063
F7	UK	111	4.17	.0986	.765
	LIBYA	124	4.04	.0828	1.060
F8	UK	111	4.06	.09343	.853
	LIBYA	124	3.96	.0907	.976
F9	UK	111	3.77	.1071	.908
	LIBYA	124	3.50	.0665	1.296
F10	UK	111	3.90	.0923	.887
	LIBYA	124	3.89	.0844	.892

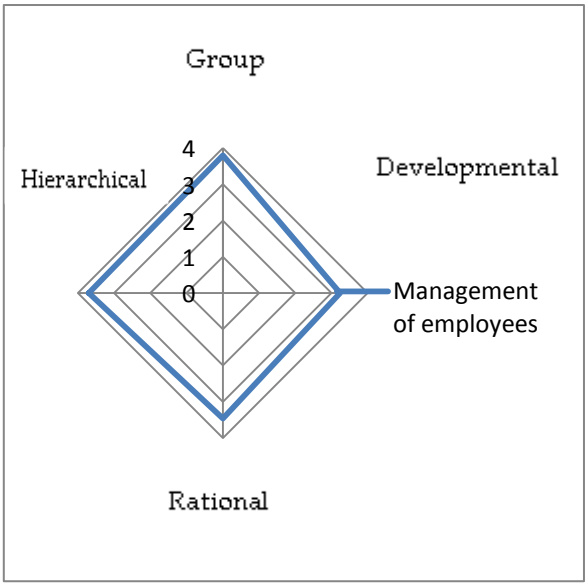
11.20 APPENDIXIV-G- Six OC profiles for Libyan companies



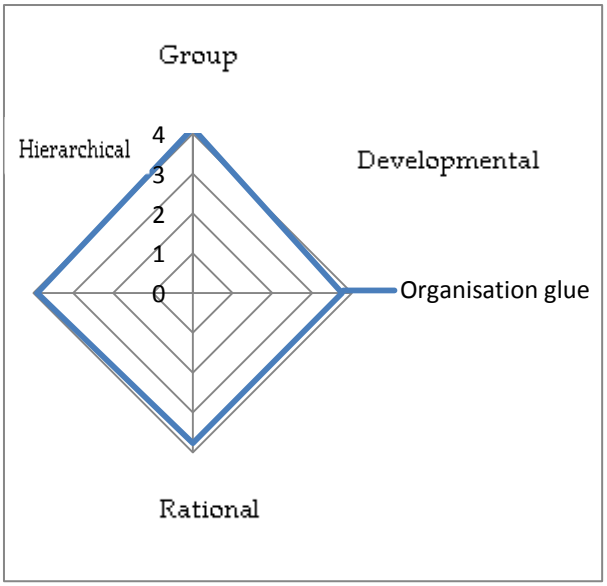
(a) Dominate culture



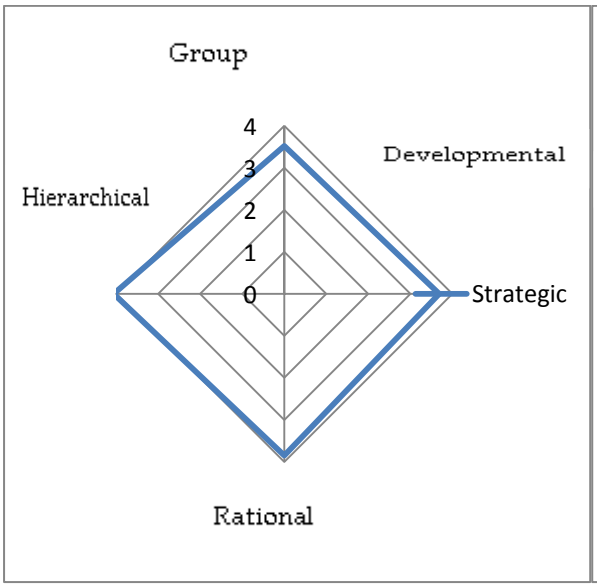
(b) Organisational leadership



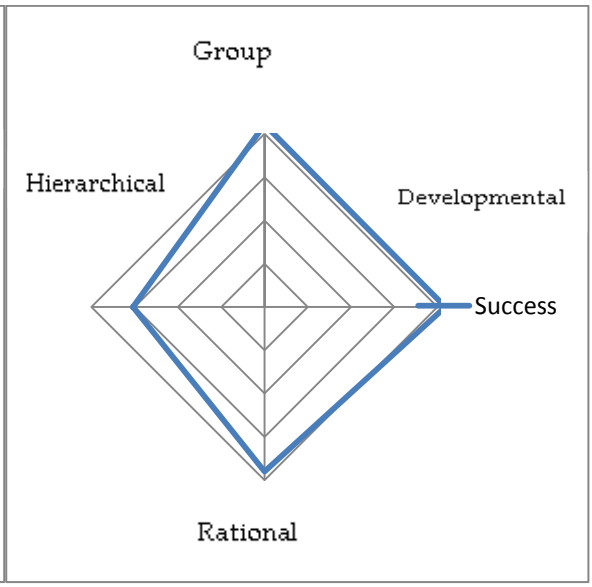
(c) Management of Employees



(d) Organisation Glue



(e) Strategic emphasis



(f) Criteria of Success

11.21 APPENDIX V- Publications

Journal Publications

[1] Elgharib, M. And Aspinwall, E. (2013),"TPM Implementation in Large and Medium Size Organisations", Journal of Manufacturing Technology Management, Vol. 24, No. 5, pp. 688-710.