AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN ORGANISATIONAL CULTURE AND MAINTENANCE IMPLEMENTATION IN IRAQI POWER PLANTS

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Abstract

This thesis explorers the reasons for power shortage and the level of maintenance implementation in Iraqi power plants, furthermore, it examines the current organisational culture in Iraqi power plants, and its effect on maintenance implementation factors. Currently the active power plant units in Iraq are producing only 54% their designed capacity, which is in turn only supplying 50% of the countries' demand. Therefore, to try and understand the reasons for this low level of efficiency, this research uses an exploratory sequential mixed method design, starting with semi-structured interviews (qualitative) with nine power plant managers or their representatives, followed by a questionnaire survey (quantitative), receiving 484 responses from the employees of those nine power plants.

The reasons for power shortage in Iraq were identified, Furthermore, the level of maintenance implementation in the Iraqi power plants, was examined found to be at a medium level. In terms of organisational culture, not enough attention has been paid in the literature. This lack of research in the area of cultural effect on maintenance implementation was one of the main motivators for this study to answer the following question; to what extent do organizational culture profiles effect maintenance implementation factors in organisations. Structural equation modelling (SEM) technique was used to examine the relationship between organisational culture and maintenance implementation factors. Furthermore, based on the research findings, maintenance improvement framework was developed and detailed plans for implementation were formulated. The framework was built on the basis that improving organisational culture will improve the factors affecting maintenance and these factors will facilitate Total Productive Maintenance (TPM) implementation in Iraqi power plants.

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Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Faculty Ethics Committee / University Ethics Committee / external committee [RE-EE-13-140409-5345421fd0d21] on [09/04/2014].

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List of Abbreviations

ANOVA	Analysis of Variance
AVE	Average Variance Expected
BM	Breakdown Maintenance
CBM	Condition Based Maintenance
CCQ	Corporate Culture Questionnaire
CI	Continuous Improvement
CM	Corrective Maintenance
CMMS	Computerized Maintenance Management Systems
CQ	Culture Questionnaire
CR	Composite Reliability
CVF	Competing Values Framework
IDP	Internally Displaced People
JIPM	Japanese Institute of Plant Maintenance
MP	Maintenance Prevention
MPM	Maintenance Performance Measurement
O&M	Operation and Maintenance
OCA	Organisational Culture Assessment Instrument
OCI	Organisational Culture Inventory
OEE	Overall Equipment Effectiveness
PdM	Predictive Maintenance
PM	Preventive Maintenance
PrM	Productive Maintenance
RCM	Reliability Centred Maintenance
SEM	Structural Equation Modelling
SIGIR	Special Inspector General for Iraq Reconstruction
SOC	Survey of Organisational Culture
SPSS	Statistical Package for the Social Sciences
TBM	Time Based Maintenance
TPM	Total Productive Maintenance
TQM	Total Quality Management
UNDP	United Nations Development Programme

Chapter 1. Introduction

1.1 Introduction to Iraq's Electricity Shortages

Before 1990, Iraq's power system was at the top of the Middle East region with generation capacity exceeding the local demand of electricity, with more power plants to be built. However, during the Gulf War in 1991, about 90% of Iraq's power generating and distribution systems were destroyed and full recovery has never happened. Immediately after the war, with limited resources and lack of spare parts, Iraq was able to recover and restore about 50% of the generation capacity, which was sufficient until the mid-1990s [1].

However, the international sanctions and economic embargo that followed the war, seriously affected economic growth in Iraq and the power sector was never fully rebuilt. This led to a significant reduction in electrical power generation capacity, resulting in a huge shortage in electricity supply for domestic, commercial and industrial users. In fact, during this period Iraq had the lowest average consumption of electrical power in the Middle East, it was almost one third that of neighbouring countries such as Iran, Saudi Arabia and Turkey [2].

In 2003, before the Iraqi freedom war, the country's electricity production was about 3.4 GW with a demand for 4.7 GW [3]. However, during the war, the electricity power infrastructure suffered again from military actions, and after the war from vandalism, sabotage and corruption, the bad security situation, as well as being targeted by terrorist groups. Following the war, at the end of 2003, the Iraqi Ministry of Electricity started to invest to rebuild the existing power plants and build new plants, which helped to increase the supply of electricity to 3.5 GW. However, it was unable to keep pace with rising demand of 7 GW, because Iraq was once again open to the

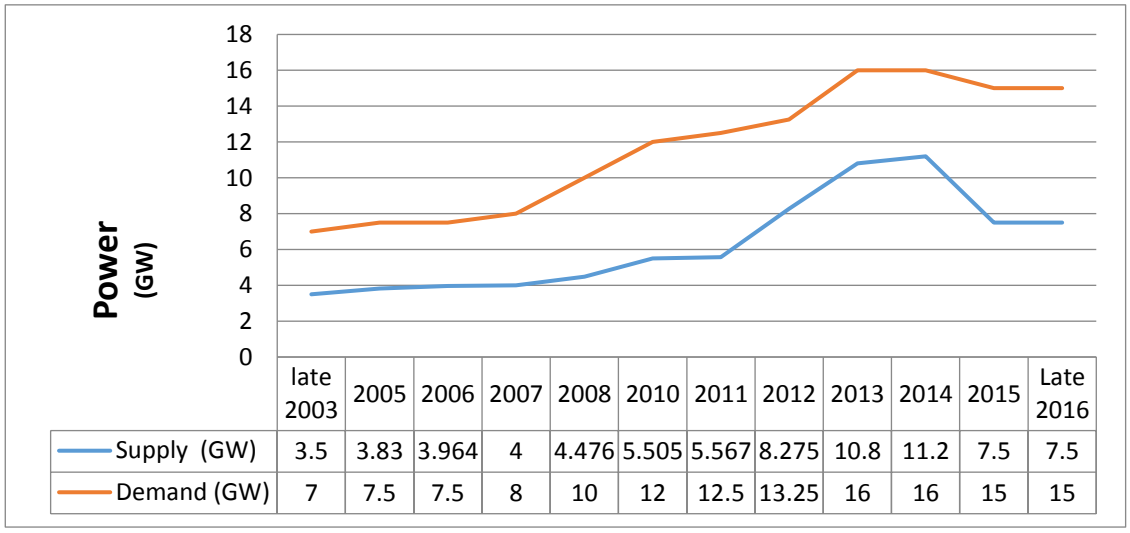
global market, which enabled importation of all types of household electrical equipment and devices leading to higher demand for electricity.

By 2008 the demand had increased again to 10 GW and the supply was only 4.5 GW. Iraqi households were supplied on average just 8 hours of electricity per day through the public network and a quarter of these had no access to an alternative source of power. Even with the support of expensive communal and private generators, households in most governorates were receiving less than 18 hours of electricity per day. According to the United Nations Development Programme (UNDP) [4] the electricity supply has since deteriorated even further in some areas, particularly Baghdad, but the Iraqi Kurdistan region has seen some slight improvements. For Iraq's internally displaced People (IDPs), the situation is often very poor, with 37% of IDP households receiving less than four hours of electricity daily [5].

The deteriorated transmission system and poor quality of the network is also severely impacting economic development. Many businesses have to invest a significant amount of their revenues in expensive private generators. This reduces profitability, deters potential investment and hinders economic growth, diversification and job creation [5].

By 2014 the power supply had increased to 11.2 GW due to new power plants being commissioned in the period from 2012 to 2014. However, in the middle of 2014 three important cities (Mosel, AlAnbar, and Salah Alden) were attacked and controlled by terror group, and this led to a drop in power supply to 7.5 GW because the power plants in those cities were out of production.

As shown in Figure 1.1, there has been a steady increase in power supply and demand from 2003 to 2016 in Iraq, but unfortunately the shortfall between the two has never really been reduced and demand is still significantly higher than supply. The power demand increased from 7 GW in late 2003 to 16 GW in the middle 2014 while the power supply from the Iraqi power stations only increased from 3.5 GW to 11.2 GW during the same period. Unfortunately, the power supply dropped again to 7.5 GW in the second half of 2014 until the present time due to bad security situation and the current financial difficulties in Iraq due to the oil price drop.



	late 2003	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015	Late 2016
Supply (GW)	3.5	3.83	3.964	4	4.476	5.505	5.567	8.275	10.8	11.2	7.5	7.5
Demand (GW)	7	7.5	7.5	8	10	12	12.5	13.25	16	16	15	15

Figure 1.1 Electricity supply and demand in Iraq from late 2003 to late 2016

According to the Iraqi Ministry of Electricity, there are currently seven types of power production station used in Iraq, see Table 1.1 [6]. There are a total number of 483 units which have a combined design capacity of 18.922 GW. However, the current active units have a combined designed capacity of 12 GW, but unfortunately their current production rate is about 6.5 GW, which means they are only producing 54% of their designed capacity.

If these existing plants could be made more reliable the current shortage of power in Iraq could be significantly reduced or even completely eliminated. For example, if

the current active plants were running at 84% of their designed capacity the power supply in Iraq could be increased from 11.2 GW to 16 GW which would more than cover the current total power demand of 15 GW.

Table 1-1 Number, type and power production rate of Iraqi power production units [6]

Production station Type	Number of units	Number of active units	Total design capacity of the units (GW)
Steam Turbine Stations	29	27	6.470
Gas Turbine stations	142	131	8.522
Mobile stations	22	5	0.308
Diesel stations	29	26	0.459
Hydro power stations	37	33	2.513
Supported Diesel stations	212	100	0.290
Hyundai Diesel stations	12	12	0.360
Total	483	334	18.922

1.2 Purpose of the study

The main purpose of this study is to identify the reasons for power shortage in Iraq and to classify the level of maintenance implementation and organisational culture profiles in Iraqi power plants, and subsequently empirically examine the relationships between organisational culture and maintenance factors.

Examining the literature to date indicated that there is no previous study which has identified the reasons for the power shortage and current level of power production in Iraq; furthermore, a knowledge gap exists that has been pointed out by several researchers on the importance of examining the influence of organisational culture on maintenance factors. This study thus represents the first study that has attempted to explore the factors behind the power shortage in Iraq, and to investigate the effects of organisational culture profiles on maintenance implementation factors. Understanding these effects will help organisations to determine which cultural profiles to focus on and enhance in order to improve

individual maintenance factors, which help to develop maintenance implementation and ultimately reduce power shortages.

1.3 Problem statement

The power generation rate in Iraq is currently at 54% of its designed capacity, which can only supply about 50% of the country's current demand. Therefore, there is a big gap between the production rate and designed capacity of Iraqi power plants, which needs to be addressed and the reasons for this shortfall need to be identified as there is no research that has addressed or empirically examined these reasons.

As stated in the in literature review chapter, many researchers have identified organisational culture as being a barrier impeding maintenance from being implemented successfully. However, there is no study that has linked or measured the impact of different organisational cultures on maintenance implementation factors, practice or performance. These clarifications about the literature led to identification of a critical gap in terms of the reasons for power shortage in Iraqi and the effect of organisational culture on maintenance implementation factors, which formed the following four key research questions to be addressed:

1. What are the main reasons for the power shortage in Iraq?
2. What is the level of maintenance implementation in the Iraqi power plants?
3. What are the existing types of organisational culture in the Iraqi power plants?
4. What is the relationship between organisational culture and the maintenance implementation factors?

1.4 The aim and objectives of the research

The overall aim presented in this thesis is to investigate the reasons for power shortage in Iraq, and to examine the level of maintenance implementation in Iraqi

power plants. Moreover, to examine the influence of cultural profiles in power plants on maintenance implementation factors in order to understand their influence on development of an effective maintenance framework for Iraqi power plants. The main objectives of the research are to:

- Investigate the barriers and difficulties influencing current power production rate in the Iraqi power plants.
- Investigate the level of maintenance implementation in the Iraqi power plants.
- Identify the types of organisational culture existing in the Iraqi power plants.
- Investigate what types of organisational culture are effecting what types of maintenance factors.
- Develop a theoretical maintenance framework for Iraqi power plants based on the findings.

1.5 Thesis organisation

This thesis is structured in eight chapters as can be seen in figure 1.2, as follow:

- Chapter one: Introduction – provide information on the research purpose, background, problem statement, the aim and objectives, research questions, and the organisation of this thesis.
- Chapter two: Literature Review - provides a review of Iraq's electricity shortages, power plants reliability, and maintenance strategies, development of maintenance and a review on total productive maintenance (TPM), and its development, TPM pillars, TPM implementation steps, and factors affecting it. This chapter also reviews previous work on organisational culture and its relationship to maintenance, and how to measure organisational culture.

- Chapter three: Methodology- Provides a review of the research philosophy, approach, design and strategy and the use of mixed methods exploratory sequential design to collect data, which started with qualitative data collection (semi structured interviews) with nine power plant managers, and then quantitative data collection (questionnaires) from 1000 employees from nine power plans in Iraq.
- Chapter four: Interview processes and results - Presents the generation of interview questions, the process of conducting interview, and the analysis and results.
- Chapter Five: Questionnaire Data Analysis and Results - Presents the results from the empirical survey based research on barriers affecting power generation rate, level of maintenance implementation, organisational culture profiles in Iraqi power plants, and the effect of organisational culture on maintenance factors.
- Chapter Six: Discussion - Discusses the main findings from the results of chapter four and chapter five in relation to the existing body of knowledge and the primary data analysis.
- Chapter Seven: Framework development – Develops a new framework that helps to implement TPM in Iraqi power plants based on the empirical findings.
- Chapter Eight: Conclusion – Presents the conclusions developed based on the empirical findings, pointing out the contributions of the study and its limitations and recommends directions for future research.

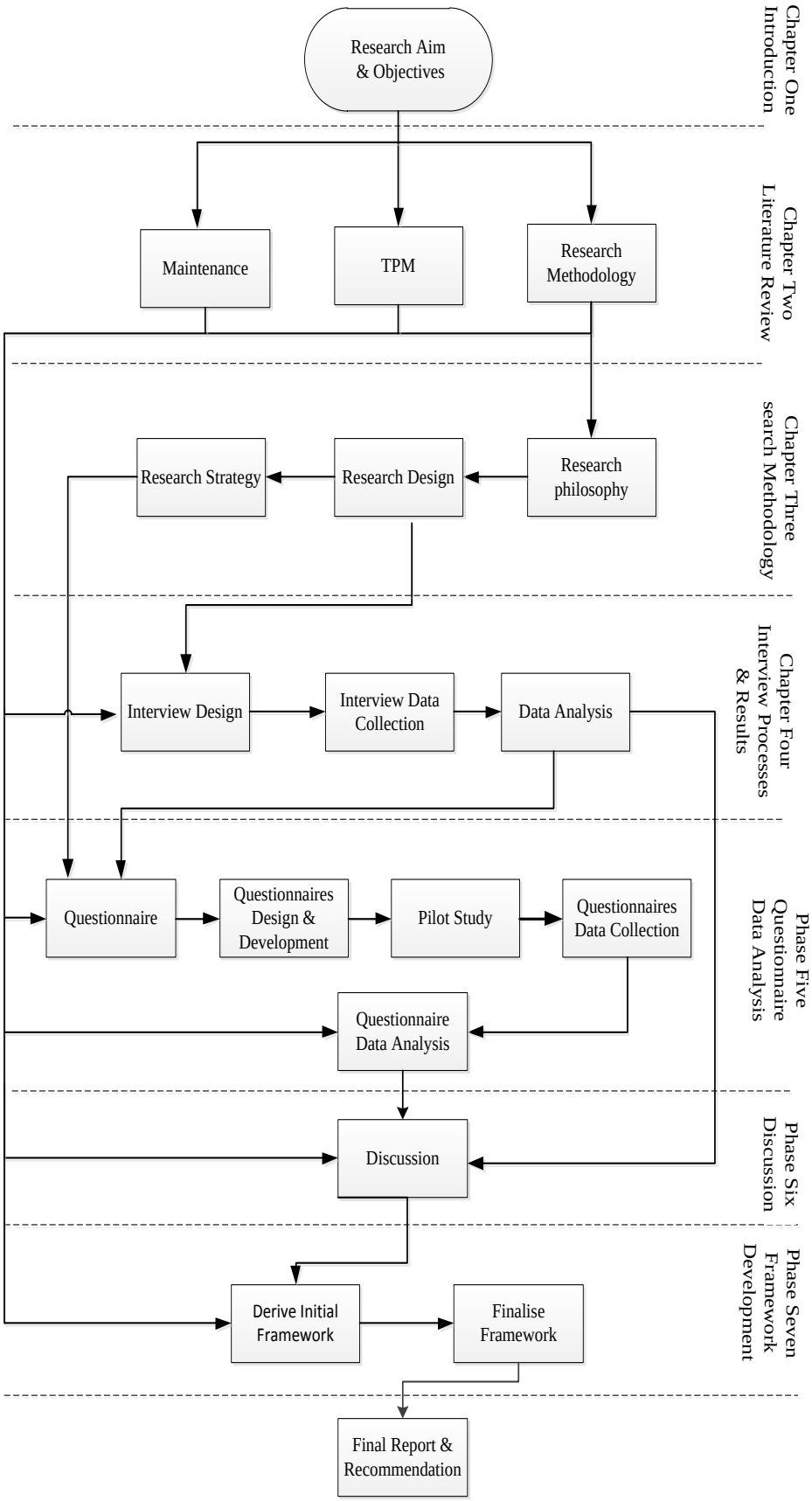


Figure 1.2 Research methodologies of this research

Chapter 2. Literature Review

2.1 Introduction

This chapter aims to present a comprehensive literature review in the area of power plants availability and reliability, maintenance strategies, practice, factors affecting implementation, and its relation to organization performance. The Total Productive Maintenance (TPM) concept will be discussed in depth covering TPM development, TPM and its impact on overall organization performance, and barriers and success factors in TPM implementation. Furthermore, organisational culture and its relationship to maintenance will be discussed.

2.2 Power plant availability and reliability

Plant reliability and availability is the backbone of power plant business performance. Failure of plants to reach optimum availability can cause substantial financial threats to the plant stakeholders [7]. Availability of power plants is very essential to any operator, to guarantee revenue, plants should be available for the maximum possible period of time, and planned stoppages must be at minimum rate and unplanned breakdowns must be avoided [8]. Foon and Terziovski [7] mentioned that loss of thermal power plants availability in Malaysia for 2.5 years, cost the power company around RM175m (£34m). Zhao [9] mentioned in order to reach the critical goal of the organisation and increase plant profitability, many factors need be evaluated, such as system performance, the aging and reliability of machines and equipment, maintenance practices, electricity market price and availability of fuel. Obodeh and Esabunor [10] attributed the failures in gas turbine power station in Nigeria to the high temperature, furthermore, they added, improving maintenance practices will result in improving power station availability. In the light of that, Oyedepo and Fagbenle [11] linked availability and reliability of power plants parts

and materials and also to maintenance strategy and policy with a decrease of sudden breakdowns, through the use of maintenance techniques such as a preventative maintenance system, which will increase power plants availability. Furthermore, they added, that management personnel of power plants need to formulate a new maintenance philosophy that improves maintenance and performance, reduces breakdowns, improves production and reliability of equipment and machines, with attention to total quality maintenance and total productive maintenance. In addition to that, unit size, number of operating units, cost of maintenance, availability of spares, and low fuel price are considered as factors characterising power plants in order to increase their competitive advantages [12].

It has been shown that power plant reliability is affected by direct and indirect factors such as installation, process, operator's skills, maintenance staff training, environmental variables (air temperature, humidity and solid particles concentration) and gas quality [13].

Most of the power units in Iraq were built in the 1970s and 1980s and were badly affected by military operation and poor maintenance during the 1990s. The ambient conditions for power plants in general, and gas turbines in particular, has a significant effect on the power production and efficiency [14]. The temperature in Iraq can be as high as 45 °C during the summer, thus the power plants must use chiller systems to reduce compressor inlet air temperatures. The chiller system cooling tower can be easily effected by dust which is normal during the summer in Iraq. The high amount of the dust mixes with cooling tower water and makes mud which can block the chiller system pipes and prevent it from functioning correctly, causing the temperature of the inlet air to increase which reduces the units' efficiency.

Power plants which run on natural gas have a higher efficiency as compare to other fuels [15], The fuel type used in Iraqi power stations is a heavy black oil instead of natural gas and light petroleum products, therefore it has a bad effect on the units life cycle which indeed need more maintenance to keep them running while using such fuel types.

One example is Doura Power Plant, one of the main power plants supplying electricity for the Baghdad area of Iraq, which has six units, each with a designed capacity of 160 MW. According to the Special Inspector General for Iraq Reconstruction (SIGIR) [16] in their report about power plant rehabilitation in Iraq, they determined several factors led to problems at Doura Power Station; only one out of ten staff are well trained employees from the Saddam era, also the maintenance staff are only familiar with and have dealt with short term operation and maintenance, and they ignored or they did not know the importance of maintenance programs such as preventative maintenance. The power plant did not have formal maintenance program practices for both emergency and routine maintenance. Also there was questionable maintenance practice which led to the failure of Unit 5 in 2006 and 2007. The plants closed cooling systems were not working because the exciter's heat exchanger was not well maintained therefore the temperature increased and exceeded the designed range by 15 ˚C. This high temperature then damaged the exciter's insulating paint, resulting in the exciter being prone to electrical flashover. There was also a large bearing that failed and damaged the shaft on a piece of component equipment because of inadequate lubrication. The bearing ran nearly dry and generated so much heat that it had to be cut by mechanics to remove it from the rotating shaft. SIGIR's inspection of the Doura Power Plant concluded that "sustainable operations of generators cannot be reasonably assured unless the Ministry of Electricity's O&M practices improve" [17].

This example clearly highlights that in order to have an increase in power production in Iraq, using existing units, power plants must introduce significant, efficient, and productive maintenance strategies and policies, which can overcome the many factors currently affecting the power production.

2.3 Maintenance

The Oxford dictionary defines maintenance as “The process of preserving a condition or situation or the state of being preserved” [18]. The British Standard Glossary of terms (3811:1993) defines maintenance as: “The combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function” [19]. Maintenance can also be defined as: All actions appropriate for retaining an item/part/equipment in, or restoring it to, a given condition [20]. Silkunas [21] defined maintenance in more comprehensive way “Maintenance refers to activities directed toward maintaining current technological, managerial and operating standards and upholding such standards through training and discipline”.

It is necessary for any plant, organization or system to have maintenance in order to have efficient operation. Management of an organization can formulate the direction of how to choose and apply the right maintenance strategy to meet the organization goal, because the way of carrying out a specific maintenance strategy or technique has a direct effect on equipment life span. Many companies think of maintenance activities just as a fix solution, because they didn’t link it to their organization’s commercial strategy and they lack an understanding of the impact of maintenance on their organization’s business performance [22].

2.3.1 Maintenance and Performance Measurement

Performance measurement has a real importance in focusing human and other resources on a particular part of a business. In several organisations, the criteria to be measured will have more importance than those which are not [23]. Kaplan and others [24] emphasized, in order to enhance business performance, researchers need to develop a “balanced set” of measures, enhance the current measures, and generally improve measurement systems. Performance measurement is an essential principle of management. It has a high importance in all manufacturing functions, therefore it has direct importance in maintenance functions [25]. Performance measurement can help to identify the gaps between the existing and preferred performance in organizations, and indicate the direction development required for closing those gaps [26]. Furthermore, performance measures provide a significant connection between the organization strategies and action that will be taken by management and therefore it supports the implementation and execution of improvement enablers [27] [28]. Moreover, the performance measurement has a direct impact on manufacturing performance by making the maintenance managers focus maintenance staff and resources to particular areas of the system [24].

Westerkamp [29] stated that there are two parts that need to be examined in order to asses maintenance performance in organisations, which are the management side of maintenance and the technology used to perform maintenance. Raouf [30] for example, suggested a framework for evaluating maintenance management in an organisation. His framework was built on assessing two aspects of maintenance, the first aspect to examine is the maintenance management system, which involves examining organisation structure, procedures, resources, and the suitability of information systems. The second aspect involves the maintenance management’s

principles, which include quality control procedures, maintenance planning and scheduling, spare parts control and training programs.

Maintenance in an organisation therefore, contains two parts [31], the first part which represents the maintenance management system, tools, methods, structure, information, and technology required to implement maintenance strategies in organisations. While the structure of organisations means there are different departments to perform operation and maintenance tasks, and technologies in order to achieve the required results of the maintenance work, which are in line with providing information systems which collect and report data of maintenance [32]. The second part of a maintenance system consists of people who perform maintenance duties such as technicians, operators, managers, and organisation culture. The maintenance department needs to utilise everyone involved in maintenance skills, knowledge, motivation, and teamwork both in their own and other departments. Riis, et al. [32] added that organisation culture needs to be part of the maintenance management systems, furthermore, organisations need to plan and implement training, and involve personnel in decision making to support information flow.

In this regard, Al-Muhaisen and Santarisi [33] mentioned that there are several factors that need to be examined to in order to assess maintenance practice. These are; productivity audit, organisation and staff policies, training for management, planners, and personnel, motivation, budgets and costs control, work design and scheduling, job performing facilities, inventory, preventive maintenance and documentation, work measurements, and data processing. Furthermore, Reason and Hobbs [34], Identified; documentation issues, time stress, insufficient housekeeping and tool control, inadequate coordination and communication, lack of

knowledge of problems and procedures as the main influences to give a rise in maintenance errors.

It is important to realise that responsibilities of classic maintenance included fault identification and diagnosis, repair, replacement, correction and testing, spare parts providing, failure analysis, planning and scheduling of maintenance activities [35]. In spite of that, Thorsteinsson and Hage [36], establish a wider and improved explanation of maintenance tasks by dealing with maintenance service as a product. They considered maintenance tasks to fall into three main groups (technical, human, and economic) as follows:

The technical part:

- The maintenance products. Specification of the different types of services and products from the maintenance function. Specification in relation to each plant system.
- Quality of the maintenance.
- Maintenance functioning methodology.
- Maintenance resources, such as equipment for maintenance, outsourcing maintenance.
- Maintenance materials and spare parts planning, relationship with suppliers.
- Controlling maintenance, maintenance and staff scheduling and planning.

The human part:

- Relationships in the maintenance department, and relation with other departments.

- Maintenance task and external relation with governmental health, environment and safety producers, customers, suppliers' organisation, customer, vendors, neighbours, etc.
- Organisation of the maintenance task, work design and organisation structure.

The economic part:

- Maintenance breakdown, maintenance work responsibility, maintenance documentation.
- Cost benefit of maintenance.
- Maintenance economy. Economic control of maintenance: cost estimates, budgets, cash flow, accounting for the maintenance function. Plan investment and financing.

Furthermore, they developed a radar diagram figure 2.1, which was formulated based on five managerial tasks which are maintenance goals and strategies, analysis, and controlling maintenance, maintenance and planning, which included the twelve maintenance tasks. This radar diagram is used to diagnose and evaluate the current level of effort that the organisations use to reach the required level of maintenance actions [36]. This helps management to understand their current action and direct them to establish the required changes in improving their maintenance management strategy.

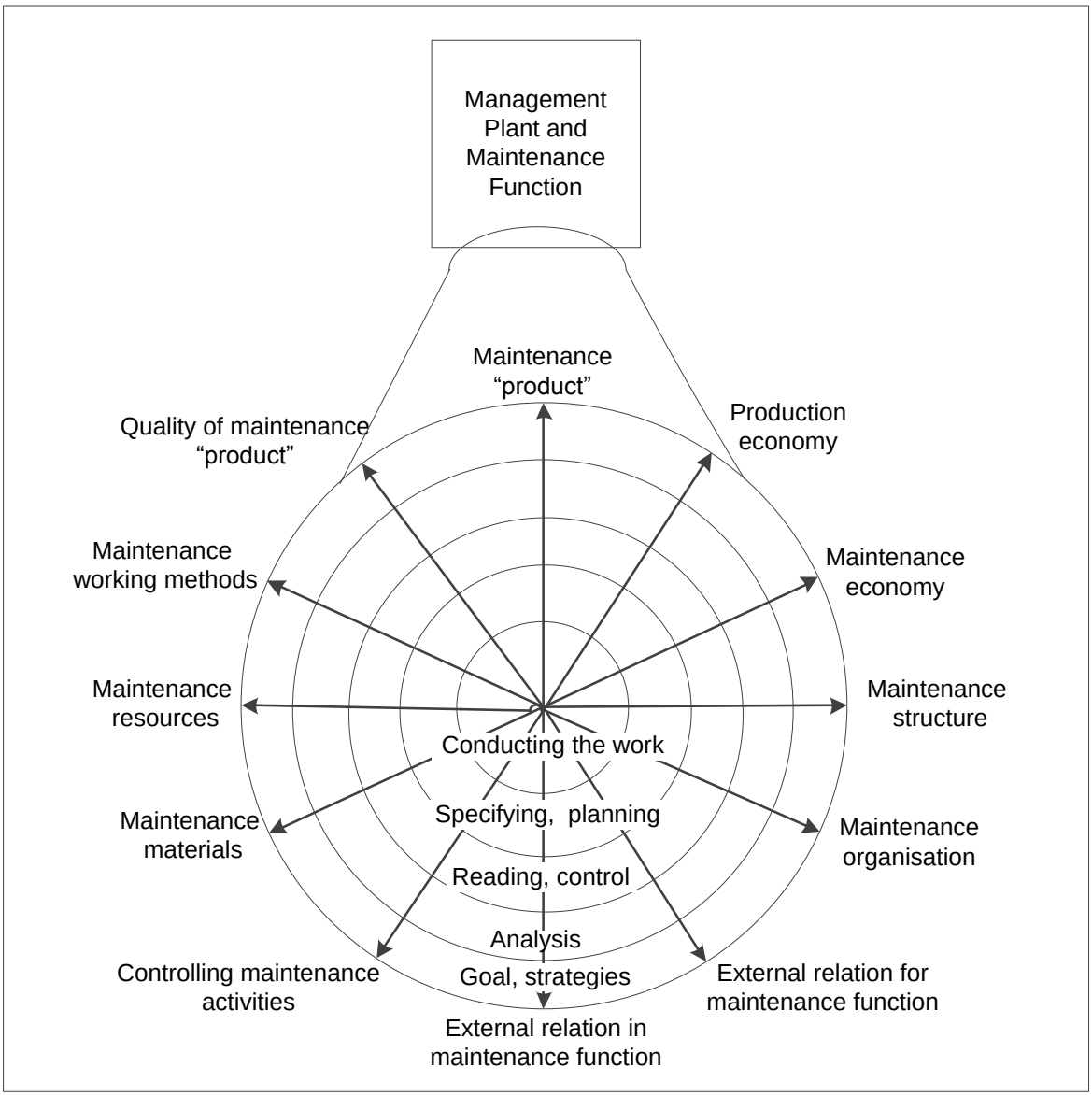


Figure 2.1 Radar Diagram for analysis of maintenance tasks [36]

Parida and Kumar [37] stated that "What cannot be measured cannot be managed effectively" In their research, which studied the challenges and issues related to the development and implementation of maintenance performance measurement (MPM), they addressed several factors behind the importance of MPM implementation within an organization such as: measuring value created by the maintenance, revising resource allocations, justifying investment, health, safety and environment issues, adapting to new trends in operation and maintenance strategy, focus on knowledge management, and organization structural changes. Their study

found that in order to have an effective implementation of MPM, organizations need to involve all employees and also all related matters need to be addressed. They also suggested that the overall equipment effectiveness (OEE) measures only the internal effectiveness, therefore it can be insufficient, hence companies need to measure both internal and external maintenance effectiveness.

In maintenance management, Jonsson [38] investigated the maintenance management status in different Swedish manufacturing industries. He used a survey strategy through questionnaires, and 747 questionnaires were sent to maintenance and production managers to companies with 50 or more employees, whilst only 284 responses were received. The questionnaire consisted of five factors; strategy, organization, human aspects, tools and techniques, and support mechanisms. Hani Shafeek, [39] used face to face interviews and questionnaires to study the main parts of maintenance management, which consisted of fifteen areas (training, organizations, maintenance planning, inventory, financial optimization, maintenance work orders, document management, maintenance automation, maintenance general practices, predictive maintenance, preventive maintenance, continuous improvement, operations, maintenance report, and reliability maintenance) in ten cement companies. He investigated the relationships between maintenance management practices and maintenance improvement, and found that predictive maintenance, preventive maintenance, financial optimization, and general maintenance practices are success areas of maintenance management in the cement industry. While the maintenance work orders, maintenance automation, continuous improvement and training programs, are the failure of maintenance management in that industry.

2.3.2 Development of maintenance

Through the years, maintenance programs in organisations have been developed from simple breakdown maintenance through to complex TPM system (Fig 2.2) [40].

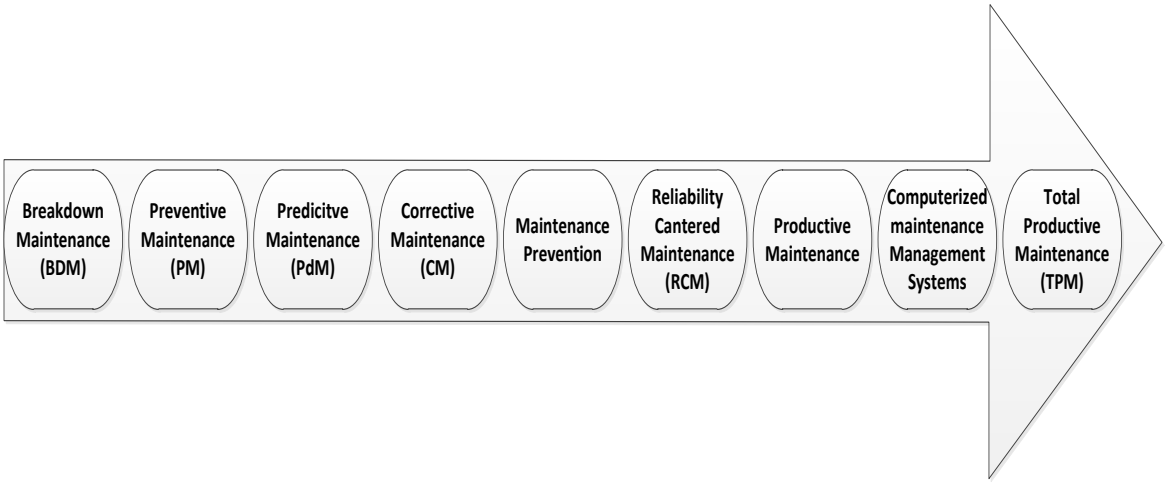


Figure 2.2 Development of Maintenance Concept [37]

Breakdown maintenance (BM): This maintenance strategy was adopted in manufacturing companies before 1950, it means that maintenance is done after the machine breakdown or when the performance of the equipment goes down. This method has disadvantages such as high repair costs due to unplanned stoppages of the machine, spare parts access, and how long it takes to perform the maintenance activity.

Preventive maintenance (PM): This maintenance concept was adopted in 1951, it refers to equipment checks to prevent machine breakdowns in order to increase their life span by planning and scheduling maintenance activities in advance [41]. The maintenance department create time based maintenance (TBM) which is carried out after a certain period of time or based on the amount of machine usage, which includes several tasks, for example; inspection, cleaning, lubrication, modifications, and alignment. It aims to decrease the possibility of equipment failure and to keep the performance of machines very near to their original status [42]. The

drawback of this strategy is the requirement to disturb production to perform the work activities.

Predictive maintenance (PdM): Is also referred to as condition based maintenance (CBM), it means that maintenance performed is based on the machines condition or performance. First it needs to check conditions of equipment such as temperature, noise, vibration, and lubrication, so when one or more of them indicate an unusual level then maintenance can take place to restore the machine to the preferable condition [43]. Predictive maintenance is therefore similar to preventive maintenance which also aims to reduce the possibility of machines breakdowns. however, Predictive maintenance is executed only when there is need [44].

Corrective maintenance (CM): This maintenance strategy was introduced in 1957, it refers to increasing reliability of machines by eliminating failure through the improvement of the machines, and improving the equipment maintainability [45].

Maintenance prevention (MP): Introduced in 1960s; in the development of new equipment or machines, maintenance prevention must be taken into consideration at the design stage and should aim to ensure reliable equipment which is easy to use and care for, so the operators can easily use, adjust and run it. The manufacturer uses the learning from earlier equipment failures, product manufacturing, feedback from production areas, customers and marketing functions to ensure hassle free operation for the existing or new production systems.

Reliability Centred Maintenance (RCM) was founded in the 1960s, and was used by aircraft manufacturers, airlines and government. It is a process used to determine the maintenance requirements of any physical asset in its operating context by identifying the functions of the asset, the causes of failures and the effects of the failures [46].

Productive maintenance (PrM): The maintenance strategy which involves all activities to improve equipment productivity by performing Preventive Maintenance, Corrective Maintenance and Maintenance Prevention. The aim of productive maintenance is to increase the productivity of companies by reducing the cost of equipment from design, fabrication, operation and maintenance, and the losses caused by equipment degradation.

Proactive maintenance: The maintenance strategy that utilises preventive and predictive maintenance strategies, which aim to avoid breakdowns through monitoring the machines and carrying out repairs [47].

Computerized maintenance management systems (CMMS): it deals with the information on maintenance workforce, spare-parts inventories, repair schedules and equipment histories. It may be used to plan and schedule work orders, to expedite dispatch of breakdown calls and to manage the overall maintenance workload.

Total Productive maintenance (TPM): the concept of TPM was introduced in 1971 by the Japanese Institute of Plant Maintenance (JIPM) and can be defined as preventative and productive maintenance which should engage all levels of organization structure from top management staff to shop floor operators [48]. It was developed based on productive maintenance, and it is a unique maintenance approach that increase equipment effectiveness, reduces breakdowns, increase workplace safety, and reduces cost, waste and increases profitability of companies.

2.4 Total Productive Maintenance (TPM)

In today's highly competitive environment, companies are striving to achieve world-class level and are therefore required to have efficient and effective strategies, in

order to overcome the losses which occur in the shop floor in terms of time, cost, materials, and machine downtime. In this regard the JIPM identified six categories of equipment loss [44]:

- Breakdowns due to equipment failures.
- Set up and unnecessary adjustments.
- Idling and minor stops.
- Running at reduced speed.
- Start-up losses.
- Rework and scrap.

Machine breakdown can significantly affect the profitability and effectiveness of the company and for this reason companies are trying hard to develop a maintenance system which can reduce or terminate the sudden breakdown. Maintenance in industry has a high impact on the production process and also on the productivity and efficiency of the company. Thus a strategic approach to improve the performance of machines using maintenance activities is to effectively adapt and implement strategic Total Productive Maintenance (TPM) initiatives in organizations.

TPM is an approach to achieve rapid improvement of production processes by involving and empowering production related employees and introducing an ongoing process of quality improvement [44]. It describes a synergistic relationship among all organizational functions, but particularly between production and maintenance, for continuous improvement of product quality, operational efficiency, capacity assurance, and safety [49].

The main purpose of TPM in any organization is achieving zero defects, zero breakdowns and a highly safe workplace during production process, through

enhancing the machine efficiency and reducing the wastes in time, cost and material, in order to achieve high profits [50]. It relies on three major approaches: maximising equipment effectiveness, autonomous maintenance by operators and small group activities. These approaches are supported by seven interrelated maintenance steps [51] which were developed to simplify the maintenance activities, and have the effect of increasing the production capabilities, maintenance and supervision and allow staff to direct resources to the next stage of development.

TPM has been accepted as the most promising strategy for improving maintenance performance [50, 52] and its implementation is proven to give increased equipment effectiveness, higher productivity, better quality, fewer breakdowns, lower costs, reliable deliveries, motivating working environments, enhanced safety and improved morale of employees [40]. According to Attri et al [50] and Wireman [53], the key aspects of TPM can be listed as follows;

- Improving equipment effectiveness; this will help machines to perform at their designed production rate.
- Improving maintenance efficiency and effectiveness; this aims to reduce the costs associated to maintenance procedures.
- Early equipment management and preventative maintenance, to reduce the amount of the maintenance required.
- Training; staff skills and knowledge need to be improved in order to contribute to maintenance and TPM.
- Operators involvement in routine maintenance, this means operators take responsibility and ownership of the machines and execute simple maintenance tasks, to allow maintenance personnel to use maintenance resources for advanced technical characteristic of TPM.

2.4.1 TPM pillars

TPM activities, structure and implementation are organised and built on eight pillars [44]. The TPM model was firstly introduced by Nakajima [40] figure 2.3, who specified the eight pillars as; autonomous maintenance; focused improvement; planned maintenance; quality maintenance; education and training; safety, health and environment office TPM; development management. The implementation of this framework results in employees' productivity enhancement, controlling maintenance cost, and reduction in machine breakdowns and increases in machines productivity. As it can be seen in figure 2.3, the eight pillars stand on foundation which can be known as 5s which are:

Sorting: removing unnecessary items from place of work.

Setting: arranging all essential items and raw materials in order to reduces waiting of searching time.

Shining (Cleaning): is a way of making any defects visible and ensure reaching the required quality.

Standardizing: documenting the improvements in order to be used in future for quality and training purposes.

Sustaining: the improvements through scheduled audits is a way of stabilizing the system by ensuring the agreed standards are being followed.

These five practices are considered as initiative for TPM as it results in a clean, visually organized workplace that is self-maintaining.

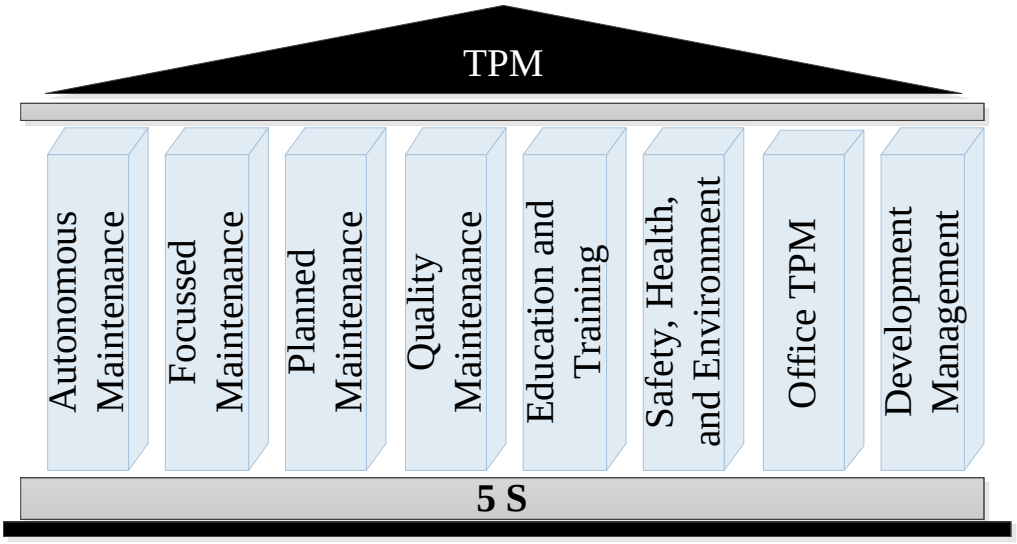


Figure 2.3 TPM model Nakajima [40]

However, western experts on TPM eliminated some pillars from the original model to simplify and fit TPM in the western environment, such as Yeomans and Millington [54] who suggested that focus needs to be on the single autonomous maintenance pillar when an organisation implements TPM. On the other hand, Steinbacher and Steinbacher, [55] and Ahuja and Khamba [56] integrated the training and education pillar into other pillars instead of as a stand-alone pillar as in the Nakajima Model.

2.4.2 Factors affecting TPM implementation

Many factors contribute to maintenance and TPM implementation both successfully and unsuccessfully. The manner of which have been highlighted by many researchers who identified different factors that play critical roles in implementing TPM. The key factors affecting TPM implementation in organisations can be explained as follows:

2.4.2.1 Top management support

Implementing TPM successfully, requires organisations to have a top management team that understand the benefits of a such a program, and provide commitment to

support the TPM activities mentioned earlier in section 2.4, such as the selection of teams, training, and motivation to all organisation levels [52]. Many researchers highlighted the importance of top management in having successful TPM implementation [57]. Nakajima [44] stated that the top management's main responsibility is to establish encouraging environments that support autonomous activities. Similarly, Park and Han [58] illustrated that top management is firstly responsible for forming an organisation environment that facilitates and supports the efforts even before the official start of TPM. Furthermore, they added, since top management in organisations has the power of change, the company strategy shall include TPM in the business strategy and link the policy between company departments. Likewise, Ahuja and Khamba [56] mentioned a solid commitment is needed by top management to TPM implementation by developing communication techniques between management and employees to explain the importance and expected benefits of TPM to their organisation. However, Bakerjan [59] stated that a large number of companies failed to implement TPM because of the lack of management support and understanding of the real goals of a TPM program. Bamber [60] argues that organisations need to re-create a top management steering group that arrange for the essential planning, commitment and direction of the TPM program. Another study by Cooke [61] highlighted lack of management support as barrier for not implementing TPM successfully in four processing/manufacturing companies in the UK. In the same vein, Chan et al [62] who studied the effectiveness and the implementation of TPM in an electronics manufacturing company, stated that the company tried to introduce TPM in the 1990s but it failed for several reasons - one of them was the lack of top management support of TPM. Similarly, in Rodrigues and Hatakeyama's [63] study on analysis of the fall of TPM in companies, they determined that direct managers and superior

staff are not truthfully committed, and this leads to ruination of the already established structure of TPM.

2.4.2.2 Culture

The literature has emphasized the importance of organisation culture in introducing and implementing a new maintenance program such as TPM. Since the new maintenance program will bring a big concern to most employees who may be afraid of the new routine change that may come with the new program, learning difficulty of skills needed, and other factors such as work design and work load.

The recent study by Attri et al [50] on analysis of barriers of TPM stated “The biggest challenge before the organization is to be able to make radical transformation in the organization’s culture for ensuring overall employee participation towards the maintenance and manufacturing performance improvement through TPM initiatives”. This was in line with the work of Patterson et al [52] who found cultural resistance as noticeable issue in TPM implementation, therefore it is not an easy task because the organisations need to create new culture that accept TPM. Eti et al [64] have referred to the implementation of TPM in Nigeria manufacturing industries. Their research results show that for implementing TPM successfully, TPM strategy and organization culture should be closely aligned to achieve the required changes.

2.4.2.3 Training and Education

Training and education has been found to have a great impact on organizations performance, in today’s complex workplace with advanced technology, organizations need to invest more and more in every part of their structure in order to survive the competitive environment. The need for well qualified personnel has become a strategic target. Training has become an important factor for any

organization in the world because proper training will improve the skills, knowledge, and abilities of new and old employees [65], therefore the training will increase the employees and organization efficiency and effectiveness [66]. Most successful companies tend to invest more in training than unsuccessful ones [67]. Many researchers have found there is a relationship between training practices and organizational performance [68-71].

As mentioned earlier, training and education is a very important for TPM implementation and needs to be conducted in the early steps of the process. A considerable amount of literature has been published on TPM which has highlighted training as a critical factor and a key component for a successful implementation of in many industries. Furthermore, as training and education start in the early stages of the TPM steps, top management must make a considerable effort in creating, developing and starting training activities for employees to enhance their skills, knowledge and attitude to firstly accept the change brought by TPM and secondly to develop their ability to achieve productivity [56, 61, 62, 72-74].

2.4.2.4 Communication

TPM implementation involves hard work which requires cooperation and collaboration between top management and other levels in the organisation to introduce TPM and the activities associated with it. These activities include launching training and education campaigns, formulating, developing and spreading the TPM plan among all organisation levels, and cooperation between deferent departments such as operation and maintenance departments to perform jobs accompanying the TPM program. Such activities all require a communication strategy that can eliminate any concerns brought to employees by TPM, and to facilitate the TPM implementation [58, 75].

However, a lack of communication has been found to act as barrier preventing TPM from successful implementation. Rodrigues and Hatakeyama [63] highlighted communication issues in managers decision making and the way they are communicated with individuals involved as key reasons for TPM failure. Similarly, Ahuja and Khamba [40] classified lack of communication as one of the obstacles obstructing organizations from achieving excellence through TPM. Furthermore, they added that establishing trust through effective and proper communication, involving employees in decisions, exchanging ideas with others, and giving feedback will enhance and improve TPM implementation in an organisation.

2.4.2.5 Teamwork

Maggard [76] defines teamwork as “the management system that organizes people into natural unit teams and/or high performance teams in order to accomplish a company’s stated goals and objectives”. Teamwork therefore, is a group of people gathered together with the purpose to perform a specific job or to solve particular problems. The purpose of teamwork is to share skill, knowledge, experience and ideas between those people in order to get better results when they are performing their task. Many researchers found a positive relationship between teamwork and organisation performance. Banker et al, [77] for example, suggested that the use of a team has resulted in significant improvements in many industries. Hoegl et al [78] in their research identified six aspects (communication, balance of member contributions, coordination, mutual support, cohesion and effort) of teamwork which have a great association to team performance. Adams et al, [79] identified seven characteristics of effective teams: role clarity, goal clarification, productive conflict resolution, accountable interdependence, mature communication, common purpose and psychological safety.

To reach TPM implementation benefits of minimising breakdowns and maximising machine reliability and availability, organisations are required to give a long-term commitment on providing training, management support, and emphasising the importance of teamwork between different departments and among personnel within one department [40]. Ireland [80] highlighted that one of TPM's strategic objectives is to introduce effective and efficient team working in organisations, while Kocher et al [81] mentioned that TPM aims to bring production and maintenance functions together throughout good working practices of team working and continuous improvement. In the same vein, Kulkarni and Dabade [82] argued that the participation of operators in autonomous maintenance results in enhancement of teamwork between productions and maintenance. On the other hand Lee [61] found that teamwork in the organisations he investigated tended to be an issue leading to unsuccessful implementation of TPM.

2.4.2.6 Motivation

Motivation is a practice of human resource management which can help organizations to achieve their goal and high performance by motivating their employees to perform their job well [83]. The employees performance is not only based on their actual skills but also on their personal level of motivation when performing their job [84]. Taghipour et al [85] stated that employee motivation is an important factor to have progress, overcome difficulties and achieve business goals. In order to implement TPM successfully, top management need to be motivated and also need to motivate employees in all levels to perform TPM tasks. Attri [86] stated that management of organisations need to motivate and empower their employees, and should encourage operators to participate in TPM activities, furthermore, management should use reward schemes to motivate all employees and to increase

their willingness to perform their job better. On the other hand, Bamber et al [87] have found motivation of management and personnel as a factor affecting successful implementation of TPM in UK manufacturing organizations. In contrast Lee [61] highlighted lack of motivation as one of the difficulties in implementing TPM four processing/manufacturing companies in UK, which found the motivation and satisfaction are low. Similar to Lee study, Ahuja and Khamba [40, 56] have also stated that lack of motivation is an obstacle that impedes TPM from being implemented successfully.

2.4.2.7 Other factors

In a review of several studies investigating the factors affecting maintenance and TPM implementation, several other factors have been highlighted by the literature. Ahuja and Khamba [40] found integration of TPM goals and objectives into business plans led to successful implementation of TPM. On the other hand several researchers such Bakerjan [59] and Bamber et al [87] agreed that organisations which did not allow sufficient time for the development of TPM programs faced failure in TPM implementation, and this finding was also supported by Rodrigues and Hatakeyama [63]. They found that a lack of follow-up of the progress of the program and its evaluation, and a lack of time for the autonomous maintenance as other contributors for TPM failure in organisations. On other hand, Ahuja and Khamba [88] and Baglee [89] attributed the failure of TPM implementation to some financial limitations as TPM requires additional resources for new machines and training. In addition to that, Davis [90] added the lack of structure and relationship to strategic needs, and attempts to apply TPM in the same way it is implemented in Japan, using the standard approach found in Japanese publications, are other main reasons for TPM failure within UK manufacturing organisations. Lack of awareness

of TPM concepts and principles among the employees, and lack of understanding and knowledge of TPM has been attributed as an obstacle in implementing TPM in organisation by Ahuja et al [40] and McAdam and Duffher [91].

2.4.2.8 Summary of enablers and barriers highlighted by literature review

Tables 2.1 and 2.2 illustrate the enablers and barriers facing maintenance and TPM implementation in organisation which highlighted and demonstrated by researchers.

Table 2-1 TPM enablers highlighted by previous researchers

No	Enablers	Cited by
1	Top management support	[44] Nakajima (1989) [87] Bamber et al (1999) [58] Park and Han (2001) [62] Chan et al (2005) [92] Ahuja and Khamba (2008a)
2	Culture	[58] Park and Han (2001) [92] Ahuja and Khamba (2008a) [93] Reiman, Teemu. Oedewald, (2006)
3	Communication	[58] Park and Han (2001) [64] Eti et al. (2004)
4	Training and Education	[74] Benjamin S. Banched (1997), [64] Eti et al. (2006) [62] Chan et al (2005) [92] Ahuja and Khamba (2008a) [94] Imad Alsyouf (2009)
5	Teamwork	[95] Kumar et al (2006)
6	Motivation	[87] Bamber et al (1999) [96] John J. Lawrence (1999)
7	Business strategy	[95] Kumar et al (2006) [94] Imad Alsyouf (2009)

Table 2-2 TPM barriers highlighted by previous researchers

No	Barriers	Cited by
1	Lack of Top management support	[59] Bakerjan (1994) [97] Adam et al (1997) [62] Chan et al (2005) [90] Davis (1997) [63] Rodrigues and Hatakeyama (2006) [87] Bamber et al (1999)
2	Culture	[69] Becker (1993) [96] Lawrence (1999) [40, 92] Ahuja and Khamba (2008a,b)
3	Communication	[69] Becker (1993) [40] Ahuja and Khamba (2008b)
4	Lack of motivation	[87] Bamber et al (1999), [40] Ahuja and Khamba (2008b)
5	Lack of training and education	[69] Becker (1993) [59] Bakerjan (1994) [97] Adam et al (1997) [90] Davis (1997) [87] Bamber et al (1999) [62] Chan et al (2005) [63] Rodrigues and Hatakeyama (2006) [40] Ahuja and Khamba (2008b)
6	Financial	[92] Ahuja and Khamba (2008a) [89] Baglee (2010)
7	Relation between maintenance and operation staff	[40, 92] Ahuja and Khamba (2008a, b)
8	Other factors	[89] Baglee (2010)

2.5 Organisation culture

Organisational culture is a feature that can distinguish between successful organisations and unsuccessful organisations [98]. It has been known to have a strong effect on organisation performance and effectiveness [99]. With modern advanced technology and increases in plants and industries complexity, organisations are required to compete in this competitive market and increase their productivities and produce profits therefore, organisational culture has become more and more important and therefore organisations' management started to discover new methods to manage the required change in organisation culture to achieve better performance [98, 100].

Organisational culture has been studied widely and linked to different disciplines by many researchers such [101-104]. Moreover, many researchers have defined

organisational culture, Jaeger [105] for example defined organisational culture as a communal set of thoughts shared by group of people on what they're doing, know, believe, and mean, these ideas and thoughts, exchanged to/and shaped the organisation behaviour as it was constructed on "commonly held attitudes, values, and beliefs" of organisation members [106]. One of the latest definitions of organisational culture is stated as "the general pattern of mind sets, beliefs and values that members of the organisation share in common, and which shape the behaviours, practices and other artefacts of the organisation which are easily observable" [107]. Organisational culture therefore, reflects behaviours, attitude, assumptions and understanding of organisation members, which also helps to determine the practices of those member in organisations [108]. As a result, organisational culture can be used as a variable to distinguish between organisations, places, and regions [109].

2.5.1 Organisational culture and maintenance

The importance of organizational culture has been widely investigated and studied in terms of its relationship with and effects on total quality management (TQM) implementation [102-104]. Furthermore, there has been much empirical research regarding the effect of organisational culture on organisation performance [110-112]. In terms of maintenance, most previous studies have examined the organisational culture as a maintenance element when it comes to improving maintenance activities or introducing a new maintenance program such as TPM [50, 80, 96].

Maintenance has an important role in all organisations and industries, since it affects machines reliability, which can have an impact on production rate, quality and cost, which will in turn effect on the companies' profitability [89]. Baglee and Knowles.

[113] stated that a well-developed organized maintenance strategy is needed in order to achieve higher productivity and better quality, and many technologies, methodologies and strategies have been developed to fulfil that purpose. Jostes and Helms [114] recommended that a major culture change was needed for USA industry in order to be competitive in the global economy of the 1990s and beyond. Patterson et al [52] stated descriptions of successful TPM implementations talk about establishing new cultures. In addition, Lawrence [96] mentioned a significant change in organisational culture was needed to implement TPM, and many organisation have difficulties in establishing the required change in culture. Furthermore, Ireland and Dale [80] indicated that implementing autonomous maintenance provided the company with its biggest changes to organisational culture and competencies. This finding was supported by Mostafa [115] who also suggested that a big change in organisation structure and culture is required when the organisation wants to adopt a proactive maintenance approach. Eti et al [64] have referred to the implementation of TPM in Nigeria manufacturing industries. Their research results show that for implementing TPM successfully, strategy and organization culture should be well aligned to the required changes.

In a likewise manner, culture was pointed out by Raouf et al [116] as one of the key decision elements of maintenance strategy. This statement was supported by Graisa and Al-Habaibeh [117] who indicated culture change is needed for organisation personnel and management in order to obtain the required benefits of implementing the available technology. Furthermore, Knezevic and Narayan [118] indicated that organisation culture influences people behaviour, which is one of the factors that in turn affects human reliability. Furthermore, they added that in order to advance a continuous improvement cycle, the organisation needs to establish a

culture that will not accept continuing failures. Thus, the essential need of change in maintenance approaches is the biggest motivator for culture changes [119].

Recently, Maletič et al [120] stated that “not enough attention has been paid in the literature in order to explore the impact of different organisational culture on maintenance performance”. This lack of research in the area of cultural effect on maintenance variables, practices, and implementation, is the main motivator to explore this effect in this thesis and to answer the following question; to what extent do organizational culture types effect maintenance implementation factors in organisations.

2.5.2 Measuring organisational culture

A wide-range of approaches of how to evaluate organisational culture using different measurements have been discussed and employed by many researchers [99, 107, 121]. However developing the right set of measures that can describe organisational cultures in organisations has been found to be a significant challenge [122]. The following researchers developed different methods to asses and identify types of culture in organisations;

In 1987, Cooke and Lafferty developed Organisational Culture Inventory (OCI) [123] which was enhanced by Thomas et al [124]. It aims to measure people/security culture, satisfaction culture and task/security culture, through the use of 120 questionnaire items.

Tucker et al [125] developed Survey of Organisational Culture (SOC) which used 55 items that aimed to measure 13 dimensions to define culture in organisations. The dimensions are; orientation to customers, orientation to employees, congruence amongst stakeholders, impact of mission, managerial depth/maturity, decision making/autonomy, communication/openness, human scale,

incentive/motivation, cooperation versus competition, organisational congruence, performance under pressure, theory S/theory T.

Walker et al. [126] developed Corporate Culture Questionnaire (CCQ) which was developed based on a review of previous researches, using between 69 to 126 items to measure four dimensions of culture in organisations, which are; performance, human resources, decision-making, and relationships.

MacKenzie developed Culture Questionnaire (CQ) [127] which aimed to measure twelve cultural dimensions (employee commitment, attitudes to and belief about innovation, attitudes to change, style of conflict resolution, management style, confidence in leadership, openness and trust, teamwork and cooperation, action orientation, human resource orientation, consumer orientation and organisational direction), through the use of 76 survey items.

Cameron and Freeman [100] developed a Competing Values Framework (CVF), which aimed to measure and assess four different culture types, described as: group culture, development culture, hierarchal culture, and rational culture. Each organisation usually has one or more these types. Their CVF has a solid theoretical basis, assesses both similarity and strength of culture and also simple and quick to complete.

2.5.2.1 Competing value framework (CVF)

A competing value framework (CVF) model was adopted in this research to empirically measure the organisation culture profile in Iraq power plants. The CVF was developed by Quinn and his associates [99, 128]. The rationale behind choosing and using this model in particular in this study is because the model has been empirically validated and the items reliability and validity has been examined. The CVF has been proven to be a valuable tool and framework to assess and

classify the dominant cultures of organisations because it helps identify types of culture that exist in organisations [129]. Moreover, CVF has been widely used in assessing organisation culture profiles in many industries and countries [102, 104, 108, 130].

As can be seen in figure 2.4, the CVF was built on two dimensions and reflects four culture types (group culture, development culture, hierarchal culture, and rational culture), with each one characterising different values. The flexibility control dimension (vertical) emphasises to what extend the organisation focuses on stability and change.

Figure 2.4 Competing Values Framework [107]

A focus on flexibility specifies the organisations requirement for flexibility and spontaneity, while the focus on control specifies the organisations need for staying stable and controlled. On the other hand the internal-external dimension (horizontal), represents that the organisations emphasis on inner organisation which means they put emphasis on sustaining and improving internal factors while the

external environment means the organisation puts emphasis on competency with other organisations to deliver satisfaction to customers [129].

2.6 Summary

This chapter began with a historical overview of Iraqi electricity shortages and details of the number of power units in Iraq. The findings indicated that power shortage in Iraq can be significantly reduced or even completely eliminated. If for example, the current active plants were running at 84% of their designed capacity the power supply in Iraq could be increased from 11.2 GW to 16 GW which would more than cover the current total power demand of 15 GW. The literature regarding Iraqi power plants reliability indicated that sustainable operations of generators cannot be reasonably assured “unless the Ministry of Electricity’s O&M practices improve”. This example clearly highlights that in order to have an increase in power production in Iraq using existing units, power plants must introduce significant, efficient, and productive maintenance strategies and polices which can overcome the many adverse factors affecting the power production.

Different definitions of maintenance were then discussed and the importance of maintenance measurements were examined with links to different aspects related to maintenance, and then development of maintenance was discussed. In addition to that the development and importance of TPM were highlighted, and the main TPM models were also deliberated and factors affecting TPM were identified and debated. It has been found that the aim of TPM is to keep the plant and equipment at its highest productive level through the cooperation of all areas of the organization. TPM is a partnership between maintenance and production within an organization to improve product quality, reduce waste, reduce manufacturing cost and increase equipment availability.

Finally, after an explanation of organisational culture, several theoretical models to measure organisational culture profiles in organisation were examined and CVF model was selected.

In conclusion the review of previous literature suggests organisational culture is a factor which contributes to having successful or unsuccessful maintenance implementation in an organisation however, there is a considerable lack of research precisely on the impact of organisational culture on maintenance implementation factors which needs to be covered.

Chapter 3. Methodology

3.1 Introduction

This chapter describes the methodology selection, design and implementation for this research. The aim of this chapter is to identify the appropriate methodology that will be used to help to answer the research questions and meet the objectives of the research. It will discuss research types, identifying both advantages and disadvantages of them, and justify the selection of each method used.

The Oxford dictionary defines Research as ‘’the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions’’. Grinnel [131] defined research as “a structured inquiry that utilises acceptable scientific methodology to solve a problem and creates new knowledge that is generally applicable”. Research methodology can be defined as “a practice of doing head work, fieldwork, and text work” [132]. Research methodology is the heart of any research, in order to answer research questions and meet research objectives and aims, the researcher should identify which research strategies (methods) are to be used for example whether they should use a case study, experiment, or survey, and what is the best tool to collect and analyse data.

3.2 Research philosophy

Research philosophy can be defined as the development of the background, knowledge and the nature of research [133]. It is an idea of what data should be collected, used and analysed about particular phenomenon. According to Saunders et al, research philosophy holds significant beliefs about the way in which a researcher sees the world. These beliefs will support the choice of strategy and methods of research in following the objectives see Figure 3.1 [134]. The researcher needs to identify the frequently hidden philosophical consideration, which is

effecting the reasoning of the research and both will influence the data needed and the analysis of this data [135]. Understanding the philosophy of research helps the researcher to understand the complete research mechanisms and procedures need to be taken, and it also helps to identify a suitable research design to meet the research objective and answer research questions [136]. Johnson and Clark [137] argued that the essential issue is not so much whether our research should be philosophically informed, but it is how capable researchers are of using and justifying their philosophical selections from many choices that they could adopted.

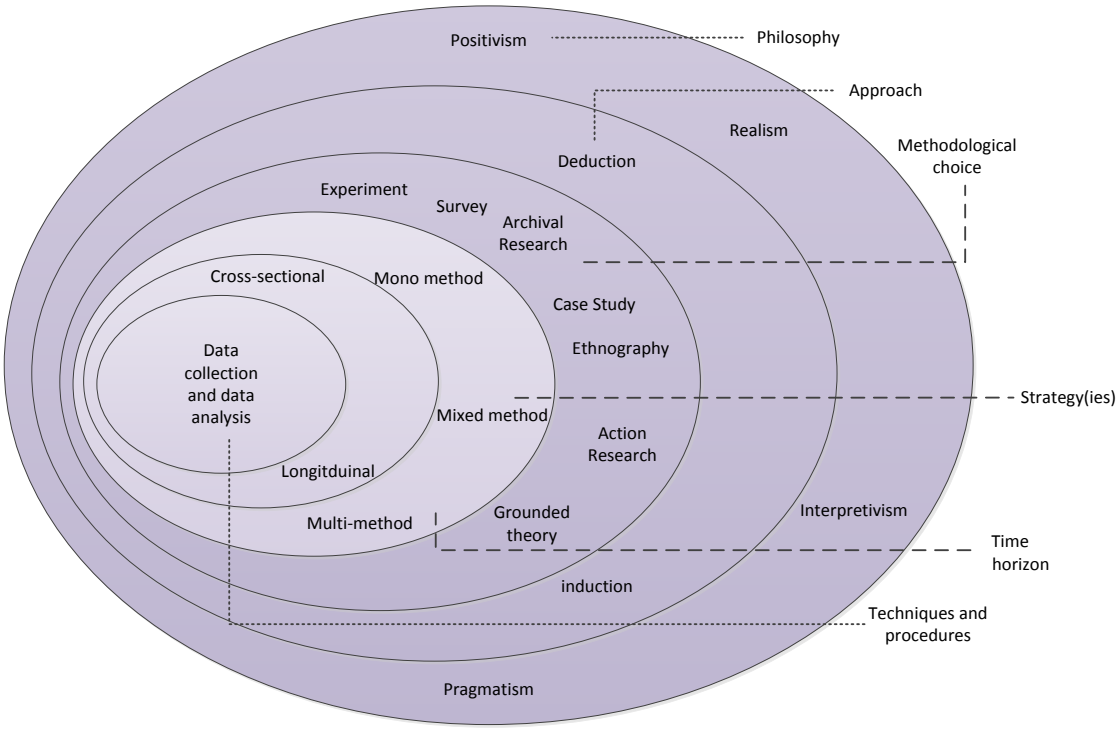


Figure 3.1 The research onion [130].

3.2.1 Research paradigms

A paradigm is defined as a philosophical framework which leads how scientific investigation should be carried out, based on people's philosophies and their assumptions about the world and the nature of knowledge [138]. Collis and Hussey [138] mentioned that adopting a particular paradigm is determined by researcher assumptions, but it is affected by the leading paradigm in that area of research and

the problem under investigation. While Saunders et al [134] indicated that pragmatism argues that the research question is the most important determinant of paradigm the researcher adopts, since one paradigm may be more suitable than the other for answering a particular question. Therefore, the paradigm is an important concept to the research procedure because it can be applied in all types of studies.

Ontology can be defined as “philosophical assumptions about the nature of reality” [136], which increases the queries that researchers have about the way the world functions and the obligations held to specific views. There are two aspects of ontology which are; objectivism which states the existence of phenomena in the social world on its own, separately from humans, who are involved [139], constructivism or subjectivism which means that social phenomena occur from the perceptions of social actors (people) [134]. This means that the researcher is part of the research and inputs his/her meanings and thought to that research [139].

Epistemology is “a research assumption concerning what constitutes acceptable knowledge in a field of study” [134]. In order to understand epistemology, researchers need to understand the three aspects of epistemology. Positivism is that generated based on the assumption that reality is independent from us and it is not affected by the act of examining it, which aims to discover theory based on empirical research [138], that means the researcher and the topic are independent from each other and have no effect on one another [140]. According to Gilbert [141] and Collis and Hussey [138] positivism is a method of developing and collecting valid and reliable facts about society which can be analysed statistically with the purpose of generating explanations about how the world functions. Saunders et al [133] stated that the positivism paradigm is a highly structured procedure that uses numerical analysis which leads to statistical results. This statement is supported by

Collis and Hussey [138] who mentioned that theories fall down under positivism, and since theory is a set of interrelated variables, and those variables can be related and measured, therefore positivism is associated with quantitative research which can be analysed statistically.

Distinct from positivism, interpretivism which was established as a result of positivism not being able to cope with the requirements of social scientists, is supported by assumptions that social reality is formed by people's perceptions, therefore it is subjective, and furthermore the researcher cannot be separated from what he or she is researching [135, 138]. Saunders et al [133] stated interpretivism is an epistemology that is essential for researchers to know and recognize the difference between people in their roles as social actors. Many researchers such as Collis and Hussey [138], and Corbin and Strauss [142] indicated that interpretivistis research findings are determined from analysis of qualitative data, unlike positivism which derives results finding from quantitative research data which is analysed statistically, since the interpretivistis seeks to understand the meaning, and tries to understand what is happening, while the positivist deals with frequency, which focuses on facts.

Realism is an "Epistemological approach that asserts that knowledge of social phenomenon is based on both what can be observed and recorded and hidden structure and mechanisms whose effects can be observed" [139].

As this research combines two different methods, namely interviews and questionnaires, the author considers that the research follows objectivist ontology as the thesis acknowledges the maintenance phenomena independent of whoever is studying it or analysing it. Thus independency leads towards a positivist epistemology.

3.3 Research Approaches

There are three types of research approaches which are based on the reasons for their adoption, the deductive approach; normally means the research starts with theory, which is driven from literature of previous researches, and the aim of the research to test that theory. While in the inductive approach; research starts with data collection in order to explore a phenomenon and then build a theory based on the result of that data. On the other hand the abductive approach combines the deductive and inductive approaches, starting with data collection in order to discover phenomena, to produce or adjust an existing theory, and test that theory with another set of data [143]. This research uses the deductive approach as it fits to the aim of the research by deducting information based on the data collected.

3.4 Research Design

Research design is " a procedural plan that is adopted by the researcher to answer questions validly, objectively, accurately, and economically" [144]. It is a process that includes all research assumptions and the data collection and analysing methods which can be known as procedures of inquiry. This inquiry can be quantitative, qualitative, or mixed methods that provide specific direction for procedures in a research design [145].

3.4.1 Quantitative Research Design

Quantitative research is usually connected with positivism, particularly when used with highly structured data collection techniques. It is generally connected with the deductive approach, when the purpose is to test theory by using data. It might also use an inductive approach when using data to develop a theory. The purpose of quantitative research is to examine the relationships between variables, which are measured and analysed statistically. Quantitative research is normally related to

survey and experimental research strategies, survey strategies usually being managed through questionnaires or even structured interviews [143].

3.4.2 Qualitative Research Design

Qualitative research is usually related to interpretivism, especially when researchers want to understand the meaning of subjective and socially built phenomenon [134]. Qualitative research sometimes involves naturalistism, when the researchers want to study phenomenon in its natural setting, while trying to make sense of, or interpret, and gain an in depth understanding [146].

Hair et al [147] mention that the researcher may choose qualitative research in situations such where little is known about the research problem, previous researches do not explain the research questions completely, it is difficult to access information related to psychological, subconscious, and culture through an experiment or survey, and if the research aim is to generate a new hypotheses to be tested quantitatively.

Normally qualitative research starts with an inductive approach, especially when it is used to develop a higher theoretical perception than those already existing in the literature. While a deductive approach is used in some qualitative researches to test theoretical perspectives which already exist [148]. However, many qualitative researches also use an abductive approach, where inductive uses data to develop a theory, and deductive is used to test the theory. The research strategies related to qualitative research are: survey, case study, action research, narrative research, ethnography, and grounded theory [143].

3.4.3 Mixed Methods Research Design

Mixed methods research generally involves combination or integration of quantitative and qualitative research. The general purpose of combining quantitative and qualitative approaches is to have a better understanding of research problems than when using either one approach alone [145]. Johnson et al [137] stated that "mixed methods research is the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study".

Mixed methods has many strengths, such as it is mostly useful in survey, field research, and evaluation [149] since it has wider focus than mono method designs, and allows researchers to collect more information about a particular topic [150]. Mixed methods can overcome the weaknesses of using quantitative or qualitative research, since it has been argued that quantitative research sometimes suffers from researchers' biases and interpretation, from weak understanding or analysis of the text and also difficulties in hearing the respondents' voice. On the other hand, qualitative research seems to be inefficient because of the bias of researchers' personal interpretations, and also the limited ability in generalizing the result. Moreover mixed methods research allows the researches to use many available tools of data collection methods which is not possible when the researcher uses either qualitative or quantitative methods [151].

Creswell et al [145] suggested three major types of mixed method designs, the first of which is the convergent parallel design, see Figure 3.2. In this type of mixed method design, researchers converge or merge quantitative and qualitative data in order to provide comprehensive analysis of the research problem.

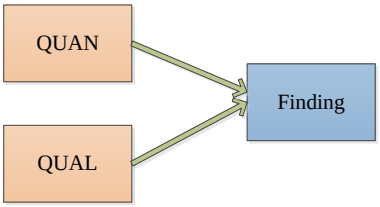


Figure 3.2 Mixed Methods convergent parallel design

While in the explanatory sequential design, the researcher starts with collecting quantitative data, then analyses and uses that data to build the qualitative part of the data collection, then analyses this to come out with final findings, see Figure 3.3. The explanatory sequential design aims to provide explanations of phenomena and how and why there is a relationship between two or more parts of phenomenon or a situation. It helps to elaborate and enrich the explanation of theories.

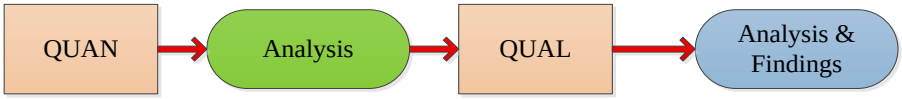


Figure 3.3 Mixed methods explanatory sequential design

On other hand, the exploratory sequential design in figure 3.4 is used as an initial investigation into relatively little or unknown areas of research. It has been emphasised to be a beneficial approach to discover what is happening and looking for new understandings. It can be used to build new instrument, modify an existing instrument or to identify appropriate instruments to use in the quantitative phase [152].

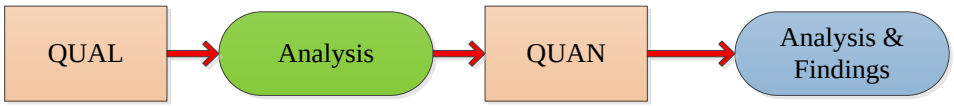


Figure 3.4 Mixed methods exploratory sequential design

Creswell et al [152] suggested four major types of mixed method designs, which are triangulation design, embedded design, explanatory design, and exploratory design, all these designs combine quantitative and qualitative data collection methods.

Therefore researchers need to prioritise between quantitative or qualitative methods, where the research approach can lead to the correct prioritisation, based on the purpose of the research [143]. Creswell et al [152] proposed that designs starting with qualitative methods are most suitable when the research aims to explore a phenomena, especially when the researcher wants to identify unknown variables or to build new instruments, then the qualitative finding will be used as a guide to the quantitative instruments development.

3.5 Nature of Research:

Exploratory research is used as an initial investigation into relatively little or unknown areas of research. It is a beneficial approach to discover what is happening and look for new understandings. It is a useful method to understand a problem and can be conducted when studying a literature review, case studies, focus group discussions or conducting interviews and talking to experts [143, 153].

Explanatory research aims to provide explanations of phenomena and how and why there is a relationship between two or more parts of phenomenon or a situation. Explanatory research can provide the researcher with the reasons behind a particular theory therefore it can answer the “why” questions. It helps to elaborate and enrich the explanation of theories. Normally explanatory research uses quantitative data to establish and validate relationships using correlation analysis for example, or uses qualitative data to explain reasons [153, 154]. The data in explanatory research is quantitative.

Exploratory research is used in this thesis, since it is based on the lack of research about the applicability of the level of maintenance implementation and the research model in the Middle East context, in this case Iraq. Thus this thesis aims to explore

the maintenance implementation level, factors affecting the maintenance level, and the effect of organizational culture on maintenance factors and practises.

3.6 Research Strategy

A research strategy can be defined as “a plan of how the researcher will go about answering his or her research question” [134]. There are number of research strategies, therefore the selection of a particular strategy should be based on the research nature, situation, objectives and questions. Each strategy has advantages and disadvantages, therefore the researcher should take in to consideration several factors when he or she chooses a strategy such as knowledge, time and other resources, access to data and participants. The researcher may choose more than one strategy in the research, for example a survey with a case study, or combine a number of different strategies within a mixed methods approach [134].

3.6.1 The Survey Strategy

A survey can be defined as a method of gathering data from a sample of a population in order to investigate the characteristics of that population [155]. This method has been widely used in business and engineering management research, allowing the researcher to collect a large amount of data from a large population [156]. It is a powerful strategy which provides a rapid, low-cost, effective and accurate way to collect and assess data and information when managed correctly [157]. According to Fink [158] a survey is “a system of collecting information to describe, compare and explain: practice, knowledge, behaviour or attitude”. A survey aims to describe populations characteristics or may use correlation analysis to test explanatory theories. There are two methods which can be used to collect data and information about any problem, situation, people or phenomenon for

research using a survey, which are based on the source or type of data collected, and can be categorised as primary data and secondary data, see figure 3.5 [144].

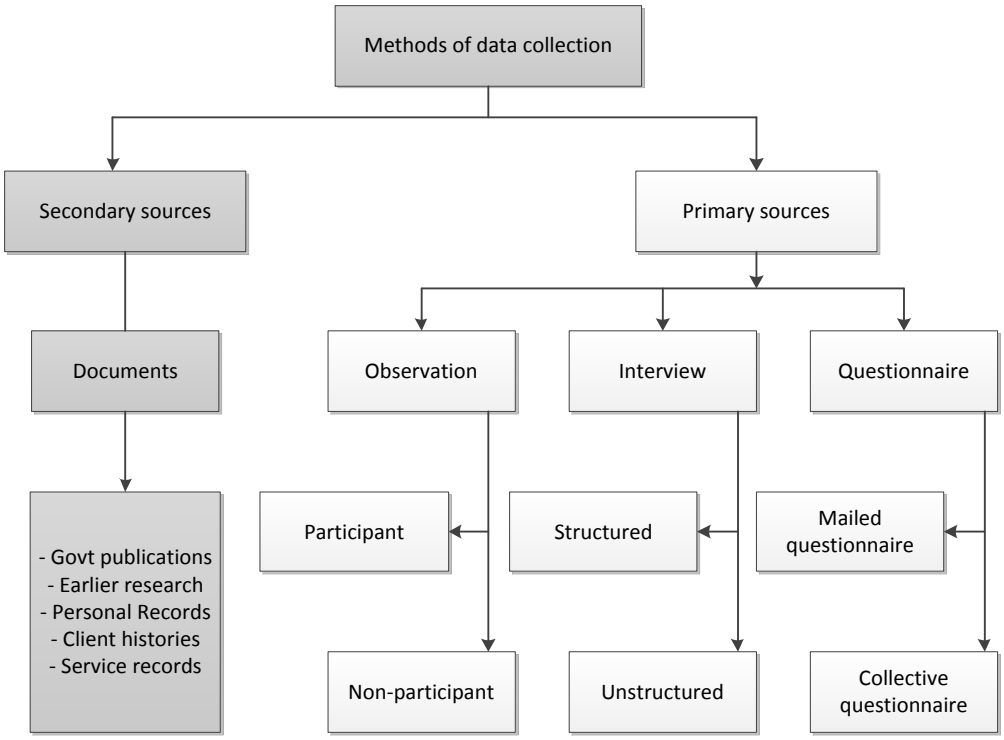


Figure 3.5 Methods of data collection [140]

Secondary sources or secondary data is data which is collected and documented by someone else before the current project or research starts [157]. It could be government or semi-government publications, earlier research, personal records and mass media [144]. Secondary data has a number of advantages, it could save in resources, time and money, because it is considered less expensive to use secondary data then collect the data yourself, also if the researcher needs data quickly, they can rely on secondary data because it is already collected and available, it can also be useful to compare with the data collected, it may lead to an unexpected result or even a new discovery. One disadvantage of secondary data is that difficulties in accessing or collecting it can cost a lot of money, for example data collected for commercial purposes such as market research, may not be available online or in libraries. In some cases, the researcher might collect data which is not

useful for the research purpose and objectives. Another disadvantage of using secondary data is that it may result in ethical problems, as some data may have already been published, and also the researcher may need to get permission from the organization that produced the data to use it [134].

There are many methods to collect primary data, but using a particular method relies on the type of study and the researcher's skills. Sometimes a researcher can't use the right collecting technique because of a lack of resources or even a lack of skills. Therefore the researcher should have enough information about the target population such as education level, age range, economic group, and also he or she must understand that some samples are not easy to deal with when using a particular method of data collection, because he or she may not feel comfortable expressing feeling in the interview for example [144]. It is important to clarify and explain to the responded the purpose of the study or research. Many researchers have stated that there are three common primary research sources: observation, interview, and questionnaire survey [159, 160].

3.6.1.1 Interviewing

The interview is a useful method to collect data and information, it is a conversation between two or more people, and it can be done face to face or over the telephone. The interview helps to collect valid and reliable data related to research questions and aims. The interviewer has the right to choose the question format and content, and the method of asking the question; he or she can be flexible when asking questions as there is no restriction on question order or formation, or can be inflexible, so he or she follows the questions in order and sequence. [144]. The interviewer should inform the interviewee about the aim of the study and the confidentiality of the information. Furthermore the interviewer should be able to

avoid bias when asking the question to the interviewee [161]. The interview strategy can be structured, semi-structured or unstructured:

Structured Interview: is a written set of questions prepared by the interviewer to be asked to the interviewee by person to person conversation, over the phone or other modern communication approaches. It can contain open ended or closed questions and the interviewer must read the questions exactly and follow the question order as it is written in the question list, and record the response. The advantage of this method is that it is useful to collect quantifiable, uniform data. Structured interviews are also known as quantitative research interviews [144, 162].

Unstructured interview: in this type there is no questions list to be asked. The interviewer may generate questions or raise issues in a moment, therefore he or she must have a great knowledge, skills, and clear idea about the area to be explored. It allows the interviewees to speak freely to express feeling or behaviour related to the topic [163].

Semi-structured interview: in this type of interview technique the interviewer has a list of questions and he or she has control over whether or not to follow the question sequence depending on the conversation flow. Furthermore, the interviewer may ask more questions in response to what are seen as significant replies [164].

According to Kothari [165], the interview technique has advantages and weaknesses. The main advantages are as follows:

1. More and in depth information can be obtained.
2. The interviewer skills can overcome the respondents' resistance.
3. Personal information can be easily obtained.

4. During the interview, observation methods can also be applied to recoding verbal answers to various questions.
5. It is easy to control the samples effectively because the non-response remains very low.
6. The interviewer can usually control which persons will answer the question.
7. Spontaneous reaction from respondents can be captured which is not possible when using a questionnaire.
8. The interviewer can adapt the language of the interview based on the respondent's ability or educational level to avoid confusing questions.
9. Great deals of information about the respondent's personal characteristics and environment can be collected which usually has a great value in interpreting results.

Disadvantages and weaknesses of interview methods are as follows:

1. Interviewing a large and wide-ranging geographical sample can be very expensive.
2. There is a possibility of bias of the interviewer or the respondents.
3. It is not easy to approach executives, high income people, or officials.
4. It is time consuming method when it requires a large important sample.
5. The presence of the interviewer may over stimulate the respondent.
6. Selecting, training and supervising the field staff is required which is more complex for organizations.
7. Interviewing may lead to systematic errors.
8. Effective interview requires a good relationship with respondents in order to enable free and frank responses. This is often a difficult requirement.

3.6.1.2 Questionnaire

The questionnaire is another type of data collection method. It is an efficient method for researchers to gather data about specific interests. It is a list of questions which are used to ask and gather information from respondents, which can then be analysed statistically. The meaning of the questions will not be explained to the respondents like in an interview, therefore the questions should be easy and clear to understand and the respondents should read and follow the questionnaire easily [19].

A questionnaire also has advantages and disadvantages [165]. The advantages of a questionnaire are as follows:

1. Questionnaires can be considered a low cost data collecting method even if the sample is large and geographically wide.
2. Questionnaires are free from the bias of the interviewer because the respondent answers questions with his/her own words.
3. Respondents have sufficient time to think and give answers.
4. Questionnaires can also reach respondents who are not easily approachable.
5. Dependable and reliable results can be generated when using large samples.

The main disadvantages are:

1. Low rate of return of properly filled questionnaires because of bias due to no-response.
2. It can only be used when respondents are educated and cooperating.
3. The researchers lose control over the questionnaire once it is sent.
4. It is difficult to modify the method once questionnaires have been sent.
5. There is a possibility of ambiguous answers or oversight of replies.

6. It is hard to know whether willing respondents are really representative.
7. It can be a slow method.

Questionnaire design

The researcher should design the questions of the questionnaire carefully and ensure that the questions provide correct information to the respondents. Therefore, the questions should be clear, unbiased, unambiguous, and moreover the questions should sustain the respondent's motivation and interest [144]. It has been suggested that the questionnaire should be short, and the designer or developer should start with general questions and background information, and then explore the key area of interest with further questions [166]. Designing of the questionnaire should meet the research questions, objectives, and ensure that the correct data is collected. Chalmers suggested that any researcher who is developing and designing a questionnaire should do the following [167]:

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

Question types

The questionnaire survey has two types of question designs:

Open-ended questions; are easy to build since there are no responses given, which allows the respondents to have the freedom to express and write their answers down, and therefore the respondents may give good information, thoughts and ideas. It has been suggested to avoid asking several open-ended questions to a large sample, without preparing them to

spend a huge amount of time and effort in answering the questions [163, 168].

Closed questions; are the most used method in research, the responded can choose (tick) from listed possible answers provided by the researcher, the closed question and answers can be coded and analysed quantitatively [168, 169].

Questionnaire administration

There are different ways to administer the questionnaire:

Mailed questionnaire: it is a widely used method by sending the questionnaire to potential respondents by post, therefore the researcher needs to have access to the respondents' addresses. Also it can be done by sending at a web-based questionnaire to respondents electronically via email. The questionnaire must have a covering letter to explain to respondents the purpose, benefits of the study and how the data collected will be used. Mailed questionnaires have been shown to produce low response rates [144, 153].

Collective questionnaire: it can be done by delivering the questionnaires by hand to each respondent and then collecting them later. This method might ensure a higher response rate, because the researcher can explain the purpose and importance of the study to respondents in person [144].

3.7 Methodology to investigate maintenance and TPM

Many researchers have conducted different research methodologies, such as interview, questionnaire, observation, case study, process simulation, and experiments, in order to investigate the maintenance and TPM implementations in

organisations. However, many researchers choose interview or/and questionnaire as data collection methods to address maintenance practices and implementation in companies, given that, maintenance has different aspects such as technical, human, and economic, which require emphasise on employees' opinions to understand the situation.

McDonald et al [170] conducted 33 semi-structured interviews in four maintenance organisations, with maintenance and safety managers. The sample they interviewed included quality management, quality investigators/auditors and training personnel, production and middle management, chief Executives. Their interviews focused on the different elements such as policy, standards, organisation and planning of work, personnel training, monitoring, quality discrepancy, reporting Incident/accident investigation, feedback, human/organisational change. Kutucuoglu et al [171] carried out interviews with quality manager, maintenance personnel, and operations managers. They used the interview to get the feedback about framework designing, and to assess the performance measurement systems (PMS) in maintenance validity.

Similarly, Reiman et al [93] conducted two semi-structured interviews with four main themes about: employee's own work, the maintenance work organizing, maintenance task, and organizational culture. The first interviews with three members were more focused on maintenance task demands, the second one interviews were with nineteen employees (foremen, planners, line managers, technicians, and maintenance head). Azadeh et al [172] used the interview technique in their research to ask managers and employees their opinion about working environment and ergonomic considerations and their relation to teamwork,

safety, human factors, organizational and management factors, motivation and training.

Parida [173] for example conducted 38 interviews with LKAB employees from different departments (maintenance, production, automation, finance and account, and process). The purpose of their interview was to understand the production and maintenance (processes, planning, order, inspection, reporting, and cost) in order to study, analyse, and develop maintenance performance indicators (MPI). In the same vein, Reynir et al [174] interviewed the head of operation and technical supervisor of Reykjavik power plant and head of maintenance management at Landsvirkjun power plant in Iceland. The purpose of the interview was to identify what maintenance systems are used in those power plants, and also to identify how the power plants measure maintenance activities, how the use of data can improve maintenance, and identify which solutions are desirable for the power plants.

Questionnaire has been widely used in many researches in many fields, to collect information about believe, vision, experience, opinion, perceptions, trends and patterns. Many researchers have used a questionnaire to investigate different aspects of maintenance in different industries around the world, such as; in maintenance management; [38, 39, 175-177] maintenance strategies [95], culture and maintenance [93, 178], maintenance proficiency [179], maintenance quality and productivity [180], teamwork and maintenance [181], maintenance performance [182-184], maintenance practice [94], and safety and maintenance [170]. Also in many areas of TPM, such as; TPM and manufacturing performance [56, 185-187], TPM enablers [86, 88, 92, 188-190], TPM barriers [50, 61], TPM implementation [91, 191], TPM and job characteristics [192], and TPM practice [193].

3.8 Research Process and Methodology of this Research

In order to discuss and choose the most suitable research strategy for this study, it is useful to revisit the aim and objectives, discussed in Chapter one. The overall aim presented in this thesis is to investigate the reasons for power shortage in Iraq, and to examine the level of maintenance implementation in the Iraqi power plants. Moreover, to empirically examine the evidence on the influence of cultural characteristics of power plants on maintenance implementation factors to better understand their influence on development of a comprehensive and effective TPM framework, and the main objectives of the research are:

- Investigate the barriers and difficulties influencing the current power production rate in the Iraqi power plants.
- Investigate the level of maintenance implementation in the Iraqi power plants.
- Identify the types of organisational culture existing in the Iraqi power plants.
- Investigate what types of organisational culture are affecting what types of maintenance factors.
- Develop a theoretical maintenance framework for Iraqi power plants based on the findings.

Based on the philosophical stand, mixed methods exploratory sequential design has been chosen, see figure 3.6, and the process for the research is described as follows:

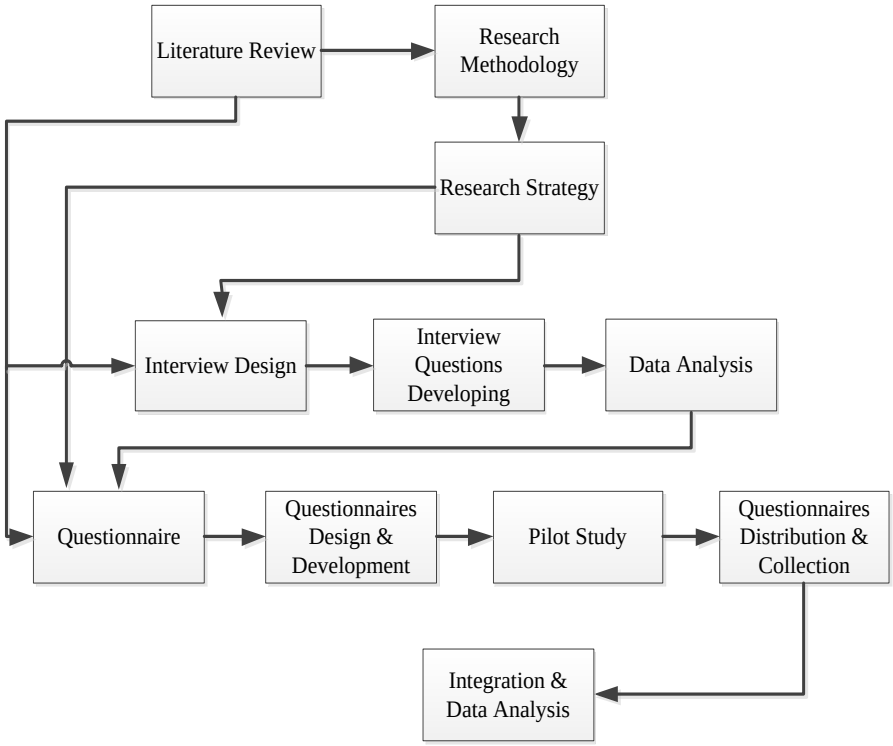


Figure 3.6 Research methodology of this research

3.8.1 Qualitative:

Semi structured interviews are used to collect data and to raise information, in the case of this research to cover information which could not be found in the literature or other sources of information, due to the limited number of resources, data, and unavailability of researches related to power plants operation and maintenance in Iraq. Moreover, semi structured interviews can be used to establish new instruments or variables that are affecting reliability of the Iraqi power plants, which will provide the insights for the second step (Quantitative).

The semi structured interviews were conducted with the Iraqi power plant managers or their representatives. The aims of using this method are to determine the number of employees, the power plants actual capacities and current production rates, maintenance activities and annual budgets for maintenance, organizational structures, culture, and management styles.

The interview is structured in three main sections as follows; the full set of interview questions can be seen in Appendix 1.

1. General introduction questions for managers about experience, education level and field of study, and other questions related to power plant age, number of employees, which will help to identify the questionnaire sample number, the designed capacity and actual production of the power plant units, the reason behind the power shortage in Iraq from top managements point of view, and how it can be overcome in the power plant manager's perspective.
2. The second part of interview questions are related to maintenance in the interviewees' power plant. Those questions are considered important because they will give a better understanding to the maintenance activities from top the management and maintenance departments point of view, those questions are developed to cover the information that the researcher couldn't find in the literature review or from any other source [194] in order to meet the research the aim and objectives. The questions will cover areas such as; if the power plants have a formal maintenance department or policies, how many employees are within the maintenance department, maintenance planning, budget, maintenance strategy and program, how the maintenance is performed, maintenance procedure documenting and analysing, spare part availability and inventory planning and employees' performance evaluating.
3. The third part of the interview is questions related to managerial and human factors which may be considered to have an impact on maintenance and organization performance in terms of training, management style, teamwork, motivation health and safety, and organization culture.

3.8.2 Quantitative:

Based on the literature review findings, providing theoretical constructs, along with insights provided by the interview stage, the second stage involves the application of questionnaires in order to gather information about barriers affecting power plants, the level of maintenance implementation and the effect of organisational culture on maintenance factors and practices.

Survey questionnaire design: Based on the research aims and objectives, the questionnaire was organized into the following three sections in order to provide empirical evidence to answer the research questions specified in chapter one and to test the hypotheses. The full questionnaire can be seen in Appendix 2:

Section one: Survey questions on respondent profile: The questions that will provide general information about participants such as: age, job title, experience, and education level.

Section two: there are two parts of this category:

Table 3.1 shows the questionnaire constructs with a brief description and source and questions measuring the construct and their scale.

1. The questions in the first part of section two cover the power plant barriers, which are already discussed in chapter two. In order to design and develop the questionnaire, the researcher identified the factors affecting power plant reliability from previous research studies and from themes which emerged from the interview data analysis. Twelve closed end questions which are rated on a five point Likert-type scale ranging from 1 (strongly agree) to 5 (strongly disagree), and one open ended question were developed.

2. The objective of the second part is to identify the level of maintenance implementation and good quality maintenance management practices in the targeted power plants, using the key factors of effective maintenance management which were identified from reviewing the literature. Sixteen main questions (1-16) were asked to respondents to indicate their level of disagreement/agreement on maintenance practices in their power plants. Again, a five point Likert scale (from 1 to 5) with end points of “strongly agree” and “strongly disagree” was used, in order to calculate an overall score for each factor. which has been drawn from Cholasuke et al [177], Nakajima [44], Noha [195], Graisa [117], Maletič et al [184].

Section three: This section consists of four parts,

1. The first part of this section consists of questions on organisational culture, the aim of this part of the questionnaire is to identify culture type in the power plants and its characteristics. Many researchers have used instruments which were developed based on Denison and Spreitzer model in correspondence with Cameron and Quinn, (OCAI) measurement items, such as Al-Khalifa and Aspinwall [108], Reiman and Oedewald [196], Reiman and Oedewald [93], Stock, McFadden [197] Zu, Robbins [104], and Al-Jalahma [198]. Questions 1 -32 in part 3 section 3 were developed to measure the score on each of the four cultures types (Group, development, rational, and hierarchical). The respondents were asked to select the level of importance of each question using a seven point Likert scale (1-not at all to 7-very well).
2. The second part of section three has twenty-eight statements, all are rated on seven summated scales from 1 not at all to 7 very well, which have five dimensions; organization structure and work design, sense of personal

responsibility, decision making, sense of control and communication climate and safety and environment. Those dimensions are adapted from Reiman et al [93] measure of psychological characteristics related to work, and measures of individual perceptions and conceptions, and Morgeson et al [199] work design questionnaire, and Leon et al [200] work on decision making.

3. Training: has been found to have great impact on organizations performance, in today's complex workplace with advanced technology, organizations need to invest more and more in every part of their business in order to survive in today's competitive environment. Therefore, the need for well qualified personnel has become a strategic target. Training has become an important factor for any organization in the world because proper training will improve the skills, knowledge, and abilities of new and old employees [65], therefore the training will increase the employees and organization efficiency and effectiveness [66]. Most successful companies tend to invest more in training than unsuccessful ones [67]. Many researchers have found there is a relationship between training practices and organizational performance [68-71]. The current study has used twelve items from 1 to 12 in Appendix 3 section 3.c rated on a five point Likert-type scale ranging from 1 (strongly agree) to 5 (strongly disagree).
4. Motivation: Motivation is the practice of human resource management which can help organizations to achieve their goal and high performance by motivating their employees to perform their job well [83]. The employees performance is not only based on their actual skills but also on their personal level of motivation when performing their job [84]. Taghipour et al [85] stated that employee motivation is a an important factor to have progress,

overcoming difficulties and achieving business goals. The motivation questionnaire items were developed based on Islam [201], and Roman [202]. Islam et al, identified six factors that motivate employees which are; (1) high salaries, (2) good working environment, (3) job security, (4) promotion, (5) appreciation of work, (6) interesting work [201]. Fifteen items rated on a five-point scale from (strongly agree) to (strongly disagree) can be seen in Appendix 3, section 3.c, questions 13 to 27).

5. Teamwork: Teamwork is a group of people gathered together with the purpose to perform a specific job or to solve particular problems. The purpose of teamwork is to share skill, knowledge, experience and ideas between those people in order to get better results when they are performing their task. Many researchers found a positive relationship between teamwork and organisation performance. Banker et al [77] for example, suggested that the use of a team has resulted in significant improvements in many industries. Hoegl et al [78] in their research identified six aspects (communication, balance of member contributions, coordination, mutual support, cohesion and effort) of teamwork which have a great association to team performance. Adams et al [79] identified seven characteristics of effective teams: role clarity, goal clarification, productive conflict resolution, accountable interdependence, mature communication, common purpose and psychological safety.

   In this instance, teamwork is measured based on 22 items which are rated on a five-point scale from (strongly agree) to (strongly disagree), as can be seen in Appendix 3, section 3.d

3.9 Research Model

In order to answer objectives 3, 4, and 5 in chapter one section 1.4, and based on the literature review on TPM and TQM, the methodology of this part follows the research carried out by Zu et al [104], studied the link between organizational culture and TQM/Six Sigma practices, and is highly related to the objectives of this research as it focusses on the impact of organization culture on maintenance practices. Therefore, the model proposed for this thesis is as can be seen in figure 3.7:

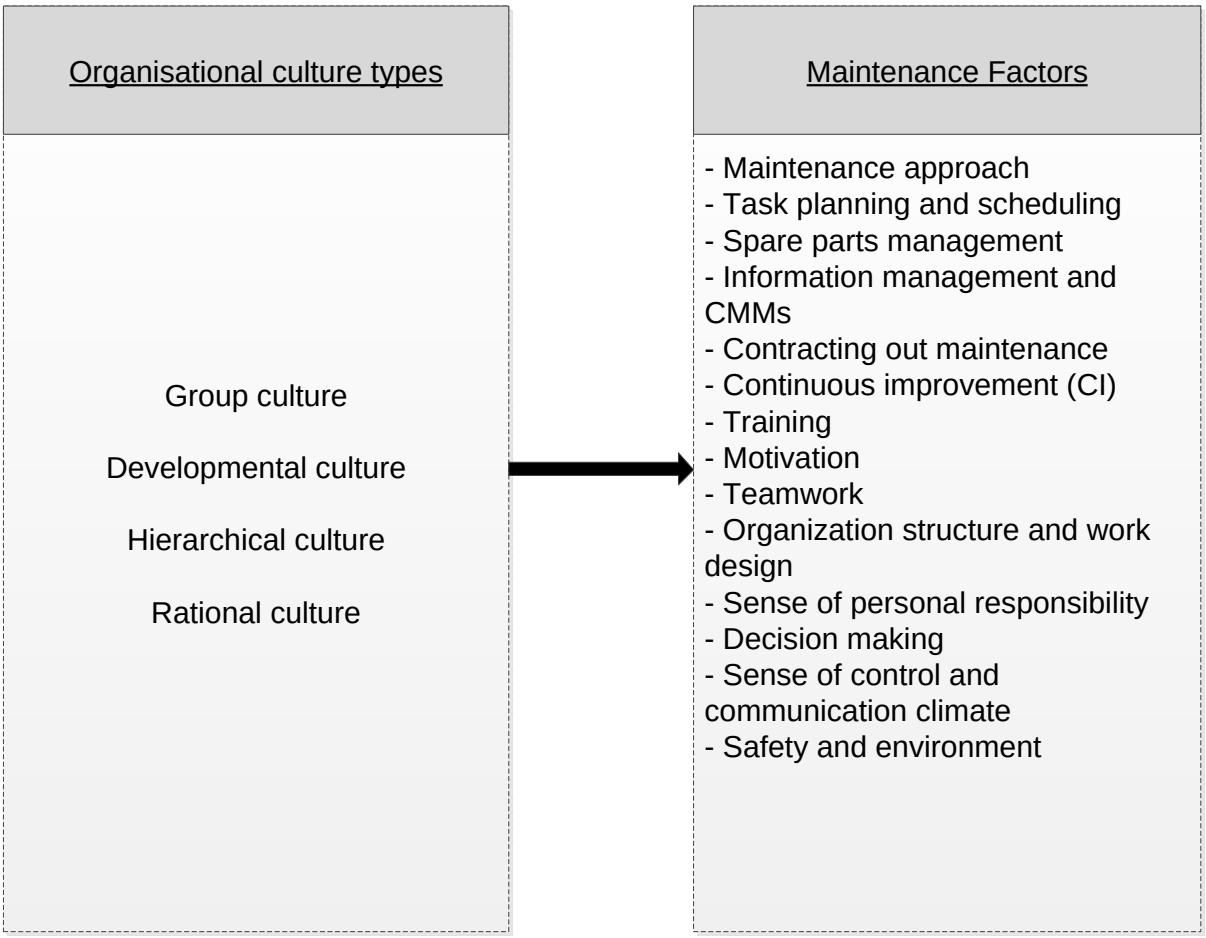


Figure 3.7 Theoretical framework

Table 3-1 Description of constructs and measurements

Construct	Description	Source	Questions	Scale
Maintenance approach	The type of maintenance technique that originations use which is affecting the maintenance performance.	[177]	1- Power plant is using evaluation method to choose the right maintenance approach. 2- Maintenance approach in the power plant is efficient.	Five points Likert scale
Task planning and scheduling	Planning and scheduling of maintenance work and activities can lead to high organization performance through decreasing the unplanned stoppage, increasing machine performance, lowering maintenance costs.	[177]	3- The equipment is accurately labelled for maintenance work. 4- Goals and duties of maintenance and planned maintenance are clearly defined. 5- Computerized systems for maintenance task planning and scheduling is used and it is efficient. 6- Higher percentage of work is planned. 7- Higher percentages of task are achieved.	Five points Likert scale
Spare parts management	Spare parts have a significant impact on maintenance activities, managing spare parts effectively can save maintenance costs which can impact the organizations performance.	[177]	8- Computerized system is used to control spare parts. 9- The spare parts are unavailable when I need them. 10-The parts, spares, and materials used an adequate.	Five points Likert scale
Information management and CMMs	Maintenance depends on information management, which is managing maintenance data, from collecting, analysing and providing reports to maintenance personnel and organization management	[177]	11- Computerised maintenance management system is used in the power plant. 12- Maintenance records are analysed using computerised system.	Five points Likert scale
Contracting out maintenance	Contracting maintenance to sub-contractors can lead to positive or negative benefits to organization because they need to pay more attention on how well those contractors, and how much benefits they gain from them.	[177]	13- The power plant does not gain benefit from contracting out maintenance to maintenance contracting companies. 14- I learn much from contractors who work at the power plant.	Five points Likert scale
	Long term improvement which can better maintenance	[177]	15- Power plant management welcome any improvement ideas from employees.	Five points Likert scale

Continuous improvement (CI)	performance on how they do things in a better way and how the employees are involved to provide management with ideas to improve work, and how management response.		16- The power plant systematically monitors the maintenance improvement suggestions.	
Organization structure and work design	Organization structure is the degree to which people feel that goals, tasks and responsibilities are well defined. To what degree the work designing and structuring will affect the performance on organisations.	[199]	1- Organizational culture, structure and processes influence my work activities positively. 2- The work is organized smoothly. 3- The goals of my work are clear. 4- The working climate at my work community is not good. 5- I have a clear picture of how my work contributes to the general goals of the organization. 6- My work tasks are clearly defined. 7- My workload is suitable. 8- On the whole, my work is stressful. 9- The job involves solving problems that have no obvious correct answer. 10- The job requires me to be creative 11- The job often involves dealing with problems that I have not met before.	Seven point Likert scale
Sense of personal responsibility	The view that person is personally n charge for the outcomes of his/her work	[93]	12- The job requires unique ideas or solutions to problems 13- It is mainly my responsibility that my work leads to the desired outcomes 14- It is mainly my supervisor's responsibility that my work leads to the desired outcomes	Seven point Likert scale
Decision making	The effectiveness of decision making	[200]	14- Decision making process in the power plant is efficient 15- I am involved in making decisions that affect my work in the power plant 16- Employees are allowed to appeal decisions made by managers.	Seven point Likert scale
Sense of control and communication climate.	Communication is the sharing and understanding of information between two or more people or groups, about the ways of doing work, introducing new technologies or practices, and the	[93]	17- The flow of information at my organizations is sufficient 18- I receive a great deal of information from my manager and co-workers about my job performance 19- Important data are presented and communicated to employees. 20- Charts showing plant performance are presented in plant floor. 21- We have easy access to the information we need. 22- I know on what basis my work performance is assessed	Seven point Likert scale

	communicating climate between management and its employees.			
Safety and environment	The safety policy and procedures within the organization.	[93]	23- My opinion the power plant has a clear and long term safety policy. 24- The company set improvement targets to reduce accidents and pollution. 25- The safety of the plant has worried me often. 26- The health and safety signs and procedure allocated everywhere in the plant.	Seven point Likert scale
Training	Proper training will improve the skills, knowledge, and abilities of all employees which will increase the employees and organizations efficiency and effectiveness.	[70]	1. Employees are receiving training based on their education qualification. 2. Employees are receiving structured training for different work positions. 3. There is no clear training policy in the power plant. 4. Goals of training programme are set up clearly with aim to future plans. 5. Operation and maintenance staff are receiving necessary training for new technologies or techniques. 6. The company implements a scheduled training program for improving operation and maintenance staff. 7. All training programs that attend are useful and important. 8. The training requests expressed by you are taken into consideration 9. The management at this plant believes that continual training and upgrading of employees' skills is not important. 10. The power plant assesses the employees' needs for training. 11. There is an evaluation of the knowledge acquired during training processes. 12. The application of the knowledge acquired during training processes to the work place is evaluated	Five points Likert scale
Motivation	Motivation is practice of human resource management which can help organizations to achieve their goal and high performance by motivating their employees to perform their job well. The employee's performance is not only based on the employee actual skills but	[202]	1- I'm satisfied with my current position at power plant. 2- I'm satisfied with my current pay. 11-I get extra pay for high performance. 14-My evaluations in power plant are fair. 12-There is opportunity to be promoted in my work. 3- I think that I need more attention from management in order to be motivated. 4- I feel encouraged to come up with new and better ways of doing things.	Five points Likert scale

	also on the personal level of motivation when performing their his job.		5- I'm involved in decisions that affect my work 7- Management looks to me for suggestions and leadership. 10- I receive enough information from management on what is going on in my division. 8- I have the tools and resources to do my job well. 13-I'm satisfied about relationship with other staff member at work. 9- I think my work is not interesting. 12- Considering all things, I am generally satisfied with my job. 15-Working conditions in power plant are not excellent.	
Teamwork	Teamwork is to share skill, knowledge, experience and ideas between people in order to get better results when they are performing their task, Teamwork is found to have a positive relationship with organisation performance.	[203]	1- Power plant management encourages teamwork. 2- I'm very satisfied with the teamwork interaction within power plant. 3- Good association between my department and other I need to work with. 4- I understand my task requirements and role within the team. 5- I clearly understand other member's responsibilities within the team. 6- Team goals are set clearly with to meet the task requirements. 7- I clearly understood my team goals. 8- Team goals are challenging. 9- Often there are conflicts between team members. 10- The team is able to resolve conflicts. 11- Managing conflict is a way to improve team performance. 12- I agree with what people say so we can continue and finish the task. 13- We support and motivated each other when tasks are difficult. 14- Other members in my team depend on me to get their tasks done 15- It is difficult to ask members of this team for help 16- I can effectively communicate and discuss my ideas in a team. 17- I receive valuable feedback from the team. 18- The team purpose usually developed by the team. 19- Team purpose and team goals are related. 20- No one in this team would purposely act in a way that undermines my efforts 21- If I make a mistake in this team, it will not be held against me. 22- My unique skills are valued when I'm working in a team	Five points Likert scale

Group Culture	Group culture places based on flexibility and internal orientation. Organisations with this culture help the development of human resources, highlighting openness, participation, cohesiveness and commitment to all involved.	[104]	1- Initiative 6- Open communication 9- Shared/collective responsibility 12- Mutual trust 13- Feedback 27- Personnel wellbeing 31- Co-operation 23- Admitting one's own mistakes 28- Individual	Seven point Likert scale
Development culture	Organisations with development culture are considered as dynamic, entrepreneurial, and inspired workplaces. It is based on flexibility but with more concentration on the external environment.	[104]	1- Initiative 4- Financial goals 15- Flexibility 19- Cost-effectiveness 26- Productivity / profitability 29- Efficient working 20- The possibilities of new technology 24- Openness towards new ideas and techniques	Seven point Likert scale
Rational Culture	Rational Culture is focusing on external environment but is control-oriented. It highlights productivity, performance, achievement of goals, and which relay on competition.	[104]	7- Personnel development 10- Questioning of old routines 18- Continuous development 25- Learning 17- Goal achievement 30- Quality	Seven point Likert scale
Hierarchical Culture	Hierarchical culture is based on control and internal orientation. It gives emphasis to rules and regulations, and standardization to achieve control and stability.	[104]	2- Definition of clear responsibility areas 5- Systematic way of working 8- Goal setting 11- Centralized decision making	Seven point Likert scale

3.10 Method of data analysis

This study used a mixed research method for data collection, starting with a qualitative method (semi-structured interviews), which were conducted with power plants general managers, or their representatives in order to obtain more information about power shortage in Iraq and the level of electricity production and the reasons why power plants do not run in high capacity. A template analysis method was used to analyse data collected from these interviews.

This was followed by a quantitative method (questionnaires were the main tool) for data collection. Statistical techniques were used to analyse the data obtained from questionnaires to help interpret the results of this study. Statistical analysis was carried out using SPSS (Statistical Package for the Social Sciences), version 22 and structural equation modelling (SEM) was used to examine the relationship between the independed variables (organization Culture) and the depended variables (maintenance factors) by using Smart PLS software.

The first part of questionnaire analysis consists of analysis of personal demographics; identifying the barriers and the level of maintenance implementation in the power plants. Descriptive statistics in SPSS is used for this analysis. While the second part of analysis is measuring relationships between organisational culture and maintenance practice factors.

3.10.1 Reliability and Validity Evaluation

Bryman and Cramer [160] stated that measurements of validity and reliability constitute the most important principles in evaluating the accuracy of results

found in any research. It is generally agreed that when a means of measuring a concept is proposed, it must be both reliable and valid.

3.10.2 Reliability

Reliability can be defined as “the degree to which measurement are free from error and therefore yield consistent results” [204]. Measuring the same consistent variable can be done without having highly associated items which can make a consistent instrument [205].

Cronbach‘s alpha coefficient is a generally used measure of reliability in many fields such as the social sciences and business. The range if values of Cronbach‘s alpha is from 0 to 1. Sekaran [206] considered a Cronbach‘s alpha value of less than 0.60 to be poor, while Hair et al [207] suggested that a minimum level of Cronbach‘s alpha of 0.60 is required in order to be acceptable.

3.10.3 Validity

Saunders et al, describes validity as the amount to which data collection methods precisely measure what they were supposed to measure [162]. Validity also states the degree to which dimension results differentiate individuals who are likely to be diverse in a particular point of view [208]. Sekaran [206] stated that content validity is important to make sure that the instrument holds a suitable and representative set of items that signify the conception. Crooper and Schindler, [209] stated that content validity can be achieved by defining the research topic and instruments of measurement scale carefully. Furthermore Saunders et al [143] , suggested that a questionnaire can be reviewed by experts who can comment and judge on its suitability,

along with allowing recommendations on the questionnaire structure to be done.

3.10.4 Structural Equation Modelling SEM

Structural Equation Modelling is used for analysing the data. Since the proposed model does not follow exact previous research, and it is an exploratory approach, in which some of the hypothesized relationships between the variables have not been previously tested, the Partial Least Square SEM (PLS-SEM) is considered the most appropriate approach compared with the covariance based SEM [210]. Hair et al, suggest that, assessment of a PLS-SEM model must contain two stages:

1. The first step contains of the assessment of the measurement model, which can be named the outer model, which shows the relationship of the latent variables with the observed variables.
2. The second step is the assessment of the structural or inner model, presenting the relationship between the latent variables

3.11 Summary

This chapter has explained the research methodology and the research design of this study, and the selection of an appropriate research strategy in order to meet the research aim and achieve its objectives, before explaining the development of the research instruments. The next chapter will discuss the data collection and data analysing techniques of this research.

Chapter 4. Interview Process and Results

4.1 Introduction

The previous chapter discussed the choice of a suitable methodology for this research. This current chapter presents the interview question design, pilot test of interview questions, validity and reliability of the interview, interview coding, and processes that have been carried out with power plants managers or their representatives and analysis of the interviews.

Interviews help researchers to obtain greater details and gain more in depth knowledge about what is being investigated. It is a method of discovering what others feel and think about their worlds [211]. Semi-structured interview is the preliminary data-gathering tool of this research. It allows researchers to have a list of questions to be covered and to collect valid and reliable data and information that is related to the research aim and objectives. These interviews aim to discover particular information from interviewees who know or have access to the data or information being studied. The aim of the semi structured interviews was to find out information about the power plants which could not be found in the literature review or other sources of data, and also to investigate the maintenance activities within those power plants, the factors behind the power shortage in Iraq, and the power plant managers' thoughts and perceptions about their organization's culture and factors affecting them.

The interviews were done in two stages; the first stage was a pilot interview, followed by personal interviews which involved face to face interaction and communication between the interviewer and interviewees.

The researcher travelled to Iraq and visited all power plants detailed in chapter two, and then interviews were conducted with 9 power plant managers, or their representatives. The interviews were conducted during the period of March to April 2015, while the time allocated for each interview varied from interview to interview, with the average being around one hour.

4.2 Generation of Interview Questions

The semi-structured interview questions were generated from the theoretical frameworks and other related aspects developed in the literature review. The literature review was the main source in developing questions related to TPM and maintenance framework development, implementation, and success factors and barriers that have previously been shown to lead to failure or successful implementation within originations. The interviews question was designed in order to meet the aim and objectives of this research.

The full list of interview questions is shown in Appendix 1 and is divided into three major groups as shown in Table 4.1, with each group having subgroups in order to simplify the answer coding process and to help in data analysis. The interviews were structured to meet the following criteria; firstly, to provide unambiguous, non-leading, and open ended questions in order to reduce any bias, and to increase validity and reliability of the interview. Secondly, to cover factors affecting power plant maintenance and possible enablers and barriers that will affect TPM framework design. Thirdly, to give a proper input to the second stage of data collection, the questionnaire design.

Table 4-1 Interview questions groups

No	Group	Subgroup	Number of Questions
1	General Information	Demographic questions	This part consists of ten questions.
		Information about power plant	
		Power production and power shortage	
2	Maintenance in power plant	Maintenance	This part consists of twenty questions.
		Spare parts	
		Employees' performance	
3	Organization culture	Training	This part consists of fifteen questions
		Relationship and communication between management and staff	
		Team working	
		Organizational culture, structure and processes	
		Health, safety and Environment	

4.3 Pilot Study

It has been widely cited that a pilot study is important when research is being conducted because it helps researchers to enhance their data collection method in terms of data content and procedures [148]. The aim of a pilot study "is to try out the research approach to identify potential problems that may affect the quality and validity of the results" [212]. And also to identify any issues that may occur among the interview questions, for example, repeated questions, length of questions and confusion questions [213].

The researcher conducted two pilot studies to improve the validity and reliability of the interview questions. The purpose of conducting two pilot studies was to get feedback from different backgrounds and different organisations, since the first pilot study was conducted with a governmental

power plant, and the second pilot study was conducted with a private maintenance contracting company.

The first pilot study was conducted with the head of the planning department at a gas power plant in Iraq; the researcher sent the first draft of interview questions via email, to check if the questions were well structured, appropriate and easy to understand.

A manager and an engineer of a power plant maintenance company in Iraq were used as a second pilot study to test the interview questions and they highlighted two questions that needed to be rephrased. According to the responses from the pilot studies the following changes were made to the interview:

1. Some of the interview questions were revised to be clearer to the respondents, because some questions had the same meaning, and some of them were combined questions.
2. Changing some questions in part three (organization culture) from closed ended to open ended questions to give the responded freedom to express their feelings and perceptions when answering questions.

4.4 Interview Process

The interview process is a method of collecting interview data and can be seen in figure 4.1. Details of the nine power plants and the interview respondents' profiles are shown in tables 4.2 and 4.3 respectively. The interview process started by giving an explanation of the purpose of the research to the interviewees and informed them that names of their power plants will kept

confidential in the research. The next step of the process was explaining the interview data collection methods such as audio recording or pen and paper transcribing; only four of the interviewees gave their consent for audio recording and the rest did not give permission. The third stage was to ask the respondents the interview questions and their opinions and perceptions about them and to ask for further clarification or explanation when required.

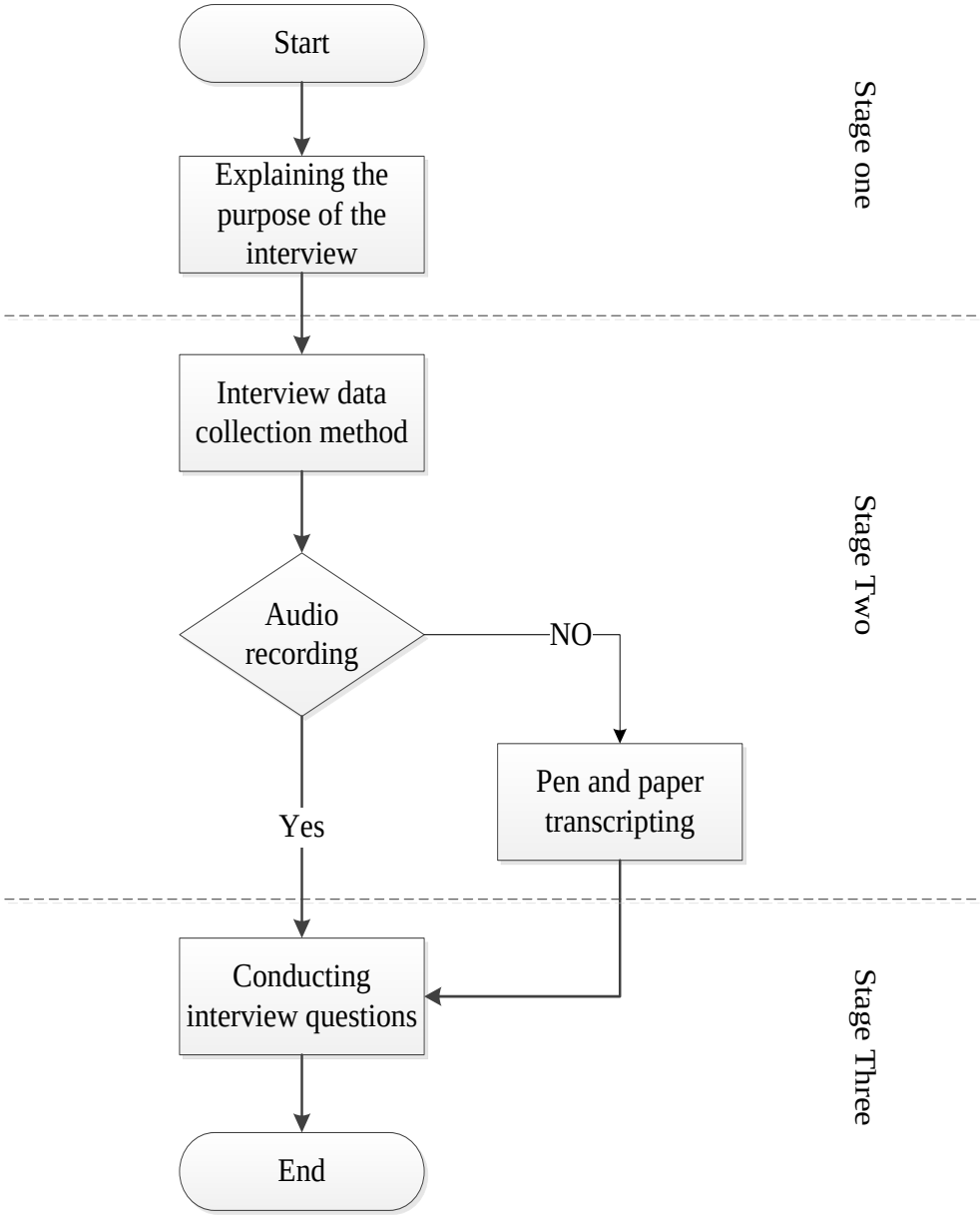


Figure 4.1 The interviews processes

Table 4-2 Power plants and interview respondents profiles

	Type	Employees Number	Respondent	Circumstances of Interview
A	Gas Power plant	600	Power plant manager	Transcribed
B	Steam power plant	1530	Power plant manager	Recorded
C	Gas Power Plant	600	Power plant manager	Transcribed
D	Hydroelectric Power Plant	130	Power plant deputy manager	Transcribed
E	Diesel Power Plant	452	Power plant manager	Transcribed
F	Gas Power Plant	450	Head of planning department	Recorded
G	Gas Power Plant	400	Power plant manager	Recorded
H	Gas Power Plant	311	Head of operation department	Transcribed
I	Gas Power Plant	300	Power plant deputy manager	Recorded

Table 4-3 Experience, education level, and field of last qualification of the interview respondents

Power plant	Experience in the power industry	Education level	Field of last qualification
A	13 years	Master degree	Mechanical Engineering
B	18 years	BSc degree	Mechanical Engineering
C	28 years	BSc degree	Mechanical Engineering
D	23 years	BSc degree	Mechanical Engineering
E	10 years	Master degree	Mechanical Engineering
F	11 years	BSc degree	Mechanical Engineering
G	15 years	BSc degree	Mechanical Engineering
H	15 years	BSc degree	Mechanical Engineering
I	10 years	BSc degree	Electrical Engineering

Figure 4.2 shows the differences between the designed capacity and the current production rate in MW of each power plant under investigation, while Figure 4.3 shows that the power plants produce only 2422.8 MW of their 4158 MW designed capacities which mean they are producing only 58%.

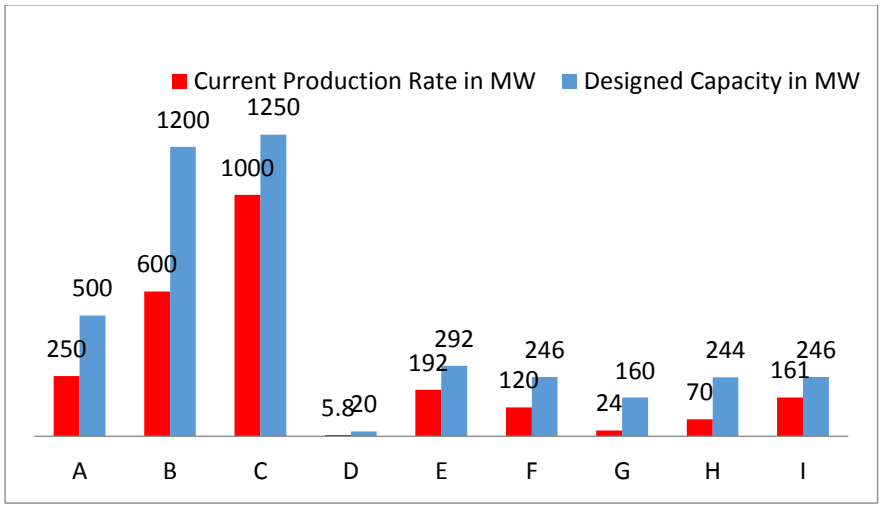


Figure 4.2 Differences between the design capacities and the current production rate of the power plants in MW

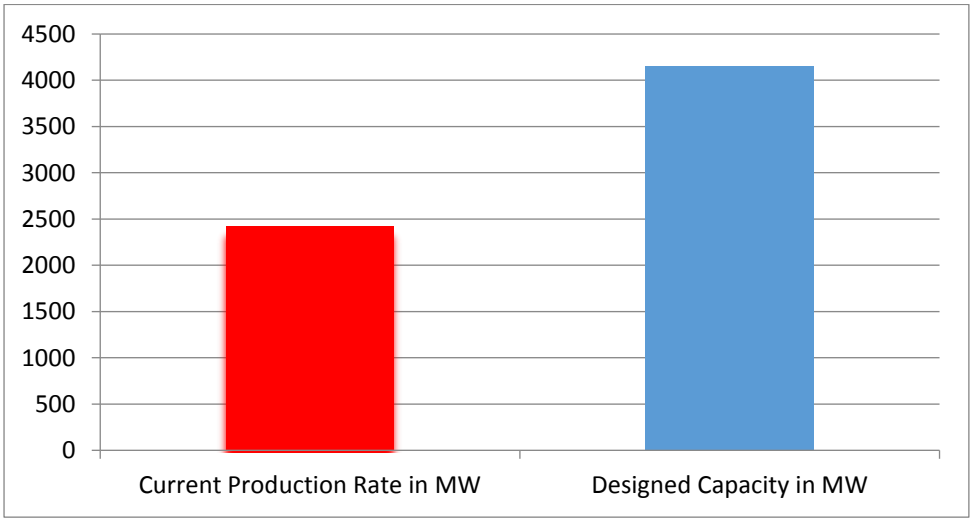


Figure 4.3 Total current production rates and the designed capacity of the power plants

4.5 Data Transcription and Coding

After each interview, the researcher listened to the digital voice recording or read the written answers from the interview and made notes of themes and interesting issues. After all the interviews were complete the researcher

transcribed the findings in Arabic and then translated them into English. In order for the researcher to understand the details of the collected data, and to enable him to identify the similarities of the emerging themes, the transcripts were read several times, the final typed text was then proof read and prepared for analysis.

Template analysis technique is one of the most popular data analysis methods used for analysing qualitative research. King [214] stated that “A template analysis is essentially a list of codes or categories that represent the themes revealed from data that have been collected, template analysis combines a deductive and an inductive approach to qualitative analysis in a sense that codes can be predetermined and then amended or added to as data is collected and analysed”.

The aim of template analysis is to provide an outline of the main themes and sub themes revealed from qualitative data collected from the interviews to the readers [215]. It also provides a flexible technique which produces rich data allowing the researcher to compare perceptions from several groups about their practise and experiences within a specific situation [214].

Data coding is a procedure of allocating labels to phrases and words collected in the interviewing process to help the researchers to distinguish and combine the data during the data analysis phase [216], and also helps the researchers to draw meaningful conclusions by identifying patterns in data, determining connections between them, and sorting them into categories [206].

The researcher started by preparing a provisional codes list [217] which was developed based on the interview questions, therefore the coding at this stage

was not creating codes based on the findings. Since the nature of this research is inductive, the inductive coding has also been used. Inductive coding starts with the process of reading the transcripts line by line within a paragraph, several times, to generate codes and to identify themes and categories [218]. As the list of codes increased, in order to reduce it and to avoid the duplication of codes, the researcher began renaming, resorting and regrouping codes and ensured that the codes were grouped into the right category or concept. The second stage of coding was axial coding, which is to identify the relationship between categories, to identify themes, and to configure and explain themes in order to reduce the large amount of data.

Miles and Huberman stated that “Data reduction is the process of selecting, focussing, simplifying and transforming the data that appears in written-up field notes or transcriptions.” [216]. The coding processes were done on each of the power plants interviews and the data was analysed individually. The identified concepts were grouped into categories which, is an important process because it reduces the number of units to work on [219].

4.6 Findings

The finding of the template analysis based on the power plants interviewees responses during the interviews were as follows:

4.6.1 Theme 1: Factors affecting the current power production rate

According to the themes established in the coding analysis, two categories related to the factors affecting current power production rate in the investigated power plants emerged as sub-themes (high codes);

- External
- Internal

4.6.1.1 External Factors

The analysis shows that there a number of factors affecting the power plants and preventing them from running at full capacity or even at their desired power production rate. It can be concluded that those factors fall into four categories, table 4.4 illustrates the sub-themes (High and low codes) which were developed based on the findings from respondents shown in table 4.5.

Table 4-4 External Factors affecting power production rate

Themes	Sub-themes Initial High Code	Sub-Themes Initial Low Code
Factors affecting the current power production rate	External	Weather condition and temperature Planning War National grid instability

Weather condition and temperature: All interviewees attributed the differences between the designed capacity and current production rate to weather condition and temperatures, (transcripts 1-9) table 4.5.A.

Planning: One respondent (transcript 4) attributed the differences between the designed capacity and current production rate to planning issues table 4.5.B,

War: War was found to be another factor affected the differences between the designed capacity and current production rate (transcript 2), table 4.5.C

National grid instability: One interviewee (transcript 3) stated that national grid instability is another factor affecting the current production rate which can be seen in table 4.5.D.

Table 4-5 Transcription on external factors

	Sub-Themes (Low Code)	Transcript No.	Question 1 - Why do you think there is a difference between the designed capacity and actual production rate
A	Weather condition & temperature	1	"Because of external circumstances such **environment and weather condition** and **aging**."
		3	"Depends on operating conditions where the design capacity is for ideal condition, the **heat**, fuel used, and spare parts availability and the materials used and the stability of the national grid. All those factors affect the power production capacity"
		5	"There are limitations imposed by the nature of the work and **weather conditions**."
		6	"Because of **Ambient temperature**, type of fuel used, and also because of some breakdowns, therefore we can't reach the designed capacity"
		7	"The first reason is that gas turbine power production units all over the world are affected by **temperature**, the efficiency of the unit goes down, when the **temperature** rises up"
		8	**"Weather conditions"**
		9	"The designed capacity is in ideal conditions, at a temperature of 25 degrees Celsius, and a certain air density, in the normal conditions of the region, the **temperature and density of dust and dirt**, affects the performance of the power plant."
B	Planning	4	**"Planning issues"**
C	War	2	"Iraq has experienced many **wars** and during the **wars,** the Iraqi infrastructure was targeted including electricity power stations, so there are missile strikes all over the place at the stations, and after 2003 through terrorism and sectarian **war** the power stations suffered again from bombing with mortars and therefore suffered damage, and it was good that the station reduced its production from 300 to 200 MW per unit only compared to the circumstances faced by the country in general and the station in particular, there is no station bombed with rockets and hit the turbine, the turbine is running in 3000 RPM and should be no vibration through its work, which hits by a missile, but say Praise God, that the station still works until now"
D	National grid instability	3	"Depends on operating conditions where the design capacity depends works in ideal condition, the heat, fuel used, and spare parts availability and the materials used and the **instability of the national grid** all those factors affecting the power production capacity."

4.6.1.2 Internal Factors

Table 4.6 is a summary of the sub-themes that emerged based on the analysis on the internal factors affecting the power plants which are preventing them from running at full capacity or even at the desired power production rate.

Table 4-6 Internal Factors

Themes	Sub-themes Initial High Code	Sub-Themes Initial Low Code
Factors affecting the current power production rate	Internal	Power plant aging. Spare parts and materials. Fuel type. Breakdowns. Unit efficiency

The following sub themes (low codes) emerged from the respondents' answers "Power plant aging"; "Spare parts and materials"; "Fuel Type"; "Break downs" and "Unit efficiency". These factors have been stated by many respondents as can be seen in table 4-7.

Table 4-7 Transcription on internal factors

Sub-Themes (Low Code)	Tran-script No.	Question 8 - Why do you think there is a difference between the designed capacity and actual production rate?
Power plant aging.	1	"**Aging**."
	4	"Focus on the gas turbine power plants which its production is expensive and **deteriorate so fast**"
	7	"The second reason in relation to units of this power plant is **aging** since the operational life of the units is 40 years surely this time period affected the efficiency of the units."
Spare parts and materials	3	"**Spare parts** availability and the **materials** used
	4	The units has problem even though there is planned maintenance because unavailability of original genuine **spare parts**."
	8	"Availability **of spare parts** for maintenance"
Fuel type	3	**"Fuel used**"
	6	"Type of used **fuel**"
	8	"Lack **fuel supplies"**
Breakdowns	6	"Also because of some **breakdowns** therefore we can't reach the designed capacity."
Unit efficiency	3	"Yes there is a difference for several reasons: **Efficiency of the unit**"

4.6.2 Theme 2: Power shortage Factors

According to the themes developed in the template analysis, two categories related to the factors affecting power shortage in Iraq emerged as sub-themes (high codes);

- Direct
- Indirect

The respondents were asked the following questions; **"In your opinion, what are the main reasons for the power shortage in Iraq?", "Do you think the allocated annual budget for the power plant maintenance is enough?", "Does the power plant have enough budgets for training?", "Are inventory parts available when needed? ☐Yes, ☐No, Why?"**

4.6.2.1 Direct

Detailed investigation for reasons behind the power shortage in Iraq identified another category of sub themes which can be seen in table 4.8.

Table 4-8 Direct factors affecting power shortage

Themes	Sub-themes Initial High Code	Sub-Themes Initial Low Code
Power shortage Factors	Direct	Planning and Vision Low efficiency and capacity Administrative, law and Training Budget, Financial & Operation costs Spare parts Fuel

While tables 4.9 and 4.10 Show the respondents' responses regarding the direct factors affecting the power shortages in the Iraqi power plant.

Table 4-9 Transcription on direct factors affecting power shortage

Sub-Themes	Tran-script No.	Question 9 - In your opinion, what are the main reasons for the power shortage in Iraq?
Planning & Vision	1	"**Lack of careful planning** of actual need for energy" "**Absence of real solutions** of the problem of electricity production"
	3	"**How to exploit the power distribution**, and put the right person in the right place" "**Planning** and training."
	4	"**Absence of correct planning**"
	5	"**Poor planning**, in power industry there are three sectors (production, transmission and distribution), and it has been focusing on production and distribution only. "**The belief** that thermal power plants are the best solution and because of the water crisis and because of the belief depletion of water has become a focus on the gas turbine power plants which its production is expensive and deteriorate so fast."
	6	"**The absence of significant solutions** of the problem of electricity, where the government headed recently to gas power units specifically, which are known that those units has a low high-capacity and high operational cost" "Because of **absence of radical solutions**"
Efficiency & capacity	1	"Relying on a power plant with **low efficiencies and capacities**"
	4	"A **large capacity** plants must be build"
	7	"The government headed recently to gas power units specifically, which are known that those units have a **low capacity**" "Because of absence of radical solutions to this problem by taking advantage of steam power generating units with **large capacities**"
Administrative & law & training	3	"First and foremost **administrative**, **effectiveness of the law**, and how to exploit the power distribution and put the right person in the right place" "Planning and the need for **training**"
Fuel	7	Another problem, is the **fuel problem**, the country suffers from the problem of the scarcity of **fuel**, the types of fuel used expensive, which means most of the gas units were operating on diesel fuel, in the last year, the ministry start to operate the units on the Heavy Oil and Crude oil, which of course also these types of fuel has disadvantages because it needs chemical materials and these chemicals prices are high"
Budget, Financial & Operation costs	3	"**Budget** and the instability of the **financial allocations**"
	5	"Focusing on the gas turbine power plants which its **production is expensive** and deteriorate so fast"
	7	"Of course there are several reasons, including: the conditions experienced by the country, **financial first**," "The government headed recently to gas power units specifically, which are known that those units has a low capacity and high **operational cost**"

	9	"Production of electricity in the development as a well-known the development of production needs to **cost**"

Table 4-10 Transcription on direct factors affecting power shortage

Sub-Themes	Tran-script No.	Question 13 -Do you think the allocated annual budget for the power plant maintenance is enough?
Budget, Financial & Operation costs	2	"Currently is **not enough.**"
	3	"**Not enough**."
	4	"**It is not enough.**"
	5	"It was enough but this year is **not enough**"
	6	"It is **not enough** for this year."
	8	"It was enough for previous years but this year is **not**."
Sub-Themes	**Tran-script No.**	**Question 26 -"Does the power plant have enough budgets for training?"**
Budget, Financial & Operation costs	9	"It was enough for last years, but this year **I don't think is enough**."
	2	"**Currently N**o, where there is no budget for training in the power plant, there is a training division within the plant with self-potential and there are some people who have the theoretical and practical experience are doing training courses inside the power plant to develop the technical level of staff"
	3	"**No**"
	4	"**No it not enough**, and the power plant has no trainer and possibility for training course is not available."
	6	"The training budged **has been stopped**."
	7	"In fact, the power plant **does not have a budget for training** as the station's budget is through the Directorate General of production, so we don't have a specific budget for training, because the training is done by the employees of the station, and means that each head of department make training sessions prepared by planning department, according to the station need to these courses and the trainee is employee in the power plant so there is no financial need. In the case of need we send employees to training centres in the Ministry in that case general directorate pays for those courses, therefore we do not have a specific program or specific amounts."
	8	"**Power plant does not have a budget for training** because it does not have a special finance unit which is directly linked to the general directorate of production."
Sub-Themes	**Tran-script No.**	**Question 23 - "Are inventory parts available when needed? □Yes □No Why not?"**
Spare parts	1	"**No**"
	2	"Most of them, but **not all**, and the rest are brought either by manufacturing them or purchase from local companies or external suppliers."
	3	"**No**, due the financial difficulty, slow process of ordering and getting permeation from higher authorities, and some spare parts are not available locally so we need to order them from manufacturers overseas."
	4	"**No** due to the financial ability, and spar part availability in market"

	5	"No, but most of them available."
	7	"Some of them, **not all what we need is available**, sometimes we bring from other power plants."
	8	"**No**, and it is big problem for ministry of electricity."

4.6.2.2 Indirect factors

The other sub theme relating to the power shortage in Iraq which emerged from the transcripts was indirect factors. Table 4.11 illustrates the sub themes developed from the findings and table 4.12 shows the respondents' responses.

Table 4-11 Indirect factors of power shortage

Themes	Sub-themes Initial High Code	Sub-Themes Initial Low Code
Power shortage Factors	Indirect	Situation in Iraq Culture and power demand Weather

Table 4-12 Transcription on indirect factors of power shortage

Sub-Themes	Tran-script No.	Question 9 - In your opinion, what are the main reasons for the power shortage in Iraq?
Situation in Iraq	1	"Because of the **situation** in Iraq and the failure to build a new power plants for more than 25 years"
	2	"In June 2014 power plants in western and north of Iraq such as in Salah Aldeen, Alanbar and Mosel Governorates were not running or **suffered from damage** since those were out of government control, even though power plants in the safe governorates were supplying those areas with electricity."
	3	"One of the reasons mentioned by ministry of electricity is that well-known companies in the world are not willing to work in the difficult **security environment**, therefore the ministry of electricity contract with other companies such as Asian or local Iraqi companies and certainly these are not given the reliability of global companies."
Culture & power demand	1	"The absence of energy consumption **culture** within the customers"
	2	"The supply less than the **demand**, even though the power plants run in their full capacity still cannot cover the **demand**, because after 2003 the people were able to buy all kind of household electrical supplies such as (Fridges, TVs, Air-condition systems, etc.), since Iraqi people were not able to afford to buy them before 2003. For example

		Karbla Governorate was consuming 60 MW now it needs 600 MW to cover the **demand**.”
	6	“Increase in **demand**.”
	8	“Production does not cover the **demand**, the lack of a **culture** of rationalization of consumption, not the use of technology in consumption, low electricity price supplied to the consumers, the lack of quality control on imported equipment and devices that consume high electricity.”
Weather	4	“We should not be relying on temporary stations such as gas power plants, they are unsuccessful because the weather in Iraq is **very hot** in summer and not suitable for such plants, and **air laden with dust**, as in Iraq negatively affecting the power plants, the gas power plant is considered to meet the temporary need”
	5	“The belief that thermal power plants are the best solution and because of the **water crisis** and the belief **depletion of water** has become a focus on the gas turbine power plants which its production is expensive and deteriorate so fast.”

4.6.3 Theme 3: Maintenance

In regard to the maintenance theme which was found based on the interview analysis, two sub themes were developed; practice and equipment and spare parts. Table 4.13 shows the power plants maintenance practices sub themes.

Table 4-13 Maintenance in the power plants

Themes	Sub-themes Initial High Code	Sub-Themes Initial Low Code
Maintenance	Practice	Structure Policy Strategy Perception Documenting & Analysis
	Equipment and Spare Parts	Computerized inventory Availability of spare parts Spare parts purchase planning

4.6.3.1 Maintenance practices

In depth investigation of maintenance practices in the power plants resulted in four sub themes being developed from the respondents’ answers. In terms of maintenance structure, the following question was asked to interviewees **“Do you have a formal maintenance department in the power plant? □Yes □No (if you chose No please explain why)”** and it has been found that all

power plants have the same maintenance structure and they have three main departments to carry out maintenance activities; Mechanical maintenance department, electrical maintenance departments and automated control department. It has also has been found that power plant B has two more maintenance departments which can be seen in transcript 2, table 4.14, while respondents in transcripts 2, 4, and 8 considered engineering or technical support departments as another maintenance department.

Table 4-14 Maintenance structure

Sub-Themes	Tran-script No.	Question 11 - Do you have a formal maintenance department in the power plant? □Yes □No (if you chose No please explain why)"
Structure	1	"We have **mechanical** maintenance department, **electrical** maintenance department and **automated control** department."
	2	"We have maintenance departments such as **boilers maintenance department**, **turbines maintenance department**, **electrical maintenance** department, and **automatic control** department, and **engineering support** department which considered as maintenance department and it has big maintenance workshop for unit maintenance, rotary and assistance devices division and water inlet and supporting systems maintenance division. Most of power plant departments have maintenance divisions."
	3	"Yes we have, **mechanical** maintenance department, **electrical** maintenance department and **automated control** department."
	4	**Mechanical** Maintenance, **electrical** maintenance, **automated control** and **technical support departments.**"
	5	"There three maintenance departments (**Mechanical**, **Electrical**, and **automated control**)"
	6	"Yes we have **mechanical** maintenance department, **electrical** maintenance department, and **automated control** maintenance department."
	7	"Yes, we have **mechanical** maintenance department, **electrical** maintenance department and **automated control** department."
	8	"Yes, there are maintenance departments such as **Mechanical** department, **Electrical** department, **automated control** department, and **technical support** department."
	9	"Yes we have maintenance departments; such as **mechanical** department, **electrical** department, and **automated control** department, all of them are involved in maintenance activities."

Next, the interviewees were asked if they have maintenance policies in the power plants. All respondents were confused between maintenance policy and the type off maintenance carried out, see table 4.15, and it was discovered that there are no written maintenance policies in any of the power plants.

Table 4-15 Maintenance policy

Sub-Themes	Tran-script No.	Question 12 - Does your power plant have a maintenance policy? □Yes □No (if you chose No please explain why)”,
Policy	1	“There are scheduled and periodic maintenance.”
	2	“There are a clear maintenance plans and programs in place and we have clear objectives and goals and we're working on, based on the power plant abilities and the support of the Middle Euphrates Power Production General Directorate and the Ministry of Electricity.
	3	“Yes, scheduled, routine, and emergency maintenances.”
	4	“5 years plan and investment plan.”
	5	“There are two types of maintenance: Emergency maintenance, and scheduled maintenance which relies on operating hours, which is simple maintenance and major maintenance.”
	6	“We use the maintenance recommendation of GE.”
	7	“Yes, all power plants have plans for maintenance depends on the operating hours of the units, and there are three types of maintenance depending on this time period, which is the maintenance of the combustion chambers and its duration is two weeks, and maintenance of the hot path and its duration is 3 weeks, and general maintenance and its duration 28 days. Of course there is another type of maintenance which is emergency maintenance and depends on the sudden breakdowns and then the staff proceeds reformed after the breakdown and to repair them.”
	8	“Yes, based on the manufacturer's recommendations.”
	9	Yes, we depend on your procedure GE Company and the manufacturer which relies on operating hours, maintenances are carried on at the end of operating hours based of specific recommendations of the manufacturer.

Table 4.16 illustrates the interviewees’ responses to a question about the type of maintenance strategies that they are use in the power plants, all power plants have emergency maintenance, and scheduled maintenance.

Table 4-16 Maintenance strategy

Sub-Themes	Tran-script No.	Question 14 - "What type of maintenance strategies does the power plant use? Please specify"
Strategy	1	Emergency maintenance and periodic Preventive maintenance.
	2	"Programmed maintenance and emergency maintenance. Programmed maintenance: it set by technical departments and planning department for three years, currently we have three-year plan for 2015-2017. The emergency maintenance, to be reactive maintenance or preventive for technical emergencies, now we have back production unit number four out of the work, the Air heater has block out and aging baskets, now it been put out for 20 days for the purpose of switching those baskets which considered emergency maintenance. The programmed maintenance plans are working in coordination with the Middle Euphrates Power Production General Directorate and the Ministry of Electricity"
	3	"Scheduled, this is daily, weekly, monthly and annually."
	4	"Annual maintenance, preventive maintenance and emergency maintenance."
	5	"Scheduled maintenance consists; simple maintenance in every 2000 working hours, and major maintenance from 12000 to 24000 working hour."
	6	"CI maintenance every 8000 working hours, hot path maintenance every 24000 working hours, and major maintenance every 48000 working hours."
	7	"The combustion chambers maintenance, hot path maintenance and general or major maintenance"
	8	"Scheduled Maintenance is depending on the number of operating hours where there periodically checked every 6000 hours and medium maintenance every 18,000 hours and major maintenance (basic) 24,000 every hour."
	9	"In the first 8000 hours there is CI which is inspection the first row of blades.At second 8000 hours there CI Maintenance. 24,000 hours there is hot gas path maintenance, open parts of the combustion chambers and access to the animated blades. In 34,000-hour Major maintenance opening of all steady and moving blades and fix them."

The interviewees were then asked **"What is your opinion about maintenance management in your organization? And do you think it needs to be improved? And if so, how?"** Table 4.17 shows that most of the interviewees stated that maintenance in their power plants is good and it can

be improved by providing training for staff, spare parts and materials, financial support, psychological guidance for employees.

Table 4-17 Perception about maintenance

Sub-Themes	Tran-script No.	Question 15 - What is your opinion about maintenance management in your organization? And do you think it needs to be improved? And if so, how?"
Perception	1	"**Fair**, and yes we need to improve it through effective **training** courses."
	2	"**Relatively good**" "we need **financial support**, and we need **policy and development training for staff opening training** courses, even we need to **psychological guidance** for employee, and I think that employees psychological guidance is a problem must be placed in high priority
	3	"**Good maintenance** management and yes it needs to be improved through intensive **training** for employees and through **real practices sessions** at the work site."
	4	"**Good** management and monitor the percentage of completion and send a report every two weeks to the Directorate with the percentage, and if there is any fault is being mentioned in the report. It can be improved through the use of **administrative programs** and also through the use of **specialized experienced staff**."
	5	"Maintenance is unspecified work, it needs tool for success constantly, such as (the staff needs to be **trained** and to be **motivated**) the commitment to complete the program makes the person able to detect the defect and thus develop it."
	6	"Until now it is **good**, but it need to be improved by providing of **spare parts**, enough **budged** because this year the budged is not enough, and provide **training courses** for staff."
	7	"Almost maintenance programs in this power plant is considered to be **distinctive programs** on the grounds that it is old compared to other power plants, some of the staff are considered as founders of since they been working in this station for 40 years and they gained experiences and their expertise better than others and compared to newly establish stations. Certainly has to have a **continuous development** and **training** because the employees in the electricity sector did not take adequate opportunity for training outside the country, especially training with companies specialized in training or experts in this area, currently the focus of the power plants, especially the plant and the rest of the power plants is to rely on internal training of departments, the training done by members through engineers and organized by the training department inside the power plant. There are several possible factors to improve the performance of maintenance, first by providing the success requirements of the maintenance which are provision of **spare parts** and **setting maintenance programs** accurately depends on the operating hours and the use of **expertise** to determine the technical problems

		and the provision of adequate **financial resources** and **staff training**".
	8	"**Good** management and off course it needs to improve through **training** courses for staff in manufacturers."
	9	"I think it works **well** and rely on the operating hours were not encroach upon the hours of operation and delay maintenance, I think that our staff works well, and certainly when the passage of time staff will gaining experience, but we lack the **training** we do not get opportunities abroad or from the manufacturer, and for maintenance training opportunities are few."

The last sub theme that emerged from the interview findings on maintenance practices in the power plants is maintenance documenting and analysing. The respondents were asked **"Is it mandatory for maintenance staff to document the maintenance procedure?"** table 4.18, and it has been found that the maintenance activities and procedures are documented.

Table 4-18 Documenting maintenance work

Sub-Themes	Tran-script No.	Question 16 - Is it mandatory for maintenance staff to document the maintenance procedure?
Documenting & Analysis	1	"We are working to implement it now, through the documenting the procedures with quality management department."
	2	"**Of course**, and they are documents at the particular department who deals with maintenance as directly responsible of maintenance activities and has their own history, and planning department documenting the maintenance procedure since is documenting all power plant records and if can't have the information required from that particular department we can referenced to the planning department. Is through technical reports to the station management and those reports will be transferred to the planning department for the purposes of documentation and technical follow-up, the planning department has engineers who have expertise in operation and maintenance of power plant for the purpose of authentication and access to technical problems and knowledge at the same time it will documented with the particular department."
	3	"**Yes**, prepared documents for all equipment available in the site (follow up card)."
	4	"**Yes**, there is documentation in the maintenance records in operating and maintenance departments. Those records are used if any think taken place again in the future."
	5	"**Yes**, through reports after the job done."

	6	"The planning department **document** any work done, report them and documenting and maintenance, a daily reports are provided from maintenance departments to planning departments."
	7	"**Certainly** when maintenance activity implemented, whether it is emergency maintenance or scheduled or planned maintenance, first plan is placed before the start of maintenance, a time plan identifies detailed activities of maintenance and timing, and after that it accomplishes the planned compared to the actual work, weekly reports and data about what has been achieved send to the General Directorate power production. After that completion of maintenance activities a technical report with all the activities and procedures and all previous readings and subsequent readings after conducting maintenance and replacement of parts a documented report is prepared with the photos and archived and a copy of it is sent to the General Directorate power production
	8	"**Yes** it is mandatory, every department documenting the carried out work."
	9	"department of the maintenance **documents**, and especially the general scheduled maintenance, and report to the planning department about every work that were made during maintenance, the emergency maintenance is not fully documented but operating department document them through work orders and procedures for processing and completion of maintenance, quality of treatment and time."

In addition, the interviewees were asked **"Does the power plant keep records of breakdowns? □Yes □No (if you chose No please explain why)"**. Eight respondents agreed that breakdown records are kept in the power plants, while one respondent stated that there is no systematic record and a form must be provided for maintenance which is considered important (transcript 8). Table 4.19 shows the interviewees' responses.

Table 4-19 Breakdowns records

Sub-Themes	Tran-script No.	Question 17- Does the power plant keep records of breakdowns? □Yes □No (if you chose No please explain why)
Documenting & Analysis	1	"**Yes**"
	2	"**Yes**, in all departments, in the planning department and the department of Inspection."
	3	"**Yes**, in the Planning department."
	4	"**Yes**"
	5	"**Yes**"
	6	"**Yes**"

	7	"**Yes**"
	8	"There is no systematic record, a form must be provided for maintenance of documentation which should be considered important."
	9	"**Yes**, we keep records within the work orders, possible return to works orders to know type of treatment, quality of it and the time of breakdown but as a record of failures we don't have."

After that the interviewees were asked **"Are all records analysed? □Yes □No (if you chose No please explain why)"**. Four respondents stated that breakdown records are not analysed (transcript 1, 4, 6 and 8), while the other respondents agreed that breakdown records are analysed, but one stated that the breakdowns records are not analysed frequently. Table 4.20 shows the responses of interviewees.

Table 4-20 Breakdowns analysis

Sub-Themes	Tran-script No.	Question 18 -Are all records analysed? □Yes □No (if you chose No please explain why)
Documenting & Analysis	1	"**No**"
	2	"**Yes**"
	3	"**Yes**" but not frequently
	4	"**No**"
	5	"**Yes**"
	6	"**No**"
	7	"**Yes**, it is very important to take advantage of the analysis of records and causes of repeated breakdown and inferred to faults through similar situations"
	8	"**No**"
	9	**Yes**, the records are analysed if the breakdown is repeated, so we analysed the previous breakdowns, but if only one breakdown we don't analyse it."

In order to investigate which department in the power plant is responsible for analysing breakdown records, the following question was asked **"Please specify which department analyses the breakdown records"**. It has been found that breakdown records are not analysed in four power plants (transcripts 1, 4, 6 and 8), while in other power plants various departments usually undertake the analysis, see table 4.21

Table 4-21 Which department analyse the breakdowns records

Sub-Themes	Tran-script No.	Question 19 - Please specify which department analyses the breakdown records;
Documenting & Analysis	1	"**None**"
	2	**"**First, there are two departments and their role is analysis and examination, **engineering inspection** department is specializes in faults and inspection of minerals and failure analysis of metallic, boilers in particular, and the second department **examination and efficiency**, which handles equipment inspection."
	3	**"Scheduling maintenance and specialist department**."
	4	"**None**"
	5	"Operating department in coordination with specialised maintenance department."
	6	"**None**."
	7	"Usually is the **department concerned**, whether mechanical breakdown is the mechanical department etc. as well as the existence of the opinion Committee meet each morning between the heads of departments with the station manager and discussing what is required to be accomplished in that day and the coming days and the plan in general, the mechanism of the faults maintenance and what is the best method to fix them."
	8	"**None**"
	9	"**Planning** department and **maintenance** departments."

"Does the maintenance department set up maintenance plans based on analysed breakdown records?" was asked to respondents in relation to the documenting and analysing sub theme of maintenance practice in power plants. Four respondents stated "No" (Transcripts 1, 4, 6, and 8), while two respondents agreed that their maintenance departments set up maintenance plans based on the analysed breakdown records (Transcripts 2 and 5), Table 4.22 shows the respondents responses.

Table 4-22 Setting maintenance plans based on breakdown analysis.

Sub-Themes	Tran-script No.	Question 20 - Does the maintenance department set up maintenance plans based on analysed breakdowns records?
Documenting & Analysis	1	"**No**"
	2	"**Yes**"
	3	"**Yes by planning department**."
	4	"**No** but we rely on the annual plan."
	5	"**Yes**"
	6	"**No**, but the scheduled maintenance plans are done by planning department and inform the maintenance departments with date and activities of maintenance."
	7	"The plans are set up by **specialized maintenance department** with coordination with planning department."
	8	"**Not based the breakdowns** records but by visiting the site by the operation and maintenance department and study the situation and make work plan."
	9	"The periodic maintenance depends on the number of hours but other maintenance, for example, sudden breakdowns, drives in the power department frequent breakdowns because long periods of work or continuing to work, dividing the electricity is before the beginning of the summer maintenance work, because in the summer the country the need electricity so we cannot extinguish units an electric motor for maintenance work, so before the peak season there are quarterly proactive maintenance, and maintenance work is expected to defective parts in subsequent periods, and previous breakdowns analysis."

The final question of this category **was "Does the power plant have adequate equipment for maintenance?"**. Table 4.23 shows that five respondents agreed that they have adequate equipment for maintenance, (Transcripts 1, 2, 5, 8 and 9), while the other respondents' answers were negative (Transcripts 3, 4, 5 and 7).

Table 4-23 Maintenance equipment adequacy

Sub-Themes	Tran-script No.	Question 21 - Does the power plant have adequate equipment for maintenance?
Documenting & Analysis	1	"**Yes**"
	2	"We can say we have **most of them**, but some specialized monopolistic equipment is not available, for example, turbines, as a former head of the turbines department, there is ability to switch blades seventh stage of low pressure turbine pressure, but there is no ability to switch phase five and six, and others because we don't have

		specialized equipment to switch those blades, because only manufacturers and monopolistic companies have them.”
	3	“**No**, there is lack some equipment.”
	4	“**No**, we need some maintenance equipment.”
	5	“**Yes**”
	6	“Currently **no**, because of the financial resources problem and the power plant are established recently.”
	7	“It is **difficult** to say it is enough.”
	8	“**Yes**”
	9	“There is **enough** equipment for maintenance because we try to prepare them before the maintenance period.”

4.6.3.2 Spare parts

The second sub theme of the maintenance theme that emerged from the interview analysis is spare parts which has another three low code sub themes (Computerized inventory, availability of spare parts, and spare parts purchase planning), which emerged from respondents answers to three questions. Under computerized inventory, table 4.24, it has been found that four respondents agreed that there are computerized inventory systems in their power plants (Transcripts 2, 4, 5, and 8) while respondents of transcripts 6 and 9 stated that they have lists of spare parts. On the other hand, respondents of transcripts 1, 3 and 7 agreed that they don’t have computerized inventory but they are in the process of using it.

Table 4-24 Spare parts management

Sub-Themes	Tran-script No.	Question 22 - Are spare parts stores at your power plant computerized?
Computerised inventory	1	We are working to implement computerized spare parts system.”
	2	“**Yes**.”
	3	“**Not yet**, in the process of using computer.”
	4	“**Yes**.”
	5	“**Yes**.”
	6	“The stores department has a computer and there is a list of spare parts.”

	7	“We have computers in departments of planning and stores but we are in the process of using spare parts management software.”
	8	“**Yes**, using warehouse management software, and currently working to uniform program for all power plants.”
	9	“There is data list for spare parts in stores department and supervised by planning department.”

The second low code sub theme that emerged under the spare parts theme is the availability of spare parts. Table 4.25 illustrate the interviewee’s responses; only two respondents agreed that spare parts are available when they need them (Transcripts 1 and 6). While the other respondents stated that not all spare parts are available when they need them for several reasons such as the current financial difficulties, time of ordering and supplying, administration process and unavailability of spare parts locally.

Table 4-25 Availability of spare parts

Sub-Themes	Tran-script No.	Question 23 - Are inventory parts available when needed? □Yes □No Why not?
Availability of spare parts	1	“**Yes**.”
	2	“Most of them, but not all.”
	3	“**No**, due the financial difficulty, slow process of ordering and getting permeation from higher authorities, and some spare parts are not available locally so we need to order them from manufacturers overseas.”
	4	“**No**, due to the financial ability, and spar part availability in market.”
	5	“**No**, but most of them are available.”
	6	“**Yes**.”
	7	“**Some of them**, not all what we need is available, sometimes we bring from other power plants.”
	8	“**No**, and it is big problem for ministry of electricity.”
	9	“**Not all of them**, the main spare parts and materials are available, but some precise materials are not always available but it is possible collected from the local market or purchase orders.”

The last low code sub theme of the spare parts theme is spare parts purchase planning. Four respondents agreed there is annual planning of spare parts purchase (Transcripts 1, 5, 8 and 9), while respondents of transcripts 2, 3, 5

and 7 stated that there is planning and it relies on the need and maintenance scheduling. On the other hand, one respondent stated that planning of purchases occurs every six months. Furthermore, it has been found that there can be delays in supplying of external orders.

Table 4-26 Spare parts planning

Sub-Themes	Tran-script No.	Question 24 - Does the power plant plan in advance to have the spare parts ready in store? □Yes □No (if you choose yes, please state how regularly) □Annually □Half a year □Quarterly □Monthly
Spare parts planning	1	"Yes, **Annually**."
	2	According to the need for the equipment, according to the real need for the units, which is not absurd buying, but the purchase is relying on problems. It is difficult to specify, because we can buy small pieces of maintenance on a quarterly basis, while the large pieces are out of the station ability so we need support from the Ministry of Electricity and the Middle Euphrates Power Production General Directorate and sometime it take one or two years or more."
	3	**Yes**, every part according to its schedule, but there is a delay in supplying materials and spare parts from outside the country (external requests)."
	4	"It is planned before the maintenance season and should be reported in the plans and there is difficulty in obtain imported materials and spare parts."
	5	"**Annually**"
	6	"Currently every **six months**, since the spare parts should be available and because the purchase order take around two months which means if we don't plan in advance the units will be shut down."
	7	"It happen but not for long periods, but of the need to planned maintenance program, so we know the number of units that will be maintained and what types of maintenance and what are the spare parts and materials required, and whether materials required for maintenance are available in the stores and in the spare parts are not available, a purchase request is organized to secure them."
	8	"**Annually**"
	9	"**Annually**, the needs of spare parts are studied daily, because of the fundamentals of the power plant preparing spare parts before maintenance season.

4.6.4 Theme 4: Human resources

Based on the findings derived from the interview analysis, the human resources theme emerged, and has five categories; employee's performance, training, teamwork, organization culture and structure, and health, safety and environment. Each category has sub themes, as illustrated in table 4.27.

Table 4-27 Human resources and its sub themes

Themes	Sub-themes Initial High Code	Sub-Themes Initial Low Code
Human resources	Employees performance	Evaluation Method Performance rating
	Relation between employees and management	Relation Employees suggestion
	Teamwork	Perception of Teamwork Methods to encourage teamwork
	Organization culture and structure	Organization culture and structure
	Health, Safety and environment	Pollution Policy Improving safety Signs and procedures

4.6.4.1 Employees performance

The first sub them of the human resources theme is employees' performance, the respondents were asked two questions **"Does the power plant top management track their employees' performance? What method do you use to evaluate employees' performance? □Yes, □No Please explain why?"** The performance evaluation method varied but the common theme was direct evaluation from supervisors or heads of departments (Transcripts 1, 2, 3, 4, 5, 6, 7, 8 and 9). One responded added that there is a special committee to evaluate the performance of employees (Transcript 3).

Table 4-28 Employees performance evaluation

Sub-Themes	Tran-script No.	Question 25 - Does the power plant top management track their employees' performance? Yes, what method do you use to evaluate employees' performance? No, Please explain why?"
Evaluation Method & Performance rating	1	"**Yes** through the **direct evaluation from supervisors**."
	2	"The evaluation mechanism used is a **hierarchy**, in the power plant there are a manager, and head of departments and head of divisions and head of Groups, the department may consist of a hundred or two hundred people, and the divisions have different number they may have three people or 50 people, and the group are usually 3 or more persons, and the evaluation done through hierarchy, and this does not mean that the plant manager does not have access directly to the divisions, groups, or employees, and not rely on the head of department, head of the Division official or group assessment only, but to rely on their assessment and direct evaluation by the plant manager and field tour within the plant and communicate with staff. Add to that the station manager is a former employee of the plant and he knows the staff and their possibility and efficiency, therefore there is the possibility of the correct evaluation."
	3	"Monitoring each employees attendance, performance, technical or administrative level based on the **direct supervisor recommendations** and special **committee** to evaluate the performance and job descriptions."
	4	"**Direct evaluation** (observation and monitoring) of performance and duties from **heads of departments**, which report to the power plant management."
	5	"Through **reports** from **supervisors and heads of departments** to the management."
	6	"**Yes**, through the **daily report** of activities been done, and also through the **daily meeting** between the management and technician, engineers."
	7	"Certainly, the duties of management to monitor the staff performance, there are several ways of staff evaluation, assessment and evaluation by their **supervisors**, and through **training courses and grades** they get from end of training course test, and by **monitoring** their performance by the station management."
	8	"**Yes**, there are annual evaluations **by heads of departments** which will be sent to power plant management."
	9	"**Yes**, the staff performance is monitored through the **head of the department** and monitor the status of employees and their response to the scientific courses they need (scientific level and the level of performance)."

Respondents were asked to rate their employees' performance **"On a scale of (1) poor, (2) fair, (3) good, (4) high (5) excellent, how do you rate the overall employees' performance (OEP)?"** Figure 4.4 shows the ratings that

were given by the interviewees, it can be seen that three of the nine respondents rated their employees' performance as high, while five respondents rated them as good. On the other hand, one respondent rated their employees' performances in his power plant as fair.

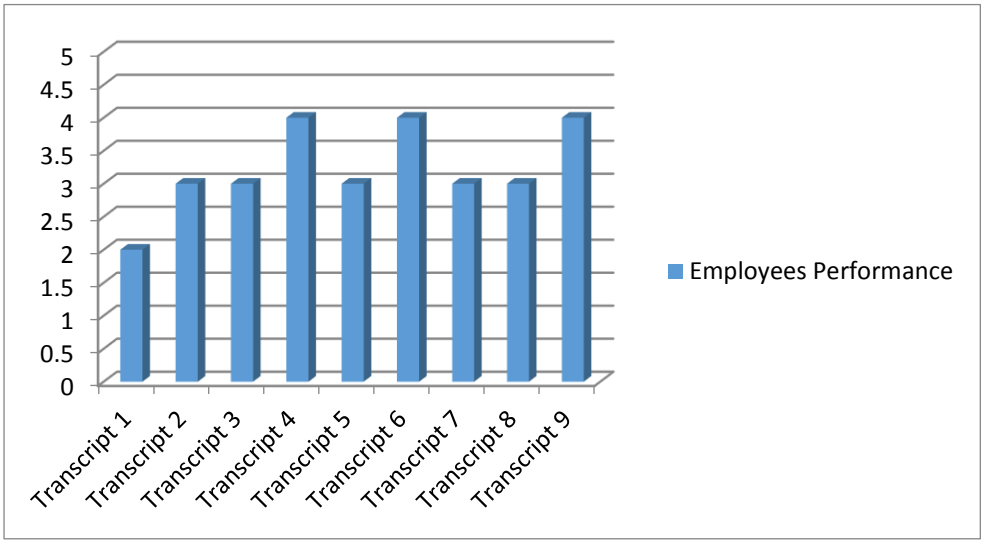


Figure 4.4 Employees performance rating

4.6.4.2 Relation between employees and management

The second sub theme of the human resources theme is the relation between top management and employees in the power plants. The interviewees were asked **"What do you think about the relationship between the top management and employees?"** Table 4.29 shows that all respondents agreed that there is good relationship between power plant management and employees.

Table 4-29 Relationship between the top management and employees

Sub-Themes	Tran-script No.	Question 27 -What do you think about the relationship between the top management and employees?
Relation between employees & management	1	"**Fairly good**"
	2	"**Objective** relationship based on clear professional dealing (transparency), there is nothing vague."
	3	"**Fairly good**"
	4	"It is **good** relation and it needs to be improved."

	5	"The relationship is **good** and there is no barrier between management and employees."
	6	"There is **good** relation between the management and employees."
	7	"A **good** relationship with a common interest and does not have a choice but to communicate with each other."
	8	"**Good** relationship."
	9	"**Good** or average relationship"

Then the interviewees were asked **"Does the top management pay attention to employees' suggestions?"** As shown in table 4.30 it has been found that the employees can propose suggestions to the power plants management, the suggestion mechanism is the employees suggest or propose his /her idea to the supervisors or head of department who then deliver those suggestions or proposals to the power plant managers to study them and take action.

Table 4-30 Management attention to employees' suggestions

Sub-Themes	Tran-script No.	Question 28 -"Does the top management pay attention to employees' suggestions?"
Employees suggestion	1	"**Yes**, the employees can propose any suggestion to their **supervisors**, the supervisors forwards those suggestion to the management."
	2	"**Sure**, through direct meetings with employees or their **representatives**, or meeting with group of staff, for example meeting with head of groups or department employees which is available since the date of the establishment of the plant, a humanist communication with the employees, a friendly, tinged with love while retaining respect. Brought through formal memos through the head of the department to the power plant management."
	3	Sort of, to suit the general situation."
	4	**Yes**, the useful suggestions are welcomed, the suggestion is proposed to the supervisor or heads of departments, and to management, and assign committee to study the proposal by power plant, or the general directorate or the ministry."
	5	"**Yes**, through submitting memos to supervisors, heads of departments to management."
	6	"**Yes**, a written suggestion is submitted to the power plant manager and if it suitable the work is carried out."

	7	“Possible to listen to all suggestions, whether scientific, built on the foundations of scientific or suggestions for just proposal and there was no harm to listen to all proposals, and some proposals have helped in solving big problems, and the mechanism of the proposal is carried out by meeting between specialists and management of the power plant and during the meeting raised the idea and the mechanism for implementation, we got more than one case and we got positive results.”
	8	“**Sometimes**, the suggestions are studied based possibility of execution.”
	9	“The **management pays attention to employees' suggestions**, and there are continuous association between management and staff, any proposal suggested from both maintenance or operation staff is delivered to the station manager by Heads of Departments.”

4.6.4.3 Teamwork

Teamwork is another sub theme of the human resources theme that emerged from interview analysis, and four questions were asked; **"Do you think that teamwork is important for productive maintenance?”** All respondents agreed that team work is important, and they thought that team work in the power plant is good when they were asked “What do you think about the teamwork within your organization?” see table 4.31.

Table 4-31 Perception of Teamwork

Sub-Themes	Tran-script No.	Question 29 -"Do you think that teamwork is important for productive maintenance?”
Perception of Teamwork	1	“**Yes**”
	2	“**Yes**, the most important thing for each team work action in any production plant or manufacturer the whole country is respect the work from the inside of people, you must reform society and in plant to add love of work, for example, the plant manager helps cleaning person in order to make staff look at cleaner with respect, or to deal with worker who working on a technical problem respectfully so the worker respects his work.”
	3	“**Yes**”
	4	“**It is very important**”
	5	“**Teamwork is important in every field**.”
	6	“**Yes off course** because maintenance need teamwork.”
	7	**“**Teamwork is very important in the production process, in every place of work and cannot be any single person to achieve what is required work, team work is required to be

		thoughtful and put the right person in the right place, there is no benefit from teamwork without outputs, so when we have the right resources and options the team work is useful."
	8	"**Yes**."
	9	**"Yes, of course**."
Sub-Themes	**Tran-script No.**	**Question 30 - What do you think about the teamwork within your organization?**
Perception of Teamwork	1	"**Fairly good**"
	2	"**Important** and **essential**. I wish that the employees respects what they doing from their inside."
	3	"It is good"
	4	"It is good."
	5	"It considered being good."
	6	"It is an active team working and all departments should engaged and work together for example the mechanical department staff can't work without help from automated control department to remove the sensors and also without help from electrical department but switching the electrical circuits off."
	7	"Considered ideal and in its best condition compared to the general situation of the country."
	8	**"**Working as one team."
	9	"I think is perfect, because there is association and good team working in performing work."

On the other hand, when the respondents were asked **"Are you satisfied with the teamwork interaction within the power plant departments?"** see table 4.32, seven respondents were satisfied with the teamwork in their power plants while one responded was not satisfied and stated the reason as "Not satisfied, most of the staff are new to the job, which generates significant problems for the administration because of inexperience and lack of balance between rights and duties." (Transcript5).

Table 4-32 Interviewees satisfaction on teamwork

Sub-Themes	**Tran-script No.**	**Question 31 -"Are you satisfied with the teamwork interaction within the power plant departments?"**
Perception of Teamwork	1	"**Sort of**"
	2	Before I worked at the power plant, I found that some heads of departments collaborators and some of them limited like personal properties, this thing does not serve the work because the power plant needs everyone, and there must be cooperation and integration to achieve the

		goals, and that thoughts was eliminated, now there is a **good** cooperation between department, and each department supports the other in order develop the power plant, and to address technical problems, and we aim that the team work will be better since we did not get to the required level.”
	3	“**Yes**”
	4	“**Yes**”
	5	“**Not satisfied**, most of the staff are new to the job, which generates significant problems for the administration because inexperience and lack of balance between rights and duties.”
	6	“**Yes** because, there is good cooperation and there is a good understanding.”
	7	“**Yes**, the work between the station departments is an example of unity and integrative work, for example mechanical work cannot be completed and operating the units without the intervention of the electricity department and department of automated control, and thus the output of our work is the integration and continue between the departments.”
	8	**“Yes**.”
	9	**“**There is association and **good team working**, if mechanical fault happen for example, you can see all heads of departments are there for collaboration and opinion and help”

Next, the interviewees were asked **“What methods do the power plant top management use to encourage teamwork?”** see table 4.33. Their responses varied as follows;

1. Orders to perform the assigned work
2. Rewards, and incentive bonuses
3. Acknowledgement letter
4. Moral and psychological support
5. Through listening to the views of employees at all levels
6. Promote a culture of teamwork and selflessness
7. Appreciation and praise and communicate with them and to recall their achievements.

The common method to encourage team working is financial rewards, and incentive bonuses, while two respondents indicated the financial rewards and

incentive bonuses have been stopped in this current financial year due the financial difficulties in the country (Transcripts 2 and 4).

Table 4-33 Methods to encourage teamwork in power plants

Sub-Themes	Tran-script No.	Question 32 -What methods do the power plant top management use to encourage teamwork?
Methods to encourage teamwork	1	"Through **direct orders** to perform the assigned work, **rewards**, **bonuses** and **acknowledgement letter**"
	2	"In the last year, the overtime and **bonuses** were under the power plant manager authority, as gives a small amount but significant, a 25 000 dinars to staff was staying after the official working hours to perform additional tasks and to be an incentive when the work is hard and tiring and as an example what happened in the water outlet where they were lifting and extraction of clays from a depth of 12 meters and in large quantities and incentive bonuses was distributed, in addition to the moral and psychological support, and now this year overtime and bonuses was stopped and only moral and **psychological support** remains for the power plant, which is inadequate for employees, and the power plant management has sent several requests to the Directorate and the ministry to return the rewards incentive."
	3	"Through the **listening to the views of employees** in all levels and provide an incentive reward for outstanding work."
	4	"The power plant management encourages teamwork and all departments interact to identify problems or work with each other. There were bonuses and wrote acknowledgements either from the power plant or the general Directorate but the bonuses currently stopped."
	5	"Reward and promote a culture of teamwork and selflessness."
	6	"Even though if the management does not support the team working, the staffs needs to work together because it is not solo job."
	7	"Several methods through direct encouragement and financial support through the equivalent, and written thanks letters, appreciation and praise and communicate with them and to recall their achievements."
	8	**"**Through rewards and incentives."
	9	**"**Through equivalent and punishment, and equivalent divided into categories A, B, and C."

4.6.4.4 Organization culture and structure

This was the fourth sub theme that emerged from the interview analysis and table 4.34 shows that six respondents agreed that organisational culture is very influential on maintenance activities (Transcripts 1, 2, 3, 4, 5, and 9), while respondents of transcripts 6 and 7 stated it is influential to some extent, and that of transcript 8 stated it is influential.

Table 4-34 organizational culture effect on maintenance activities

Sub-Themes	Tran-script No.	Question 33 - How do you think the organizational culture affect the activities of maintenance in the power plant? (1. Very influential, 2. influential, 3. influential to some extent, 4. few, 5. Does not affect at all)"
Organization culture and structure	1	"Very influential"
	2	"Very influential"
	3	"Very influential"
	4	"Very influential"
	5	"Very influential, because most of staff are new to the job, affecting the organizational culture, and it's one of the factors affecting the completion of work"
	6	"Influential to some extent"
	7	"Influential to some extent"
	8	"Influential"
	9	"Very influential"

The interviewees were then asked **"Do you think organizational culture, structure and processes influence maintenance activities? and how?"** see table 4.35. All respondents agreed that the organizational culture, structure and processes strongly influence maintenance activities. Furthermore, there are some issues found in some power plants, such as in transcript 2 it has been noticed that there are issues of responsibility between the electricity department and the turbine department. While in transcript 5 it is noted that there is also an issue of responsibility between the operation department and the stores and spare parts departments. On the other hand, in transcript 6 there is problem of hiring people from none engineering or

technical backgrounds in the power plants, since the hiring is carried out by the ministry of electricity because of nepotism and patronage. In addition, one interviewee (Transcript 7) stated there is a problem of large numbers of employees and how to arrange and assign work to them since some of the employees are not specialised or qualified.

Table 4-35 Organization culture and structure

Sub-Themes	Tran-script No.	Question 34 -Do you think organizational culture, structure and processes influence maintenance activities? And how?
Organization culture and structure	1	"The organization culture, structure influences the maintenance activities strongly."
	2	"Structural positively affect the maintenance system and work, is not an obstacle to maintenance work and there is no indication that the current structure negatively affect the maintenance work, with the presence of the ownership of some responsibilities, for example, the Department of turbine and the Department of electricity where the generating unit obstetric bracketed mechanical (big machine) where maintaining the hydrogen pressure inside the unit which cools generating a mechanical part but under ownership as part of generating extensions (where that generated is under the electricity department and the bracketed is part of generating extensions), so officially is the electricity department responsibility but the reality it is under the turbine department because turbine department dose the mechanical work, and if it had the correct structure must be maintained by the electricity department, and this is one those minor problems which are not a burden but simple."
	3	**"**Do not affect in case of providing permission each according to his responsibility."
	4	**"**Yes it influence, and the power plant must have a clear structure because the power plant has different departments each department has different divisions."
	5	**"**Of course, any work without an organizational structure is random work, and yes it needs to be improve, for example, that the fuel division is within the stores and spare part department which generate problem because operation department needs fuel to operate the plant and it is disturbing process to order fuel from stores and spare part department."
	6	**"**Yes off course it influencing the maintenance, for example, is hiring some people with agriculture degree holder or a teacher is power plant is affecting maintenance negatively. We can't improve the structure because of Nepotism and patronage."

	7	**"**Certainly affect, because the organizational structures at the plant and the rest of the power plants do not depend on the global calibrator and the presence of a large number of employees because we cannot be any way to leave them without work we are forced to involve them in the activities and what is disproportionate with specializations and therefore forced to include everyone in the work of both specialists and non-specialists."
	8	"Yes affect, same structure were applied by the ministry in 2014 for all power plants."
	9	**"**Of course it influence, and it does not need for improvement."

4.6.4.5 Health, Safety and environment

The final sub theme that emerged from the human resources theme is Health, Safety and environment which has four sub themes; pollution, policy, improving safety, and signs and procedures. The respondents were asked five questions under this category, first they were asked **"Does the organization measure the pollution levels emerging from the Power plant?"** see table 4.36. Five respondents stated no because they don't have tools or devices to measure pollution and emissions at the power plant (Transcripts 1, 6, 7, 8, and 9), while three interviewees agreed that they measure pollution and emissions in coordination with general governorate of power production and the ministry of electricity or state government (Transcripts 2, 3 and 5). On the other hand, one respondent stated they don't measure pollution and emissions because it is a green power plant (Transcript 4).

Table 4-36 Pollution level measurements

Sub-Themes	Tran-script No.	Question 35 - Does the organization measure the pollution levels emerging from the Power plant?
Pollution	1	We **don't** have the right tools."
	2	"**Yes**, every period of time, a committee of the Ministry Environment come to measure, as well as the environment division inside the station."
	3	"**Yes**, through monitoring and follow-up devices."
	4	"There is **no pollution** because it is green power plant."
	5	"There is environment division within the power plant monitoring the plant performance and pollution in

		coordination with environment department from governance."
	6	"We **don't have** equipment and devices for measuring emissions and pollution at the plant, but Ministry of Environment is possible measure the pollution and emissions."
	7	"It **does not** have a specific measure, and since the power plant is working on one type of fuel which is natural gas, which is known low pollutants."
	8	"**No**, because the absence of emission analysers and the station is working on a fuel natural gas which is low emission."
	9	"**Currently no**, because emissions measurement devices are not available, and I think the emission rates were measured by visiting the Department of Environment from the Ministry of Electricity."

The respondents were then asked **"Does the power plant have Health and Safety and Environmental policies?"** see table 4.37. All respondents agreed that they have a health and safety department or division which is responsible for health, safety and environmental procedures and policies.

Table 4-37 Health and Safety and Environmental policies

Sub-Themes	Tran-script No.	Question 36 -Does the power plant have Health and Safety and Environmental policies?
Policy	1	"We have safety department who is responsible about health and safety policies within the power plant."
	2	"Yes through the environment division one of the of safety department divisions."
	3	"Yes"
	4	"There is a safety department monitoring the related issues."
	5	"Yes, there is industrial safety and environment department in the power plant."
	6	**"**There is safety department responsible on safety, the environment and health."
	7	"There is a specialist department of safety and the environment and is headed by an engineer and it has divisions who has engineers are doing their duties, including the safety of staff and in terms of safety requirements."
	8	"There is safety policy and there is no health policy."
	9	"Absolutely, there is a safety specialist department and the Environment Division."

The question **"What is your opinion on guidance and safety procedures at the plant?"** was then asked, see table 4.36. Eight respondents agreed that

safety procedures were good, (Transcripts 1, 2, 3, 4, 5, 6, 8, and 9), while one respondent stated that he can't be optimistic and say safety procedures can be good or very good but they are acceptable, (Transcript 7).

Table 4-38 Safety procedures at the power plants

Sub-Themes	Tran-script No.	Question 43-What is your opinion on guidance and safety procedures at the plant?
Safety procedures	1	"It is good."
	2	"Good"
	3	"Good, but it needs to be improved."
	4	"It is good."
	5	"It is good."
	6	"It is good."
	7	"We can say that it is acceptable and cannot be optimistic and say good or very good on the grounds that this matter has nothing on who manages this process and the implementing agency and community awareness, and because of community awareness in Iraq as a whole and the power plant in simple level it can be said that it is acceptable."
	8	"Good"
	9	"It is followed all the safety measures in all maintenance work, and it is good in general."

In regards to improving safety in the power plants, the interviewees were then asked **"How the safety procedures can be improved?"** (table 4.39) and it has been found that the safety producers could be improved by providing the following;

1. Training courses
2. Increase the awareness of work safety culture.
3. Safety equipment.
4. The safety department should emphasize the safety procedure to the employees

Table 4-39 Health and safety improvement requirements

Sub-Themes	Tran-script No.	Question 37 -How the safety procedure can be improved?
Improving safety	1	"It can be improved through training and increase the awareness of safety culture."
	2	"It can be improved through training and increase the awareness of work safety culture."
	3	"By providing training courses, and equipment."
	4	"By providing training courses"
	5	"By searching for new systems or programs"
	6	The safety department should emphasize the employees to follow safety procedure in the power plant."
	7	**"**Through the provision of safety requirements and raise awareness and encourage workers in this regard, and give the value and priority of occupational safety. On the grounds the orientation in general for production departments and non-production or supporting department is giving less value which is not same in other countries, for example."
	8	"Through staff training"
	9	"By increasing awareness and culture of staff on safety procedures and guidance through training courses, because sometimes the employee is neglecting safety procedures because he consider it as luxury but in reality it is essential because it is safety, it is possible to encourage employees through training courses and through the presence of heads of departments and to hold accountable people who is not commitment to safety procedures."

The final question regarding health and safety was "**Are health and safety signs and procedures allocated everywhere in the plant?"** see table 4.40. Five of the respondents agreed that health and safety signs and procedures were allocated everywhere in the plant (Transcripts 3, 4, 5, 8, and 9), while respondent one stated "they are available to some extent" (Transcript 1), and respondent two stated "Relatively yes" (Transcript 2). The sixth respondent stated no to the question (Transcript 6), while the seventh respondent stated "Yes it exists but is not within acceptable limits." (Transcript 7).

Table 4-40 Health and safety signs and procedures allocation in the power plants

Sub-Themes	Tran-script No.	Question 38 -Are health and safety signs and procedures allocated everywhere in the plant?
Signs & procedures	1	“Available to some extent.”
	2	“Relatively Yes”
	3	“Yes.”
	4	“Yes.”
	5	“Yes”
	6	“No, because the new power plant and not fully received it still a projects belonging to the Directorate of projects, and the implementation company did not complete some work.”
	7	“Yes it exists but is not acceptable limits.”
	8	“Available everywhere in the plant.”
	9	“Yes they are allocated everywhere in the plant.”

4.6.5 Theme 5: Overcoming power shortage

According to the interview analysis and based on the findings from transcript two, four themes (Power plant type, Maintenance, Fuel, and Administrative and law) emerged in order to overcome the power shortage in Iraq. Table 4.41 summarises the sub themes of overcoming power shortage.

Table 4-41 Overcoming power shortage sub themes

Themes	Sub-themes Initial High Code	Sub-Themes Initial Low Code
Overcoming power shortage	Power plant type	Suitable power plant Large Capacity and efficiency
	Maintenance	Expertise Spare parts Training Fund
	Fuel	Type Quantity
	Administrative and law	Motivation Power Planning Culture

In order to know how to overcome the power production shortage and to increase the power plant production rate, the respondents were asked "**In your opinion, what actions need to be taken in order to enhance power plant reliability and increase power production?"** and the following sub themes emerged;

4.6.5.1 Power plant

Three interviewees stated in order to overcome power shortage in Iraq appropriate power plants with high efficiencies and capacities must be built with consideration to the Iraqi weather, and also looking for diversity of power production and renewable energies (Transcripts 1, 4, and 5), see table 4.42

Table 4-42 Actions to overcome power shortages (Suitable Power Plants)

Sub-Themes	Tran-script No.	Question 10 - In your opinion, what actions need to be taken in order to enhance power plant reliability and increase power production?"
Suitable power plant	1	"Selection and choosing **appropriate power plants** which are suitable for Iraqi weather" "Selection of power plants with **high efficiency** and **high capacity**"
	4	"We need steam **power plants** with **large capacities**." "Long-term plan to buy and install a new **large capacity** plants through the ministry of electricity or investment companies because the repair and maintenance some of the existing ones is ineffective."
	5	"Search for variety of **power production** (combined cycle for example), and to a clean renewable energies"

4.6.5.2 Maintenance

Improving power plants maintenance was found to be another factor that needs to be taken into consideration in order to overcome the power shortages in Iraq. The responses from transcripts 2, 3, 4, 7, 8 and 9, which can be seen in the table 4.43, mentioned several aspects of maintenance which can be improved such as providing external expertise, equipment and spare parts,

and providing efficient training for employees locally and at the equipment manufacturers.

Table 4-43 Actions to overcome power shortages (Improving Maintenance)

Sub-Themes	Tran-script No.	In your opinion, what actions need to be taken in order to enhance power plant reliability and increase power production?"
Maintenance	2	"**Maintenance** for sure, and dependence on **external expertise** in addition to our **local expertise** and provide the necessary **equipment** and **spare parts** required for replacing the used and damaged parts as a result of aging and various reasons, it means update the station in terms of equipment and develop the technical **staff skills** and expertise in order to develop the station."
	3	"Provide **training** with manufacturers."
	4	"Provide **training** for staff with manufacturers."
	7	"The second problem is the provision of **spare parts**, as the country is suffering from the financial and security problems, financial problems do not allow us to get cut sufficient parts for maintenance," "Finality by providing **training** courses for staff."
	8	"Provide **spare parts** for the units to perform **maintenance** on the specified time. The maintenance for some units was stopped for three times due the lack of spare parts." "Provide **training** of technical personnel in the operation and maintenance department."
	9	"Allocation of enough funds and more reliance on **foreign companies**," "And provide good **training** for employees."

4.6.5.3 Fuel

Table 4.44 illustrates that two interviewees (Transcripts 1 and 2) suggest that in order to overcome the power shortages, actions need to be taken to provide enough fuel quantity and quality.

Table 4-44 Actions to overcome power shortages (Fuel)

Sub-Themes	Tran-script No.	In your opinion, what actions need to be taken in order to enhance power plant reliability and increase power production?"
Fuel	1	"The need to run power plants on natural gas **fuel**."
	2	"First, by providing enough **fuel** for operation which is the basic problem,"

4.6.5.4 Administrative and law

The final sub theme that emerged from the analysis relating to the question **"In your opinion, what actions need to be taken in order to enhance power plant reliability and increase power production?"** table 4.45, was improving administration and law by providing proper planning and decision making, putting the right people in the right places, improving the administrative law because many workers are not qualified and are employed on temporary contracts.

Table 4-45 Actions to overcome power shortages (Administration and law)

Sub-Themes	Tran-script No.	In your opinion, what actions need to be taken in order to enhance power plant reliability and increase power production?"
Administrative & law	3	"Give **confidence** to workers." "Provide a stable **administrative** status where most workers are not **qualified** and on temporary contracts." "Put the **powers** that serve the work and working conditions and to handle daily conditions." "Provide stable **functional conditions** through the providing of adequate housing, transport and after working hour's bonuses."
	5	"By putting the **right person** in the **right place**" "Increase public awareness on the **culture** of **power consumption**." "Focus on the **planning** and **decision-making** to assign planning tasks to people with highly experienced and high education levels."
	9	"Proper **planning** because planning is important"

4.7 Summary of the findings and analysis

The first part of the interview questions, which can be seen in table 4.1, were asked to gather general information which could not be found in the literature or other sources of data, such as the number of employees in each power plant which, has been used to form the research population and the sample size used in questionnaire data collection stage in chapter five.

The second part of the general information questions collected information about the designed and current production rate of the power plants under investigation, which can be seen in figures 4.2 and 4.3, the findings show that the power plants are currently producing only 58% of their designed capacity. This finding supports the research problem described in chapter one, section one.

The results from the interview findings show that there are a number of reasons behind why the power plants cannot reach high power production rates which can be divided into two categories: external and Internal. Under external reasons there are four factors affecting power plant reliability which are weather condition and temperature, planning, war, and national grid instability. While the internal factors affecting power plants are power plant aging, spare parts and materials, fuel type, breakdowns, and unit efficiency.

The results also revealed the reasons behind the power shortage in Iraq, which are divided into two categories: direct factors affecting the power plants such as planning and vision, low efficiency and capacity, administrative, law and training, budget, financial and operation costs, spare parts, and the fuel quantity and type used to operate power plants. On the other hand, there are

indirect factors leading to power shortage such as the situation in Iraq, culture, power demand, and weather.

The investigations relating to maintenance practices in the power plants show that all power plants have the same maintenance structure and they have three main departments to carry out maintenance activities; Mechanical maintenance departments, electrical maintenance departments and automated control departments. It has also been found that power plant B has two more maintenance departments which are Boilers maintenance department and Turbines maintenance department, while respondents of transcripts B, D, and H considered engineering or technical support departments as another maintenance department. It has been found in regards to maintenance policy within the power plants that there is a misunderstanding of the maintenance policy term, all respondents gave different information to the question, even when the interviewer explained the meaning of the policy. Also the results from the interviews relating to maintenance strategies or programs used in power plants showed that all power plants use emergency maintenance and scheduled maintenance, the scheduled maintenance is divided into three types based on working hours which differ from power plant to another. While the maintenance management was found to be between fairly well, relatively good and good in the respondents' point of view, and it can be improved by providing training and increasing employees' motivation, spare parts, and financial support.

It has also been found under maintenance practices in the power plants that, maintenance activities and procedures are documented. Eight respondents

agreed that there are breakdown records in the power plants, however one respondent stated that there is no systematic record, and a form must be provided for maintenance of documentation which is considered important. On the other hand, four respondents stated that breakdown records are not analysed, while the other respondents agreed that breakdown records are analysed, and different departments usually undertake the analysis. Four interviewees stated that they did not agree with the statement “the maintenance department set up maintenance plans based on analysed breakdown records”, while two respondents agreed that the maintenance department set up maintenance plans based on analysed breakdown records and one respondent stated that maintenance plans are set up based on breakdown records analysis in coordination with other departments. Finally, four respondents agreed that they have adequate equipment for maintenance, while the other respondents’ answers were negative.

The results regarding spare parts indicate that spare parts stores are not computerized in three of the power plants while they are computerized in four power plants, and the remaining two interviewees indicated that they have paper lists of spare parts. The results also showed that spare parts are available in two of the power plants, while not all spare parts needed are available in the other power plants due to several reasons such as the current financial difficulties, time of ordering and supplying, administration process and unavailability of spare parts locally.

The results indicate that in four power plants there are annual plans to purchase spare parts and materials, however one power plant has a six-month

plan for spare parts purchasing, while the other four respondents stated that they plan according to the need of spare parts or before the maintenance session. Also the results show that there are delays in importing spare parts from outside of the country.

The findings of the interview indicate that the power plants track their employees' performances and direct evaluation from supervisors or heads of departments is used mostly as the method of evaluation, while in one power plant there is a special committee to evaluate the performance of employees. It has been also found that there is a good relationship between power plant management and employees. The employees can propose suggestions to the power plant management; the mechanism starts with the employee suggesting or proposing his/her idea to their supervisor or head of department, who then delivers those suggestions or proposals to the power plant manager to study them and take an action.

Teamwork has been found to be important in the respondents' point of view, and they think teamwork in the power plants is good. Seven respondents were satisfied with the level of teamwork in their power plants, however one respondent was not satisfied and the reason stated was "Not satisfied, most of the staff are new to the job, which generates significant problems for the administration because of inexperience and lack of balance between rights and duties", furthermore one of the respondent's answer was "Sort of". In order to encourage team working in the power plants several methods can be used such as; orders to perform the assigned work, rewards, and incentive bonuses, acknowledgement letters, moral and psychological support, through

listening to the views of employees in all levels, promoting a culture of teamwork and selflessness, and appreciation and praise and communication with them and to recall their achievements. However, the most common method to encourage team working is financial rewards, and incentive bonuses, while two respondents indicated that the financial rewards and incentive bonuses have been stopped in this current financial year due the financial difficulty in the country. Organization structure was found to be very influential on maintenance activities in the power plants. Furthermore, there are some issues found in some power plants, for example in transcript 2 it has been noticed that there are issues of responsibility between the electricity department and the turbine department. While in transcript 5 it was noticed that there is also an issue of responsibility between the operation department and the stores and spare parts departments. On the other hand, in transcript 6, there is a problem of hiring people from none engineering or technical backgrounds in the power plants since the hiring is carried out by the ministry of electricity because of nepotism and patronage. In addition, one interviewee (Transcript 7) stated there is a problem of large numbers of employees and how to arrange and assign work to them since some of the employees are not specialised or qualified.

The results indicated that there is no tool or devices to measure pollution and emissions at the power plants. While three interviewees agreed that they measure pollution and emissions in accordance with the general governorate of power production and the ministry of electricity or state government, another respondent stated that they don’t measure pollution and emissions because it is a green power plant. All respondents agreed that they have a health and

safety department or division with eight respondents agreeing that the guidance and safety procedures at the plant are good while one respondent stated that he can't be optimistic and say good or very good but it is acceptable. In order to improve the safety procedures, four points emerged from the findings; training courses, increase the awareness of work safety culture, safety equipment and requirements and the safety department should emphasize the safety procedure to the employees. With regards to health and safety signs and procedures, five of the respondents agreed that health and safety signs and procedures are allocated everywhere in the plant, while respondent one stated "they are available to some extent", and another respondent stated "Relatively yes", the sixth respondent stated "no" to the question, while the seventh respondents stated "Yes it exists but is not within acceptable limits".

The findings indicate in order to increase power production and overcome the power shortage in Iraq, a number of actions need to take place; by building large capacity, high efficiency power plants that are suitable to work in the Iraqi weather which is considered as having a high temperature and dusty long summer season. And by providing enough funds to perform operation and maintenance activities in the power plants, since it has been found to have a significant impact on buying spare parts and fuel, providing the necessary training for staff, providing financial rewards for employees for motivation, inviting experts or foreign companies to do major maintenance activities and so on. The results also indicate there is an urgent need to ensure proper training for staff on operation and maintenance, and safety procedures.

It has been found that spare parts unavailability found has a great impact on power plants production rate because of postponing of scheduled maintenance in some power plants for significant amount of time due the lack of spare parts. Therefore, providing significant genuine spare parts in order to perform maintenance in a specified time.

While the fuel type and quantity was found to be another cornerstone of power shortage in Iraq, therefore the power plants should be provided with the right fuel type and quantity in order to assure that power plants run without stopping because of unavailability of fuel or of breakdowns related to use of unsuitable fuel types.

Since planning has been found to be an issue within the power industry, great considerations need to be taken in this area, many respondents attribute power shortage in Iraq to absence of correct planning and real solutions to solve the power problem, and balancing between power production, transmission and distribution, selecting and installing suitable power plants with large capacities and higher efficiencies, all those solutions can be done through putting the right people with high experience and education in the right places and providing rules and laws to perform their jobs.

Increasing employees' motivation within power plant departments to perform their tasks in a better way can lead to an increase in power production in Iraq, since employees play a critical role in operation and maintenance activities in power plants. And also increasing culture awareness of customers to reduce energy consumption will help to decrease the energy demands.

Chapter 5. Questionnaire Data Analysis and Results

5.1 Introduction

The previous chapter presented the interview data collection and analysis. This current chapter aims to present the questionnaire data collection and analysis, and it is divided into five parts. The first part starts with the questionnaire response rate, followed by a descriptive analysis of the sample. The second part describes the main barriers affecting the Iraqi power plants reliability. While the third part determines the level of maintenance implementation in those power plants. The fourth part identifies the power plants organisational culture profile. Finally, the fifth part explores the effect of organisational culture types on the maintenance implementation factors.

5.2 Response Rate of the Questionnaire

The questionnaire was distributed to employees of nine Iraqi power plant. A total of 1000 questionnaires were distributed personally to the selected Iraqi power plants. As shown in table 5.1, 484 questionnaires were returned, of which 456 were completed and usable, while 28 questionnaires were either incomplete or the respondents selected more than one answer for one question. Therefore, the initial response rate was 48% and the total response rate for those that were considered as being usable was 49.8%.

Table 5-1 Power plants responses rates

Power plant	Employees Number	Questionnaire distributed	Collected	Percentage
A	600	138	65	47.1%
B	1530	302	63	20.86%
C	600	138	76	55 %
D	130	30	20	66.6%
E	452	104	66	63.46%
F	450	104	60	57.6%
G	400	92	53	57%
H	311	72	42	58.3%
I	300	69	39	56.5%
Total	4773	1000	484	48%

According to Saunders et al [133] the response rate is calculated by using the following formula:

$$\text{Total response rate} = \frac{\text{Total number of responses}}{\text{Total number in sample} - \text{ineligible}} \times 100\%$$

$$= \frac{484}{1000-28} = 49.8\%$$

The 49.8% response rate is considered good and can be attributed to the efforts which were made to increase it, which include:

1. The researcher used a collective questionnaire, by delivering the questionnaires by hand to each respondent then collecting them later. Kumar (2011) suggested that this method might ensure a higher response rate, because the researcher can explain the purpose and importance of the study to respondents [144].
2. The researcher asked his supervisor for a formal letter addressed to his sponsor, who issued a formal letter addressed to the power plants General Regional Directorate Manager, who issued a facilitate letter for the researcher to conduct his research addressed to all power plant managers.

3. The questionnaire did not contain the participants' names, or the power plants names, which helped to increase the number returned.

5.3 General demographic profile of the respondents

Table 5.2 illustrates the general demographic profile of the respondents by job title, age, work experience, and education level.

Table 5-2 General demographic profile

Category	Sub Category	N	%
Job title	Biological	4	0.8
	Biological Contract	1	0.2
	Chemist	4	0.8
	Chemist Contract	3	0.6
	Craftsman	12	2.5
	Craftsman Contract	4	0.8
	Data Logger	1	0.2
	Engineer	177	36.6
	Engineer Contract	53	11
	Physicist	1	0.2
	Physicist Contract	3	0.6
	Programmer	5	1
	Technical	145	30
	Technical Contract	68	14
Age (years)	18-24	27	5.6
	25-34	271	56
	35-44	137	28.3
	45-54	46	9.5
	55-64	3	0.6
	+65	0	0
Work experience level (years)	5 or less	244	50.4
	From 6 to 10	152	31.4
	From 11 to 15	34	7
	More than 15	51	10.5
Education level	Primary School	17	3.5
	Secondary School	65	13.4
	Diploma	132	27.3
	Bachelor degree	268	55.4
	Master degree	1	0.2
	PhD	0	0

Table 5.2 shows that the engineers represent the highest percentage of the respondents with 36.6%, while technicians represent 30% of the respondents, followed by technicians with contract jobs with 14% of the respondents, on the

other hand engineers with contract jobs represent 11% of the respondents. In terms of age, the majority of the respondent's fall under the age range of 25-34years which represents 56% of the respondents, followed by the age range 35-44years with 28.3%, while 9.5% of the respondents are from the age 45-54years, and 5.6% are under 24 years. On the other hand, in terms of work experience in the power industry, it has been found that the majority of respondents (50%) have five years or less work experience, while 31% of the respondents have from 6 – 10 years. However, 10.5% of the respondents have experience of more than 15 years, and 7% have 11- 15. In terms of education level, 55.4% of the respondents have a bachelor's degree, while holders of diploma degree represent 27.3% of the respondents. In addition, 13.4% of the respondents have a secondary school degree, and 3.5% of the respondents hold a primary school degree, only 0.2% have a Master's degree, and none of the respondents hold a PhD.

5.4 Barriers affecting power plant reliability

In order to answer research questions and meet objectives, the respondents were asked to choose the most important barriers which they believe are affecting their power plants reliability. Table 5.3 illustrates the chosen barriers and their mean scores and ranks. The lowest mean score was 2.22 and the highest 3.11. The overall reliability (Cronbach's Alpha) for all items is 0.795 which is well above the acceptable level of 0.60 for reliable constructs [207].

Table 5-3 Results regarding power plant reliability barriers

Barriers	Mean	Std. Deviation	Rank
Inadequate training and development of personnel.	2.07	1.049	1
No long term arrangement for the supply of essential parts for replacement.	2.09	1.054	2
Natural deterioration due to age and environment.	2.22	1.042	3
Quality of Fuel.	2.59	1.185	4
Lack of discernible maintenance culture.	2.62	1.106	5
Inadequate/inappropriate maintenance of facility plant and equipment for maintenance & operations.	2.63	1.117	6
Lack of successful maintenance programme by the maintenance department.	2.66	1.191	7
Insufficient fund for maintenance job.	2.69	1.299	8
Absence of a form of planned maintenance programmes.	2.72	1.137	9
Lack of skilled personnel in maintenance department	2.82	1.158	10
Lack of skilled personnel in operation department	2.89	1.162	11
Shortage in fuel supply.	3.11	1.192	12

5.5 Level of maintenance implementation in the Iraqi power plants

In order to determine the level of maintenance implementation, several variables were identified through the literature review and used in the questionnaire as measures. The following hypothesis was developed in order to assess the level of maintenance implementation;

Maintenance implantation is very low when:

H0: The level of maintenance implementation is very low in the Iraqi power plants

H1: The level of maintenance implementation is higher than very low in the Iraqi power plants

When, **H0**: median ≤ 1.80

H1: median > 1.80

Maintenance implantation is low when:

H0: The level of maintenance implementation is low in the Iraqi power plants

H1: The level of maintenance implementation is higher than low in the Iraqi power plants

When, ***H0:*** median ≤ 2.6

H1: median > 2.6

Maintenance implementation is medium when:

H0: The level of maintenance implementation is medium in the Iraqi power plants

H1: The level of maintenance implementation is higher than medium in the Iraqi power plants

When, ***H0:*** median ≤ 3.40

H1: median > 3.40

Maintenance implementation is high when:

H0: The level of maintenance implementation is high in the Iraqi power plants

H1: The level of maintenance implementation is very high in the Iraqi power plants

When, ***H0:*** median ≤ 4.20

H1: median > 4.20

The respondents were asked to answer to what extent they agreed or disagreed with the given statements. The extension is determined by 5-1= 4. In order to identify the length of each scale (statement) 4/5=0.80 is computed [220]-[221]. The upper limit for each cell is then determined by adding 0.80 to the code of Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. Table 5.4 shows the range of each scale:

Table 5-4 Scale range [222]

Points	Level of implementation	Scale range
1	Very low	From 1 to 1.80
2	Low	181 to 2.60
3	Medium	2.61 to 3.40
4	High	3.41 to 4.20
5	Very High	4.21 to 5

Table 5.5 shows the mean and the reliably for nine factors affecting maintenance implementation. It can be seen under the Cronbach's Alpha column that the reliability of all factors is above 0.6 which is considered to be good, and can be accepted based on the work of Sekaran [222].

Table 5-5 Mean, std deviation, and reliability of maintenance measurements factors

Factor	Mean	Std. Deviation	Cronbach's Alpha
Technical	2.9044	0.45253	0.703
Training and Education	2.9999	0.75485	0.892
Motivation	2.7589	0.63169	0.808
Teamwork	2.3971	0.61504	0.900
Organization structure and work design	2.9652	0.78158	0.845
Sense of personal responsibility	3.1101	0.9479	0.715
Decision making	2.1436	1.13446	0.661
Sense of control and communication climate	2.4918	1.01282	0.810
Safety and environment	2.7517	0.9897	0.820
Overall	2.724		

Based on the hypothesis and descriptive statistics, the level of maintenance implementation in the Iraqi power plants was found to be medium at mean value of 2.742. Table 5.5 also shows that the mean of all items of Technical factors (maintenance approach, task planning and scheduling, spare parts management, information management and CMMs, contracting out

maintenance, and continuous improvement) was 2.9044, which was in the range of 2.61 to 3.40, while Training and Education had mean of 2.9999, in addition, Motivation (2.7589), Teamwork (2.3971), Organization structure and work design (2.9652), Sense of personal responsibility (3.1101), Decision making (2.1436), Sense of control and communication climate (2.4918), Safety and environment (2.7517). The overall mean was 2.724, which shows that maintenance, was implemented at medium level in the Iraqi power plants.

5.6 Organisational culture profile

This part examines the total mean scores of each organisational culture type. It also shows the reliability (Cronbach alpha) of each organisational culture type, which is considered to be good, since its value is above 0.6. Table 5.6 shows the overall means, ranking and std. deviation, and the reliability for all organisation culture types.

Table 5-6 Mean, rank, standard deviation, and reliability of organisational culture types

Type of organisational culture	Mean	Ranking	Std. Deviation	Cronbach's Alpha
Rational Culture	3.7221	1	1.53698	0.807
Group Culture	3.7100	2	1.41073	0.854
Hierarchical Culture	3.6754	3	1.54253	0.778
Development Culture	3.6295	4	1.47921	0.864

It can be seen that Rational Culture is the most dominant with a mean score of 3.7221, the second most dominant is Group Culture with a mean 3.7100, while Hierarchical Culture appears third with a mean score of 3.6754 and Development Culture is ranked fourth with a mean score of 3.6295. In addition

to that figure 5.1, shows that there is slight difference between all cultures, and the overall culture of the power plants at medium level.

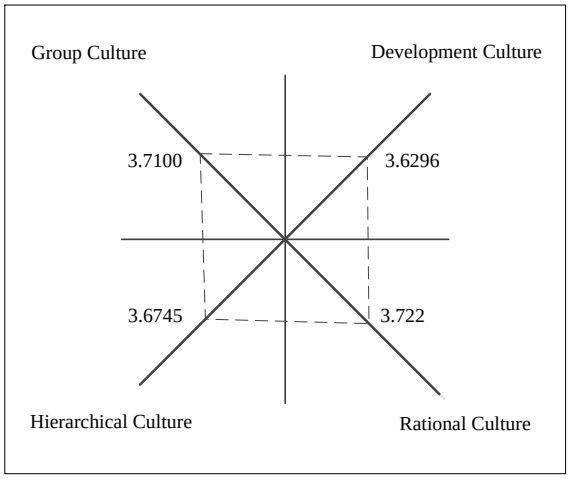


Figure 5.1 Organisational cultural profiles

5.7 The effects of "age" and "education level" and "experience" on organizational culture profile

The relationship between socio-demographic variables and cultural profiles were also analysed via analysis of variance using SPSS software version 22.

5.7.1 Age and organizational culture profile

A one-way group analysis of variance was conducted to explore the impact of age on cultural profiles, respondents were divided into five age groups (18-24 years, 25-34 years, 35-44 years, 45-54 years, and 55-64 years), and table 5.7 shows the culture profiles and age groups, number in each group, means, and standard deviation.

Table 5-7 Descriptive analysis of cultural profiles and age group

Culture profiles	Age	N	Mean	Std. Deviation
Group Culture	18-24	23	3.5466	1.69341
	25-34	261	3.6775	1.41719
	35-44	128	3.9033	1.38705
	45-54	41	3.5052	1.24339
	55-64	3	2.3333	.70470
	Total	456	3.7100	1.41073
Development Culture	18-24	23	3.4565	1.54005
	25-34	261	3.6672	1.50067
	35-44	128	3.6654	1.52286
	45-54	41	3.4654	1.18365
	55-64	3	2.3889	.41944
	Total	456	3.6295	1.47921
Rational Culture	18-24	23	3.4870	1.52890
	25-34	261	3.7287	1.54421
	35-44	128	3.8492	1.59344
	45-54	41	3.5171	1.32059
	55-64	3	2.3333	.41633
	Total	456	3.7221	1.53698
Hierarchical Culture	18-24	23	3.5217	1.69618
	25-34	261	3.6807	1.56682
	35-44	128	3.7318	1.52842
	45-54	41	3.6423	1.39919
	55-64	3	2.4444	.50918
	Total	456	3.6754	1.54253

The Levene's test of homogeneity of variances was performed which aimed to test whether the variance in scores is the same for each group or not. It is important to check the significance value (p value), if the number is greater than (0.05) at a confidence level of 95%, the homogeneity of variance assumption is not violated, but if it is equal or less than (0.05) the homogeneity of variance assumption is violated and the table of Robust Test of Equality of Means, needs to be consulted. Therefore, Table 5.8 shows the significance value of this research, the (p value) is greater than 0.05 for all cultural profiles (Group Culture: 0.412. Development Culture: 0.065. Rational Culture: 0.077.

and Hierarchical Culture: 0.397) which mean, the homogeneity of variance assumption is not violated.

Table 5-8 Test of Homogeneity of variances

Culture Type	Levene Statistic	df1	df2	Sig.
Group Culture	.991	4	451	.412
Development Culture	2.229	4	451	.065
Rational Culture	2.125	4	451	.077
Hierarchical Culture	1.019	4	451	.397

Furthermore, an ANOVA test was performed in order to test the effects of age on cultural profiles. Analysis of variance, or ANOVA, is a powerful statistical technique that involves partitioning the observed variance into different components to conduct various significance tests. The result in table 5.9 consist of five columns, the first column shows the relation between culture and age group, while the second column, Sum of Squares, refers to the sum, over all observations, of the squared differences of each observation from the overall mean, and df refers to the number of independent ways by which a dynamic system can move, without violating any constraint imposed on it. While the mean square is used to determine whether factors are significant. However, in this test, the significance level (Sig) is the most important factor to check if there is a statistically significant difference between factors.

In this regards table 5.9 shows that there are no differences in cultural profiles due to age because there was no statistically significant difference since the p values are all above 0.05.

Table 5-9 ANOVA test of effects of age on cultural profiles

		Sum of Squares	df	Mean Square	F	Sig.
Group Culture	Between Groups	13.076	4	3.269	1.652	.160
	Within Groups	892.449	451	1.979		
	Total	905.525	455			
Development Culture	Between Groups	6.945	4	1.736	.792	.531
	Within Groups	988.622	451	2.192		
	Total	995.567	455			
Rational Culture	Between Groups	10.861	4	2.715	1.151	.332
	Within Groups	1063.985	451	2.359		
	Total	1074.846	455			
Hierarchical Culture	Between Groups	5.548	4	1.387	.581	.677
	Within Groups	1077.084	451	2.388		
	Total	1082.632	455			

5.7.2 Education level and organizational culture profile

A process similar to that described in the previous section 5.7.1 was conducted in order to assess the effect of education level on organizational culture profile, table 5.10 shows the descriptive analysis, while table 5.11 shows the Test of Homogeneity of Variances which indicates that the p value is greater than 0.05 for all cultural profiles (Group Culture: 0.076. Development Culture: 0.204. Rational Culture: 0.157. And Hierarchical Culture: 0.308) table 5.11. Furthermore, an ANOVA test was performed to test the differences in cultural profiles due to education level, the results indicate that there are no differences in cultural profiles due education level because the p values are above 0.05, which can be seen in table 5.12.

Table 5-10 Descriptive analysis of cultural profiles and education level

		N	Mean	Std. Deviation	Std. Error
Group Culture	Primary School	15	4.0286	1.09624	.28305
	Secondary School	59	3.8410	1.56008	.20311
	Diploma	126	3.7311	1.48258	.13208
	Bachelor degree	255	3.6392	1.34680	.08434
	Master degree	1	6.5714	.	.
	Total	456	3.7100	1.41073	.06606
Development Culture	Primary School	15	3.6389	1.16822	.30163
	Secondary School	59	3.6243	1.52552	.19861
	Diploma	126	3.6857	1.61293	.14369
	Bachelor degree	255	3.5931	1.41690	.08873
	Master degree	1	6.0000	.	.
	Total	456	3.6295	1.47921	.06927
Rational Culture	Primary School	15	4.0133	1.04325	.26937
	Secondary School	59	3.8051	1.61228	.20990
	Diploma	126	3.7540	1.65450	.14739
	Bachelor degree	255	3.6580	1.47731	.09251
	Master degree	1	6.8000	.	.
	Total	456	3.7221	1.53698	.07198
Hierarchical Culture	Primary School	15	3.8889	1.09593	.28297
	Secondary School	59	3.8531	1.65429	.21537
	Diploma	126	3.6481	1.58229	.14096
	Bachelor degree	255	3.6261	1.51822	.09507
	Master degree	1	6.0000	.	.
	Total	456	3.6754	1.54253	.07224

Table 5-11 Test of Homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Group Culture	2.303[a]	3	451	.076
Development Culture	1.537[b]	3	451	.204
Rational Culture	1.746[c]	3	451	.157
Hierarchical Culture	1.204[d]	3	451	.308

Table 5-12 ANOVA test of effects of education level on cultural profiles

		Sum of Squares	df	Mean Square	F	Sig.
Group Culture	Between Groups	12.056	4	3.014	1.521	.195
	Within Groups	893.469	451	1.981		
	Total	905.525	455			
Development Culture	Between Groups	6.358	4	1.589	.725	.575
	Within Groups	989.210	451	2.193		
	Total	995.567	455			
Rational Culture	Between Groups	12.326	4	3.082	1.308	.266
	Within Groups	1062.520	451	2.356		
	Total	1074.846	455			
Hierarchical Culture	Between Groups	8.663	4	2.166	.909	.458
	Within Groups	1073.969	451	2.381		
	Total	1082.632	455			

5.7.3 Working experience and organizational culture profile

Table 5.13 shows the descriptive analysis, while table 5.13 shows the Test of Homogeneity of Variances which indicate that the p value is greater than 0.05 for all cultural profiles (Group Culture: 0.753. Development Culture: 0.900. Rational Culture: 0.280. And Hierarchical Culture: 0.860).

A one-way analysis of variance was conducted to explore the impact of working experience level on cultural profiles, participants' experiences were divided into four groups (Group 1: ≤5 years; Group 2: 6-10 years; Group 3: 11-15 years; Group 4 >15 years). There was a statistically significant difference at the $p < 0.05$ which can be seen in table 5.15.

To find out the source of difference, a Scheffe test was conducted table 5.16, the results from analysis shows there is one difference of rational culture regarding to working experiences level $F (3, 455) = 3.244$, $p = 0.022$. The difference was found between group 2 (6-10) ($x = 3.9986$) and group 4 (>15) ($x = 3.2625$). The results also show that there are two differences of Hierarchical culture regarding to working experience level $F (3, 455) = 4.224$,

p = 0.006. The differences were found between group 1 (≤5) (x = 3.5402) and group 2 (6 – 10) (x = 4.0324), and also between group 2 (6-10) (x = 4.0324) and group 4 (>15) (x = 3.2986).

Table 5-13 Descriptive analysis of cultural profiles and working experiences

		N	Mean	Std. Deviation	Std. Error
Group Culture	≤5	232	3.6045	1.40603	.09231
	6-10	144	3.9816	1.39378	.11615
	11-15	32	3.7232	1.35911	.24026
	>15	48	3.3958	1.42804	.20612
	Total	456	3.7100	1.41073	.06606
Development Culture	≤5	232	3.5854	1.47696	.09697
	6-10	144	3.8681	1.49278	.12440
	11-15	32	3.5234	1.41631	.25037
	>15	48	3.1979	1.40569	.20289
	Total	456	3.6295	1.47921	.06927
Rational Culture	≤5	232	3.6677	1.54856	.10167
	6-10	144	3.9986	1.53404	.12784
	11-15	32	3.5625	1.30847	.23131
	>15	48	3.2625	1.52045	.21946
	Total	456	3.7221	1.53698	.07198
Hierarchical Culture	≤5	232	3.5402	1.54313	.10131
	6-10	144	4.0324	1.51978	.12665
	11-15	32	3.6146	1.62001	.28638
	>15	48	3.2986	1.39442	.20127
	Total	456	3.6754	1.54253	.07224

Table 5-14 Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Group Culture	.400	3	452	.753
Development Culture	.195	3	452	.900
Rational Culture	1.281	3	452	.280
Hierarchical Culture	.252	3	452	.860

Table 5-15 ANOVA test of working experience level on cultural profiles

		Sum of Squares	df	Mean Square	F	Sig.
Group Culture	Between Groups	17.953	3	5.984	3.048	.028
	Within Groups	887.572	452	1.964		
	Total	905.525	455			
Development Culture	Between Groups	17.946	3	5.982	2.766	.041
	Within Groups	977.621	452	2.163		
	Total	995.567	455			
Rational Culture	Between Groups	22.652	3	7.551	3.244	.022
	Within Groups	1052.195	452	2.328		
	Total	1074.846	455			
Hierarchical Culture	Between Groups	29.525	3	9.842	4.224	.006
	Within Groups	1053.106	452	2.330		
	Total	1082.632	455			

Table 5-16 Scheffe test

Dependent Variable	Sec1Exp	Sec1Exp	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Group Culture	≤5	6-10	-.37717	.14866	.094	-.7943	.0400
		11-15	-.11874	.26425	.977	-.8602	.6228
		>15	.20864	.22220	.830	-.4149	.8321
	6-10	≤5	.37717	.14866	.094	-.0400	.7943
		11-15	.25843	.27386	.828	-.5100	1.0269
		>15	.58581	.23355	.100	-.0695	1.2412
	11-15	≤5	.11874	.26425	.977	-.6228	.8602
		6-10	-.25843	.27386	.828	-1.0269	.5100
		>15	.32738	.31980	.790	-.5700	1.2248
	>15	≤5	-.20864	.22220	.830	-.8321	.4149
		6-10	-.58581	.23355	.100	-1.2412	.0695
		11-15	-.32738	.31980	.790	-1.2248	.5700

Development Culture	≤5	6-10	-.28264	.15602	.351	-.7204	.1552
		11-15	.06198	.27733	.997	-.7162	.8402
		>15	.38750	.23320	.431	-.2669	1.0419
	6-10	≤5	.28264	.15602	.351	-.1552	.7204
		11-15	.34462	.28742	.697	-.4619	1.1511
		>15	.67014	.24511	.060	-.0177	1.3579
	11-15	≤5	-.06198	.27733	.997	-.8402	.7162
		6-10	-.34462	.28742	.697	-1.1511	.4619
		>15	.32552	.33563	.816	-.6163	1.2673
	>15	≤5	-.38750	.23320	.431	-1.0419	.2669
		6-10	-.67014	.24511	.060	-1.3579	.0177
		11-15	-.32552	.33563	.816	-1.2673	.6163
Rational Culture	≤5	6-10	-.33094	.16186	.244	-.7851	.1233
		11-15	.10517	.28771	.988	-.7022	.9125
		>15	.40517	.24193	.424	-.2737	1.0840
	6-10	≤5	.33094	.16186	.244	-.1233	.7851
		11-15	.43611	.29818	.545	-.4006	1.2728
		>15	.73611*	.25429	.040	.0226	1.4497
	11-15	≤5	-.10517	.28771	.988	-.9125	.7022
		6-10	-.43611	.29818	.545	-1.2728	.4006
		>15	.30000	.34820	.863	-.6771	1.2771
	>15	≤5	-.40517	.24193	.424	-1.0840	.2737
		6-10	-.73611*	.25429	.040	-1.4497	-.0226
		11-15	-.30000	.34820	.863	-1.2771	.6771
Hierarchical Culture	≤5	6-10	-.49218*	.16193	.027	-.9466	-.0378
		11-15	-.07435	.28784	.995	-.8820	.7333
		>15	.24162	.24204	.802	-.4375	.9208
	6-10	≤5	.49218*	.16193	.027	.0378	.9466
		11-15	.41782	.29831	.581	-.4192	1.2549
		>15	.73380*	.25440	.041	.0199	1.4477
	11-15	≤5	.07435	.28784	.995	-.7333	.8820
		6-10	-.41782	.29831	.581	-1.2549	.4192
		>15	.31597	.34835	.844	-.6615	1.2935
	>15	≤5	-.24162	.24204	.802	-.9208	.4375
		6-10	-.73380*	.25440	.041	-1.4477	-.0199
		11-15	-.31597	.34835	.844	-1.2935	.6615

5.8 Proposed conceptual framework and hypotheses development

In order to investigate how the four types of organisational culture influence the maintenance implementation factors, the following four hypotheses were developed based on research model highlighted in chapter three:

H1a: Group culture has a positive influence on maintenance factors (Maintenance approach, task planning and scheduling, spare parts management, Information management and CMMs, contracting out maintenance, continuous improvement, organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication, safety and environment, training, motivation, and teamwork).

H1b: Developmental Culture has a positive influence on maintenance factors (Maintenance approach, task planning and scheduling, spare parts management, Information management and CMMs, contracting out maintenance, continuous improvement, organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication, safety and environment, training, motivation, and teamwork).

H1c: Hierarchical culture has a positive influence on maintenance factors (Maintenance approach, task planning and scheduling, spare parts management, Information management and CMMs, contracting out maintenance, continuous improvement, organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication, safety and environment, training, motivation, and teamwork).

H1d: Rational culture has a positive influence on maintenance factors (Maintenance approach, task planning and scheduling, spare parts management, Information management and CMMs, contracting out maintenance, continuous improvement, organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication, safety and environment, training, motivation, and teamwork).

Based on the above research hypotheses, a proposed model was developed that aimed to explore and identify the influence of organisational culture on maintenance implementation. The proposed model is illustrated in figure 5.2.

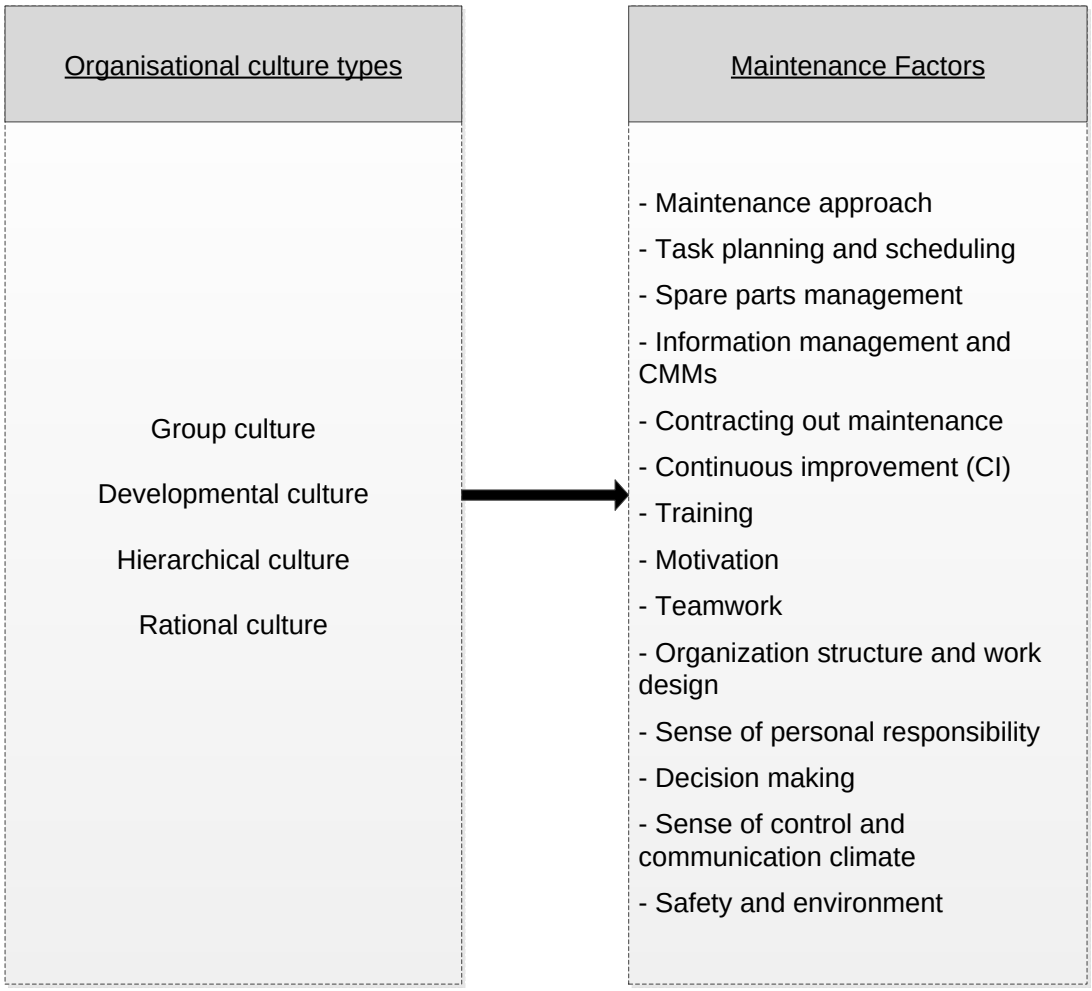


Figure 5.2 A proposed model on the influence of organisational culture on maintenance implementation factors

5.8.1 Data analysis of the effect of organisational culture on maintenance factors

Structural Equation Modelling (SEM) is used for analysing the data collected from the questionnaires. Since the proposed model does not follow exact previous research, and it is an exploratory approach, in which some of the hypothesized relationships between the variables have not been previously tested, the Partial Least Square-SEM (PLS-SEM) method is considered the most appropriate approach compared with the covariance based SEM [210]. Hair, J.F., et al suggest that, assessment of a PLS-SEM model must contain two stages:

1. The first step consists of the assessment of the measurement model, which can be named the outer model, which shows the relationship of the latent variables with the observed variables.

2. The second step is the assessment of the structural or inner model, presenting the relationship between the latent variables.

5.8.1.1 Data Characteristics

It is important to discover and treat the missing data before conducting the structure equation analysis because it might affect the estimators of the model, [223]. The missing values were treated using the SPSS imputation function. For the outer model assessment, it needed to analyse the Average Variance Expected (AVE), Composite reliability (CR) and Cronbach's alpha and the correlations of the variable's loadings. In order to assure that the outer model reaches acceptable levels, after that the inner model needs to be assessed

based on the loadings and the t-value to find if the independent variable has a significant relationship with the dependent variable.

Hair, et al [210] suggested that for using PLS-SEM, the sample size should be at least ten times the number of variables; since the final questionnaire included 18 variables and 456 responses, therefore it exceeded these minimum requirements, and can produce reliable results.

5.8.1.2 Model Assessment

Since the purpose of model assessment is to find the influence of organisational culture types (group culture, developmental culture, hierarchical culture, rational culture) on maintenance factors (maintenance approach, task planning and scheduling, spare parts management, Information management and CMMs, contracting out maintenance, continuous improvement, organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication, safety and environment, training, motivation, and teamwork) the first stage of the model assessment is to examine the measurement model, which means the assessment must define whether the items (data from questionnaires) can be included in the model to measure constructs. While the next stage of assessment is to define the constructs that can be included in the model. On the other hand, the final stage is the assessment of the model, to measure the influence of organisational culture types on maintenance factors to test the hypotheses.

Measurement Model Assessment

The aim of measurement model assessment is to confirm that the items accurately and significantly measure the construct by examining its reliability and validity [207]. Reliability is a measure of whether the data are consistent or close to each other [210]. Hair et al, suggested assessing the reliability and validity in order to examine the measurement model, with the aim to assure that items correctly and significantly measure the constructs, as well as to ensure that items can be included in the model. Four constructs were excluded from the model due to their low level of reliability (Cronbach Alpha below 0.6), see table 5.17.

Table 5-17 Excluded constructs

Constructs	Cronbach's Alpha
Maintenance approach	-0.653
Spare parts management	0.387
Contracting out maintenance	-0.561
Continuous improvement (CI)	-0.592

Preliminary PLS-SEM software runs of the model elements outer loadings, reliability, composite reliability, average variance extracted (AVE), and correlations between constructs. Hair et al [210] stated that convergent validity measures "the extent to which a measure correlates positively with alternative measures of the same construct". It can be evaluated by assessing the average variance extracted (AVE), outer loading and correlation between variables. The average variance extracted (AVE) is the average of the sum of the squared loadings and it should be higher than 0.5, and can be determined using the following equation,

$$\mathrm{AVE_j} = \frac{\sum_i^n l_{i\,j}^2}{n} \qquad (5.1)$$

where: *AVEj* is the average construct extracted of construct *j*, *lij* is the loading of indicator *i* in construct *j* and *n* is the number of loadings. Table 5.18 illustrates that three constructs (Motivation, structural design, and Teamwork) have AVE values below 0.5.

Table 5-18 AVE of the constructs

Construct	Average Variance Extracted (AVE)
Control_communication	0.570
Decision_making	0.739
Development_culture	0.628
Group_culture	0.557
Hierarchical_culture	0.716
Info_management	0.813
Motivation	0.371
Personal_responsibility	0.534
Rational_culture	0.678
Safety_environment	0.583
Structural_design	0.382
Task_planning	0.536
Teamwork	0.317
Training	0.515

In order to increase the AVE, the outer loading values of each item must be 0.7 or more, which specifies that the items provide consistency of results on the same test, and must be included in the model. Furthermore, it has been suggested that an outer loading between 0.4 and 0.7 can be included in the model if the deletion of the item does not increase the composite reliability and AVE. However, there are several items that have outer loading values lower than 0.7. Table 5.19 shows the decision is made to remove these items from the model.

Table 5-19 Items deletion decision

Construct	Item	Outer Loadings	Composite Reliability		Average Variance Extracted (AVE)		Decision
			Before deletion	After deletion	Before deletion	After deletion	
Task planning & Scheduling	Sec2BMainPract3	0.658	0.852	0.852	0.536	0.536	Delete Item
Personal Responsibility	Sec3B12	0.583	0.819	0.874	0.534	0.618	Delete Item
Organisation structure & work design	Sec3B4 Sec3B7 Sec3B8 Sec3B9 Sec3B11	0.187 0.423 0.469 0.297 0.469	0.857	0.881	0.382	0.599	Delete Items
Motivation	Sec3CMotiv1 Sec3CMotiv4 Sec3CMotiv6 Sec3CMotiv7 Sec3CMotiv8 Sec3CMotiv13	0.564 0.616 0.609 0.553 0.566 0.558	0.854	0.828	0.371	0.527	Delete Items
Teamwork	Sec3DTeam4 Sec3DTeam5 Sec3DTeam8 Sec3DTeam10 Sec3DTeam11 Sec3DTeam12 Sec3DTeam14 Sec3DTeam16 Sec3DTeam17 Sec3DTeam18 Sec3DTeam20 Sec3DTeam21 Sec3DTeam22	0.605 0.309 0.228 0.413 0.156 0.002 0.207 0.675 0.646 0.682 0.415 0.533 0.593	0.874	0.881	0.317	0.517	Delete Items

Several items have outer loadings below 0.7 as shown in table 5.18. For the construct Task planning and scheduling, item Sec2BMainPract3 has an outer loading of 0.658 which is below 0.7, with composite reliability of 0.852 and an AVE score 0.536, even with the item deleted the reliability and AVE have not changed. While for the Personal Responsibility construct, Item Sec3B12 has an outer loading score of 0.583 with construct composite reliability and AVE values of 0.819 and 0.534 respectively. In this case it has been noticed that after deletion of item Sec3B12 the composite reliability and AVE increased to 0.874 and 0.618 respectively.

Several items under the Organisation structure & work design construct have been found with low outer loading scores (Sec3B4=0.187, Sec3B7 =0.423, Sec3B8=0.469, Sec3B9=0.297, and Sec3B11=0.469), the construct composite reliability was 0.857, while the AVE score was 0.382 which is considered low since it is less than 0.5. Therefore, those items have been deleted which increased the composite reliability to 0.881, and AVE to 0.599.

The motivation construct has a composite reliability of 0.854, and AVE of 0.371. The AVE did not meet the minimum AVE of 0.5, because six items had outer loadings scores less than 0.7, (Sec3CMotiv1= 0.564, Sec3CMotiv4= 0.616, Sec3CMotiv6= 0.609, Sec3CMotiv7=0.553, Sec3CMotiv8= 0.566, and Sec3CMotiv13= 0.558), deleting those items increased the composite reliability to 0.828, and the AVE to 0.527

In order to increase the AVE of the Teamwork construct which has been found with a score of 0.317, several items were deleted since their outer loadings were below 0.7, (Sec3DTeam4= 0.605, Sec3DTeam= 0.309, Sec3DTeam8=

0.228, Sec3DTeam10= 0.413, Sec3DTeam11= 0.156, Sec3DTeam12= 0.002, Sec3DTeam14= 0.207, Sec3DTeam16= 0.675, Sec3DTeam17=0.646, Sec3DTeam18= 0.682, Sec3DTeam20= 0.415, Sec3DTeam21= 0.53, Sec3DTeam22= 0.593), deleting those items increased the composite reliability from 0.874 to 0.881, and the AVE from 0.317 to 0.517.

Discriminant Validity

Discriminant validity measures the degree to which a construct belongs to itself and not to other constructs. The square root of the construct's AVE should be higher than the highest correlation with other constructs, in order to do that the Fornel-Larcker criterion analysis is used for all constructs (Development culture, Group culture, Hierarchical culture, Rational culture, Control & communication, Decision making, Info management & CMMs, Personal responsibility, Safety & environment, Structure & work design, Task planning & scheduling, Motivation, Teamwork, and Training). Table 5.20 shows that the square root of the average variance extracted (specified by the bold font) of the all constructs is higher than the highest correlation with other constructs, except the rational culture (specified by the bold font) which has been found to correlate with Development culture, Group culture, Hierarchical culture constructs, therefore, the discriminant validity requirements are not satisfied for that construct, but it is satisfied for other constructs therefore the rational culture construct is eliminated from the analysis. While in table 5.21, after the rational culture construct is deleted we can notice that all constructs are higher than the highest correlation with other constructs, therefore the discriminant validity requirement is satisfied.

Table 5-20 Fornell-Lacker criterion for all constructs

Construct	Control_ Communication	Decision making	Development culture	Group culture	Hierarchical culture	Info Management	Motivation	Personal Responsibility	Rational culture	Safety Environment	Structural design	Task Planning	Teamwork	Training
Control communication	**0.755**													
Decision making	0.463	**0.860**												
Development culture	0.613	0.373	**0.792**											
Group culture	0.663	0.444	0.785	**0.747**										
Hierarchical culture	0.600	0.375	0.738	0.735	**0.846**									
Info management	-0.268	-0.240	-0.285	-0.256	-0.278	**0.902**								
Motivation	-0.466	-0.419	-0.438	-0.487	-0.385	0.267	**0.609**							
Personal responsibility	0.588	0.338	0.655	0.648	0.645	-0.192	-0.333	**0.731**						
Rational culture	0.644	0.397	**0.894**	**0.846**	**0.802**	-0.271	-0.465	0.698	**0.824**					
Safety environment	0.578	0.312	0.697	0.722	0.719	-0.263	-0.358	0.563	0.713	**0.763**				
Structural design	0.630	0.400	0.663	0.708	0.682	-0.226	-0.446	0.765	0.725	0.569	**0.618**			
Task planning	-0.328	-0.240	-0.368	-0.324	-0.391	0.508	0.359	-0.337	-0.384	-0.357	-0.342	**0.732**		
Teamwork	-0.451	-0.293	-0.393	-0.436	-0.369	0.295	0.579	-0.426	-0.443	-0.297	-0.501	0.435	**0.563**	
Training	-0.452	-0.248	-0.447	-0.468	-0.393	0.320	0.635	-0.226	-0.456	-0.359	-0.355	0.410	0.467	**0.718**

Table 5-21 Fornell-Lacker criterion for All Constructs after deleting rational culture

Construct	Control_ Communication	Decision making	Development culture	Group culture	Hierarchical culture	Info Management	Motivation	Personal responsibility	Safety Environment	Structural design	Task planning	Teamwork	Training
Control communication	**0.755**												
Decision making	0.464	**0.859**											
Development culture	0.613	0.374	**0.792**										
Group culture	0.647	0.430	0.790	**0.776**									
Hierarchical culture	0.601	0.376	0.738	0.769	**0.846**								
Info management	-0.268	-0.239	-0.285	-0.244	-0.278	**0.902**							
Motivation	-0.400	-0.373	-0.415	-0.433	-0.388	0.251	**0.726**						
Personal responsibility	0.579	0.326	0.659	0.664	0.661	-0.190	-0.294	**0.786**					
Safety environment	0.578	0.312	0.697	0.720	0.719	-0.263	-0.372	0.572	**0.763**				
Structural design	0.644	0.378	0.688	0.718	0.707	-0.246	-0.385	0.752	0.580	**0.774**			
Task planning	-0.327	-0.239	-0.366	-0.319	-0.391	0.508	0.361	-0.354	-0.356	-0.371	**0.733**		
Teamwork	-0.468	-0.321	-0.418	-0.475	-0.405	0.316	0.494	-0.409	-0.335	-0.513	0.440	**0.721**	
Training	-0.452	-0.247	-0.447	-0.444	-0.393	0.319	0.573	-0.244	-0.360	-0.391	0.410	0.507	**0.718**

Table 5.22 shows the summary of the measurement model reliability and validity which has been satisfied.

Table 5-22 Results summary of the measurement model

Construct	Reliability	AVE	Composite Reliability	Discriminant Validity
Control_communication	0.810	0.570	0.869	Yes
Decision_making	0.659	0.737	0.848	Yes
Development_culture	0.851	0.628	0.894	Yes
Group_culture	0.867	0.602	0.900	Yes
Hierarchical_culture	0.801	0.716	0.883	Yes
Info_management	0.771	0.813	0.897	Yes
Motivation	0.700	0.527	0.817	Yes
Personal_responsibility	0.698	0.618	0.828	Yes
Safety_environment	0.819	0.583	0.874	Yes
Structural_design	0.865	0.599	0.899	Yes
Task_planning	0.786	0.537	0.852	Yes
Teamwork	0.848	0.519	0.882	Yes

Since the constructs are built from the combination of indicator scores and the corresponding weights in linear relationships [210], the outer weights need to be significant in order to explain the relationship between the construct and the corresponding item. The Bootstrapping method, repeated randomly subsampling with replacement, is used to estimate the outer weights and t-values statistics. It is suggested that the process of subsampling be at least 5,000 times. An indicator should be deleted from the model if its outer weight and the outer loading are not significant, indicated by the t-value being lower than 1.96 at a significance level of 0.05.

Table 5.23 shows the results of the outer weight significance test, it indicates that all items are representing their construct, therefore these items should be included in the model. While Table 5.24 provides the significance test of outer loading, it can be seen that all of the constructs' items have outer loadings higher than 0.5 which indicates that all of the items can be included in the model.

As a summery since all items passed the outer weight and outer loading significance test all items have been included in the model.

Table 5-23 Significance test of outer weight

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	Significance test t- values > 1.96
Sec2BMainPract11 <- Info_management	0.508	0.511	0.044	11.528	Keep item
Sec2BMainPract12 <- Info_management	0.599	0.595	0.046	12.979	Keep item
Sec2BMainPract3 <- Task_planning	0.192	0.194	0.037	5.209	Keep item
Sec2BMainPract4 <- Task_planning	0.261	0.261	0.025	10.332	Keep item
Sec2BMainPract5 <- Task_planning	0.275	0.274	0.028	9.915	Keep item
Sec2BMainPract6 <- Task_planning	0.309	0.309	0.027	11.283	Keep item
Sec2BMainPract7 <- Task_planning	0.318	0.315	0.029	10.860	Keep item
Sec3A1 <- Group_culture	0.212	0.211	0.009	23.523	Keep item
Sec3A12 <- Group_culture	0.229	0.229	0.007	30.852	Keep item
Sec3A15 <- Development_culture	0.261	0.261	0.010	26.300	Keep item
Sec3A2 <- Hierarchical_culture	0.374	0.374	0.013	28.541	Keep item
Sec3A20 <- Development_culture	0.238	0.238	0.011	22.602	Keep item
Sec3A21 <- Personal_responsibility	0.526	0.524	0.026	20.440	Keep item
Sec3A22 <- Safety_environment	0.268	0.268	0.012	22.523	Keep item
Sec3A23 <- Group_culture	0.193	0.193	0.011	17.129	Keep item
Sec3A24 <- Development_culture	0.273	0.272	0.009	29.139	Keep item
Sec3A26 <- Development_culture	0.216	0.217	0.011	19.071	Keep item
Sec3A29 <- Development_culture	0.271	0.271	0.010	27.342	Keep item
Sec3A3 <- Safety_environment	0.287	0.287	0.016	17.917	Keep item
Sec3A31 <- Group_culture	0.214	0.215	0.010	22.187	Keep item
Sec3A32 <- Safety_environment	0.275	0.274	0.012	22.006	Keep item

Sec3A5 <- Hierarchical_culture	0.403	0.403	0.012	33.071	Keep item
Sec3A6 <- Group_culture	0.225	0.225	0.008	27.448	Keep item
Sec3A8 <- Hierarchical_culture	0.405	0.404	0.012	34.034	Keep item
Sec3A9 <- Group_culture	0.214	0.215	0.010	22.562	Keep item
Sec3B1 <- Structural_design	0.206	0.206	0.014	15.262	Keep item
Sec3B10 <- Structural_design	0.161	0.160	0.012	12.911	Keep item
Sec3B13 <- Personal_responsibility	0.401	0.401	0.018	22.660	Keep item
Sec3B14 <- Personal_responsibility	0.337	0.337	0.019	17.979	Keep item
Sec3B16 <- Decision_making	0.706	0.704	0.044	15.950	Keep item
Sec3B17 <- Decision_making	0.441	0.442	0.046	9.633	Keep item
Sec3B19 <- Control_communication	0.270	0.271	0.015	17.984	Keep item
Sec3B2 <- Structural_design	0.261	0.261	0.012	22.516	Keep item
Sec3B20 <- Control_communication	0.266	0.266	0.016	16.594	Keep item
Sec3B21 <- Control_communication	0.246	0.247	0.016	14.918	Keep item
Sec3B22 <- Control_communication	0.274	0.274	0.014	20.191	Keep item
Sec3B23 <- Control_communication	0.270	0.269	0.022	12.549	Keep item
Sec3B24 <- Safety_environment	0.263	0.261	0.013	19.546	Keep item
Sec3B25 <- Safety_environment	0.214	0.212	0.016	13.204	Keep item
Sec3B3 <- Structural_design	0.243	0.242	0.011	21.302	Keep item
Sec3B5 <- Structural_design	0.182	0.182	0.011	16.600	Keep item
Sec3B6 <- Structural_design	0.228	0.228	0.008	29.819	Keep item
Sec3CMotiv11 <- Motivation	0.345	0.347	0.030	11.530	Keep item
Sec3CMotiv12 <- Motivation	0.356	0.356	0.030	11.745	Keep item
Sec3CMotiv14 <- Motivation	0.354	0.353	0.032	11.126	Keep item
Sec3CMotiv9 <- Motivation	0.321	0.320	0.036	8.994	Keep item
Sec3CTrain1 <- Training	0.157	0.157	0.015	10.763	Keep item
Sec3CTrain10 <- Training	0.143	0.143	0.015	9.219	Keep item

Sec3CTrain11 <- Training	0.164	0.165	0.015	10.884	Keep item
Sec3CTrain2 <- Training	0.158	0.157	0.013	12.118	Keep item
Sec3CTrain4 <- Training	0.164	0.163	0.015	10.612	Keep item
Sec3CTrain5 <- Training	0.154	0.156	0.013	12.194	Keep item
Sec3CTrain6 <- Training	0.149	0.150	0.014	10.433	Keep item
Sec3CTrain7 <- Training	0.163	0.162	0.017	9.293	Keep item
Sec3CTrain8 <- Training	0.144	0.143	0.015	9.435	Keep item
Sec3DTeam1 <- Teamwork	0.263	0.263	0.023	11.494	Keep item
Sec3DTeam13 <- Teamwork	0.138	0.139	0.022	6.398	Keep item
Sec3DTeam19 <- Teamwork	0.150	0.150	0.021	7.118	Keep item
Sec3DTeam2 <- Teamwork	0.256	0.256	0.017	14.800	Keep item
Sec3DTeam3 <- Teamwork	0.217	0.216	0.019	11.660	Keep item
Sec3DTeam6 <- Teamwork	0.189	0.189	0.017	10.896	Keep item
Sec3DTeam7 <- Teamwork	0.158	0.158	0.018	9.041	Keep item

Table 5-24 Significance test of outer loadings

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	Significance test t- values > 1.96
Sec2BMainPract11 <- Info_management	0.884	0.885	0.025	35.471	Keep item
Sec2BMainPract12 <- Info_management	0.918	0.917	0.015	60.614	Keep item
Sec2BMainPract3 <- Task_planning	0.662	0.662	0.051	13.009	Keep item
Sec2BMainPract4 <- Task_planning	0.745	0.745	0.031	23.780	Keep item
Sec2BMainPract5 <- Task_planning	0.722	0.722	0.028	25.527	Keep item
Sec2BMainPract6 <- Task_planning	0.761	0.762	0.030	25.545	Keep item
Sec2BMainPract7 <- Task_planning	0.768	0.767	0.025	31.269	Keep item
Sec3A1 <- Group_culture	0.746	0.744	0.026	28.213	Keep item
Sec3A12 <- Group_culture	0.829	0.830	0.016	50.462	Keep item
Sec3A15 <- Development_culture	0.773	0.773	0.022	34.450	Keep item
Sec3A2 <- Hierarchical_culture	0.808	0.809	0.019	42.751	Keep item
Sec3A20 <- Development_culture	0.787	0.787	0.022	36.277	Keep item
Sec3A21 <- Personal_responsibility	0.823	0.822	0.017	48.028	Keep item
Sec3A22 <- Safety_environment	0.809	0.810	0.021	39.324	Keep item
Sec3A23 <- Group_culture	0.680	0.677	0.034	20.270	Keep item
Sec3A24 <- Development_culture	0.837	0.837	0.017	49.688	Keep item
Sec3A26 <- Development_culture	0.736	0.737	0.028	25.985	Keep item
Sec3A29 <- Development_culture	0.823	0.825	0.019	42.715	Keep item
Sec3A3 <- Safety_environment	0.754	0.756	0.024	30.799	Keep item
Sec3A31 <- Group_culture	0.791	0.791	0.022	35.366	Keep item
Sec3A32 <- Safety_environment	0.826	0.828	0.020	41.756	Keep item
Sec3A5 <- Hierarchical_culture	0.873	0.873	0.014	62.881	Keep item
Sec3A6 <- Group_culture	0.799	0.799	0.020	39.875	Keep item
Sec3A8 <- Hierarchical_culture	0.855	0.854	0.018	46.838	Keep item

Sec3A9 <- Group_culture	0.801	0.801	0.021	37.289	Keep item
Sec3B1 <- Structural_design	0.698	0.700	0.037	19.085	Keep item
Sec3B10 <- Structural_design	0.657	0.656	0.035	19.014	Keep item
Sec3B13 <- Personal_responsibility	0.815	0.814	0.020	40.642	Keep item
Sec3B14 <- Personal_responsibility	0.716	0.717	0.035	20.406	Keep item
Sec3B16 <- Decision_making	0.923	0.922	0.016	57.822	Keep item
Sec3B17 <- Decision_making	0.788	0.788	0.039	19.980	Keep item
Sec3B19 <- Control_communication	0.720	0.720	0.025	29.089	Keep item
Sec3B2 <- Structural_design	0.827	0.827	0.018	45.011	Keep item
Sec3B20 <- Control_communication	0.782	0.781	0.025	31.050	Keep item
Sec3B21 <- Control_communication	0.746	0.747	0.028	27.140	Keep item
Sec3B22 <- Control_communication	0.811	0.811	0.020	41.397	Keep item
Sec3B23 <- Control_communication	0.711	0.707	0.033	21.785	Keep item
Sec3B24 <- Safety_environment	0.770	0.770	0.024	32.152	Keep item
Sec3B25 <- Safety_environment	0.644	0.643	0.044	14.599	Keep item
Sec3B3 <- Structural_design	0.830	0.830	0.025	32.835	Keep item
Sec3B5 <- Structural_design	0.755	0.755	0.030	25.242	Keep item
Sec3B6 <- Structural_design	0.858	0.858	0.014	63.008	Keep item
Sec3CMotiv11 <- Motivation	0.739	0.739	0.030	25.018	Keep item
Sec3CMotiv12 <- Motivation	0.737	0.734	0.030	24.677	Keep item
Sec3CMotiv14 <- Motivation	0.753	0.750	0.034	21.983	Keep item
Sec3CMotiv9 <- Motivation	0.673	0.671	0.042	15.882	Keep item
Sec3CTrain1 <- Training	0.724	0.721	0.031	23.233	Keep item
Sec3CTrain10 <- Training	0.674	0.671	0.031	21.906	Keep item
Sec3CTrain11 <- Training	0.690	0.688	0.029	23.677	Keep item
Sec3CTrain2 <- Training	0.731	0.729	0.025	29.781	Keep item
Sec3CTrain4 <- Training	0.736	0.735	0.028	26.218	Keep item

Sec3CTrain5 <- Training	0.793	0.792	0.017	46.688	Keep item
Sec3CTrain6 <- Training	0.731	0.730	0.028	26.527	Keep item
Sec3CTrain7 <- Training	0.658	0.658	0.034	19.128	Keep item
Sec3CTrain8 <- Training	0.715	0.714	0.031	22.734	Keep item
Sec3DTeam1 <- Teamwork	0.735	0.733	0.033	22.523	Keep item
Sec3DTeam13 <- Teamwork	0.643	0.642	0.044	14.739	Keep item
Sec3DTeam19 <- Teamwork	0.647	0.645	0.050	13.043	Keep item
Sec3DTeam2 <- Teamwork	0.828	0.827	0.018	45.871	Keep item
Sec3DTeam3 <- Teamwork	0.696	0.694	0.032	21.599	Keep item
Sec3DTeam6 <- Teamwork	0.755	0.753	0.024	31.004	Keep item
Sec3DTeam7 <- Teamwork	0.723	0.721	0.030	23.944	Keep item

5.8.1.3 Structural Model Assessment (Hypotheses assessment)

The final step of the analysis is to evaluate the final structural model. Its aim is to assess the models ability to predict and evaluate the relationships between the constructs [210]. Path coefficients (β) indicating the relationships between constructs. Testing every hypothesis can be reached by looking at path coefficients (β) signs, size and the statistical significance of the latent variable and its dependent variables; the higher the path coefficient (β) the stronger effect. T-test statistics should be above 1.96, and its statistical significance P-value < 0.05.

For the ***H1a*** it has been found that Group culture has a positive influence on Organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication, safety and environment communication, and teamwork since their path coefficients (β) are positive and high, and their T-test values are higher than 1.96 and their P-value < 0.05. While Group Culture has a negative effect on Motivation, and training because they have a

negative sign β. Furthermore, Group Culture has a negative effect on Task planning and scheduling, and Information management and CMMs, because their T values were lower than 1.96 and their P values were higher than 0.05. Table 5.25 illustrates the results of the analysis.

Table 5-25 Structural model results of group culture effect on maintenance factors

	β	T Statistics	P Values	Results
Group_culture -> Control_communication	0.331	4.039	0.000	Supported
Group_culture -> Decision_making	0.328	3.703	0.000	Supported
Group_culture -> Info_management	0.079	0.825	0.410	Not Supported
Group_culture -> Motivation	-0.237	2.711	0.007	Not Supported
Group_culture -> Personal_responsibility	0.195	2.737	0.006	Supported
Group_culture -> Safety_environment	0.244	3.675	0.000	Supported
Group_culture -> Structural_design	0.275	3.810	0.000	Supported
Group_culture -> Task_planning	0.143	1.464	0.144	Not Supported
Group_culture -> Teamwork	0.375	4.233	0.000	Supported
Group_culture -> Training	-0.210	2.481	0.013	Not Supported

Regarding to H1b: The Developmental Culture was found to have a positive influence on the following factors of maintenance implementation; task planning and scheduling, spare parts management, Information management and CMMs, organisation structure and work design, sense of personal responsibility, sense of control and communication, safety and environment, motivation, and training, since their (β) sign is positive and their T value is higher than 1.96 in addition their P value < 0.05.

It has also been found that Development Culture had a negative effect on decision making because the T test was lower than 1.96 and the P value is higher than 0.05.

The Development Culture has also been found to have a negative effect on (Teamwork) because the β value was negative, and T value was lower than 1.96 and P value higher than 0.05. Table 5.26 shows the results of the Structural Model.

Table 5-26 Structural model results of development culture effect on maintenance factors

	β	T Statistics	P Values	Results
Development_culture -> Control_communication	0.217	2.901	0.004	Supported
Development_culture -> Decision_making	0.059	0.771	0.441	Not Supported
Development_culture -> Info_management	0.213	2.538	0.011	Supported
Development_culture -> Motivation	0.171	2.112	0.035	Supported
Development_culture -> Personal_responsibility	0.284	4.126	0.000	Supported
Development_culture -> Safety_environment	0.252	4.326	0.000	Supported
Development_culture -> Structural_design	0.236	3.472	0.001	Supported
Development_culture -> Task_planning	0.238	3.226	0.001	Supported
Development_culture -> Teamwork	-0.087	1.038	0.300	Not Supported
Development_culture -> Training	0.247	3.104	0.002	Supported

For the hypothesis H1c: Hierarchical culture had a positive influence on Task planning and scheduling, organisation structure and work design, sense of personal responsibility, sense of control and communication, and safety and environment because their statistical results show a positive β value and a T value higher than 1.96, while P values were lower than 0.05.

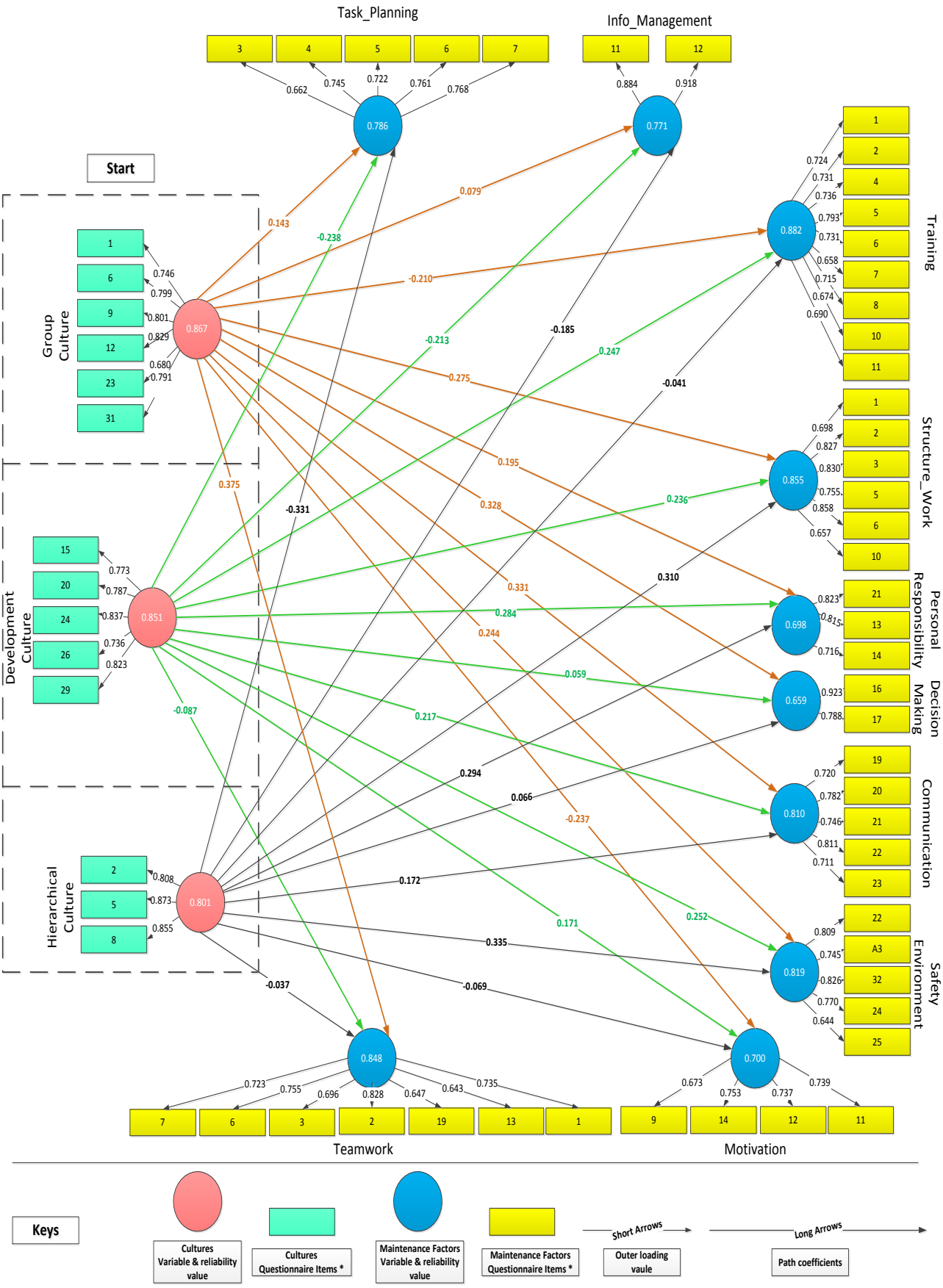
Hierarchical culture had a negative effect on Decision Making because the result of the T value was lower than 1.96 and the P value was higher 0.05. It also has been found that Hierarchical culture had a negative effect on Information management and CMMs, teamwork, training, motivation, since the β value was negative, and the

T value was lower than 1.96 and P value higher than 0.05. The table 5.27 shows the results of structural model of Hierarchical culture effect on maintenance factors.

Table 5-27 Structural model results of hierarchical culture effect on maintenance factors

	β	T Statistics	P Values	Results
Hierarchical_culture -> Control_communication	0.172	2.768	0.006	Supported
Hierarchical_culture -> Decision_making	0.066	0.745	0.457	Not Supported
Hierarchical_culture -> Info_management	-0.185	2.183	0.029	Not Supported
Hierarchical_culture -> Motivation	-0.069	0.916	0.360	Not Supported
Hierarchical_culture -> Personal_responsibility	0.294	4.308	0.000	Supported
Hierarchical_culture -> Safety_environment	0.335	5.878	0.000	Supported
Hierarchical_culture -> Structural_design	0.310	4.999	0.000	Supported
Hierarchical_culture -> Task_planning	0.331	4.034	0.000	Supported
Hierarchical_culture -> Teamwork	-0.037	0.460	0.645	Not Supported
Hierarchical_culture -> Training	-0.041	0.570	0.569	Not Supported

The last hypothesis H1d: (Rational culture has a positive influence maintenance factors) was not tested because the rational culture was eliminated from the model because it had been found to correlate with Development culture, Group culture, Hierarchical culture constructs. Figure 5.3 shows the result of the structural model on the effect of organisational culture types (Group, Development, Hierarchical and Rational) on maintenance factors. The yellow rectangles refer to the variables items name, while the blue bubbles refer to the overall variables reliability, while the arrows pointing to the items (yellow rectangles) refers to the outer loading values, and the coloured arrows refer to path coefficients (β) values.



*** For full description of questionnaire items refer to Table 3-1**

Figure 5.3 Final structural model

5.9 Summary

This chapter presented the analysis and findings of the data collected from the questionnaires, starting with a descriptive analysis of the responses, followed by identifying barriers affecting power plants reliability. The level of maintenance implementation was determined and has been found to be at a medium level. In addition, the effect of organisational culture types on the maintenance implementation factors, showed that group culture has a positive influence on organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication, safety and environment communication, and teamwork, but it has a negative effect on motivation, training, task planning and scheduling, and Information management and CMMs.

While developmental culture was found to have a positive influence on the following factors of maintenance implementation; task planning and scheduling, spare parts management, Information management and CMMs, organisation structure and work design, sense of personal responsibility, sense of control and communication, safety and environment, motivation, and training. It also has been found that development culture had a negative effect on decision making and teamwork.

In addition, hierarchical culture had a positive influence on task planning and scheduling, organisation structure and work design, sense of personal responsibility, sense of control and communication, and safety and environment, and had a negative effect on decision making, information management and CMMs, teamwork, training, motivation.

Furthermore, rational culture was not tested because it was eliminated from the model as it had been found to correlate with Development culture, Group culture, and Hierarchical culture constructs.

Chapter 6. Discussion of the Findings

6.1 Introduction

This chapter discusses the results and the findings presented in chapters 4 and 5 in relation to the existing body of knowledge and the following research questions developed in chapter 1:

1. What are the main reasons for the power shortage in Iraq?
2. What is the level of maintenance implementation in the Iraqi power plants?
3. What are the types of organisational culture existing in the Iraqi power plants?
4. What is the relationship between organisational culture and the maintenance implementation factors?

The study used exploratory sequential mixed method design to achieve the research objectives, which involved qualitative data collection using nine semi-structured interviews with nine power plant managers in order to identify the reasons for power shortage and to gain information about maintenance, and human resource practices in the power plants. And then followed by quantitative data collection through a questionnaire from 484 power plant employees, which aimed to identify the factors affecting the power plants reliabilities, and to measure the level of maintenance implementation, identify the organisational culture profile in those power plants, and explore the influence of organisational culture on factors affecting the maintenance implementation in the power plants.

6.2 What are the main reasons for the power shortage in Iraq?

The first question and objective of this study was to identify the factors affecting the current production rates and the reasons for the power shortage in Iraq. To achieve this, the researcher investigated the factors affecting the power plants reliabilities,

which involved a literature review, followed by an exploratory sequential mixed method investigation, which started with a qualitative study (semi structured interviews) with nine power plant managers or their representatives and the quantitative study (questionnaires) with employees from nine power plants, in order identify factors affecting the current low production rate and the main reasons for power shortage in Iraq (Section 4.5.1) and (Section 5.4).

The literature review showed that many factors are affecting power plants reliabilities, such as process, human, power plants age, weather, power plant installation and location, operation and maintenance practices [9, 10, 224, 225]

These previous studies have mentioned different factors that can affect the power plants reliabilities. Each power plant type has specific factors affecting its reliability which also can be varied from and country to another. Therefore, it is important to understand those factors and their relation to the low production rate and power shortage in Iraq.

After identifying the factors from the literature review, the first stage of the exploratory sequential mixed method (qualitative) was conducted. The results from the interviews show that there are a number of factors that prevent the power plants from running at higher production rates. Table 6.1 illustrates that these barriers are divided into two categories: Internal and external.

Table 6-1 Summary of internal and external factors

Category	Barriers	Number of responses	Ranking
Internal	Planning and vision	6	1
	Fuel and quantity	4	2
	Low efficiency and capacity	4	2
	Budget, Financial & Operation costs	4	2
	Spare parts and materials	3	3
	Power plant aging	3	3
	Breakdowns	1	4
	Administrative, law and Training	1	4
Category	**Barriers**	**Number of responses**	**Ranking**
External	Weather condition	9	1
	Situation	4	2
	Culture and power demand	4	2
	National grid instability	1	3

Under internal reasons, there are eight barriers which were ranked based on how many times they were stated by interviewees. Planning and vision was found to be the most influential on production shortage, which has been mentioned six times; it has been noticed that there is a lack of careful planning on the need of energy. While fuel type and quantity, low efficiency and capacity power generating units, budget, financial & operation costs, were all mentioned four times each and ranked as the second largest barriers affecting power production rate and power shortage.

All these factors are highly linked to planning and vision. For example, the country suffers from a scarcity of fuel, the gas units are currently operating on heavy oil and crude oil instead of natural gas, and these types of fuel have disadvantages because they need expensive chemical additives to make them useable. Relying on low efficiency and capacity power generating units has been attributed as a power shortage factor. The high operational costs, and also to the instability of the financial allocation to the power plants contributed to the power shortage. In addition, spare parts and power plant aging represent the third factor affecting power shortage,

since they were mentioned three times by interviewees. Unavailability of spare parts and insufficient spares to perform maintenance, and as mentioned earlier the government have focussed on the gas power plants which are considered expensive and deteriorate so fast, which off course need more investment on their maintenance. The final factors on power shortage are breakdowns, administrative, law and training, which have each been mentioned once.

Moreover, four factors were considered as external factors affecting power production rate. All interviewees attributed the differences between the designed capacity and current production rate to weather conditions in Iraq and to high temperatures during the summer season, while the unstable situation in Iraq represented by war and violence, which affected the Iraqi power industry infrastructure, was mentioned four times. Culture and power demand was also mentioned four times as a power shortage factor, which can be attributed to the lack of the energy saving culture, the low price of electricity supplied to the consumers, and the lack of quality of imported electrical equipment and devices that consume high amounts of electricity, resulting in a higher demand. In addition to that the national grid instability were attributed to be affecting power supply because the national power grid was old and the government only focused on building and maintaining the power production unites.

Furthermore, the researcher explored the research question in more detail with the power plants employees using a questionnaire survey (Section 5.4 and 5.5).

Table 5.3 in chapter 5 shows the mean, standard deviation and the rank of 12 barriers affecting the power plants reliability. The inadequate training and development of personnel ranked as the most important factor affecting the power plant reliability followed by no long term arrangement for spare part supply, and then

the power plants deterioration because of the age and the environment, and the quality of fuel supplied to the power plants was found to be the fourth factors affecting their reliability. This finding is consistent with the findings from the qualitative analysis and the literature review. Furthermore, five factors related to maintenance were ranked base on their mean score from 5 to 9 which are: the lack of discernible maintenance culture, inadequate/inappropriate maintenance of plant facilities and equipment for maintenance & operations, lack of a successful maintenance programme by the maintenance department, insufficient funds for maintenance jobs, and absence of a form of planned maintenance programmes respectively. While, lack of skilled personnel in the maintenance department, lack of skilled personnel in the operations department, and shortage in fuel supply ranked from 10 to 12 based on their mean scores.

The findings of the qualitative and questionnaire analysis are consisted with findings from the literature review regarding factors preventing power plants from running at higher production rates. Oyedepo and Fagbenle [11] found several factors leading to an increase in power outages in Nigeria, such as trouble in executing maintenance activities, delay in fuel supply or fuel shortage, shutdown because of breakdowns, funds for spare parts and maintenance postponement and staff skills. Furthermore, they added problems related to maintenance often happened in Nigerian power stations because maintenance is not taken seriously by management. Moreover, maintenance procedures are not well aligned with business culture which suffers from absence of business plans, unavailability of or low budgets and unclear reports. Furthermore, simple maintenance practices are not applied. While Eti, Ogaji [226] in their research on the reliability of an electric power generating station in Nigeria found absence of process reporting on

performance and productivity, maintenance budget and cost, performance managements, breakdowns and furthermore, absence of charts and graphs about jobs and plants performance. Eti, Ogaji [75] later mentioned that developing countries are required to be accustomed to change and boost vision in pursuing improvements in areas such as energy consumption culture, improving performance, enhancing power plants availability and reliability, applying better scheduled maintenance, and improving teamwork, using autonomous maintenance-teams, with the aims of improving personnel competence and equipment performance.

6.3 What is the level of maintenance implementation in the Iraqi power plants?

To address this question, the researcher first reviewed the literature on the factors affecting maintenance implementation and the methodology to measure and analyse the level of maintenance implementation.

Nine factors affecting maintenance implementation level were identified from the literature review, and qualitative findings, which are: technical, training and education, motivation, teamwork, organisation structure and work design, sense of personal responsibility, decision making, sense of control and communication climate, and safety and environment. Table 5.5 illustrates the mean score, standard deviation, and the reliability for each construct. The sense of personal responsibility had the highest score (3.1101). Second highest score was training and education (2.9999). The organisation structure and work design had a score of (2.9652), while the technical factors had a score of (2.9044). Motivation with a score of (2.7589) was followed by safety and environment (2.7517). Sense of control and communication with a score of (2.4918), was followed by teamwork with a score of

(2.3971). However, decision making had the lowest score of (2.1436), which can be seen in figure 6.1

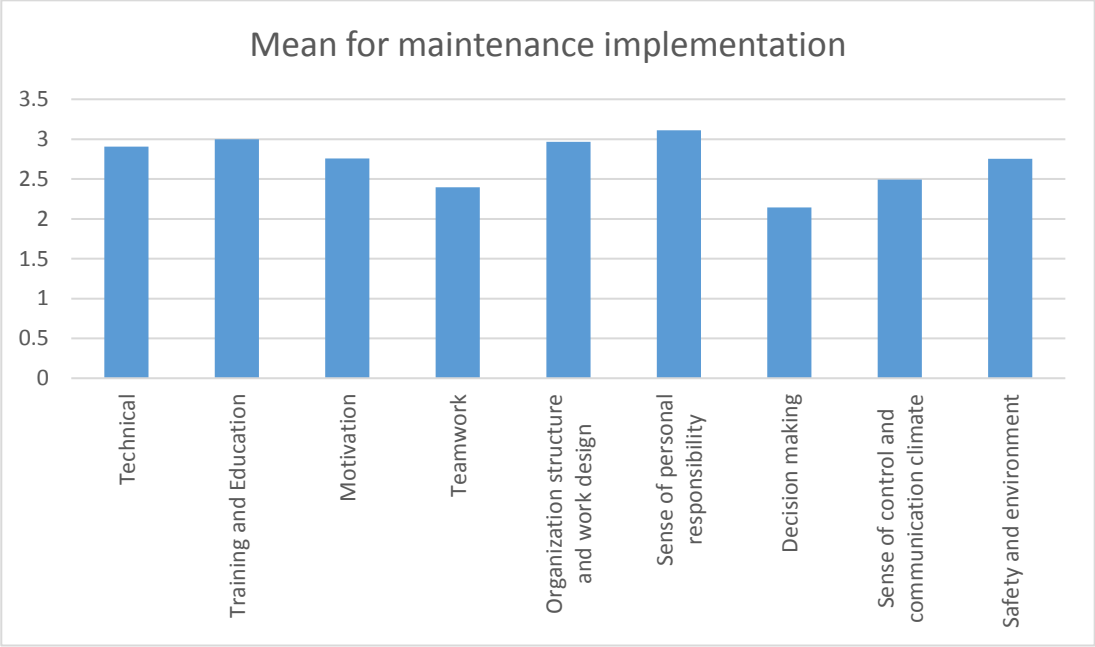


Figure 6.1 Mean score on maintenance implementation

Furthermore, four hypotheses were developed and tested using one sample t test, which can be seen in Section 5.5, and the maintenance implementation was found to be at medium level in the Iraqi power plants.

Training was found to be the most significant barrier affecting the power plants reliability from the employees' prospective (questionnaire analysis), and improving training was found to be the most important action to be taken or implemented in order to improve maintenance, which can lead to an increase in the power production rate, from the interviewees' prospective (interview analysis). In this regard, the finding is consistent with that of Chan, Laub [227], who considered lack of training and education to be the main obstacle to implementing maintenance programs such as TPM. Furthermore, Attri [50], stated that lack of training will unavoidably lead to a decrease in overall equipment effectiveness and result in failure to adopt new and improved methods.

Power plant employees' motivation was found to be at medium level, and it was also stated as one of the key actions to improve operation and maintenance activities which can lead to increased power plant reliability. Motivation is the practice of human resource management, which can help organizations to achieve their goals and higher performance levels, by motivating their employees to perform their job well [83]. The employees performance is not only based on their actual skills but also on their personal level of motivation when performing their job [84].

Maintenance is a shared responsibility, which uses a group of people gathered together with the purpose to perform a specific job or to solve particular problems. The purpose of this teamwork is to share skill, knowledge, experience and ideas between these people in order to get better results when performing tasks. Many researchers have found a positive relationship between teamwork and organisation performance. Banker, Lee [77], for example, suggested that the use of a team has resulted in significant improvements in many industries. In this work, the findings from the qualitative analysis indicated that there is satisfaction about teamwork within eight of the power plants, while one power plant manager expressed his dissatisfaction with teamwork because of a lack of experienced employees. However, the findings from the quantitative (questionnaire) analysis indicated that teamwork in the power plants was low with a mean score of 2.3971.

With regards to organization structure and work design, several issues were revealed from the interview analysis, such as conflict of machine responsibility between maintenance departments or between operation and maintenance departments. Furthermore, the large numbers of employees and hiring of employees with non-engineering or technical backgrounds led to difficulties in arranging and assigning work, as some of them are not specialised or qualified. In

this manner, Reiman [228], defined an organization structure as ‘the degree to which people feel that goals, tasks and responsibilities are well defined. New information technology and the new forms of organizing work (e.g. outsourcing) are not only changing the structure, but also the nature and requirements of the maintenance work.

Communication is sharing and exchanging of information and understanding between people or groups. It is important when the organisation introduces a new machine, process or program, as this can generate worry among employees about their jobs and the change in their work routine. Becker [69] for example has specified lack of communication as the outstanding problem when it comes to implementing a new maintenance program. Communication in the Iraqi power plants was found to be low with a mean score of 2.4918. In this regard, Oedewald [229], found that technicians in Forsmark NPP (FKA) nuclear power plant highlighted the importance of face-to-face communication because of the confusion of organisational structure. The sense of personal responsibility in the Iraqi power plants was found to be at the medium level. Reiman [228], linked building maintenance organizational structures and practices to enable a sense of personal responsibility in the plant. The sense of personal responsibility helps maintenance staff to have a clear picture of the maintenance mission. Furthermore, it requires the staff to have the capability, tools, processes and techniques, and resources to achieve the maintenance goal.

The level of decision making in the power plants was found to have the lowest mean with a score of 2.1436 which is considered as being low. Many researchers have linked having a successful maintenance program to having good decision-making. Carazas and Souza [230], for example, stated that a decision-making procedure must be applied in selecting the most appropriate maintenance strategy, and the

aim of the decision-making process is to minimize the unwanted costs associated with power plant operation. This statement was supported by Lazim and Ramayah [231], who mentioned that considering maintenance as an important decision will help to reduce breakdowns and equipment deterioration, and increase the spirit of team working.

Interview results indicated that safety and environment procedures in the power plants are good, even though there is no systematic tool or devices to measure pollution and emissions. However, the results from the questionnaire analysis indicted that safety and environment was above the low level with a mean score of 2.7517. In this context, Muller et al [232], suggested that appropriate maintenance procedures can improve the system safety as well as decrease the maintenance cost significantly.

6.4 Identify the types of organisational culture existing in the Iraqi power plants

In order to address this research question, data on four types of culture; group developmental, rational and hierarchical were collected through questionnaire surveys from employees of nine power plants (section 5.2 and 5.3). Table 5.6 showed the mean, standard deviation, and reliability of each type of organisational culture. The organisational culture profile in the Iraq power plants was determined based on the mean scores of each organisational culture type. The finding shows that rational culture has the highest score of 3.7221 followed by group culture with a mean of 3.7100, and hierarchal culture with a mean score 3.6754 followed by developmental culture with a mean score of 3.6295. It is worth saying that there is a slight deference between the mean score for rational and group cultures, and between hierarchal and developmental cultures. Furthermore, the results indicate

there is almost balance between the cultures in Iraqi power plants, even though it has been found that all four types are slightly above the medium level (3.5), since it was measured based on a 7 point Likert scale.

For comparative purpose there is no previous study found that measured the culture types of the Iraqi power industry, or any other power industry around the world. Therefore, the results in table 5.6 cannot be compared to the power industry. However, there are two studies that investigated the culture type in the Arabic countries, one in Qatar industries conducted by Al-Khalifa and Aspinwall [108] and another in the Bahraini industries conducted by Al-Jalahma [198]. both of these studies measured the organisational culture on a five point Likert scale while this study uses a seven point Likert scale. In both studies the development culture was found to have the lowest score with 3.0 for Al-Khalifa and Aspinwall, and 2.9 for Al-Jalahma. This is consistent with this research since the development culture has the lowest score of 3.6295. On other hand Al-Khalifa and Aspinwall and Al-Jalahma, in their studies found hierarchical culture had the highest scores with 3.4 and 4 respectively, while in this research hierarchical culture with a score of 3.6754 was found to be in third place, the rational culture was the highest with a score of 3.7221. Both AL Khalifa and Aspinwall's and ALJalahma's studies found rational culture with scores of 3.4 and 3.9 respectively to be second in rank, while for this study group culture was found to be in second place with a score of 3.7100. However, in AL Khalifa and Aspinwall's and ALJalahma's studies, group culture was found to be in third place with a scores of 3.1 and 3.2 respectively. Therefore, it can be noticed the organisational culture in the Iraqi power plants have lower scores for all four types of culture compared to the studies conducted in Bahrain and Qatar mentioned earlier. Table 6.2. clearly showing the comparison between Iraq, Bahrain, and Qatar,

after converting the results received from the Iraqi power plants from a seven to five points Likert scale.

Table 6-2 Culture profile comparison between Iraq, Bahrain, and Qatar on five points Likert scale

Culture	Iraq	Bahrain	Qatar
Group Culture	2.65	3.1	3.2
Development Culture	2.59	2.9	3
Rational Culture	2.65	3.4	3.9
Hierarchal Culture	2.62	4	3.4

6.5 What is the influence of organisational culture on the maintenance implementation factors?

To answer this research question, a research model and four hypotheses on the influence of organisational culture on maintenance implementation factors were developed and tested. The hypothesis proposed that group culture, development culture, hierarchical culture and rational culture have an influence on all maintenance implementation factors. The data analysis and the results of the SEM presented in Chapter 5 presented in table 6-3.

Table 6-3 The influence of culture profile on maintenance factors

Culture profile	Maintenance factor
Group culture	Sense of control & communication
	Decision making
	Personal responsibility
	Safety & environment
	Organisation structure and work design
	Teamwork
Development culture	Sense of control & communication
	Info management & CMMs
	Motivation
	Personal responsibility
	Safety & environment
	Organisation structure and work design
	Task planning & scheduling
	Training
Hierarchical culture	Sense of control & communication
	Personal responsibility
	Organisation structure and work design
	Task planning & scheduling
	Safety & environment

6.5.1.1 Impact of group culture, development culture, and hierarchical culture on sense of control and communication

The finding shows that group culture, development culture, hierarchical culture impacts the sense of control and communication at path coefficients of 0.331, 0.272, and 0.172 respectively. However, the group culture was found to have the most significant impact (β=0.331, ρ=0.000, t=4.039). This result is consistent with the findings of Denison and Spreitzer [121], and Zu et al [104], who considered communication one of most important characteristics of group culture. In addition to that, Kline [233] added that communication shaped by group culture can enable interaction between departments and their employees.

6.5.1.2 Impact of group culture, development culture, and hierarchical culture on decision making

The findings from the SEM analysis show that group culture was the only influencer of decision making in the Iraqi power generation industry (β=0.328 ρ=0.000, t=3.703). This finding is consistent with the aim of group culture which is highlighted by Quinn [128] who specified that the objective of group culture is to promote participation, and employees contribution into decision making especially for decisions that affect their jobs. Furthermore, the study by Lee and Choi [234] suggested that companies with group culture orientation understand the need of employees involvement in decision making to promote the organisations goals in order to achieve better performance.

6.5.1.3 Impact of group culture, development culture, and hierarchical culture on personal responsibility

The result presented in chapter 5 also revealed that group culture, development culture, and hierarchical culture have a statistically significant effect on personal responsibility with path coefficients of 0.195, 0.284, and 0.294. Even though all three cultures have a noticeable effect on personal responsibility, hierarchical culture had the highest score of influence. However, this finding could not be compared to any previous studies, since there has been no similar assessment of the effect of culture on personal responsibility, which is therefore considered one of the unique aspects of this research.

6.5.1.4 Impact of group culture, development culture, and hierarchical culture on safety and environment

Moreover, group culture, development culture, and hierarchical culture were also found to have a positive impact on safety and environment with path coefficients 0.244,0.252, and 0.335 respectively. Even though all three cultures have an

influence on safety and environment, hierarchical culture has been found to have the most significant effect. This can be emphasised as safety and environment regulation procedures, and implementation should be strengthened by top management of organisation. However, this finding could not be compared to the literature as there is no similar studies have been conducted in this domain.

6.5.1.5 Impact of group culture, development culture, and hierarchical culture on organisation structure and work design

The findings in chapter 5 also indicated that group culture, development culture, and hierarchical culture have an effect on structure and work design. However, hierarchical culture had the highest path coefficient of 0.310 compared with group culture at 0.275, and development culture at 0.236. In this regard Denison and Spreitzer [121] stated that people in organisations with hierarchical culture tended to work together with high coordination using formal problem-solving techniques, follow direct instructions, and use the resources and processes. Denison and Spreitzer [121] finding was supported by Cameron and Quinn [129] who stated that structure is one of the key features of hierarchical culture. In addition to that Janićijević [235] identified organizational culture as an influencer on selecting and implementing organizational structure.

6.5.1.6 Impact of group culture, development culture, and hierarchical culture on teamwork

The finding of this study revealed that only group culture has an effect on teamwork, (β=0.375, ρ=0.000, t=4.233). This finding is consistent with that of Cameron and Quinn [129], who recognised teamwork as a feature of group culture in their study on the CVF model. Furthermore, this finding is supported by Bradley and Parker

[236] who mentioned that managers in organisation with a group culture profile will be more engorges for teamwork activities.

6.5.1.7 Impact of group culture, development culture, and hierarchical culture on training

The data analysis presented in chapter 5 showed that only development culture has a significant impact on training with a path coefficient of 0.246. This result is supported by the findings of Al-Zamany, Hoddell [237] who argued that organisations with a development culture profile tend to invest in training courses. As development culture highlights the importance of organisation growth by searching for support from external environments, new tools, technologies, resources, and innovation, they can be an inspired place to work [121].

6.5.1.8 Impact of group culture, development culture, and hierarchical culture on motivation

Development culture was also found to be the only organisational culture type that has a statistically significant impact on motivation, with a path coefficient of 0.171. This finding is supported by the aim of development culture, which emphasizes the importance of providing an interesting workplace by providing an environment with less pressure and fear, which increases the employees sense of responsibility, trust, and involvement in organisational matters [238].

6.5.1.9 Impact of group culture, development culture, and hierarchical culture on maintenance task planning and scheduling

The findings from the SEM analysis in chapter 5 shows that development culture and hierarchical culture have an influence on task planning scheduling with path coefficients of 0.238 and 0.331 respectively. Hierarchical culture also has a statistically significant impact on maintenance task planning and scheduling.

Cameron and Quinn [129] mentioned that organisations with a hierarchical culture profile tend to have formal organised work, and the work and employees are administered by structure and procedures. Furthermore, this finding is also supported by Schroeder et al [239] who stated planning activities can be well established with hierarchical culture profile.

6.5.1.10 Impact of group culture, development culture, and hierarchical culture on maintenance information management and CMMs

The finding of this study revealed that only development culture has an effect on maintenance information management with a path coefficient of 0.213. This result is in line with work of Özşahin et al [240] who found development culture to have an impact on information management- communication. Denison and Spreitzer [121], justifies that and state that development culture emphasises organisation growth by searching for support from the external environment, new tools, technologies, resources, and innovation.

6.6 Summary

This chapter has presented a discussion of the findings that have emerged from the semi-structured interviews in chapter four and the questionnaire analysis in chapter five with reference to the existing body of knowledge. The factors behind the power shortage in Iraq and the current power production rate of Iraqi power plants were illustrated and discussed. Furthermore, the level of maintenance implementation was tested using hypotheses and sample t tests, which were found to be at a medium level. In addition to that, organisational culture profiles shaping the power plants were addressed and also were found to be at a medium level. Moreover, the effect of organisational culture profiles on maintenance factors were addressed, discussed and linked to the literature,

The next chapter, will introduce, and discuss the proposed TPM framework for Iraqi power plants based on the findings discussed in this chapter.

Based on the findings, in order to improve teamwork, decision making, sense of control and communication, and safety and environment, the group culture profile of power plants should be emphasised and improved. While in order to improve training and education, motivation, and information management and computerised maintenance management systems, extra effort is needed to improve the development culture profile in the power plants. In addition to that, improving the hierarchical culture profile will result in improving maintenance task planning and scheduling, organisation structure and work design, and sense of personal responsibility.

Chapter 7. Framework Development

7.1 Introduction

In the previous chapters, the power shortage problem and the factors affecting the current power production in Iraq were identified, furthermore, the level of maintenance implementation and the effect of organisational culture on maintenance practice factors were discussed. This chapter builds on the findings of the previous chapters and presents a novel framework for improving the availability and reliability of power plants through improving maintenance activities through introducing TPM.

The findings from the thematic analysis of interviews and the statistical analysis of questionnaires showed that there are many reasons for the current low power production rate and power shortage in Iraq, in terms of internal and external factors, maintenance, human resources, organisational culture, health and safety, and environmental issues.

Furthermore, the level of maintenance implementation in Iraqi power plants was investigated based on nine factors affecting maintenance implementation, and was found to be at medium level. Moreover, the organisational culture profiles in the Iraqi power plants were identified and also found to be at medium level. In addition to that the effect of organisational culture on maintenance implementation factors were investigated and proved that there are strong links between organisational profiles and maintenance implementation factors.

7.2 Proposed framework

The framework proposed in figure 7.1 consists of three phases as follows;

1. Organisational culture change
2. Improving factors affecting maintenance
3. Building and implementing TPM

It was developed based on the importance of the research findings, of the reasons for the current low power production rate in Iraqi power plants and formulated on the basis of the empirical results of the hypotheses testing of the effect of organisational culture on maintenance implementation constructs.

This study has been able to demonstrate that Iraqi power plants need to improve their maintenance practice in order to improve their availability and reliability, and adapt a new maintenance strategy that overcomes all drawbacks found in chapters four and five.

As discussed in chapter two and confirmed in chapter six adapting a new maintenance strategy is a challenging process due to many factors, these factor play a critical role in having a successful/unsuccessful maintenance implementation program such as TPM. Therefore, maintenance factors need to be improved before attempting to implementation TPM. Thus, the Iraqi power plants first need to improve their organisational culture, as the empirical findings from chapter five indicated and statistically proved that different organisational culture profiles have a statistically significant effect on different maintenance factors.

This framework is a recommendation towards improving power plant availability and reliability by enhancing maintenance activities through achieving organisational

culture change that improves maintenance factors that lead successfully implementation of TPM.

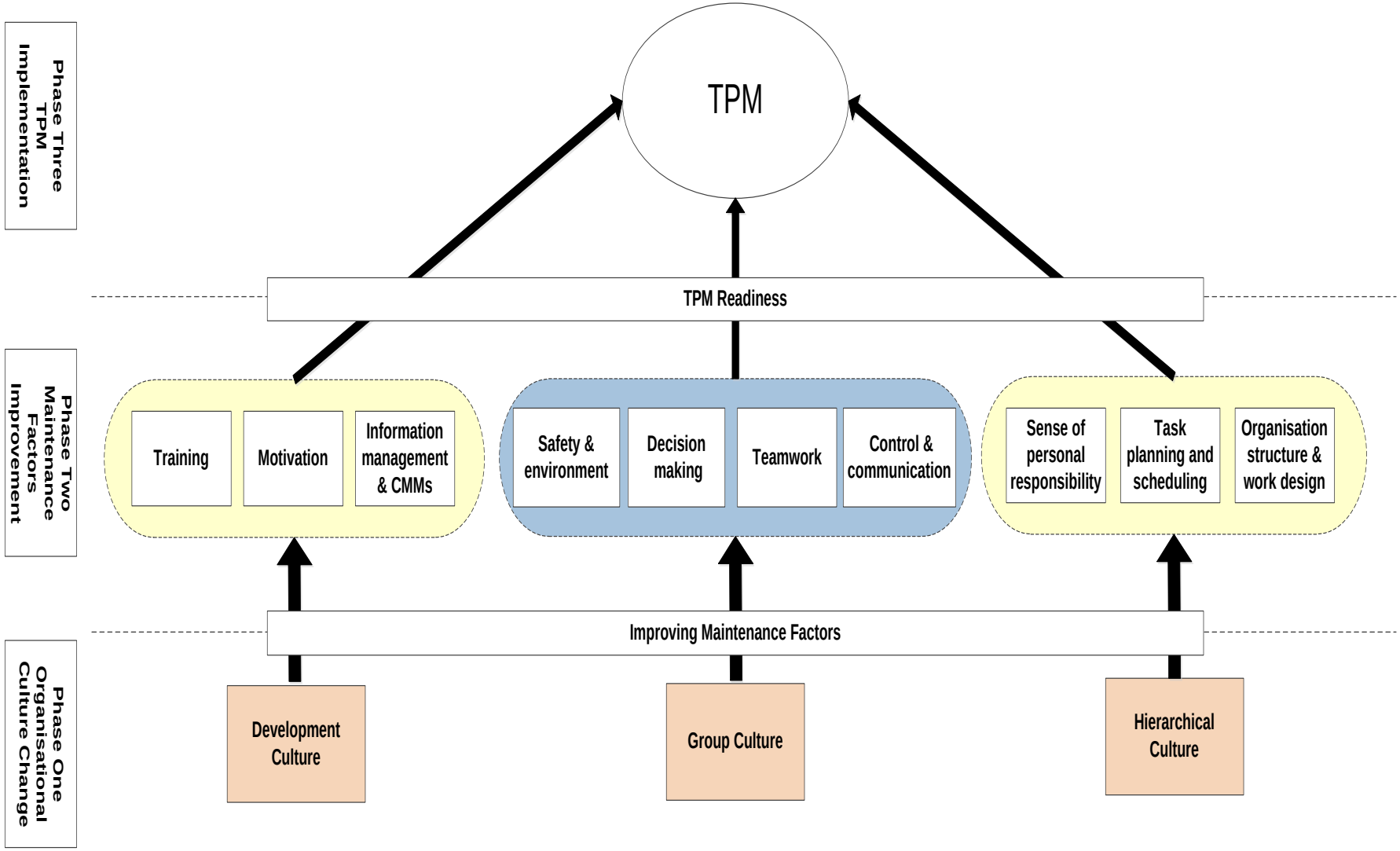


Figure 7.1 Proposed framework for successful TPM implementation and improvement of power plants

A balancing between all types of organisational culture of power plants, needs to be reached. Denison and Spreitzer [121], and Cameron and Quinn [99], highlighted the importance of viewing the four cultures as ideal types. Change in organisational culture is frequently required to achieve a flexible, dynamic, and easy-going environment, where all staff in the company are involved in solving problematic issues, which results in adding and leading to success.

After reaching the required organisational culture change, maintenance factors will be improved, these factors are an important foundation in order to have a successful TPM program. As illustrated in the literature review in chapter two, many organisations failed to implement TPM, due to lack of training and education, lack of motivation, lack of responsibility, lack of teamwork, lack of communication, and culture resistance, and financial restrictions [50, 62, 89, 189]. Improving these factors does not mean the program will be implemented easily but it will facilitate TPM implementation in the Iraqi power plants, as these factors play a vital role in having successful or unsuccessful TPM implementation [50].

As explained in chapter two, TPM mainly aims to increase the availability/efficiency of machines in a given condition, [62]. Therefore, TPM introduction to Iraqi power plants aims to improve the operation and maintenance practices, which will result in improving power production rates. Moreover, emphasizing the importance of overcoming the internal and external barriers found in the interview chapter and their direct effect on the power production rate and power shortage in Iraq, must be included in the framework, even though some of those barriers will be eliminated

automatically when the organisational culture is changed, which can lead to improved maintenance factors and introducing TPM.

7.3 Process of framework implementation

This section provides the processes of using the improvement framework in practice. Figure 7.2 shows the primary processes of implementing the improvement framework, which consists of fourteen steps.

The first step starts power plants managements diagnosis of the existing maintenance implementation and identifies the current level of maintenance implementation. While the second step start with top management commitment to improve maintenance by improving organisational culture of the power plants. Thirdly, a team should be assigned to direct the framework implementation in the power plants. The fourth stage, is diagnosis of the existing and preferred organisational culture. Fifthly, an interpretation and conclusion of the diagnosed organisational culture with a direction to the change needed. Sixth, once a plan for improvement of organisation culture is established and agreed, the next steps are implementing the organisational culture plan, beginning with the actions needed to be started, continued, and stopped, developing the timeframe and benchmarks for implementation, and initiating the strategy to communicate the new cultural values. The seventh step is checking of implementation with monitoring and analysis of the level of implementation and comparing it with the plan. The goal of the power plants overall business performance is then used to confirm the improvement in organisational culture. Eighth, after confirming the improvement in organisational culture, maintenance factors should be evaluated and

compared to the existed maintenance implementation in step one. Step nine is checking whether there are improvements or if no, a review for the previous steps needs to be taken. While if there are improvements in maintenance factors this will lead to step ten, which means the power plants are ready to implement TPM.

The TPM implementation requires four major steps. Step eleven is the preparation step, this step will start by introducing TPM officially by top management, followed by running education and training campaigns for all employees, to raise knowledge and awareness of the importance of TPM and to soften resistance to change required to TPM. Followed by, the TPM office establishing TPM policies and goals. Furthermore, a master plan preparation and formulation must be conducted by the TPM headquarters to provide a daily TPM promotion schedule. The twelfth step is to report the plan to all employees. Followed by the thirteenth step which is the start of the actual implementation of TPM. This step consists of four major tasks, which are to develop an equipment management program, develop an autonomous maintenance program, develop a planned maintenance program, and improve operation and maintenance staff skills. The fourteenth step provides implementation improvement for TPM.

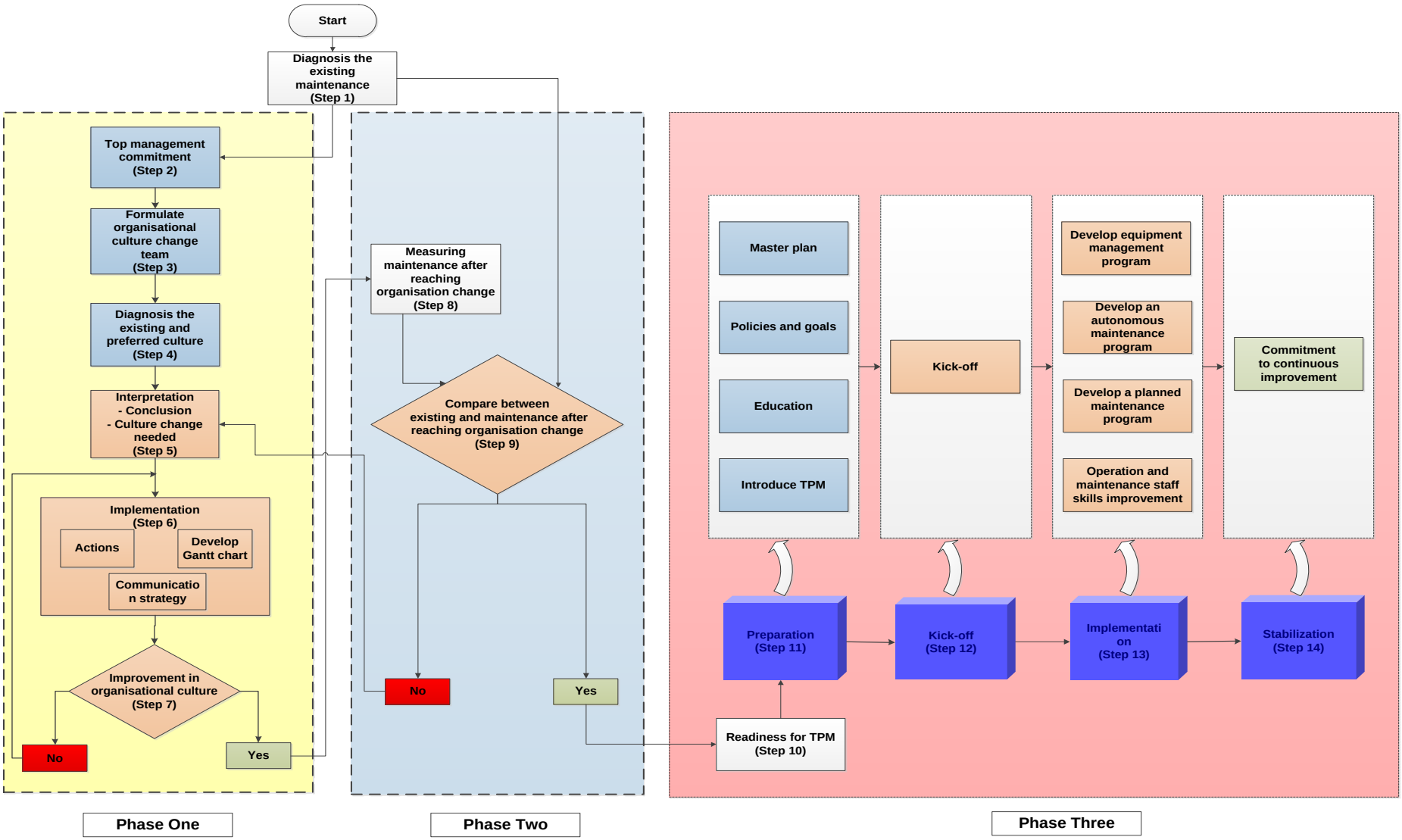


Figure 7.2 Framework implementation processes

Step 1: Diagnosis the existing maintenance

The current level of maintenance implementation needs to be evaluated and measured in order to address the need of organizational culture change and TPM implementation.

Step 2: Top management commitment

Commitment of power plants top management is the main factor to having successful organizational culture change and implementing TPM. The organizational culture change is the prime responsibility of top managers. It is essential that power plants top management be personally involved in implementing this framework, and if they fail to be part of it, it is likely the implementation will fail. The importance of the top management is represented by providing resources such as time, personnel and funds. Furthermore, the top management should know and understand the importance of organizational culture change and it will help to enhance the operation and maintenance activities in the power plants, which can lead to enhancement in availability and reliability of power production units. Moreover, top managers need to highlight the effective commitment in developing their main teams and personnel to help them to work effectively [241]. Since the framework consists of three stages, the management commitment is vital because all three stages require top management involvement. In regard to top management commitment in implementing TPM in organizations, many researchers attributed the success and failure of TPM program implementation to top management commitment and support, such as [52, 62, 87, 97, 189]

Step 3: Formulation of organisational culture change team

On the foundations of top management commitment, the organizational culture change team should be established. This team may consist of staff from the top management team and various functional departments such as finance, planning, operations, and maintenance departments. The criteria for selecting team members should be based on their possible contributions to the framework. The main responsibility of the team is to facilitate, plan, implement, and evaluate organizational culture change steps.

Step 4: Diagnosis of the current and preferred culture

This step involves assessment of the existing organisational culture that characterises power plants, and determination of the preferred culture for the future. In order to assess the existing culture, the team leader should complete the organisational culture assessment instrument (OCAI appendix 3, section 3, a), and rate the current status of the power plant. While other members of the team, who have an overall view of the power plants should also complete the OCAI by themselves. A discussion should be then held as a team regarding the culture that currently characterise the power plant. As well as agreeing each person's organisational culture profile. While in order to assess the preferred culture in the future, both the team leader and team members need to complete the OCAI again, rating and computing the way the power plant should be in the future. A discussion must be held on the culture that characterises the power plant in the future based on the agreed organisational culture of each person in the team. A comparison between the existing and preferred cultures must then be conducted to define the gaps that help identify the changes in culture that need to be initiated.

Step 5: Interpret the results from the diagnosis step

The main purpose of this step is drawing conclusions on how the organisation's culture profiles are shaping the power plant, and affecting the harmony and the strength of plant culture. Furthermore, a comparison between current and future cultures, will also help to identify the culture changes that may be required, identify which profile of group, development, hierarchal, and rational culture needs to be increased and which one needs to be decreased.

Step 6: Implementation of new culture

Agreement must be reached on which process should be started, stopped, or continued in order for the culture change process to begin. Furthermore, actions that will immediately begin the process of culture change and create noticeable results must be selected. A central part of the organisational change process is identifying measures, timetables, and benchmarks, in order to track the required change. Furthermore, communication strategy must be taken into account to keep everyone informed of the change. Which means top management should deliver a clear communication of the importance of the new organisational culture values to the power plant, and how the culture change can be achieved. In addition to that, various parts of the organisation must be changed in order to support the preferred culture change, such as structure, symbols, system, staff, strategy, style of leaders, and skills of managers.

Step 7: Evaluate the new culture implementation

After the implementation process is complete an evaluation of the level of culture change is necessary. The evaluation may be conducted using the OCAI to rate the

way the power plant is immediately after implementation. The result can then be compared to the results for the preferred culture.

Step 8: Measuring maintenance level

After reaching the preferred organisational culture level, the maintenance implementation level needs to be evaluated again, in order to do so the power plants management a lunch evaluation methods using questionnaire (Appendix 3, section 2, b, section 3, b, c, d) in order to address all maintenance factors and the overall maintenance implementation.

Step 9: Compare the maintenance practice

When the change in organisational culture is reached, it is important to evaluate the maintenance practices, since the purpose of change in the power plants organisational culture is to improve maintenance practice to enhance the power plants availability and reliability. A comparison between steps eight and one to assess the maintenance level and evaluate the improvement in maintenance factors need to be carried out.

Step 10: Introduce TPM

As illustrated in chapter two, a significant change in organisational culture is needed in order for organisations to be able to implement TPM. The effect of organisational culture was proved in chapter five of this thesis, to have a great impact on maintenance factors. Furthermore, steps to improve and change organisational culture were discussed earlier: after reaching the change in organisational culture, the power plants will have a strong foundation to implement TPM. Based on Nakajima's model for implementing TPM [44], there are four 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, developing autonomous and planned maintenance, and improving staff skills. While Phase 4, TPM stabilization, involves continually improving the TPM program [58].

Step 11: Prepare TPM

In this step, top management has the main responsibility of formulating an appropriate environment to introduce TPM. Which starts by announcing and introducing TPM as an improvement program. As mentioned in chapter two, top management commitment is highly required in order to have successful TPM implementation, [52, 62, 87, 97, 189]. Education and training on TPM must be conducted at all power plant levels, the rationale behind this is to soften any resistance, since employee resistance has been found to contribute in failure of TPM programs [50]. A TPM committee needs to be established, to be responsible to promote and coordinate TPM implementation activities. Top management has to formulate a master plan based on the TPM committee. The committee will develop basic TPM policies and reasonable, measureable goals to the high-level group, and take into consideration that each group underneath it will develop reliable goals [58]. The aim of the master plan is to provide daily schedules for promotion and implementing TPM, this includes an autonomous maintenance program, quality control, planned maintenance, and a staff skills improvement plan.

Step 12: Kick off

In this step, the TPM committee must classify preliminary responsibilities of the operators and organise the comprehensive processes. All workers move out from

their daily work routines and become involved in TPM, this can happen by emphasising training activities to the operators, which are aimed to remove the six big losses. The training, processes and procedures need to be done in coordination with maintenance staff with support from management [44, 58].

Step 13: Implement TPM

This step is a full TPM implementation, it focuses on improving equipment effectiveness by developing equipment management programs. The focus must be first on the machines that give continuing failures and losses, the rationale behind this is to eliminate those losses, which can in turn support the efforts of overcoming the employees' resistance to change, and improve targeted areas. The development of equipment management programs can be done through defining the problem machine failures, understanding, investigating and analysing, the cause of breakdowns, and formulating an improvement plan. This step can be done by cooperation between operation and maintenance departments, and by engineering, technical, and line supervision staff. While doing the development of equipment management programs, operators must be involved in autonomous maintenance programs, which aim to increase the operators' responsibility for their equipment, by requiring them to be involved in basic maintenance work, and increasing their skill level through training. Management must cautiously understand the skill levels required with respect to the current capabilities of operators, in order to formulate their training needs. This is carried out in coordination with maintenance staff in order to assign benchmarks for certification of the operators. Planned maintenance programs need to be developed, which can be done by the maintenance department in coordination with the operations department and with the support of top management and the TPM committee. The aim of planned maintenance is to

achieve and sustain availability of machines, optimize maintenance cost, improve reliability and maintainability of machines, reaching zero equipment failure and break downs, and to guarantee the availability of spare parts.

Step 14: Stabilization

This is the final step of the TPM program, which is designed to improve TPM implementation and to agree a higher goal. The TPM groups starts of continuing the improvement cycle to improve TPM outputs. Furthermore, maintenance goals can now be included in power plant business strategies to focus the company on maximizing machine availability and reliability.

7.4 Summary

This chapter introduced the framework proposed by the researcher as a road map for framework implementation in Iraqi power plants. This framework consists of three phases which make fourteen steps in total in order to implement it successfully. The emphasis of phase one (organisational culture change) was on the basis of the findings from chapter five which illustrated strong effects of organisational culture on maintenance factors. Organisational culture change is the main foundation in order to have a successful maintenance framework, and successful TPM implementation. After having the required organisational culture, maintenance factors will be improved (phase two) which can facilitate the TPM implementation (phase three). Phase three of the framework focuses on the TPM implementation plan, which runs through five steps (introduce TPM, prepare TPM, kick off, TPM implementation, and stabilization).

The next chapter, will summarize the key findings of the research thesis, giving recommendations, limitations and suggestions for future work

Chapter 8. Conclusion

8.1 Introduction

This chapter concludes the main findings of the research, highlights this research's contribution to knowledge and it presents recommendations of future research in the area.

8.2 Conclusions

The aim of this research was to investigate the reasons for power shortage in Iraq, as Iraqi power plants currently only produce 54% of their designed capacity, which only supplies about 50% of the country's demand, and to examine the influence of cultural profiles in power plants on maintenance implementation factors. In order to achieve this the following four objectives were formulated:

1. Investigate the barriers and difficulties influencing the current power production rate in the Iraqi power plants.
2. Investigate the level of maintenance implementation in the Iraqi power plants.
3. Identify the types of organisational culture existing in the Iraqi power plants.
4. Investigate what types of organisational culture are effecting what types of maintenance factors.
5. Develop a theoretical maintenance framework for Iraqi power plants based on the findings

Therefore, this study used exploratory sequential mixed methods design in order to address these research questions. The main findings of this research can be summarised as follows:

The reasons for power shortage in Iraq were identified from carrying out qualitative and quantitative data collection and analysis, the main findings of the qualitative part can be summarized in five factors based their importance level as: lack of planning and vision, lack of fuel, low efficiency and capacity, low budget, and lack of spare parts.

The questionnaire results on the reasons for the low power generation rate, showed that six barriers were highlighted based on their significance level, which are: inadequate training and development of personnel, no long term arrangement for the supply of essential parts for replacement, natural deterioration due to age and environment, quality of fuel, lack of discernible maintenance culture, inadequate/inappropriate maintenance of facilities plant and equipment for maintenance & operations.

The second objective of this research was to assess the level of maintenance implementation in Iraqi power plants. To address this, four hypotheses were developed, and data from 456 employees of nine power plants were collected and analysed statistically using a t-test. Testing the hypotheses illustrated that maintenance implemented at medium level at Iraqi power plants.

In terms of organisational culture, the results showed that the nine power plants investigated tended to have almost balanced cultures, even though rational culture was found to be slightly higher than the others, followed by group culture, and developmental culture, and hierarchal culture tends to be the lower culture. However, all cultural profiles were found to be at a medium level.

To determine the relationship between organisational culture and the maintenance implementation factors, a research model and four hypotheses on the influence of

organisational culture on maintenance implementation factors was developed and tested using SEM methods. Based on the findings, group culture was found to have a statistically significance influence on teamwork, decision making, sense of control and communication, and safety and environment. While development culture found to have high impact on training and education, motivation, and information management and computerised maintenance management systems. In addition to that, the hierarchical culture profile tends to influence maintenance task planning and scheduling, organisation structure and work design, and sense of personal responsibility. However, the influence of rational culture on maintenance implementation factors could not be tested because its constructs were found to correlate with development culture, group culture, and hierarchical culture constructs.

The findings of the empirical analysis highlighted the importance of organisational culture in forming the factors affecting maintenance. The effective implementation of maintenance practice requires an organisational environment that inspires communication between top management and other functions in power plants and also between different power plant departments, as well as employee involvement in decision making processes in order to perform their job effectively. In addition, establishing and facilitating change in an organisations structure and work design with the aim of providing the necessary resources for training, and maintenance task planning is required. Maintenance policy also needs to be integrated in to power plants main strategies. Furthermore, all of these factors require changing people's culture, behaviour, attitudes and working practices.

Furthermore, a framework for improving power plants availability and reliability was developed based on the findings from literature review, and empirical results of this research. This framework focuses on achieving organisational change that can improve maintenance factors, which will shape the power plants readiness for introducing the TPM strategy.

8.3 Limitations of research

This research has a few limitations:

1. The interviews and questionnaires were conducted in Arabic language and translated into English. Although every effort has been made to ensure the accuracy of translation, there could be some minor differences between the languages in transferring the technical information.
2. Even though the results of this study can be generalised in Iraqi power plants because it targeted nine plants, the finding cannot be completely generalised to other countries because of the differences in culture from place to place.
3. Due to time limitations, this study is considered to be a cross-sectional design study. Therefore, future studies are encouraged to consider longitudinal designs.

8.4 Recommendations for further research

This study has examined for the first time a new relationship between organisational culture and the maintenance domain, and has been carried out in Iraqi power plants. Therefore, it is important that other scholars examine the relationship between organisational culture and other factors effecting maintenance which were not conducted in this study, in both the power plant industry or other industries, in different regions.

It is important to assess all organisational culture profiles in organisations, as in this study the influence of rational culture on maintenance factors was not investigated because rational culture found to be correlating with group and development cultures variables.

An evaluation for the developed framework can be conducted to assess its suitability for the Iraqi industry or other industries around the world, and to make any amendments required based on actual implementation.

Development of a systematic approach using software or a website to address the organisational culture existing and preferred, and maintenance implementation level which can be based on the questionnaire variables in appendix three and five.

8.5 Significance of the Study

This is the first study to investigate the reasons for the power shortages in Iraq which for the last 30 years have never been met or even reached 80 % of the country's demand. Furthermore, in order to have an increase in power production a unique strategic framework has been designed to enhance maintenance activities in the Iraqi power plants. The significance of the study consists of both theoretical and practical perspectives:

8.5.1 Theoretical perspectives

- Used mixed methods research strategy, which allowed the researcher to collect data from both the managements prospective and employees prospective.
- Used a large sample number in order to generalise the findings. In addition to that, it also avoids the common method variance problem (using only one respondent from each organisation) which was highlighted by the literature,

through collecting data from many respondents from each of the nine power plants under study.

- This research contributes to the area of barriers affecting power plants and level of maintenance implementation in Arabic countries specifically, and on the effect of organisational culture effect on maintenance factors in general by adding to the limited work that currently exists.
- This study is the first research on measuring the effect of organisational culture on maintenance factors using the structural equation modelling (SEM) technique.
- This study adds to the existing knowledge on maintenance and its implementation as it is the first study, both in a western and non-western context that has explicitly and empirically examined the influence of organisational culture on maintenance factors.

8.5.2 Practical perspectives:

- First, it will raise the awareness of the decision makers to the barriers affecting power plant reliabilities, and the relationships between organisational culture that shape power plants in Iraq and factors that are effecting maintenance.
- Second, understanding the effect of each individual barrier on plant reliability in other words plant performance, will encourage plant stakeholders to overcome all the obstacles by adapting a new strategy based on those limitations such as TPM. Establishing which types of culture could/should be strengthened or developed to enhance maintenance factors to be considered as a baseline to support TPM implementation by power plants in order to adopt a TPM approach.

- Third, this study will provide companies with new dimensions in their vision toward establishing TPM strategies in order to increase their competitiveness level.

List of Publications

1. Aljanabi, Darkam, Birkett, Martin and Walker, Sara (2015) ***A Mixed Methods Approach to Investigate the Need for Total Productive Maintenance (TPM) in Iraqi Power Plants*****.** MMIRA Asia Regional Conference, 19th- 20th September 2015, Osaka, Japan.

2. Aljanabi, Darkam, Birkett, Martin and Connor, Chris (2016) ***Development of a unique methodology to determine the current level of maintenance implementation within the Iraqi power industry***, IMA World Maintenance Forum, 5th- 7th April 2016, Lugano, Switzerland.

3. Aljanabi, Darkam, Birkett, Martin and Connor, Chris (2016) ***Investigation the Need of Total Productive Maintenance (TPM) Framework Development for Deployment within the Iraqi Power Generation*****.** First International Conference on Maintenance Engineering, The University of Manchester 30th -31st Augst, Manchester, United Kingdom.

4. Aljanabi, Darkam, Birkett, Martin and Connor, Chris (2016) ***Investigating the need of Total Productive Maintenance (TPM) Framework Development for Deployment within the Iraqi Power Generation Industry.*** Journal of Maintenance Engineering, 1. pp. 437-446.

5. Aljanabi, Darkam, Birkett, Martin and Connor, Chris (2016) ***Investigation into the on-going Power Shortage and Level of Maintenance Implementation in Iraqi Power Plants***. Submitted to journal of quality in maintenance engineering

6. Aljanabi, Darkam, Birkett, Martin and Connor, Chris (2016), ***The Impact of Organisational Culture on Maintenance Practice Factors: Empirical Study in the Iraqi Power Plants.*** Submitted to Journal of Operation Management.

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Appendix 1: Interview survey

Dear Sir/Madam

My name is Darkam S Dawai and I am PhD scholarship holder from the Iraqi Ministry of Higher Education and Scientific Research, studying PhD in the Faculty of Engineering and Environment, department of mechanical and construction engineering, at Northumbria University, UK. My research is Development of a Strategic Total Productive Maintenance (TPM) Framework for Deployment within the Iraqi Power Generation Industry.

This interview is a part of my research which aims to understand the operation and maintenance practices, and their relation to power production in power plants.

Your participation is very important to complete this research. The information gathered for this research will be analysed for the purpose of my academic study only, any company confidential data will not be published anywhere without written permission from you and your company.

Please spend a part of valuable time to answer the following questions.

Your cooperation is highly appreciated.

Yours faithfully

Darkam S Dawai

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al_dherghim@yahoo.com

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General information

1. How long you have been working in the power industry?
2. What is your highest education level?
3. What was the field of study of your last qualification?
4. What is the total number of employees at your power plant?
5. In what year was the power plant commissioned?
6. What is the total designed capacity of the power plant in MW?
7. What was the total actual production rate for calendar years 2013 and 2014 in MW?
8. Why do you think there is a difference between design and actual capacity?
9. In your opinion, what is the main reasons for the power shortage in Iraq?
10. In your opinion, what actions need to be taken in order to enhance power plant reliability and increase power production?

Maintenance in the power plant

11. Do you have a formal maintenance department in the power plant? □Yes □No (if you chose No please explain why)
12. Does your power plant have a maintenance policy?
13. Do you think the allocated annual budget for the power plant maintenance is enough?
14. What type of maintenance strategies does the power plant use? Please specify
15. What is your opinion about maintenance management in your organization? And do you think it needs to be improved? And if so, how?
16. Is it mandatory for maintenance staff to document the maintenance procedure?
17. Does the power plant keep records of breakdowns? □Yes □No (if you chose No please explain why)
18. Are all records analysed? □Yes □No (if you chose No please explain why)
19. Please specify which department analyses the breakdown records:
20. Does the maintenance department set up maintenance plans based on analysed breakdown records?
21. Does the power plant have adequate equipment for maintenance?
22. Are spare parts stores at your power plant computerized?
23. Are inventory parts available when needed? □Yes □No Why?

24. Does the power plant plan in advance to have the spare parts ready in store? □Yes □No (if you choose yes, please state how regularly) □Annually □Quarterly □Monthly
25. Does the power plant top management track their employees' performance? □Yes, what method do you use to evaluate employees' performance? □No Please explain why? On scale (1) poor, (2) fair, (3) good, (4) High (5) Excellent, how do you rate the overall employees' performance (OEP)?

Organisational Culture

26. Does the power plant have enough budgets for training?
27. What do you think about the relationship between the top management and employees?
28. Does the top management pay attention to employees' suggestions?
29. Do you think that teamwork is important for productive maintenance?
30. What do you think about the teamwork within your organization?
31. Are you satisfied with the teamwork interaction within the power plant departments?
32. What methods do the power plant top management use to encourage teamwork?
33. How do you think the organizational culture affect the activities of maintenance in the power plant? (1. Very influential 2. influential 3. influential to some extent 4. few 5. Do not affect at all)
34. Do you think organizational culture, structure and processes influence maintenance activities? And How?
35. Does the organization measure the pollution levels emerging from the Power plant?
36. Does the power plant have Health and Safety and Environmental policies?
37. How the safety procedure can be improved?
38. Are health and safety signs and procedures allocated everywhere in the plant?

Appendix 2: Interview survey in Arabic language

بسم الله الرحمن الرحيم

م/ مقابلة

تحية طيبة

أني الطالب (ضرغام صالح دواي) المبتعث من قبل وزارة التعليم العالي العراقية لدراسة الدكتوراه في جامعة نورثامبريا في بريطانيا في تخصص الهندسة الميكانيكية والتخصص الدقيق الصيانة الانتاجية الشاملة. وموضوع بحث الدكتوراه هو (تطوير نظام صيانة انتاجية شامل واستراتيجي لغرض نشره في محطات الكهرباء).

المقابلة هي جزء من بحثي الذي يهدف إلى فهم ممارسات التشغيل والصيانة، وعلاقتها بإنتاج الطاقة في محطات توليد الطاقة.

مشاركتكم مهمة جدا لاستكمال هذا البحث. وسيتم تحليل المعلومات التي تم جمعها لهذا البحث لغرض دراستي الأكاديمية فقط، لن يتم نشر أي بيانات سرية للشركة في أي مكان بدون إذن مكتوب من قبلكم أو الشركة.

أقدر كثيرا تخصيص جزء من وقتكم الثمين بمشاركتكم الفاعلة في الاجابة على الأسئلة واستكمال المقابلة.

ولكم جزيل الشكر والتقدير وادامكم الله ذخرا وعوناً لبلدنا الحبيب

الطالب : ضرغام صالح
البريد الالكتروني:darkam.janabi@northumbria.ac.uk
al_dherghim@yahoo.com
رقم الهاتف: 00447920114414

معلومات عامة

1. كم هي مدة عملك في قطاع الطاقة؟
2. ما هو أعلى تحصيل دراسي حاصل عليه؟
3. ما هو التخصص لأخر شهادة درستها؟
4. كم هو عدد الموظفين في محطة الكهرباء التي تعمل فيها؟
5. في أي عام تم تشغيل المحطة؟
6. كم هو المعدل التصميمي (MW) للمحطة التي تعمل فيها؟
7. كم هو معدل الانتاج الفعلي (MW) في المحطة التي تعمل فيها للأعوام 2013 و 2014؟
8. لماذا تعتقد أن هنالك فرق بين السعة التصميمية والسعة الانتاجية في المحطة التي تعمل فيها؟
9. في رأيك، ما هي الأسباب الرئيسية لنقص الطاقة الكهربائية في العراق؟
10. في رأيك، ما هي الإجراءات الواجب اتخاذها من أجل تعزيز فعالية محطة الكهرباء وزيادة إنتاج الطاقة فيها؟

الصيانة في محطة الكهرباء التي تعمل فيها

11. هل لديكم في محطة الكهرباء قسم مختص بالصيانة؟ نعم ☐ كلا ☐ (اذا كان جوابك كلا يرجى توضيح الاسباب)
12. هل لدى المحطة سياسة صيانة واضحة ومحددة وماهي؟ نعم ☐ كلا ☐
13. هل تعتقد أن الميزانية السنوية المخصصة للصيانة في محطة توليد الكهرباء كافية؟
14. ما هي انواع أو برامج الصيانة المتبعة في محطة توليد الكهرباء؟
15. ما هو رأيكم في إدارة الصيانة في المؤسسة الخاصة بك؟ وهل تعتقد أنه يحتاج إلى تحسين؟ وإذا كان الأمر كذلك، كيف؟
16. هل هو إلزامي لموظفي الصيانة لتوثيق إجراءات الصيانة وكيف يتم ذلك؟
17. هل المحطة تحتفظ بسجلات للاعطال ؟ نعم ☐ كلا ☐
18. هل يتم تحليل سجلات الاعطال؟ نعم ☐ كلا ☐
19. يرجى ذكر اي قسم يقوم بتحليل بينات الاعطال؟
20. هل قسم الصيانة يضع خطط الصيانة بالاعتماد على بيانات الاعطال التي تم تحليلها؟
21. هل لدى قسم الصيانة المعدات الكافية للصيانة؟
22. هل يتم استخدام الحاسوب في عمليات تخزين وادارة قطع الغيار في محطة الكهرباء؟ وكيف؟
23. هل كل قطع الغيار متوفرة عند الحاجة اليها؟
24. هل محطة الكهرباء تخطط مقدما لشراء قطع الغيار وخزنها في المخازن؟ نعم ☐ كلا ☐ (اذا كان الاختيار نعم رجاء تحديد الفترة) شهري ☐ فصلي ☐ سنوي ☐
25. هل الادارة العليا لمحطة الكهرباء تتبع وتراقب اداء الموظفين ؟

    نعم ☐ ماهي الطريقة المستخدمة لتقييم أداء الموظفين؟

    كلا ☐

على مقياس (1) ضعيف المستوى (2) وسط (3) جيد (4) جيد جدا (5) ممتاز، كيف تقيم الاداء الكلي للموظفين في محطة الكهرباء؟

1 2 3 4 5

الثقافة التنظيمية

26. هل لدى محطة الكهرباء ميزانية كافية للتدريب؟
27. كيف تصف العلاقة بين الادارة العلية والموظفيين؟
28. هل الإدارة العليا تولي اهتماما لاقتراحات الموظفين؟ وكيف؟
29. هل تعتقد أن العمل الجماعي مهم لصيانة انتاجية؟
30. ما رأيك في العمل الجماعي داخل محطة الكهرباء؟
31. هل أنت راض عن التفاعل والعمل الجماعي داخل وبين اقسام محطة للطاقة؟ وكيف تصفه؟
32. ماهي الطرق المتبعة من قبل الادارة لتشجيع العمل الجماعي داخل محطة الكهرباء؟
33. في اعتقادك كيف تؤثر الثقافة التنظيمية في فعاليات الصيانة في محطة الكهرباء؟

(1. مؤثر جدا 2. مؤثر 3. مؤثر الى حد ما 4. قليل 5. لا تؤثر اطلاقا)

34. هل تعتقد ان هيكلية المحطة تؤثر على نظام الصيانة؟ وكيف؟
35. هل يتم قياس نسب الانبعاثات الناتجة من محطة الكهرباء؟ وكيف؟ اذا كان الجواب ب كلا يرجى بيان السبب.
36. هل يوجد في محطة الكهرباء سياسية صحية وسلامة وبيئية واضحة ومحددة؟ وماهي؟
37. كيف يمكن تحسين اجراءات وارشادات السلامة في المحطة؟
38. هل علامات وتطبيقات السلامة والصحة موجودة في جميع اجزاء المحطة؟

Appendix 3: Questionnaires survey

Dear Sir/Madam

My name is Darkam S Dawai and I am PhD scholarship holder from the Iraqi Ministry of Higher Education and Scientific Research, studying PhD in the Faculty of Engineering and Environment, department of mechanical and construction engineering, at Northumbria University, UK. My research is Development of a Strategic Total Productive Maintenance (TPM) Framework for Deployment within the Iraqi Power Generation Industry.

This questionnaire is a part of my research which aims to understand the operation and maintenance practices, and their relation to power production in power plants.

Your participation is very important to complete this research. The information gathered for this research will be analysed for the purpose of my academic study only, any company confidential data will not be published anywhere without written permission from you and your company.

Please spend a part of valuable time to answer the following questions.

Your cooperation is highly appreciated.

Yours faithfully

Darkam S Dawai

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Section 1- General information;

Please choose the appropriate box:

1. **What is your job title?** …….
2. **Age:**

   ☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ 65+
3. **How long you have working in the power industry?**

   ☐ 5 years or less ☐ 6 to 10 years ☐ 11 to 15 years

   ☐ More than 15 years
4. **What is your education level?**

   ☐ Primary School ☐ Secondary School ☐ Diploma ☐ Bachelor degree

   ☐ Master degree ☐ PhD

Section 2 -Technical and maintenance practices in the power plant;

a. **Studies showed that power plants do not run at full design capacity, what do you think could cause that? Please tick (✓) the appropriate box from the following:**

No	Factor	SA	A	N	DS	SD
1	Lack of a successful maintenance programme by the maintenance department.	☐	☐	☐	☐	☐
2	No long term arrangement for the supply of essential spare parts	☐	☐	☐	☐	☐
3	Lack of discernible maintenance culture.	☐	☐	☐	☐	☐
4	Absence of a form of planned maintenance programmes.	☐	☐	☐	☐	☐
5	Inadequate/inappropriate maintenance of plant facilities and equipment for maintenance & operations.	☐	☐	☐	☐	☐
6	Insufficient funds for maintenance jobs.	☐	☐	☐	☐	☐
7	Natural deterioration due to age and environment.	☐	☐	☐	☐	☐
8	Inadequate training and development of personne	☐	☐	☐	☐	☐
9	Lack of skilled personnel in operation department	☐	☐	☐	☐	☐
10	Lack of skilled personnel in the maintenance department	☐	☐	☐	☐	☐
11	Shortage in fuel supply.	☐	☐	☐	☐	☐
12	Poor quality of Fuel.	☐	☐	☐	☐	☐
13	Others, please specify					

b. To what extent do you agree or disagree with the following statements related to maintenance practices in your power plant, Please tick (✓) the appropriate box from the following:

No	Factor	SA	A	N	DS	SD
1	The power plant is using an evaluation method to choose the right maintenance approach.	☐	☐	☐	☐	☐
2	The maintenance approach in the power plant is inefficient.	☐	☐	☐	☐	☐
3	The equipment is accurately labelled for maintenance work.	☐	☐	☐	☐	☐
4	Goals and duties of maintenance and planned maintenance are clearly defined.	☐	☐	☐	☐	☐
5	A computerized system for maintenance task planning and scheduling is used and it is efficient.	☐	☐	☐	☐	☐
6	A High percentage of maintenance work is planned.	☐	☐	☐	☐	☐
7	A High percentage of maintenance tasks are achieved.	☐	☐	☐	☐	☐
8	A computerized system is used to control spare part.	☐	☐	☐	☐	☐
9	The spare parts are available when I need them.	☐	☐	☐	☐	☐
10	The parts, spares, and materials used are adequate.	☐	☐	☐	☐	☐
11	A computerised maintenance management system is used in the power plant.	☐	☐	☐	☐	☐
12	Maintenance records are analysed using a computerised system.	☐	☐	☐	☐	☐
13	The power plant gains no benefit from contracting out maintenance to maintenance contracting companies.	☐	☐	☐	☐	☐
14	I learn much from contractors who work at the power plant.	☐	☐	☐	☐	☐
15	Power plant management welcome any improvement ideas from employees.	☐	☐	☐	☐	☐
16	The power plant systematically monitors the maintenance improvement suggestions.	☐	☐	☐	☐	☐

Section 3 - Organization culture and human resources

a. **Rate to what extent you perceive that the following statements are valued at your organization. Circle the corresponding number. Your response should indicate your personal feeling of whether or not the given statement is considered important in your organization (1=not valued at all by the organisation, 7=valued very highly by the organisation)**

No	Factor	Not at all						Very highly
1	Initiative	1	2	3	4	5	6	7
2	Definition of clear responsibility for areas or departments	1	2	3	4	5	6	7
3	Avoidance of all risks	1	2	3	4	5	6	7
4	Financial goals	1	2	3	4	5	6	7
5	Systematic ways of working	1	2	3	4	5	6	7
6	Open communication	1	2	3	4	5	6	7
7	Personnel development	1	2	3	4	5	6	7
8	Goal setting	1	2	3	4	5	6	7
9	Shared/collective responsibility	1	2	3	4	5	6	7
10	Questioning of old routines	1	2	3	4	5	6	7
11	Centralized decision making	1	2	3	4	5	6	7
12	Mutual trust	1	2	3	4	5	6	7
13	Feedback	1	2	3	4	5	6	7
14	Autonomous/independent decision making	1	2	3	4	5	6	7
15	Flexibility	1	2	3	4	5	6	7
16	Personal proficiency	1	2	3	4	5	6	7
17	Goal achievement	1	2	3	4	5	6	7
18	Continuous development	1	2	3	4	5	6	7
19	Cost-effectiveness	1	2	3	4	5	6	7
20	The possibilities of new technology	1	2	3	4	5	6	7
21	Personal responsibility	1	2	3	4	5	6	7
22	Occupational safety	1	2	3	4	5	6	7
23	Admitting one’s own mistakes	1	2	3	4	5	6	7
24	Openness towards new ideas and techniques	1	2	3	4	5	6	7
25	Learning	1	2	3	4	5	6	7
26	Productivity / profitability	1	2	3	4	5	6	7
27	Personnel wellbeing	1	2	3	4	5	6	7
28	Individualness	1	2	3	4	5	6	7
29	Efficient working	1	2	3	4	5	6	7
30	Quality	1	2	3	4	5	6	7
31	Co-operation	1	2	3	4	5	6	7
32	Safety	1	2	3	4	5	6	7

b. The following statements are about your organization and your job. Please mark how well each statement describes you and your job by circling the corresponding number.

No	Factor	Not at all						Very well
1	Organizational culture, structure and processes influence my work activities positively.	1	2	3	4	5	6	7
2	The work is organized smoothly.	1	2	3	4	5	6	7
3	The goals of my work are clear.	1	2	3	4	5	6	7
4	The working environment in my work community is good.	1	2	3	4	5	6	7
5	I have a clear picture of how my work contributes to the general goals of the organization.	1	2	3	4	5	6	7
6	My work tasks are clearly defined.	1	2	3	4	5	6	7
7	My workload is suitable.	1	2	3	4	5	6	7
8	On the whole, my work is stressful.	1	2	3	4	5	6	7
9	The job involves solving problems that have no obvious solution.	1	2	3	4	5	6	7
10	The job requires me to be creative	1	2	3	4	5	6	7
11	The job often involves dealing with problems that I have not met before.	1	2	3	4	5	6	7
12	The job requires unique ideas or solutions to problems	1	2	3	4	5	6	7
13	It is mainly my responsibility that my work leads to the desired outcomes	1	2	3	4	5	6	7
14	It is mainly my supervisor's responsibility that my work leads to the desired outcomes	1	2	3	4	5	6	7
15	The decision making process in the power plant is efficient	1	2	3	4	5	6	7
16	I am involved in making decisions that affect my work in the power plant	1	2	3	4	5	6	7
17	Employees are allowed to appeal decisions made by managers.	1	2	3	4	5	6	7
18	The flow of information at my organizations is sufficient	1	2	3	4	5	6	7
19	I receive a great deal of information from my manager and co-workers about my job performance	1	2	3	4	5	6	7
20	Important data is presented and communicated to employees	1	2	3	4	5	6	7
21	Charts showing plant performance are presented on the plant floor.	1	2	3	4	5	6	7
22	We have easy access to the information we need.	1	2	3	4	5	6	7
23	I know on what basis my work performance is assessed	1	2	3	4	5	6	7
24	In my opinion the power plant has a clear and long term safety policy.	1	2	3	4	5	6	7
25	The company sets improvement targets to reduce accidents and pollution.	1	2	3	4	5	6	7
26	The safety of the plant often worries me	1	2	3	4	5	6	7

27	The health and safety signs and procedure are allocated everywhere in the plant.	1	2	3	4	5	6	7

c. **To what extent do you agree or disagree with the following statements related to Training and Motivation practices in your power plant,** Please tick (✓) the appropriate box from the following:

No	Factor	SA	A	N	DS	SD
1	Employees are receiving training based on their education qualification.	☐	☐	☐	☐	☐
2	Employees are receiving structured training for different work positions.	☐	☐	☐	☐	☐
3	There is no clear training policy in the power plant.	☐	☐	☐	☐	☐
4	Goals of the training programme are set up clearly with aims to future plans.	☐	☐	☐	☐	☐
5	Employees are receiving necessary operation and maintenance training for new technologies or techniques.	☐	☐	☐	☐	☐
6	The company implements a scheduled training program for improving operation and maintenance staff.	☐	☐	☐	☐	☐
7	All training programs that are attended are useful and important.	☐	☐	☐	☐	☐
8	The training requests expressed by you are taken into consideration	☐	☐	☐	☐	☐
9	The management at this plant believes that continual training and upgrading of employees' skills is important.	☐	☐	☐	☐	☐
10	The power plant assesses the employees' needs for training.	☐	☐	☐	☐	☐
11	There is an evaluation of the knowledge acquired during training processes.	☐	☐	☐	☐	☐
12	The application of the knowledge acquired during training processes to the work place is evaluated.	☐	☐	☐	☐	☐
13	I'm satisfied with my current position at power plant	☐	☐	☐	☐	☐
14	I'm not satisfied with my current pay.	☐	☐	☐	☐	☐
15	I think that I need more attention from management in order to be motivated.	☐	☐	☐	☐	☐
16	I feel encouraged to come up with new and better ways of doing things.	☐	☐	☐	☐	☐
17	I'm involved in decisions that affect my work.	☐	☐	☐	☐	☐
18	Management looks to me for suggestions and leadership.	☐	☐	☐	☐	☐
19	I have the tools and resources I need to do my job well.	☐	☐	☐	☐	☐
20	I think my work is interesting.	☐	☐	☐	☐	☐
21	I receive enough information from management on what is going on in my division.	☐	☐	☐	☐	☐
22	I get extra pay for high performance.	☐	☐	☐	☐	☐
23	There is opportunity to be promoted in my work	☐	☐	☐	☐	☐
24	Considering all things, I am generally satisfied with my job	☐	☐	☐	☐	☐

25	I'm satisfied about relationship with other staff members at work.	☐	☐	☐	☐	☐
26	My evaluations in power plant are fair.	☐	☐	☐	☐	☐
27	Working conditions in the power plant are excellent.	☐	☐	☐	☐	☐

d. **To what extent do you agree or disagree with the following statements related to Teamwork practices at your power plant,** Please tick (✓) the appropriate box from the following:

No	Factor	SA	A	N	DS	SD
1	Power plant management encourages teamwork.	☐	☐	☐	☐	☐
2	I'm very satisfied with the teamwork interaction within power plant.	☐	☐	☐	☐	☐
3	There is good association between my department and others I need to work with.	☐	☐	☐	☐	☐
4	I understand my task requirements and role within the team.	☐	☐	☐	☐	☐
5	I don't understand other member's responsibilities within the team.	☐	☐	☐	☐	☐
6	Team goals are set clearly to meet the task requirements.	☐	☐	☐	☐	☐
7	I clearly understood my team goals.	☐	☐	☐	☐	☐
8	Team goals are challenging.	☐	☐	☐	☐	☐
9	Often there are conflicts between team members.	☐	☐	☐	☐	☐
10	The team is able to resolve conflicts.	☐	☐	☐	☐	☐
11	Managing conflict is a way to improve team performance.	☐	☐	☐	☐	☐
12	I agree with what people say so we can continue and finish the task.	☐	☐	☐	☐	☐
13	We support and motivated each other when tasks are difficult.	☐	☐	☐	☐	☐
14	Other members in my team depend on me to get their tasks done	☐	☐	☐	☐	☐
15	It is difficult to ask members of the team for help	☐	☐	☐	☐	☐
16	I can effectively communicate and discuss my ideas in a team.	☐	☐	☐	☐	☐
17	I receive valuable feedback from the team.	☐	☐	☐	☐	☐
18	The team purpose is usually developed by the team.	☐	☐	☐	☐	☐
19	Team purpose and team goals are related.	☐	☐	☐	☐	☐
20	No one in this team would purposely act in a way that undermines my efforts	☐	☐	☐	☐	☐
21	If I make a mistake in this team, it will not be held against me.	☐	☐	☐	☐	☐
22	My unique skills are valued when I'm working in a team	☐	☐	☐	☐	☐

Appendix 4: Questionnaires Survey in Arabic language

بسم الله الرحمن الرحيم

م/ استبيان

تحية طيبة

اني الطالب (ضرغام صالح دواي) المبتعث من قبل وزارة التعليم العالي العراقية لدراسة الدكتوراه في جامعة نورثامبريا في بريطانيا في تخصص الهندسة الميكانيكية والتخصص الدقيق الصيانة الانتاجية الشاملة. وموضوع بحث الدكتوراه هو (تطوير نظام صيانة انتاجية شامل واستراتيجي لغرض نشره في محطات الكهرباء).

الاستبيان هو جزء من بحثي الذي يهدف إلى فهم ممارسات التشغيل والصيانة، وعلاقتها بإنتاج الطاقة في محطات توليد الطاقة.

مشاركتكم مهمة جدا لاستكمال هذا البحث. وسيتم تحليل المعلومات التي تم جمعها لهذا البحث لغرض دراستي الأكاديمية فقط، لن يتم نشر أي بيانات سرية للشركة في أي مكان بدون إذن مكتوب من قبلكم أو الشركة.

أقدر كثيرا تخصيص جزء من وقتكم الثمين بمشاركتكم الفاعلة في الاجابة على الأسئلة واستكمال الاستبانة.

ولكم جزيل الشكر والتقدير وادامكم الله ذخرا وعوناً لبلدنا الحبيب.

الطالب : ضرغام صالح دواي

البريد الالكتروني al_dherghim@yahoo.com

رقم الهاتف: 00447920114414

الجزء الاول – معلومات عامة

يرجى الاختيار من الحقل المناسب

أ. ما هو عنوانك الوظيفي؟ .....

ب. العمر:

☐ 18- 24 ☐ 25- 34 ☐ 35- 44 ☐ 45- 54 ☐ 55-64 ☐ +65

ت. كم هي المدة التي عملت فيها في قطاع الطاقة؟

☐ 5 سنوات او اقل ☐ 6 الى 10 سنوات ☐ 11 الى 15 سنة ☐ أكثر من 15 سنة

ث. ما هي أعلى شهادة حاصل عليها؟

☐ ابتدائية ☐ إعدادية ☐ دبلوم ☐ بكالوريوس ☐ ماجستير ☐ دكتوراه

الجزء الثاني – الممارسات التقنية والصيانة في محطة الكهرباء

أ. أظهرت الدراسات أن محطات الكهرباء لا تعمل بكامل طاقتها التصميمية، برأيك ما هي العوامل التي يمكن أن تسبب ذلك؟ يرجى وضع علامة(✓) في الخانة المناسبة لما يلي:

ت	العوامل	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
1	عدم تنفيذ برنامج صيانة ناجح من قبل قسم الصيانة	☐	☐	☐	☐	☐
2	عدم وجود ترتيبات طويلة الأجل لتوريد قطع الغيار	☐	☐	☐	☐	☐
3	غياب ثقافة صيانة واضحة	☐	☐	☐	☐	☐
4	غياب برامج الصيانة المخطط لها	☐	☐	☐	☐	☐
5	صيانة غير كافية أو غير ملائمة لمعدات ومرافق الصيانة والتشغيل	☐	☐	☐	☐	☐
6	ميزانية غير كافية لأعمال الصيانة	☐	☐	☐	☐	☐
7	التدهور او التلف بسبب العمر او البيئة	☐	☐	☐	☐	☐
8	برامج التدريب والتطوير للموظفين غير كافية أو غير ملائمة	☐	☐	☐	☐	☐
9	نقص الموظفين المهرة في قسم التشغيل	☐	☐	☐	☐	☐
10	نقص الموظفين المهرة في قسم الصيانة	☐	☐	☐	☐	☐
11	نقص في إمدادات الوقود	☐	☐	☐	☐	☐
12	سوء نوعية الوقود	☐	☐	☐	☐	☐
13	يرجى ذكر أي عوامل أخرى تراها مؤثرة					

ب. إلى أي مدى توافق أو لا توافق مع العبارات التالية المتعلقة ممارسات الصيانة في محطة الطاقة الخاصة بك، يرجى وضع علامة (✓) في الخانة المناسبة مما يلي:

ت	العوامل	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
1	يتم استخدام طرق التقييم منهج صيانة صحيح في محطة الكهرباء.	☐	☐	☐	☐	☐
2	منهج الصيانة في محطة الكهرباء غير فعال.	☐	☐	☐	☐	☐
3	معدات الصيانة والاجزاء المراد صيانتها معلمة ومصنفة بشكل دقيق.	☐	☐	☐	☐	☐
4	أهداف وواجبات الصيانة محددة بشكل واضح.	☐	☐	☐	☐	☐
5	يتم استخدام الحاسوب للتخطيط وجدولة اعمال الصيانة وانه فعال.	☐	☐	☐	☐	☐
6	نسبة عالية من اعمال الصيانة يخطط لها.	☐	☐	☐	☐	☐
7	نسبة عالية من اعمال الصيانة يتم تحقيقها.	☐	☐	☐	☐	☐
8	استخدام نظام الحاسوب لإدارة وتحكم بقطع الغيار.	☐	☐	☐	☐	☐
9	في الكثير من الاحيان قطع الغيار غير متوفرة عندما احتاجها.	☐	☐	☐	☐	☐
10	الأجزاء وقطع الغيار، والمواد المستخدمة هي كافية وملائمة.	☐	☐	☐	☐	☐
11	نظام ادارة الصيانة بالحاسوب مستخدم في محطة الكهرباء.	☐	☐	☐	☐	☐
12	ويتم تحليل سجلات الصيانة باستخدام نظام محوسب.	☐	☐	☐	☐	☐
13	محطة الكهرباء لا تحصل على فائدة من التعاقد مع شركات صيانة.	☐	☐	☐	☐	☐
14	أتعلم كثيرا من المقاولين الذين يعملون في محطة توليد الكهرباء.	☐	☐	☐	☐	☐
15	إدارة محطة توليد الكهرباء لا ترحب بأفكار تحسين العمل من الموظفين.	☐	☐	☐	☐	☐
16	ادارة محطة الكهرباء تراقب بشكل منهجي اقتراحات تحسين الصيانة.	☐	☐	☐	☐	☐

الجزء الثالث – ثقافة المنظمة والموارد البشرية

أ. يرجى تقييم الى أي مدى تعتقد أن العبارات التالية في موضع تقدير او اهتمام في مؤسستك، بوضع دائرة حول الرقم المناسب، حيث أن (1 = لا تقدر على الإطلاق من قبل المحطة، 7 = لها قيمة عالية جدا من قبل المحطة).

الرقم	العوامل	لا تقدر						قيمة عالية
1	المبادرة	1	2	3	4	5	6	7
2	التعريف للمسؤولية الواضحة لكل الاقسام	1	2	3	4	5	6	7
3	تجنب جميع الاخطار	1	2	3	4	5	6	7
4	الاهداف المالية	1	2	3	4	5	6	7
5	طرق عمل منهجية	1	2	3	4	5	6	7
6	التواصل المفتوح	1	2	3	4	5	6	7
7	تطوير الموظفين	1	2	3	4	5	6	7
8	تحديد الاهداف	1	2	3	4	5	6	7
9	المسؤولية المشتركة / الجماعية	1	2	3	4	5	6	7
10	استعراض الروتين القديم	1	2	3	4	5	6	7
11	مركزية صنع القرار	1	2	3	4	5	6	7
12	الثقة المتبادلة	1	2	3	4	5	6	7
13	ردود الافعال	1	2	3	4	5	6	7
14	استقلالية اتخاذ القرار	1	2	3	4	5	6	7
15	المرونة	1	2	3	4	5	6	7
16	الكفاءة الشخصية	1	2	3	4	5	6	7
17	تحقيق الهدف	1	2	3	4	5	6	7
18	التطوير المستمر	1	2	3	4	5	6	7
19	الفعالية من حيث التكلفة	1	2	3	4	5	6	7
20	إمكانيات التكنولوجيا الجديدة	1	2	3	4	5	6	7
21	المسؤولية الشخصية	1	2	3	4	5	6	7
22	السلامة المهنية	1	2	3	4	5	6	7
23	الاعتراف بالأخطاء الشخصية	1	2	3	4	5	6	7
24	الانفتاح على الأفكار والتقنيات الجديدة	1	2	3	4	5	6	7
25	التعلم	1	2	3	4	5	6	7
26	الإنتاجية / الربحية	1	2	3	4	5	6	7
27	رفاهية الموظفين	1	2	3	4	5	6	7
28	الفردية	1	2	3	4	5	6	7
29	كفاءة العمل	1	2	3	4	5	6	7
30	الجودة	1	2	3	4	5	6	7
31	التعاون	1	2	3	4	5	6	7
32	السلامة	1	2	3	4	5	6	7

ب. يرجى وضع دائرة حول الرقم المناسب الذي يصف مؤسستك ويصف عملك جيدا. حيث أن (1 = لا تقدر على الإطلاق من قبل المحطة، 7 = لها قيمة عالية جدا من قبل المحطة).

الرقم	العوامل	لا تقدر						قيمة عالية
1	الثقافة التنظيمية، والهيكلية والعمليات تؤثر بشكل ايجابي على انشطة العمل.	1	2	3	4	5	6	7
2	العمل منظم بشكل سلس.	1	2	3	4	5	6	7
3	اهداف عملي واضحة.	1	2	3	4	5	6	7
4	بيئة العمل في المجتمع العملي رديئة.	1	2	3	4	5	6	7
5	لدي صورة واضحة عن كيفية إسهام عملي في تحقيق الأهداف العامة للمنظمة.	1	2	3	4	5	6	7
6	مهام عملي معرفة بصورة جيدة.	1	2	3	4	5	6	7
7	عبء العمل الخاص بي مرتفع جدا.	1	2	3	4	5	6	7
8	بشكل كامل عملي مجهد.	1	2	3	4	5	6	7
9	تتضمن وظيفتي حل مشاكل ليس لها حل واضح.	1	2	3	4	5	6	7
10	وظيفتي تتطلب مني ان أكون مبدعا.	1	2	3	4	5	6	7
11	غالبا ما تنطوي وظيفتي على التعامل مع مشاكل لم اقابلها من قبل.	1	2	3	4	5	6	7
12	تتطلب وظيفتي افكار فريدة من نوعها لحل المشاكل.	1	2	3	4	5	6	7
13	في الاساس أنها مسؤوليتي بأن يؤدي عملي الى النتائج المرجوة.	1	2	3	4	5	6	7
14	في الاساس انها مسؤولية مشرفي بأن يؤدي عملي الى النتائج المرجوة.	1	2	3	4	5	6	7
15	عملية صنع القرار في المحطة غير فعالة.	1	2	3	4	5	6	7
16	أنا اشارك في القرارات التي تؤثر على عملي في محطة الكهرباء.	1	2	3	4	5	6	7
17	يحق للموظفين باستئناف القرارات الصادرة من المدراء.	1	2	3	4	5	6	7
18	تدفق المعلومات في المحطة غير كفوء.	1	2	3	4	5	6	7
19	اتلقى قدرا كبيرا من المعلومات من مسؤولي وزملائي حول أدائي الوظيفي.	1	2	3	4	5	6	7
20	يتم عرض ومشاركة البيانات والمعلومات المهمة مع الموظفين.	1	2	3	4	5	6	7
21	عرض الرسوم البيانية حول أداء المحطة في المحطة.	1	2	3	4	5	6	7
22	سهولة الوصول والحصول على المعلومات التي نحتاجها.	1	2	3	4	5	6	7
23	أنا أعلم على أي أساس يتم تقييم أدائي.	1	2	3	4	5	6	7
24	في رأيي المحطة لديها سياسة سلامة واضحة وطويلة الامد.	1	2	3	4	5	6	7
25	تحدد الشركة أهداف تحسين للحد من الحوادث والتلوث.	1	2	3	4	5	6	7
26	السلامة في المحطة غالبا ما تقلقني.	1	2	3	4	5	6	7
27	علامات وإجراءات الصحة والسلامة غير متوفرة في كل مكان في المصنع.	1	2	3	4	5	6	7

ج. الى أي مدى تتفق مع العبارات التالية المتعلقة بممارسات التدريب والحوافز في محطة الكهرباء التي تعمل فيها، الرجاء وضع علامة (✓) في المكان المناسب لما يلي:

ت	العوامل	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
1	الموظفين يتلقون تدريب على اساس مؤهلاتهم العلمية.	☐	☐	☐	☐	☐
2	الموظفين يتلقون التدريب المنظم لمختلف مناصب العمل.	☐	☐	☐	☐	☐
3	لا توجد سياسة واضحة للتدريب في محطة توليد الكهرباء.	☐	☐	☐	☐	☐
4	أهداف برامج التدريب موضوعة بشكل واضح ومناسب مع الخطط المستقبلية.	☐	☐	☐	☐	☐
5	موظفي التشغيل والصيانة يتلقون التدريب اللازم للتقنيات والتكنولوجيا الحديثة والجديدة.	☐	☐	☐	☐	☐
6	الشركة تنفذ برامج تدريب مخطط لها لتحسين أداء موظفي التشغيل والصيانة.	☐	☐	☐	☐	☐
7	جميع البرامج التدريبية التي حضرتها مفيدة ومهمة.	☐	☐	☐	☐	☐
8	طلبات التدريب التي أطلبها أو احتاجها تؤخذ بعين الاعتبار.	☐	☐	☐	☐	☐
9	الادارة في محطة الكهرباء تؤمن بان أن التدريب المستمر وتطوير مهارات الموظفين ليس مهما.	☐	☐	☐	☐	☐
10	محطة توليد الكهرباء تقييم احتياجات الموظفين للتدريب.	☐	☐	☐	☐	☐
11	هنالك تقييم للمعرفة المكتسبة من عمليات التدريب.	☐	☐	☐	☐	☐
12	يتم تقييم تطبيق المعرفة المكتسبة خلال عمليات التدريب في أداء العمل والمهمات.	☐	☐	☐	☐	☐
13	أنا راض على منصبي الحالي في محطة الكهرباء.	☐	☐	☐	☐	☐
14	أنا غير راض عن راتبي الحالي.	☐	☐	☐	☐	☐
15	أعتقد أنني بحاجة الى المزيد من الاهتمام من الادارة من أجل ان يكون لدي حافز للعمل.	☐	☐	☐	☐	☐
16	أشعر بالتشجيع للتوصل إلى طرق جديدة وأفضل للقيام بمهامي.	☐	☐	☐	☐	☐
17	أنا لا أشارك في أتخاذ القرارات التي تؤثر على عملي.	☐	☐	☐	☐	☐
18	الادارة تنظر الي للحصول على اقتراحات.	☐	☐	☐	☐	☐
19	لدي الادوات والموارد التي احتاجها للقيام بعملي بشكل جيد.	☐	☐	☐	☐	☐
20	أعتقد أن عملي مثير للاهتمام.	☐	☐	☐	☐	☐
21	أحصل على معلومات كافية من الادارة للقضايا التي تتعلق بقسمي.	☐	☐	☐	☐	☐
22	لا أحصل على أجر اضافي عن الاداء العالي.	☐	☐	☐	☐	☐
23	هناك فرصة عادلة للحصول على ترقية في عملي.	☐	☐	☐	☐	☐
24	بالنظر الى جميع الجوانب، أنا راض بشكل عام على وظيفتي.	☐	☐	☐	☐	☐
25	أنا راض على العلاقة مع الموظفين الاخرين في العمل.	☐	☐	☐	☐	☐
26	تقييم أدائي في العمل عادل	☐	☐	☐	☐	☐
27	ظروف العمل في محطة الكهرباء غير ممتازة	☐	☐	☐	☐	☐

د. الى أي مدى تتفق مع العبارات التالية المتعلقة بممارسات العمل الجماعي في محطة الكهرباء التي تعمل فيها، الرجاء وضع علامة (✓) في المكان المناسب لما يلي:

ت	العوامل	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
1	ادارة محطة الكهرباء تشجع العمل الجماعي.	☐	☐	☐	☐	☐
2	أنا راض جدا عن التفاعل والعمل الجماعي داخل محطة توليد الكهرباء.	☐	☐	☐	☐	☐
3	هنالك ترابط جيد بين قسمي وباقي الاقسام الذين احتاج ان اعمل معهم.	☐	☐	☐	☐	☐
4	أنا أفهم متطلبات مهمتي ودوري داخل الفريق.	☐	☐	☐	☐	☐
5	أنا لا أفهم مسؤوليات الاعضاء الاخرين داخل الفريق.	☐	☐	☐	☐	☐
6	يتم تعيين أهداف الفريق بشكل واضح لتلبية متطلبات المهمة.	☐	☐	☐	☐	☐
7	أنا أفهم بوضوح أهداف فريقي.	☐	☐	☐	☐	☐
8	أهداف الفريق ليست صعبة.	☐	☐	☐	☐	☐
9	في كثير من الأحيان هناك صراعات بين أعضاء الفريق.	☐	☐	☐	☐	☐
10	فريقي قادر على حل الصراعات.	☐	☐	☐	☐	☐
11	إدارة الصراع هو وسيلة لتحسين أداء الفريق.	☐	☐	☐	☐	☐
12	أنا أتفق مع ما يقول الناس حتى نتمكن من مواصلة وإنهاء المهمة.	☐	☐	☐	☐	☐
13	نحن ندعم ونشجع بعضنا البعض في المهام الصعبة.	☐	☐	☐	☐	☐
14	الأعضاء الاخرين في فريقي يعتمدون علي لإنهاء مهامهم.	☐	☐	☐	☐	☐
15	من الصعب أن أطلب من أعضاء فريقي الحصول على المساعدة.	☐	☐	☐	☐	☐
16	يمكنني التواصل بشكل فعال ومناقشة أفكاري في الفريق.	☐	☐	☐	☐	☐
17	أحصل على دعم قيم من الفريق.	☐	☐	☐	☐	☐
18	الغاية من الفريق تطور من قبل الفريق.	☐	☐	☐	☐	☐
19	غاية واهداف الفريق مترابطة مع بعض.	☐	☐	☐	☐	☐
20	لا يمكن لأحد في هذا الفريق يتصرف عمدا بطريقة تقوض جهودي.	☐	☐	☐	☐	☐
21	إذا أخطأت في هذا الفريق، لن يتم استخدامها ضدي..	☐	☐	☐	☐	☐
22	يتم تقدير مهاراتي الفريدة عندما اعمل ضمن فريق.	☐	☐	☐	☐	☐